



Empowering Teachers in the Digital Age: Leadership Strategies for Enhancing Pedagogic Competencies in High Schools

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Abstract

This study examines the strategies employed by school principals to enhance the digital pedagogic competencies of teachers in three public high schools in Kluet Utara, Aceh, Indonesia. With the growing demand for digital integration in education, effective leadership is critical in preparing teachers to utilize digital tools in classroom settings. Using a qualitative descriptive approach, data were collected over a two-month period through semi-structured interviews, direct observations, and document analysis. The findings revealed three main themes: (1) Professional Development Initiatives, (2) Infrastructure and Resource Allocation, and (3) Collaborative Practices. Professional development programs, such as workshops and training sessions, played a crucial role in developing foundational digital skills. Infrastructure investments in internet connectivity and digital resources facilitated digital integration, though resource limitations in some schools posed challenges. Collaborative practices, including peer mentoring and team-based problem solving, played a crucial role in fostering a supportive environment for digital teaching. However, teachers faced challenges related to varying levels of digital proficiency, time constraints, and limited resources. This study highlights the importance of a comprehensive, leadership-driven approach to developing digital competencies among teachers, suggesting that a combination of continuous professional development, adequate resources, and collaborative support can significantly enhance digital integration in schools. These findings underscore the necessity for educational leaders to adopt a comprehensive, multifaceted approach to building digital competencies among teachers. By strategically integrating continuous professional development, adequate infrastructure, and collaborative frameworks, school leaders can significantly accelerate digital transformation efforts. For policymakers, this research underscores the crucial importance of aligning educational policies with resource allocation and leadership training to facilitate systemic digital integration. In an increasingly digitalized educational landscape, such leadership-driven strategies are indispensable for achieving equitable and effective teaching outcomes on a broader scale.



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1. Introduction

The global digital transformation has fundamentally reshaped educational paradigms, transitioning technology from a supplementary tool to an integral

component of modern pedagogy [1]. This shift has become particularly pronounced in secondary education, where digital literacy increasingly determines both teaching effectiveness and student outcomes [2]. The

rapid evolution of digital technologies demands that educational institutions create learning environments that effectively leverage these tools while preparing students for an increasingly digitalized world [3].

School leadership has emerged as a pivotal factor in successfully navigating the complexities of digital transformation within educational settings [4]. Principals, in particular, play a dual role as visionaries and facilitators, responsible for not only envisioning a technologically integrated future for their schools but also implementing strategies to make that vision a reality. Effective leadership in this area requires principals to carefully orchestrate the integration of digital tools and resources while supporting teachers in developing their Technological Pedagogical Content Knowledge (TPACK). This framework combines technology skills with pedagogical expertise and subject content knowledge to enhance digital teaching effectiveness [5].

To drive this transformation, school leaders must employ a strategic, multifaceted approach. First, a clear strategic vision and careful planning are essential. Principals must articulate a vision for digital learning that aligns with their school's goals, addressing both immediate needs and long-term aspirations [6]. This vision provides a roadmap for decision-making and helps to rally teachers, students, and the broader school community around common objectives. Additionally, resource allocation and infrastructure development are crucial components of effective management. Effective leaders work to secure the financial, technical, and human resources necessary to establish a robust digital learning environment, ensuring that teachers have access to the necessary tools and infrastructure [7].

Professional development is another critical area where principals' leadership is needed. Implementing targeted professional development programs enables teachers to enhance their digital competencies in alignment with the school's strategic vision, thereby fostering confidence and capability in utilizing new technologies [8]. Tailored training programs that address varying levels of digital literacy can help to bridge skill gaps, enabling all teachers to engage meaningfully with digital tools in their classrooms.

Finally, managing cultural change is perhaps one of the most challenging yet essential elements of digital transformation. Resistance to change, often rooted in traditional teaching practices or skepticism about the efficacy of digital tools, can impede progress. Effective principals must serve as change agents, fostering an open and supportive culture where innovation is encouraged and the benefits of technology are

communicated [9]. By actively addressing resistance and promoting a growth-oriented mindset, school leaders can foster a culture that embraces digital transformation as a means to enhance teaching and learning outcomes.

However, significant gaps persist in teachers' pedagogic competencies for digital integration, particularly in regions with limited resources and training opportunities [10]. In Indonesia, specifically in Aceh Province, recent Teacher Competency Tests have revealed substantial challenges in effectively applying digital teaching methods [11]. This competency gap highlights a critical area for leadership intervention and systematic improvement [12]. Specifically, within Aceh Province, recent Teacher Competency Tests have revealed substantial challenges in teachers' ability to effectively apply digital teaching methods. These assessments highlight significant gaps in digital proficiency, particularly in adapting technology to pedagogical practices. This underscores the need for systematic improvements to support teachers in developing the skills required for effective digital integration. Addressing these challenges is especially critical in the context of Aceh, where disparities in infrastructure and access to resources further complicate efforts to bridge the digital competency gap. This study examines how school leaders in Aceh Province address these deficiencies through targeted strategies, offering insights into leadership approaches that promote meaningful improvements in teachers' digital pedagogical competencies.

Significant disparities in teachers' digital literacy levels present a substantial challenge in implementing digital education effectively. While some educators exhibit high proficiency and enthusiasm for integrating technology, others struggle with foundational digital skills, creating an implementation divide that hinders collective progress within schools. This gap in digital competencies not only affects the ability of schools to standardize digital teaching practices but also exacerbates inequalities in students' learning experiences, as the quality of technology usage in classrooms becomes inconsistent. Bridging this divide requires targeted leadership strategies that cater to the varying needs of teachers, ensuring equitable access to digital training and resources while fostering a culture of peer collaboration to support continuous improvement. This research seeks to explore these challenges, focusing on how school leaders in Kluet Utara address these disparities to enhance teachers' digital pedagogic competencies and achieve cohesive progress in digital integration. The complexity of addressing these challenges is compounded by several interconnected factors that

significantly impact the integration of digital competencies in educational settings. The rapid pace of technological advancement necessitates that educators and administrators continually adapt to new tools, platforms, and teaching methodologies. As digital technologies evolve, previously acquired skills quickly become outdated, placing a substantial burden on schools to provide ongoing training and support [13]. Teachers are often expected to keep pace with these changes independently, leading to inconsistencies in digital literacy levels and varying degrees of confidence in using digital tools effectively. This constant demand for upskilling can strain schools' resources, making it challenging to maintain a consistent standard of digital competency among teachers. Without systematic and sustained support, these pressures exacerbate disparities in technology integration, leaving some educators ill-equipped to meet the demands of modern classrooms. This study investigates how school leaders address these challenges, particularly in resource-constrained environments, by implementing structured and adaptable professional development initiatives.

Another pressing challenge is the disparity in digital literacy levels among teachers. While some educators possess a high level of proficiency and enthusiasm for integrating technology, others may lack foundational digital skills, resulting in a divide that can hinder collective progress within a school [14]. This variation in digital competency requires targeted, differentiated training programs that cater to teachers' diverse skill levels, thereby ensuring that all educators are equipped to deliver quality digital instruction. However, designing and implementing such tailored training is often resource-intensive and requires dedicated administrative support.

Furthermore, limited infrastructure and resource constraints pose substantial barriers to digital transformation, particularly in rural or under-resourced schools. In many educational institutions, access to reliable internet, modern devices, and updated software is either limited or unavailable, making it challenging to establish a consistent digital learning environment [15]. These infrastructural limitations not only affect teachers' ability to engage with digital tools but also impact students' learning experiences, as they may not have access to the same resources at home. Addressing these resource gaps requires substantial financial investment and policy support at multiple levels, from local administrations to national governments.

Many educational institutions, particularly those in rural or under-resourced areas, face significant barriers to establishing consistent digital learning environments. Limited access to reliable internet, modern devices, and

updated software poses challenges for both teachers and students, restricting opportunities to fully integrate digital tools into teaching practices. These disparities exacerbate educational inequities, as schools with insufficient resources struggle to keep pace with the demands of digital transformation. Addressing these challenges requires not only technical investments in infrastructure but also leadership strategies that maximize the use of available resources while advocating for additional support. This study highlights how school leaders in Kluet Utara, a region with limited digital infrastructure, navigate these barriers and foster digital competency among teachers through strategic leadership and resource allocation.

Cultural and institutional resistance to change adds another layer of complexity. In some school environments, there may be a reluctance to adopt new technologies due to traditional views on teaching or skepticism about the benefits of digital learning. This resistance is often rooted in longstanding educational practices and cultural attitudes, making it difficult to shift mindsets toward embracing technology as a valuable teaching tool [16]. Additionally, some institutions may lack the flexibility to adapt quickly due to rigid policies or bureaucratic procedures, further slowing the pace of digital integration. Overcoming these cultural and institutional barriers requires not only leadership from school principals but also a strategic approach to fostering a culture of openness, where innovation is encouraged and the benefits of digital tools are demonstrated.

Resistance to adopting new technologies remains a significant barrier to digital transformation in education. This resistance often stems from traditional views on teaching and skepticism about the benefits of digital learning, particularly in regions where longstanding educational practices and cultural attitudes prioritize conventional methods over technological innovation. Teachers and administrators may be hesitant to abandon familiar practices or doubt the efficacy of digital tools in improving educational outcomes. Such resistance can slow the pace of digital adoption and impede the development of a culture that embraces innovation. Addressing these challenges requires school leaders to actively foster an environment of openness and trust, where the value of digital integration is communicated, and support is provided to ease the transition from traditional to modern pedagogical methods. This study examines how school principals in Kluet Utara address cultural resistance and implement strategies to foster a positive attitude toward digital learning within their schools.

Despite the significance of this issue, empirical research examining specific leadership strategies for enhancing digital pedagogic competencies remains limited [17]. While studies have explored general approaches to improving teacher competencies, there is a lack of data on principals' methods for developing digital pedagogical skills specifically [18]. This research gap necessitates an in-depth investigation of leadership strategies that can effectively bridge the divide between current teaching practices and digital-first educational frameworks [19].

This study addresses a critical knowledge gap by examining the strategic approaches adopted by school principals to enhance teachers' digital pedagogic competencies in three public high schools in Kluet Utara, Aceh. Employing a qualitative case study approach, the research investigates several key areas: the strategies principals use to implement digital competency training programs, the challenges they encounter in fostering digital literacy among teachers, the support structures they develop to facilitate technology integration, and the leadership approaches they employ to manage digital transformation within their schools. By exploring these facets, the study aims to provide a comprehensive understanding of how educational leaders can effectively navigate the complexities of digital adoption in teaching.

The primary aim of this study is to explore the strategic approaches employed by school principals to enhance the digital pedagogic competencies of teachers in public high schools. Specifically, it aims to identify and analyze the strategies that principals employ to support the development of digital competency, including professional development programs and resource allocation efforts. Furthermore, the study examines the challenges faced by educational leaders and teachers in integrating digital tools into pedagogic practices, particularly in resource-limited educational settings. By investigating the support structures and collaborative practices that facilitate digital adoption, this research provides valuable insights into effective leadership in navigating digital transformation. Ultimately, the findings aim to inform educational policymakers and leaders, offering actionable recommendations for fostering a comprehensive and sustainable approach to digital integration in schools.

2. Materials and Methods

2.1. Research Design

This study employed a qualitative research design, specifically a descriptive approach, to explore the strategies implemented by school principals to enhance the digital pedagogical competencies of high school teachers. The qualitative method was chosen to gain in-

depth insights into the experiences, strategies, and challenges faced by school leaders in adapting teaching practices to a digitalized education environment. The study's design allows for a rich, contextual understanding of leadership strategies within real-world educational settings.

2.2. Study Setting and Participants

The research was conducted in three public high schools located in Kluet Utara, Aceh, Indonesia. These schools were selected due to their diverse approaches to integrating technology in teaching, as well as their principals' ongoing efforts to improve teachers' digital competencies. The participants included school principals, vice principals, and a selected group of teachers from each school who were actively involved in the schools' digital learning initiatives. In total, nine participants were recruited for the study: three principals, three vice principals, and three teachers, each representing one of the schools involved.

The sample size for this study was intentionally limited to nine participants, comprising three principals, three vice principals, and three teachers across three schools, to align with the qualitative research design and the study's focus on in-depth exploration of leadership strategies and practices. This purposive sampling approach enabled the selection of individuals who were actively involved in digital learning initiatives within their schools, ensuring that the collected data would provide rich, contextual insights into the research questions. Given the resource-intensive nature of qualitative data collection methods, such as semi-structured interviews and direct observations, this sample size was deemed sufficient to achieve data saturation while maintaining a manageable scope for analysis.

Teachers selected as "actively involved" in digital learning initiatives met specific criteria to align with the study's objectives. Priority was given to those who had participated in digital training sessions within the past year, regularly integrated digital tools (e.g., learning management systems, online assessments) into their teaching, and engaged in collaborative practices like peer mentoring or team-based problem-solving. Additionally, teachers who assumed leadership roles in school-based digital initiatives, such as guiding colleagues or serving as resource persons, were prioritized. Principals and vice principals identified candidates based on documented involvement and observed practices.

2.3. Data Collection

Data collection for this study, conducted over two months (July–August 2024), utilized semi-structured

interviews, direct observations, and document analysis to explore leadership strategies for enhancing digital pedagogic competencies. Semi-structured interviews with principals, vice principals, and selected teachers focused on strategies, challenges, and support systems for digital integration. Interviews, lasting 45–60 minutes, used open-ended questions and were recorded with participants' consent to ensure accurate transcription and analysis.

Direct observations, lasting two hours each, examined classroom use of digital tools and leadership support for digital integration. Observers followed a structured protocol, using a checklist to assess digital tool usage, teaching methods, student engagement, and leadership involvement. Data was recorded on a standardized template and validated through debriefing sessions.

Document analysis of training schedules, workshop records, and curriculum plans contextualized and verified data from interviews and observations. Triangulating these three methods provided a comprehensive understanding of leadership strategies and digital integration processes in the participating schools.

2.4. Data Analysis

Data analysis for this study was conducted using thematic analysis, a method well-suited for identifying, analyzing, and reporting patterns within qualitative data. This approach was selected due to its flexibility, which allowed for the extraction of meaningful themes that captured the core aspects of leadership strategies and pedagogical development within a digital educational framework. The thematic analysis process was structured into three key stages: data transcription and coding, theme identification, and validation of findings, each contributing to a nuanced understanding of the leadership practices and challenges involved in enhancing digital competencies.

The initial stage of data transcription and coding involved transcribing the interview recordings verbatim and thoroughly reviewing observation notes. This meticulous process allowed the researcher to capture the full depth of participants' responses. The transcriptions and notes were then subjected to initial coding, where significant phrases and recurring concepts were identified. Codes were assigned to segments of data that reflected specific ideas related to leadership strategies, obstacles encountered, and the results of initiatives aimed at improving digital competencies. This coding process laid the groundwork for identifying larger, overarching themes by organizing the raw data into smaller, conceptually related units.

In the theme identification stage, these initial codes were grouped into broader categories that represented the primary themes emerging from the data. Each theme encapsulated a central aspect of the strategies and challenges described by school leaders and teachers. For example, themes such as "professional development initiatives" emerged from discussions about training programs and workshops designed to enhance digital skills among educators. Other key themes included "infrastructure and resource allocation," reflecting the importance of access to technology and digital tools, and "collaborative practices," which underscored the role of teamwork and knowledge sharing in fostering digital pedagogic competencies. These themes provided a structured framework for understanding the varied approaches and resources used to support digital integration.

The final stage, validation of findings, was crucial for ensuring the credibility and reliability of the results. Triangulation was employed by cross-referencing data from interviews, observations, and document analyses, allowing the researcher to confirm the consistency of themes across different data sources. In addition to triangulation, the study employed member checking and peer debriefing to ensure data validity and reliability. Member checking involved sharing preliminary findings with the participants to verify the accuracy and credibility of the interpretations. This process allowed participants to provide feedback or clarify any discrepancies, ensuring that the results accurately reflected their experiences and perspectives.

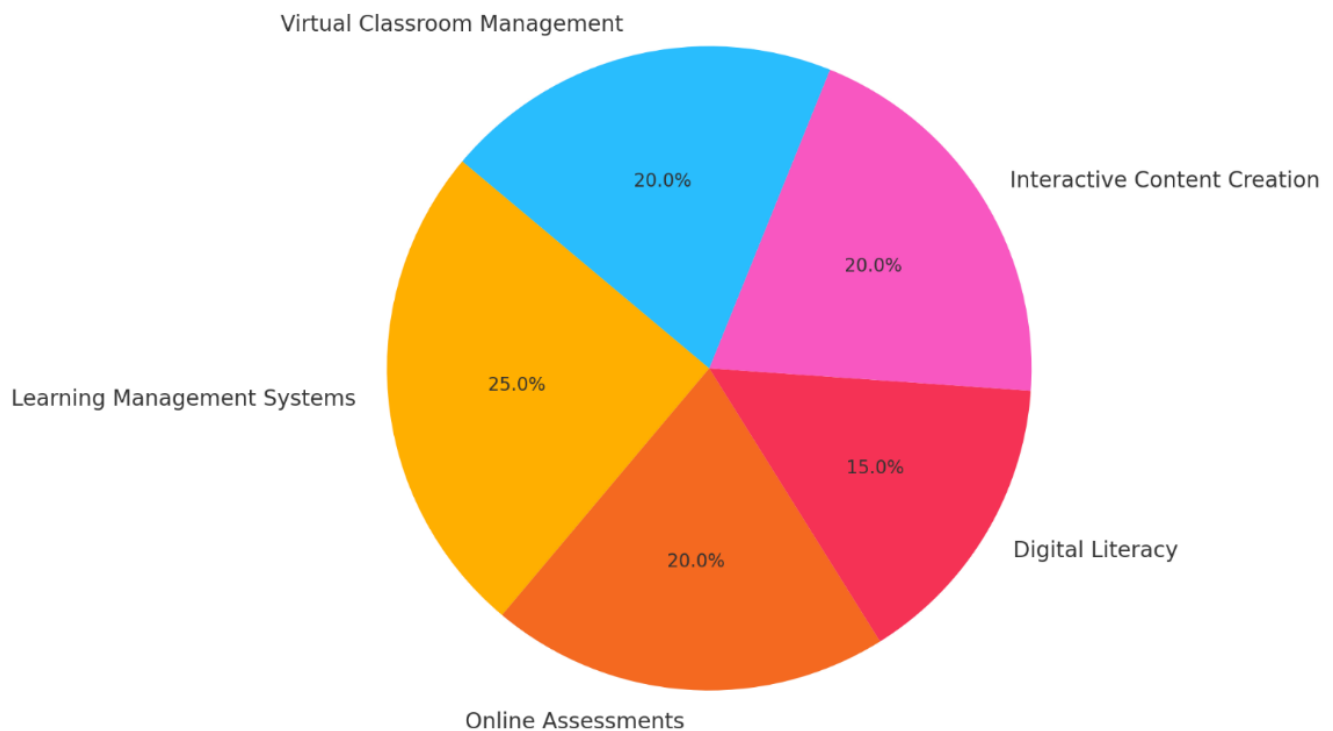
Peer debriefing was also conducted with colleagues specializing in educational leadership and digital pedagogy. These debriefing sessions provided an external perspective on the data analysis process, helping to identify potential biases and refine the thematic framework. By incorporating these additional validation methods, the study ensured a robust and credible analysis of the data collected.

Furthermore, regular peer debriefing sessions with colleagues in the fields of educational leadership and digital pedagogy were conducted to discuss and refine the emerging findings. These debriefing sessions provided an additional layer of scrutiny, helping to validate the interpretations and solidify the reliability of the themes identified in the study.

By following these systematic steps, the thematic analysis yielded a well-supported set of themes that illustrated the strategies, challenges, and support systems involved in promoting digital pedagogic competencies within the participating schools. This approach enabled a

Table 1. Professional development activities by school.

School	Type of Activity	Frequency	Focus Areas
SMA Negeri 1 Kluet Utara	Monthly Digital Workshops	Monthly	Learning Management Systems, Online Assessments
SMA Negeri 2 Kluet Utara	Digital Skills Training	Bi-monthly	Digital Literacy, Interactive Content Creation
SMA Negeri 3 Kluet Utara	Technology Integration Seminars	Quarterly	Virtual Classroom Management, Digital Content Design

**Figure 1.** Focus areas in digital training programs.

comprehensive and validated understanding of the leadership practices that shape digital competency efforts, ultimately contributing to the study's goal of providing actionable insights for educational leaders navigating the digital transition.

3. Results and Discussion

3.1. Professional Development Initiatives

A key approach employed by school leaders to enhance teachers' digital competencies was through structured professional development initiatives. These included various training programs, workshops, and seminars designed to develop digital skills relevant to integrating digital tools into the classroom. Table 1 provides a summary of the professional development activities offered across the three schools, including their frequency and focus areas.

The professional development programs not only focused on digital tools but also addressed pedagogical aspects such as adapting lessons for digital platforms,

online student engagement, and effective digital assessment techniques. Figure 1 illustrates the distribution of focus areas for digital skills training based on feedback from participants. The values in the chart represent proportional coding of recurring themes from interview responses and document analysis, rather than quantitative measurements. For example, when participants described training activities, these were coded into categories such as "Learning Management Systems" or "Online Assessments." The frequency of references to each category was then calculated as a percentage of the total references across all participants. While these values provide a visual summary of the emphasis placed on each focus area, it is important to note that they are illustrative rather than statistically representative. This reflects the study's qualitative nature, where thematic trends, rather than numerical generalizations, guide the interpretation.

Teachers from all three schools indicated that these training sessions significantly boosted their confidence in

Table 2. Teachers’ feedback on training effectiveness.

Feedback on Training	SMA Negeri 1	SMA Negeri 2	SMA Negeri 3
Training improved digital confidence	85%	80%	78%
Need for additional training	60%	70%	65%
Satisfied with the training content	75%	82%	80%

Table 3. Digital infrastructure and resource allocation by school.

School	Infrastructure Upgrades	Frequency of Upgrades	Key Resources Provided
SMA Negeri 1 Kluet Utara	Classroom Computers	Annually	High-speed Internet, Projectors, Tablets
SMA Negeri 2 Kluet Utara	Network & Software Upgrades	Bi-annually	Tablets, Multimedia Software, Projectors
SMA Negeri 3 Kluet Utara	Device Accessibility Program	Quarterly	Student Laptops, High-speed Internet

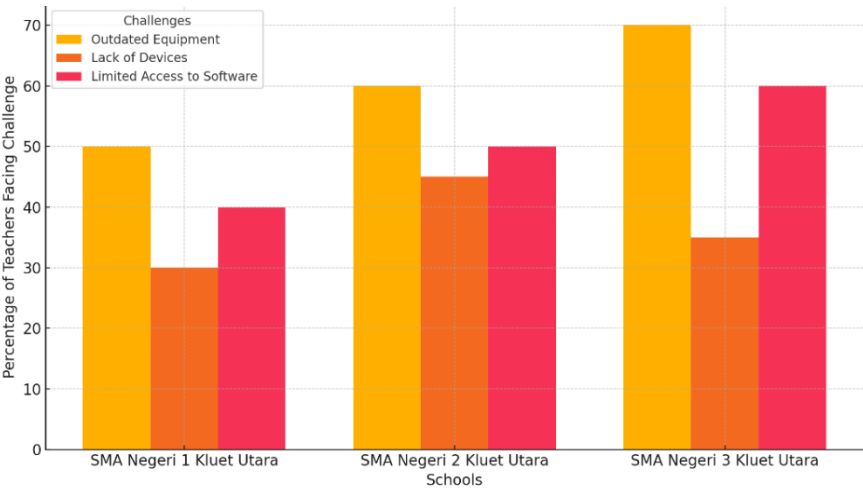


Figure 2. Challenges in digital resource utilization.

using digital tools. However, some teachers expressed the need for follow-up sessions to address ongoing challenges, as shown in [Table 2](#), which summarizes the teachers’ feedback on the training's effectiveness.

The sustainability of digital competency improvements was tracked over a two-month study using three key stages of data collection. The initial baseline assessment identified teachers’ digital proficiency levels and challenges through interviews and classroom observations. A midpoint check-in evaluated progress in confidence, digital tool usage, and implementation of training strategies. The final assessment examined how teachers sustained and expanded their competencies while identifying ongoing challenges. Data from these stages revealed trends and measured skill progression. While the two-month study provided valuable short-term insights, its limitation in assessing long-term sustainability highlights the need for extended research to evaluate lasting impacts.

3.2. Infrastructure and Resource Allocation

The provision and allocation of digital resources were essential components of each school's strategy to

enhance digital competency. Principals allocated funds to improve infrastructure, with each school addressing specific technological needs to facilitate digital teaching and learning. [Table 3](#) provides an overview of the key resources allocated by each school to support digital integration.

While the allocation of resources allowed teachers to incorporate technology into their lessons, [Figure 2](#) reveals the primary challenges faced by teachers in utilizing digital resources, including issues such as outdated equipment, lack of devices, and limited software options.

The return on investment for infrastructure upgrades was assessed using qualitative indicators linking resource allocation to observable improvements in teaching outcomes. Key indicators included teacher utilization rates, measuring the frequency with which upgraded infrastructure (e.g., high-speed internet, classroom computers, projectors) was integrated into daily teaching. Improved lesson quality was tracked through enhancements in delivery, including the increased use of interactive tools and the smoother integration of digital

Table 4. Collaborative practices for digital competency enhancement.

School	Collaborative Activity	Frequency	Purpose
SMA Negeri 1 Kluet Utara	Digital Pedagogy Meetings	Monthly	Sharing best practices in digital teaching
SMA Negeri 2 Kluet Utara	Peer Observation Programs	Bi-monthly	Feedback on digital teaching methods
SMA Negeri 3 Kluet Utara	Team-based Problem Solving	Monthly	Addressing classroom tech challenges

Table 5. Metrics for assessing training effectiveness and impact of collaborative practices.

Category	Metric	Description	Data Source
Training Effectiveness	Increase in Digital Tool Usage	Frequency and variety of digital tools integrated into classroom activities.	Observations, teacher interviews
	Improvement in Confidence	Self-reported confidence levels in using digital tools, validated by observed classroom behavior.	Teacher interviews, observations
	Retention of Knowledge	Ability to recall and apply digital teaching skills from training sessions.	Observations, teacher interviews
Impact of Collaborative Practices	Frequency of Engagement	Number of peer interactions, including mentoring and problem-solving activities.	Observation notes, teacher interviews
	Enhanced Lesson Delivery	Improvements in lesson planning and teaching execution linked to collaborative efforts.	Observations, interviews
	Student Engagement	Increased student participation and interaction during technology-integrated lessons.	Classroom observations

platforms. Teacher feedback evaluated whether the upgrades addressed barriers such as slow internet or limited access, and whether they improved lesson planning and execution. Student engagement levels were observed through increased participation during technology-enabled lessons. Efficiency gains were measured by teachers reporting reduced preparation time and simplified classroom management due to the new infrastructure. These indicators were supplemented with trends from interviews and observations. While the study emphasized qualitative methods, future research could enhance the assessment by incorporating quantitative measures, such as cost-benefit analyses or comparisons of student performance.

Despite these challenges, teachers reported that having dedicated digital resources, even if limited, significantly enhanced their ability to integrate technology into their lessons. The provision of high-speed internet and multimedia software was particularly noted as beneficial for lesson preparation and delivery.

3.3. Collaborative Practices for Digital Competency Enhancement

Collaboration among teachers was a strong theme, with school leaders fostering environments that encouraged teamwork and knowledge sharing. School leaders organized regular meetings, peer mentoring sessions, and team-based activities focused on digital pedagogy, as summarized in Table 4.

The percentage figures presented in Tables 1–4 were calculated based on the responses and data collected from the nine participants included in the study, comprising three principals, three vice principals, and three teachers. These figures represent proportions derived from qualitative coding and frequency analysis of participants' responses and observed practices within the limited sample.

The metrics for assessing training effectiveness revealed that teachers demonstrated a notable increase in their use of digital tools following professional development sessions (Table 5). Observations confirmed that participants frequently integrated tools such as learning management systems and multimedia resources into their lessons. Additionally, interviews highlighted a marked improvement in teachers' confidence levels, with many reporting greater ease and comfort in applying digital teaching methods. Observed classroom practices further validated these self-reported gains, as teachers effectively demonstrated the skills they had acquired during training sessions, suggesting strong knowledge retention.

For collaborative practices, the metrics highlighted the critical role of peer interactions in enhancing the quality of teaching. Teachers who participated in mentoring and team-based problem-solving activities reported improved lesson delivery, which was corroborated by classroom observations. Collaborative efforts also fostered increased student engagement, as teachers implemented innovative techniques learned through

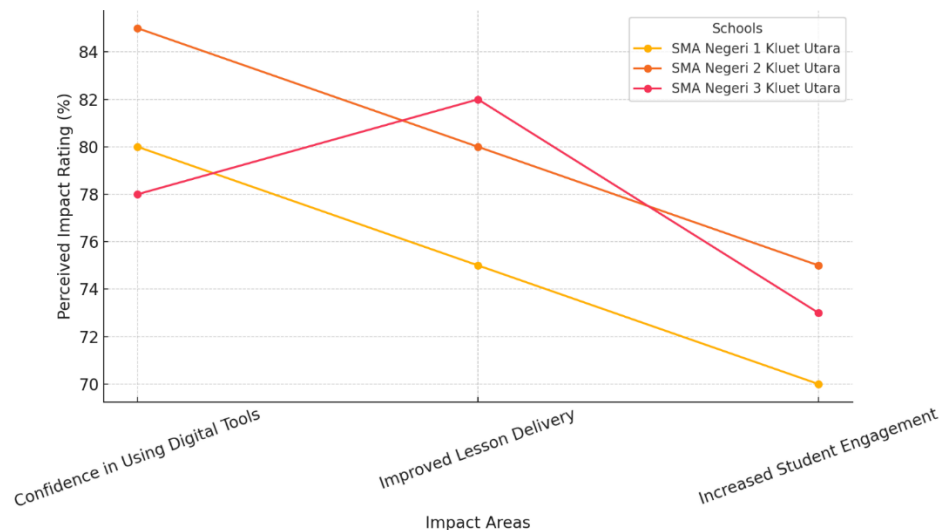


Figure 3. Impact of collaborative practices on digital competencies.

peer exchanges. These findings highlight the dual benefits of collaborative practices in enhancing teacher competency and promoting active student participation. The combined data from observations and interviews underscore the positive outcomes of training and collaboration. However, the study also acknowledges the qualitative nature of these assessments and the need for more objective measurements, such as pre- and post-assessments, to further validate the findings.

Teachers highlighted these collaborative practices as essential for building confidence in using digital tools, as they provided opportunities for peer learning and feedback.

Figure 3 presents a line chart illustrating the perceived impact ratings of collaborative practices on teachers' digital competencies. These ratings were derived from qualitative feedback collected during semi-structured interviews, where participants were asked to evaluate the influence of collaborative practices on their confidence in using digital tools, lesson delivery, and student engagement. Participants provided descriptive responses, which were coded and categorized into three impact levels: low, medium, and high. These categories were then assigned numerical values (e.g., 1 for low, 2 for medium, and 3 for high) to enable visualization of trends.

The values plotted in the chart represent the aggregated ratings from all participants, offering an illustrative summary of their perceived experiences. It is essential to note that these ratings are based on perception and not derived from objective assessments. They are intended to complement the qualitative findings by providing a visual representation of the thematic trends identified in the study.

3.4. Summary of Findings

The findings from this study reveal a multi-faceted approach to building digital competencies among teachers, with school leadership initiatives spanning professional development, resource allocation, and collaborative practices. Professional development initiatives were highly regarded, though there was demand for additional sessions. Resource allocation enabled basic digital integration, despite some limitations with outdated or insufficient devices. Collaborative practices fostered an environment of peer support, significantly improving teacher confidence and adaptability in digital teaching.

The study primarily focused on enhancing teacher digital competencies, and while direct impacts on student performance were observed qualitatively, specific performance metrics were not formally collected. However, improved teacher competencies led to noticeable increases in student engagement and participation during lessons. Observations revealed that students were more interactive and collaborative in digitally enhanced classrooms, often demonstrating higher levels of critical thinking when using tools like simulations or multimedia platforms. Teachers reported anecdotal improvements in student outcomes, such as better comprehension of complex topics and increased motivation, particularly in STEM subjects. Future research could incorporate quantitative metrics, such as test scores or assignment performance, to provide a more robust analysis of the downstream effects of teacher training programs on student performance.

Frequent professional development sessions at SMA Negeri 1 were linked to higher teacher confidence and increased use of digital tools, suggesting that ongoing

training yields better results than intensive but infrequent sessions. This highlights the importance of consistent professional development in improving teaching practices.

SMA Negeri 3 demonstrated the value of inclusive resource allocation by providing student laptops and ensuring device accessibility, which significantly enhanced student engagement. This approach contrasts with schools focusing solely on teacher-oriented resources, emphasizing the need for balanced infrastructure investments.

At SMA Negeri 2, peer mentoring programs were particularly effective in fostering teacher confidence and encouraging skill-sharing. These programs provide a replicable model for fostering collaboration and professional development among educators.

Together, these results underscore the importance of a comprehensive strategy that combines training, resources, and collaborative support to enhance digital pedagogic competencies in schools. Future efforts should focus on addressing the challenges of resource limitations and expanding ongoing professional development to ensure sustained improvements in digital pedagogy.

3.5. Discussion

The findings of this study highlight the multifaceted approach that school leaders in Kluet Utara have undertaken to foster digital pedagogic competencies among teachers. Through a combination of professional development initiatives, infrastructure investment, and collaborative practices, school leaders have made significant strides in preparing educators for the digital demands of modern classrooms. This discussion section interprets these findings in light of existing literature on educational leadership and digital integration, examines the implications of these strategies, and addresses the challenges and limitations observed.

3.5.1. Professional Development as a Cornerstone of Digital Competency

The study revealed that professional development initiatives, such as workshops, digital skills training, and interactive seminars, were highly valued by teachers and served as the foundation for building digital competencies. This aligns with research by Hennessy et al. [20], who argue that ongoing professional development is essential for equipping teachers with the skills necessary to effectively implement digital tools. The focus on skills such as online assessments, learning management systems, and content creation addresses

both technical and pedagogical needs, which are essential for digital integration. However, the findings also suggest that some teachers require additional training to sustain their competency development, indicating the need for continuous, adaptive professional development programs.

3.5.2. Infrastructure and Resource Allocation: Key Enablers and Limitations

The role of infrastructure and resource allocation emerged as another critical factor in the successful implementation of digital teaching practices. Access to high-speed internet, multimedia resources, and digital devices allowed teachers to integrate technology into their lessons more effectively. This finding is consistent with those of Hustad and Olsen [21], which emphasize that adequate infrastructure is a prerequisite for meaningful digital integration. Despite these efforts, some resource constraints persisted, such as outdated equipment and limited access to devices in certain schools. These limitations highlight a common challenge in digital education, particularly in regions with constrained budgets, and suggest a need for policy-level interventions to secure more sustainable funding for digital infrastructure in schools.

3.5.3. Collaborative Practices as a Tool for Enhancing Confidence and Competence

Collaborative practices, such as digital pedagogy meetings, peer observation, and team-based problem-solving, were reported to have a highly impactful effect, with teachers indicating increased confidence and improved lesson delivery as a result. These findings align with the work of Hargreaves and Fullan [22], who emphasize that collaboration fosters a culture of shared learning and innovation, which is crucial for adapting to digital transformation. By facilitating peer learning and feedback, these practices not only improved teachers' technical skills but also created a supportive environment where educators could share their challenges and successes. This collegial approach to digital competency enhancement reflects the importance of community in professional growth. It suggests that similar collaborative models could be implemented in other schools facing digital integration challenges.

3.5.4. Challenges and Barriers to Effective Digital Integration

Despite the positive impact of the strategies employed, several barriers were identified, including varying levels of digital proficiency among teachers, limited financial resources, and time constraints. Teachers' diverse levels of comfort with technology reflect findings by [23], which

indicate that personal beliefs and previous experience with technology can influence educators' adaptability to digital tools. These varying levels of digital literacy suggest the need for differentiated support, where teachers can receive tailored guidance based on their competencies and needs. Additionally, the time constraints experienced by teachers underscore a common tension in professional development; while training is beneficial, it can be challenging to balance with existing workloads. This finding suggests that future initiatives might consider integrating digital training into teachers' regular schedules or providing stipends for additional hours spent on skill development.

3.5.5. Implications for Educational Leadership

The study's findings highlight the crucial role of school leaders in fostering digital competencies among teachers. By prioritizing digital skills training, securing necessary resources, and fostering a collaborative environment, school leaders in Kluet Utara have demonstrated an effective approach to navigating digital integration. These strategies align with transformational leadership principles, which emphasize vision, resource provision, and empowering staff to take initiative [24]. The successes observed in this study suggest that similar leadership approaches could be adopted in other educational contexts to support digital transitions, particularly in regions where resources are limited. The integration of leadership support in digital training programs could serve as a model for schools facing similar challenges in digital literacy.

3.5.6. Limitations and Recommendations for Future Research

This study's limitations include its focus on a small sample of schools within a single region, which may limit the generalizability of the findings to other contexts. Additionally, the study's qualitative design, while providing in-depth insights, may not capture the full extent of digital competency challenges faced by teachers on a larger scale. Future research could expand on this study by employing a mixed-methods approach to capture both quantitative data on digital skills and qualitative insights into teachers' experiences. Furthermore, longitudinal studies examining the long-term impact of these leadership strategies on teacher competencies and student outcomes could provide valuable insights into the sustainability and effectiveness of digital integration initiatives.

4. Conclusions

The study highlights several successes in digital competency enhancement strategies, such as increased

teacher confidence, improved integration of digital tools, and higher student engagement. However, these outcomes require further quantification to define success more clearly. Future evaluations should include specific, measurable indicators, such as changes in teacher performance metrics, the frequency of digital tool use, and measurable improvements in student learning outcomes.

While acknowledging ongoing challenges, the sustainability of these initiatives demands greater attention. To ensure long-term impact, schools must develop financial plans to maintain and upgrade digital infrastructure, establish continuous professional development programs, and secure resources for consistent implementation. A framework for scaling these strategies over time, supported by leadership and community involvement, is essential for sustaining progress.

The findings offer valuable insights for other schools but require contextual adaptation. For resource-constrained areas or those with cultural resistance to digital integration, these strategies should be tailored to local needs. Schools can start with low-cost, scalable solutions, such as open-source tools, and emphasize gradual implementation to build trust and competency.

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