

Factors Influencing the Pedagogical Competence of Elementary School Teachers in the Digital Era: A Survey Study

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ABSTRACT

This study aims to explore the factors influencing the pedagogical competence of elementary school teachers in the digital era. The integration of digital technology into education faces challenges due to gaps in teachers' pedagogical competence, which are shaped by disparities in infrastructure, digital literacy, access to professional development, policy support, and teacher attitudes and motivation. Employing a survey research design, this study involved 270 elementary school teachers from West Java Province as participants. Data were collected through a validated online questionnaire, with an Aiken's validity index above 0.8 and a Cronbach's Alpha reliability estimate of 0.867. Descriptive statistics and qualitative analysis using the Miles and Huberman model were utilized to examine the factors affecting teachers' pedagogical competence. The results reveal significant disparities in ICT device availability, low digital literacy, limited access to training, weak school policy support, and psychological barriers that hinder ICT integration. Although 73% of teachers believe ICT improves learning outcomes, 54.07% remain hesitant to experiment due to fear of failure. These findings underscore the need for holistic training programs, infrastructure improvements, inclusive policies, and peer learning-based mentoring to strengthen teachers' pedagogical competence in the digital era.

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1. INTRODUCTION

In the 21st century, characterized by rapid technological advancements, the role of digital technology in education has become increasingly significant [1], [2]. Integrating technology into teaching practices has the potential to transform pedagogical approaches, boost student engagement, and enhance learning outcomes [3]. As a result, the digital competence of teachers, especially at the elementary school level, is now regarded as a vital factor in ensuring effective education in the digital era [4], [5].

Digital competence refers to a combination of skills, knowledge, and attitudes that enable teachers to effectively use digital technologies in their professional practice [6], [7]. This encompasses not only the technical abilities needed to operate various digital tools and platforms but also the pedagogical understanding required to integrate these tools into the curriculum in a meaningful and effective way [8], [9]. Additionally, digital competence involves the capacity to assess digital resources critically, adapt teaching strategies to digital environments, and foster digital citizenship among students [10], [11].

In elementary education, where foundational skills and attitudes are developed, the role of digitally competent teachers is especially important. Elementary school teachers lay the groundwork for students' future success by fostering their interest in learning, developing critical thinking skills, and preparing them to navigate the digital world [12]. Therefore, these teachers must possess the digital competence needed to effectively integrate technology into their teaching and create engaging, meaningful learning experiences for their students [13], [14].

Despite growing recognition of the importance of digital competence, many elementary school teachers still lack the necessary skills and knowledge to use technology effectively in their classrooms [15], [16]. This gap is due to factors such as inadequate training, limited access to resources, and insufficient institutional support [17], [18]. As a result, many teachers feel unprepared to integrate technology into their teaching, which can lead to frustration and resistance [19], [20].

Moreover, there is a significant disparity in digital competence among teachers, with some possessing advanced skills and knowledge while others struggle with even the most basic tasks [21]. This gap can be attributed to various factors, including age, education level, and access to professional development opportunities [22]. Addressing this disparity is essential to ensure that all students receive high-quality education in the digital age.

To tackle the challenges and opportunities related to digital competence in elementary education, it is crucial to understand the factors that influence teachers' ability to utilize technology in their classrooms effectively. These factors can be broadly categorized into individual factors, such as teachers' attitudes, beliefs, and self-efficacy, and contextual factors, such as school culture, leadership support, and access to resources [23], [24]. By identifying these factors, policymakers and educational leaders can develop targeted interventions and support systems to enhance teachers' digital competence and promote the effective integration of technology into elementary education [25], [26].

This study aims to investigate the factors that influence the pedagogical competence of elementary school teachers in the digital era. Specifically, it will examine the relationship between teachers' characteristics, contextual factors, and their ability to utilize technology in their teaching practices effectively. Using a survey research design, this study will collect data from a representative sample of elementary school teachers to provide insights into the challenges and opportunities related to digital competence in elementary education [27]. The findings will inform the development of evidence-based policies and practices to enhance teachers' digital competence and support the effective integration of technology into elementary education.

2. METHOD

This research aims to explore factors that illustrate teachers' pedagogical competence. This study employs a survey research method [28], which helps in understanding teachers' responses regarding pedagogical competence. The sampling technique used is random sampling, with a research sample of 270 teachers. The participants are elementary school teachers in West Java Province. Data collection was conducted online using a questionnaire. This questionnaire was developed to cover topics such as digital infrastructure, teachers' digital literacy, access to competency development, school policy support, and teachers' attitudes and motivation.

The instrument was validated by four experts with diverse backgrounds: one educational technology specialist, one pedagogy expert, and two assessment specialists. These experts evaluated the research instrument, and the validation results showed that each question item had an Aiken validity index above 0.8 [29]. The Aiken validity outcomes confirm that all question items are valid, indicating the instrument's alignment with the research objectives. Subsequently, the instrument was distributed to teachers to collect data. Before analysis, the reliability of the collected data was examined. The reliability test revealed high consistency, with a Cronbach's Alpha estimate of 0.867, demonstrating the instrument's reliability in data collection [30]. Data analysis was performed using descriptive statistics, outlining factors influencing teachers' pedagogical competence. The descriptive statistical results were then qualitatively explored. Further interpretation of the findings applied the Miles & Huberman model [31]. This in-depth analysis aims to provide comprehensive insights from the survey results.

3. RESULTS AND DISCUSSION

3.1. Results

The research results indicate that several factors can describe the competence of elementary school teachers in the digital era. The findings suggest that digital infrastructure, teachers' digital literacy, access to competency development, school policy support, and teachers' attitudes and motivation provide an overview of teachers' pedagogical competence.

3.1.1. Digital Infrastructure

The study examines the factors influencing the pedagogical competence of elementary school teachers in the digital era, with a focus on digital infrastructure as a critical component. The survey results reveal a significant gap in the availability and functionality of information and communication technology (ICT) infrastructure.

Figure 1 presents the survey results on five aspects of digital infrastructure in schools. Respondents indicated that access to ICT devices remains a challenge, with only 62 teachers reporting adequate access to computers or laptops, while 172 teachers rated the condition of hardware (computers, projectors, tablets) as not always good or functional. However, 231 of the respondents agreed that internet connectivity in schools supports the use of digital learning media, suggesting relatively sufficient network capacity. In contrast, 207 teachers disagreed that schools provide adequate time and space for ICT-based lesson preparation, and 225 teachers noted the lack of clear procedures for repairing or adding ICT facilities.

These findings underscore the urgent need to improve device availability, maintenance management, resource allocation, and ICT administration systems to support comprehensive technology integration in basic education.

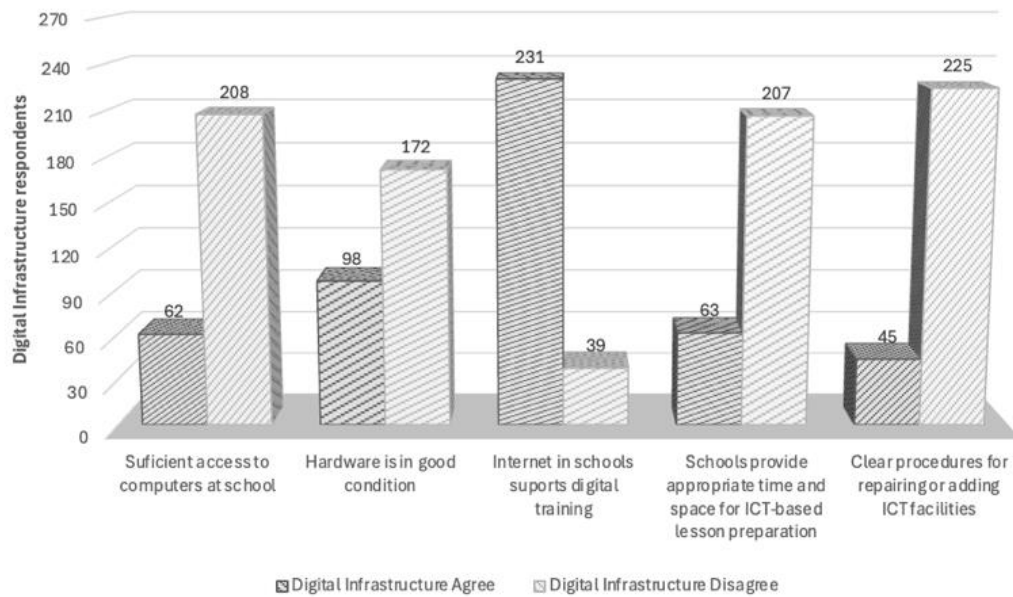


Figure 1. Digital Infrastructure.

3.1.2. Digital Literacy

Enhancing teachers' digital skills is essential for achieving technology-driven and innovative education. Nevertheless, survey results indicate that teachers' digital literacy remains insufficient.

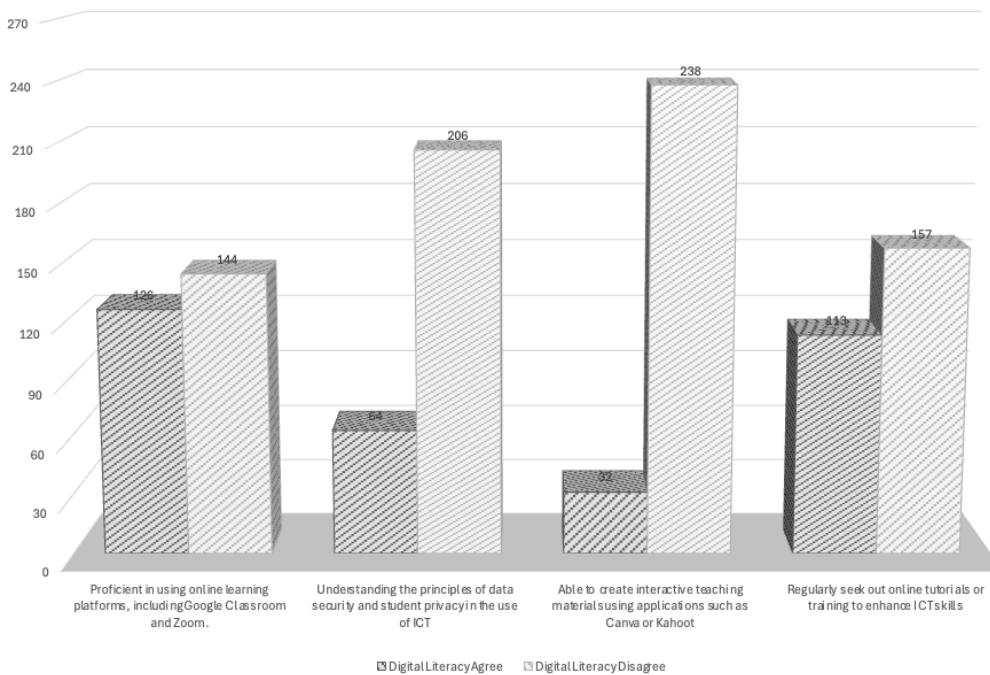


Figure 2. Digital Literacy.

Figure 2 shows that survey results reveal significant limitations in teachers’ digital literacy skills. Approximately 114 of the respondents are still unable to use online learning platforms such as Google Classroom or Zoom, highlighting a major challenge in adapting to digital-based teaching methods. Additionally, only 64 teachers understand the principles of data security and student privacy in ICT usage, while just 32 teachers can create interactive teaching materials using applications like Canva or Kahoot. These findings reflect the low technical competence among teachers in utilizing digital tools for learning, which may hinder the effective integration of technology in the classroom.

On the other hand, some teachers are making proactive efforts to improve their ICT capacity, with 157 teachers regularly accessing online tutorials or training. However, these efforts have not fully addressed the need for comprehensive competency improvement, as the majority of teachers still struggle with technical and digital security aspects. The gap between willingness to learn and practical skills indicates the need for structured training programs that focus not only on operational skills but also on digital ethics, data security, and innovative material development. Consequently, education policies must encourage inter-institutional collaboration to provide relevant and sustainable training resources to support digital transformation at the primary education level.

3.1.3. Access to Professional Development

The survey reveals significant limitations in teachers' digital literacy skills, particularly in using online learning platforms and understanding data security principles. Despite some teachers proactively accessing tutorials, there remains a gap between their willingness to learn and their practical ability to integrate technology effectively.

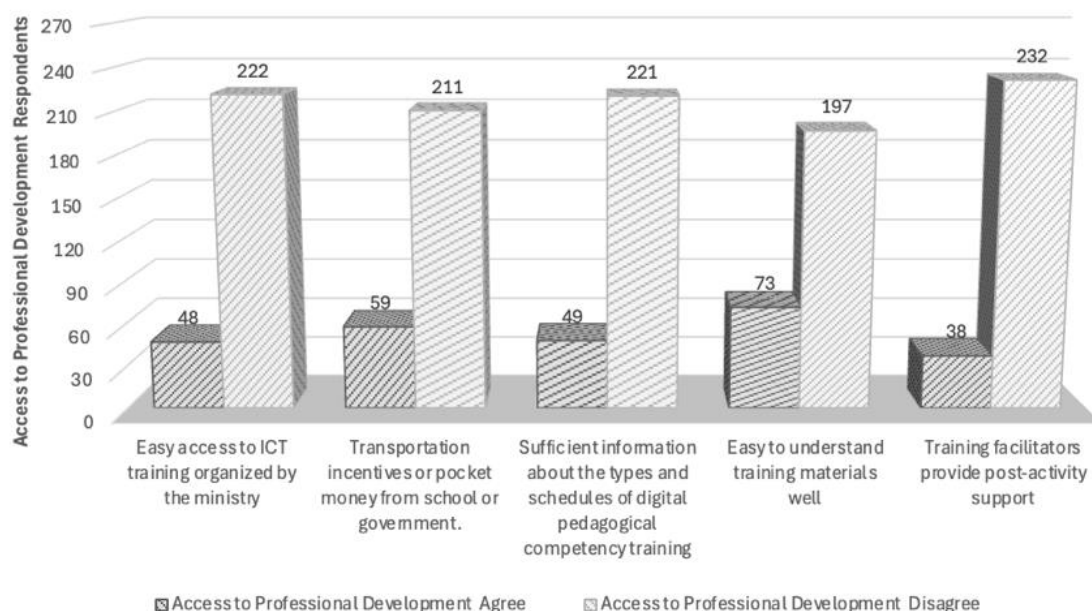


Figure 3. Access to Professional Development.

Figure 3 shows that only 48 of the respondents reported easy access to ICT training organized by the ministry, while 211 teachers cited the lack of transportation subsidies or

pocket money from schools or the government as the main structural barrier to participation. Additionally, just 49 teachers received sufficient information about the types and schedules of digital pedagogical competency training, and only 73 teachers felt they understood the training material well. Furthermore, 232 of the training facilitators did not provide post-activity mentoring, highlighting a weak system of ongoing support. These findings underscore the need for policy reforms that improve physical and financial accessibility, enhance information transparency, raise the quality of training materials, and strengthen post-training evaluation mechanisms to ensure an effective and inclusive transformation of teacher competencies.

3.1.4. School Policy Support

The study highlights the inadequate support from school policies in advancing teachers' ICT competencies, revealing a lack of strategic planning and institutional leadership. Many schools fail to provide a structured framework for ICT development, with limited encouragement from principals and insufficient allocation of resources for digital infrastructure.

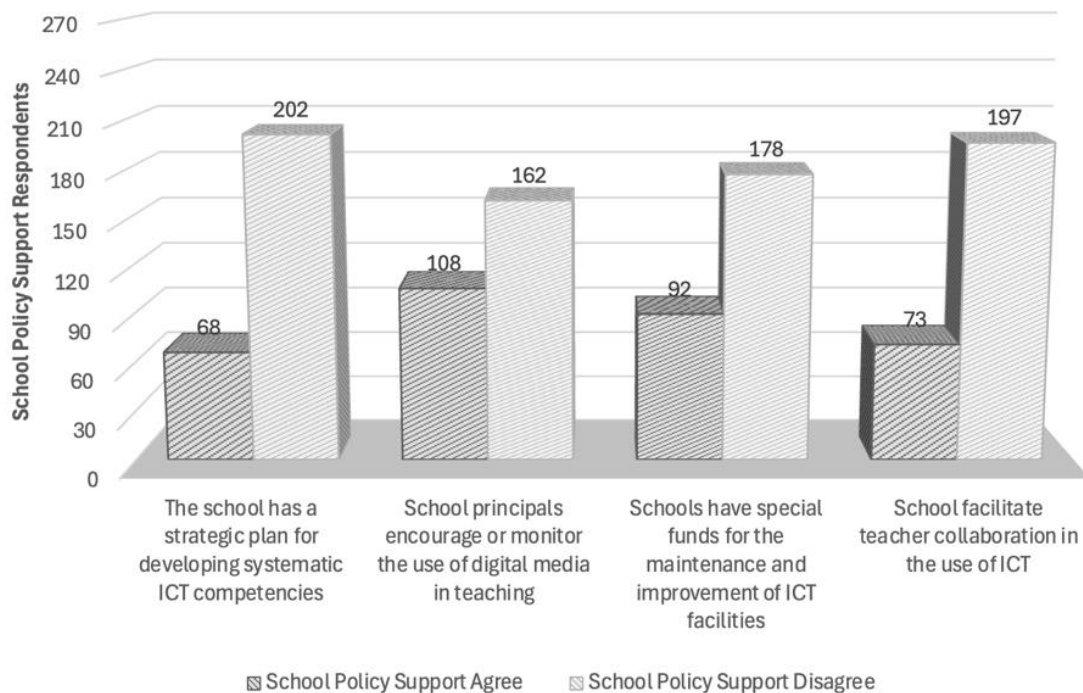


Figure 4. School Policy Support

Figure 4 shows that a total of 202 respondents reported their schools lacked a strategic plan for developing ICT competencies, highlighting the absence of a systematic policy framework to foster digital literacy. Furthermore, 162 teachers indicated that principals neither encouraged nor monitored the use of digital media in teaching, reflecting insufficient transformational leadership at the institutional level. Regarding budget allocation, 178 schools did not designate specific funds for maintaining and upgrading ICT facilities, further aggravating existing infrastructure challenges. In terms of collaboration,

197 teachers acknowledged they were not provided opportunities to share best practices in ICT use, pointing to a lack of a collaborative culture that supports pedagogical innovation. These findings underscore the need for integrated policy measures, including strategic planning, strengthened leadership, sustainable budget allocation, and the development of a collaborative ecosystem, to create a school environment conducive to the comprehensive improvement of teachers' ICT competencies.

3.1.5. Teacher Attitudes and Motivation

The study explores the diverse attitudes and motivations of teachers regarding the use of information and communication technology (ICT) in learning, revealing a mix of enthusiasm and hesitation. While many teachers recognize the potential of ICT to enhance student outcomes and are motivated to explore new methods, psychological barriers such as fear of failure hinder their willingness to experiment. Additionally, despite proactive efforts by some teachers to seek innovation through online communities, the lack of structured support mechanisms underscores the need for systematic interventions to foster a culture of safe experimentation and collaboration.

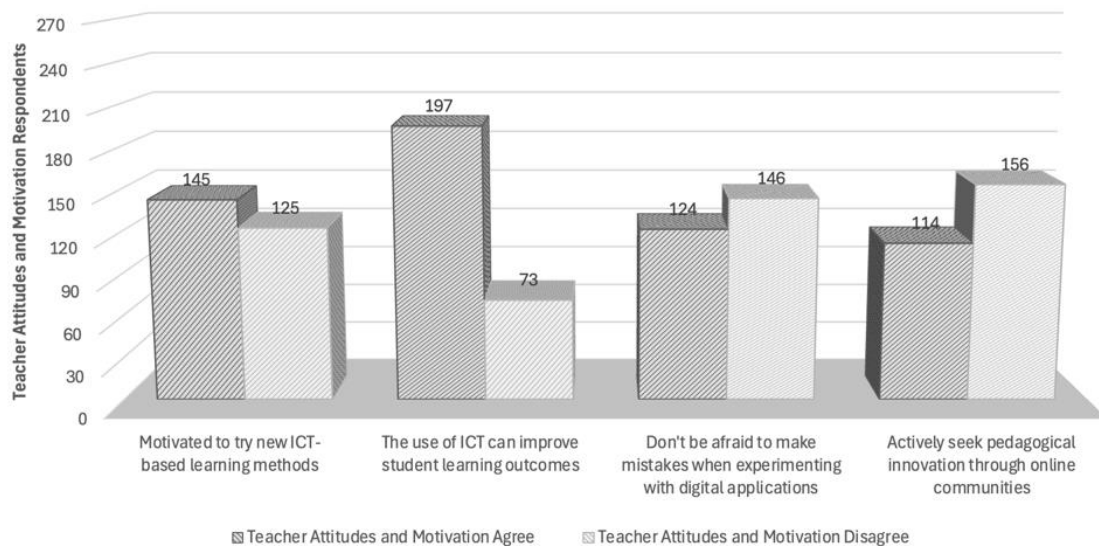


Figure 5. Teacher Attitudes and Motivation.

Figure 5 reveals diverse attitudes and motivations regarding the use of information and communication technology (ICT) in learning. A total of 145 respondents are motivated to try new ICT-based learning methods, while 197 teachers believe that using ICT can improve student learning outcomes, indicating an awareness of technology's transformative potential in education. However, there is a disparity in willingness to experiment: 124 teachers are unafraid of making mistakes when trying digital applications, whereas 146 teachers still show hesitation. Meanwhile, 114 teachers actively seek pedagogical innovation through online communities, reflecting independent efforts to develop competencies despite institutional resource limitations. These findings suggest that teachers' intrinsic motivation and belief in the benefits of ICT have not fully translated into concrete action due to psychological factors such as fear of failure.

The paradox between positive beliefs and psychological barriers underscores the need for systematic interventions to foster a sense of safety in experimentation. Although some teachers have proactively accessed online communities, such participation remains limited and lacks formal school-level collaborative mechanisms. Consequently, education policies should prioritize peer-learning-based mentoring programs, risk-tolerant training, and incentives to encourage ICT exploration without pressure. Additionally, strengthening the support ecosystem through both online communities and face-to-face collaboration can catalyze transforming individual motivation into sustainable collective practices, thereby accelerating the inclusive adoption of ICT in learning.

3.2. Discussion

In the digital era, pedagogical competencies for elementary school teachers are essential, enabling the effective integration of technology to boost student motivation, collaboration, and higher-order thinking skills [32], [33]. Digital competencies empower educators to navigate the evolving educational landscape, design enriching classroom experiences, and support student learning in a technology-rich environment [34]. As digital technologies become increasingly prevalent in education, teachers equipped with these skills are vital for successful integration, addressing the challenge of preparing students for 21st-century demands [35]. However, significant disparities persist in Indonesia, particularly regarding internet connectivity and ICT infrastructure. Access to ICT devices remains a major challenge, with only a minority of teachers having sufficient access to computers or laptops, and most reporting unreliable hardware [36], [37]. While internet connectivity in schools is considered supportive of digital learning media, the lack of time, suitable spaces for ICT-based lesson preparation, and clear procedures for ICT maintenance or upgrades further exacerbate the issue [38], [39]. These findings are consistent with studies highlighting the uneven distribution of technological support and facilities in schools [40], [41].

To bridge the digital divide and unlock technology's potential in Indonesian education, tailored professional development for educators is essential [42], [43]. Equally important is providing school-based technological tools to foster digital competencies and develop digital learning materials [44], [45], [46]. Therefore, enhancing device availability, maintenance management, resource allocation, and ICT administrative systems is crucial for comprehensive technology integration in elementary education. Survey results highlight significant gaps in teachers' digital literacy, particularly in using online learning platforms, understanding data security, and creating interactive teaching materials. These technical shortcomings may hinder the effectiveness of classroom technology integration [47], [48]. While some teachers proactively improve their ICT skills through online tutorials and training, there is an urgent need for structured, comprehensive training programs [49]. Such programs should cover operational skills, digital ethics, data security, and innovative material development. To support digital transformation in elementary education, policies must promote inter-institutional collaboration to provide relevant and sustainable training resources, especially in Indonesia, which has one of the largest digital user bases [50], [51], [52].

Findings from West Java reveal significant challenges in accessing and implementing ICT professional development programs for elementary teachers. Physical and financial limitations, insufficient information, poor-quality training materials, and limited post-training support highlight the urgent need for fundamental policy reforms [53], [54]. Research shows that teachers' attitudes toward technology greatly influence educational outcomes, emphasizing the importance of fostering positive attitudes and providing support for ICT use [55], [56]. Efforts to enhance teachers' ICT competencies must be supported by adequate facilities and relevant training programs to improve teaching quality and ensure effective, inclusive digital transformation in elementary education [57], [58], [59].

The survey also reveals weak school-level policy support for improving teachers' ICT competencies in West Java, as shown by the lack of strategic plans, limited leadership encouragement, insufficient budget allocation, and minimal collaboration [60]. This situation is further exacerbated by an uneven distribution of technological support [61]. Since ICT utilization can enhance learning quality, multidimensional policy integration, including strategic planning, leadership reinforcement, sustainable budgeting, and collaborative ecosystem development, is essential to create a supportive environment for comprehensive ICT competency enhancement [62], [63].

The study further identifies a dichotomy between teachers' intrinsic motivation toward ICT and psychological barriers to its implementation in West Java [64], [65]. While educators recognize ICT's potential to improve learning outcomes and are motivated to adopt new methods, fear of failure and hesitation remain significant obstacles [66]. Prioritizing peer-learning mentorship, risk-tolerant training, and incentives is thus crucial [67]. Additionally, fostering a safe environment for experimentation and strengthening support ecosystems through online communities and face-to-face collaboration can transform individual motivation into sustainable collective practices [68], [69], [70].

4. CONCLUSION

This study identifies five main factors influencing the pedagogical competence of elementary school teachers in the digital era: digital infrastructure, teachers' digital literacy, access to competency development, school policy support, and teachers' attitudes and motivation. Survey results reveal that digital infrastructure in West Java schools still faces disparities, with limited access to ICT devices and suboptimal maintenance management. Teachers' digital literacy tends to be low, particularly in using online learning platforms, data security, and creating interactive materials. Access to ICT competency development programs is also hindered by limited training availability, inadequate information, and a lack of post-training mentoring. On the policy side, weak strategic planning, budget allocation, and leadership support exacerbate these challenges. Although most teachers have intrinsic motivation and believe in the benefits of ICT, psychological barriers such as fear of mistakes hinder practical implementation. The study recommends multidimensional policy reforms, including infrastructure improvement, needs-based holistic training, inter-institutional collaboration, and strengthening support systems through peer learning and incentives to create a conducive environment for digital transformation in elementary education. These

findings underscore the need for sustained integration of policy and practice to address competency gaps and maximize technology's potential in learning.

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