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THE ROLE OF TECHNOLOGY IN IMPROVING TEACHING EFFECTIVENESS IN INDONESIAN ELEMENTARY SCHOOLS IN THE DIGITAL LEARNING ERA

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ABSTRACT

This study examines the role of technology in improving teaching effectiveness in Indonesian elementary schools within the digital learning era. Despite the rapid integration of digital tools in education, previous studies have shown inconsistencies in how technology contributes to teaching effectiveness, particularly in developing country contexts such as Indonesia. This research addresses this gap by synthesizing recent empirical and theoretical studies. This study employs a systematic literature review method by analyzing peer-reviewed national and international journal articles published between 2018 and 2024. Sources were collected from major academic databases using keywords related to educational technology, teaching effectiveness, and elementary education. Thematic analysis was applied to identify patterns across studies. The findings reveal that technology significantly enhances teaching effectiveness through improved instructional planning, increased student engagement, strengthened formative assessment, and support for differentiated learning. However, major challenges remain, including unequal digital infrastructure, limited teacher digital competence, and insufficient institutional support. This study contributes by providing a comprehensive synthesis of technology integration in Indonesian elementary education and offers practical implications for teachers, school leaders, and policymakers. It recommends continuous teacher training, infrastructure development, and policy alignment to ensure sustainable digital transformation in education.

Keywords: Educational Technology, Teaching Effectiveness, Elementary Education, Digital Learning, Teacher Digital Competence.

INTRODUCTION

The rapid development of digital technology in recent decades has brought significant changes to the field of education, including at the elementary school level. Digital transformation requires teachers and educational institutions to adapt to a wide range of modern learning media that continue to evolve. These changes are not merely technical but also pedagogical, influencing how learning is designed, implemented, and evaluated. As noted by Kurniawan (2022), education in the 21st century cannot be separated from technology, as it plays a crucial role in shaping both the direction and quality of the learning process. This highlights that technology integration is no longer optional but has become a fundamental necessity in elementary education.

Despite its importance, the integration of technology in learning still faces several challenges. One of the primary issues is the limited digital competence of teachers. Previous studies indicate that many elementary school teachers have not yet developed sufficient digital literacy skills to effectively integrate technology into their teaching practices. Hutagalung and Purbani (2021) emphasize that continuous digital

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literacy training is essential for teachers to design innovative and technology-supported learning. This suggests that teacher readiness is a key determinant of successful technology implementation.

In addition to teacher-related factors, disparities in technological infrastructure remain a significant barrier. Access to digital resources is not evenly distributed across Indonesia, particularly in 3T areas (remote, frontier, and outermost regions). Schools in these areas often face limitations such as inadequate devices, unstable internet connections, and a lack of computer facilities. Lestari (2020) argues that this inequality creates a "digital learning divide" between urban and rural schools, limiting equitable access to technology-enhanced learning and reducing its overall effectiveness.

Nevertheless, a growing body of research highlights the substantial potential of technology to improve the quality of learning. The use of interactive media, animated videos, simulations, and digital learning platforms has been shown to enhance student engagement and participation. Saifuddin and Putra (2023) found that digital media significantly improves students' motivation and focus in elementary education. These findings indicate that technology can serve as an effective tool to create more engaging and meaningful learning experiences.

The integration of technology in education is closely related to the TPACK (Technological Pedagogical Content Knowledge) framework, which emphasizes the importance of understanding the relationship between technology, pedagogy, and subject content. According to Mishra and Koehler (2006), teachers who master TPACK are better able to integrate technology in ways that align with students' learning needs. Therefore, TPACK serves as a foundational framework for designing innovative and effective learning in elementary schools.

In addition, constructivist learning theory provides a relevant perspective for understanding technology-enhanced learning. This theory views students as active learners who construct knowledge through interaction with their environment, including digital media and online resources. Jonassen (1999) suggests that technology can create rich learning environments that support exploratory and collaborative learning processes. Therefore, digital media should be intentionally designed to facilitate active and student-centered learning. In practice, technology-based learning can promote collaboration among students through platforms such as Google Classroom, Padlet, and Quizizz. Padmadewi et al. (2021) found that teachers who are trained in using digital tools are more capable of increasing student engagement and interaction during the learning process. This finding underscores the importance of teachers' ability to select and manage appropriate digital media in enhancing teaching effectiveness.

Furthermore, technology plays a significant role in strengthening formative assessment. Digital applications enable teachers to monitor student progress in real time, allowing for more responsive and adaptive instruction. Black and Wiliam (2018) highlight that technology-based formative assessment provides timely feedback that helps teachers adjust their teaching strategies effectively. This demonstrates that technology not only supports content delivery but also improves the accuracy and efficiency of assessment practices. However, the use of technology without proper pedagogical planning may also lead to challenges, such as student distraction and overdependence on digital devices. Izzah et al. (2022) emphasize that effective technology integration must be accompanied by strong digital classroom management

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skills to ensure that learning objectives are achieved. Therefore, teachers need to adopt clear and purposeful pedagogical strategies when integrating technology into their teaching. Based on the existing literature, it can be argued that the main challenges in technology integration are not solely related to the technology itself, but rather to teacher readiness, infrastructure availability, and institutional support.

METHODS

This study employed a systematic literature review approach to investigate the role of technology in improving teaching effectiveness in Indonesian elementary schools. This method was considered appropriate because it enables the researcher to synthesize existing knowledge from a wide range of scholarly sources without conducting direct fieldwork. By systematically collecting, evaluating, and integrating findings from previous studies, this approach provides a comprehensive understanding of trends, challenges, and best practices in technology-enhanced learning.

The data for this study were obtained from several reputable academic databases to ensure the credibility and relevance of the sources. These databases included Scopus, ERIC (Education Resources Information Center), Google Scholar**,** and SINTA-indexed national journals**.** In addition to journal articles, official reports published by the Indonesian Ministry of Education, Culture, Research, and Technology were also reviewed to provide contextual insights into national education policies and digital transformation initiatives. The literature search was conducted using combinations of keywords such as *"educational technology," "teaching effectiveness," "elementary school," "digital learning," "teacher digital competence,"* and *"Indonesia."* Boolean operators (AND, OR) were applied to refine search results and ensure the inclusion of the most relevant studies.

To maintain methodological rigor, this study applied clear inclusion and exclusion criteria. The inclusion criteria consisted of: (1) articles published between 2018 and 2024 to ensure the relevance of recent developments in digital learning; (2) studies focusing on elementary education; (3) research discussing technology integration in teaching and learning processes; and (4) articles published in peer-reviewed journals. Meanwhile, studies were excluded if they focused on higher education contexts, lacked clear relevance to teaching effectiveness, or did not provide sufficient empirical or theoretical discussion. Through this selection process, a total of 45 articles were initially identified. After removing duplicates and screening abstracts and full texts, 28 articles met all criteria and were selected for further analysis.

The data analysis process was conducted using thematic analysis, which allows for the identification of patterns and key themes across multiple studies. The analysis involved several stages. First, all selected articles were carefully read and coded to identify recurring concepts related to technology use in education. Key themes that emerged included instructional planning, student engagement, formative assessment, learning outcomes, teacher digital competence, and infrastructure challenges. Second, each theme was analyzed critically to explore relationships between findings, as well as similarities and differences across studies. This step was essential to move beyond descriptive reporting and develop a more analytical understanding of the data. Third, the results were synthesized to generate a coherent explanation of how technology contributes to teaching effectiveness in elementary schools.

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To ensure the reliability and validity of the findings, this study relied exclusively on credible and peer-reviewed sources. Cross-comparison of multiple studies was conducted to confirm the consistency of findings and minimize bias. Furthermore, the use of diverse data sources, including both national and international publications, allowed for a more balanced and comprehensive perspective.

Despite its strengths, this study has several limitations. First, as a literature review, it depends entirely on secondary data, which may limit the ability to capture current practices in real classroom settings. Second, there is a possibility of publication bias, as studies with positive findings are more likely to be published. Third, variations in research contexts, methodologies, and sample characteristics across the selected studies may affect the generalizability of the conclusions. Therefore, future research is recommended to complement these findings with empirical studies conducted in specific educational settings.

Overall, this systematic literature review provides a robust methodological foundation for understanding the role of technology in enhancing teaching effectiveness. By integrating findings from multiple sources, this study offers valuable insights into both the opportunities and challenges of technology integration in Indonesian elementary education.

RESULTS AND DISCUSSION

Result

1. Technology Integration in Learning Elementary school

   Results of the study various journal show that technology own role strategic in increase quality of the learning process teaching at school basic. Digital media such as videos, simulations, and educational games proven increase focus and understanding students. According to Mayer (2020:112), "multimedia learning improves retention Because student absorb information through two channels cognitive simultaneously, namely visual and verbal." Findings This in line with Saifuddin & Putra's (2023) study which reported improvement interest Study student after use of interactive platforms.

2. Strengthening Planning Learning Technology Based

   In addition to improving involvement students, technology play a role in make it easier for teachers to design device learning such as lesson plans, digital modules, and interactive teaching materials. Research Hutagalung & Purbani (2021) shows that The use of a Learning Management System (LMS) helps teachers organize material, managing time, and monitor achievement competence students. With the existence of platforms such as Google Classroom and Merdeka Mengajar, planning learning can made more systematic and structured.

3. Improvement Motivation and Engagement Study Student

   Findings a number of journal state that technology can increase motivation Study through mechanism gamification, digital rewards and activities collaborative (Hamzah, 2022). For example, research on the use of Quizizz and Kahoot shows that student become more active, brave try answer, and show more interest tall to material (Rahmi, 2021). Technology allows learning happen in more atmosphere interactive and fun.

Table 1. Summary Impact Technology in Elementary School Learning

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Researchers	Media/Platform	Impact on Students
Saifuddin & Putra (2023)	Interactive media	Increase motivation & focus
Rahmi (2021)	Quizizz	Student more active & competitive
Ningsih (2022)	Math games	Increase solution problem
Wahyudi (2021)	Animated video	Make it easy understanding science concept

4. Strengthening Assessment Formative Digital Based

Technology also plays a role in strengthen Evaluation of the learning process. Use of Google Forms, Live Worksheets, and other digital applications allows teachers to do assessment formative in a way fast and accurate (Black & Wiliam, 2018). The data obtained in real-time helps teachers assess difficulty students and provide intervention more right. With Thus, the assessment based technology increase quality bait come back in learning.

5. Challenges Infrastructure and the Digital Divide

However, the results literature also shows that integration technology Not yet fully running optimally. Challenges the biggest is limitations infrastructure in the 3T region. Lestari (2020) emphasized that inequality internet access " creates gap digital learning " between area cities and villages. Many schools base in a particular area Still lack device such as laptops, projectors, or stable internet connection.

6. Teacher Digital Competence as a Determining Factor

Limitations digital competence of teachers is one of the inhibitor main effectiveness use technology. According to Susilowati & Haryono (2021), many elementary school teachers experience difficulty in operate application learning so that technology No utilized in a way maximum. In fact, integration technology need ability strong technical and pedagogical skills, as explained in TPACK framework (Mishra & Koehler, 2006).

7. Relevance of TPACK and Implications Pedagogical

TPACK framework explains that use technology No may stand alone, but must in harmony with content and pedagogical strategies. Research show that teachers who understand TPACK can integrate technology in a way more effective, for example with choose the appropriate media objective learning and managing digital class in efficient (Putra, 2022). This in line with theory digital constructivism that emphasizes learning active through interaction with digital media (Jonassen, 1999).

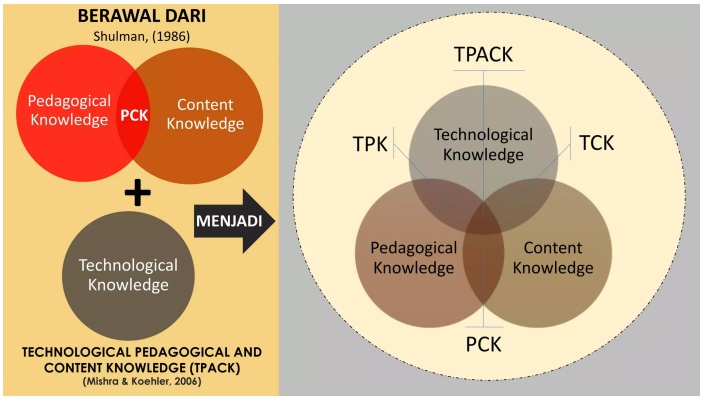

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Figure 1. Technology Integration Model in Elementary School Learning (TPACK Adaptation)

8. Influence Technology towards Learning Outcomes Student

Most of the study report that utilization technology increase results Study student in various eye lessons, including mathematics, science, and language. For example, educational games mathematics proven increase ability solution problem elementary school students (Ningsih, 2022). Animated videos also help student increase understanding science concept (Wahyudi, 2021). This show impact positive technology to achievements cognitive student.

9. Effectiveness Technology in Learning Differentiated

Literature results indicates that technology make it easier for teachers to implement learning differentiated based on individual needs of students. Digital platforms enable teachers to provide material in accordance level ability and style Study students (Tomlinson, 2017). With Thus, technology support equality access Study for student with ability different.

10. Needs Policy Supportive Schools Digital Transformation

Apart from teacher factors, policies school hold role important in success integration technology. Field studies show that schools that have clear digital vision, ongoing teacher training, and support technical tend more succeed in utilise technology (Padmadewi et al., 2021). Without strong policies, utilization technology often not consistent and only nature temporary.

11. Synthesis Findings Study

In a way overall, results analysis literature show that technology own potential big For increase effectiveness teach if supported by teacher competence, adequate infrastructure, and appropriate pedagogical strategies. Findings This in line with global research that emphasizes importance digital literacy for teachers face challenge learning 21st century (UNESCO, 2023). Technology integration No only influence the learning process, but also influence method student interact, collaborate, and build knowledge.

Discussion

The findings of this study demonstrate that technology integration plays a significant role in improving teaching effectiveness in Indonesian elementary schools. However, its effectiveness is not solely determined by the availability of technology, but rather by the interaction between pedagogical practices, teacher competence, infrastructure, and institutional support. This section critically discusses these findings by synthesizing evidence from previous studies and linking them to relevant theoretical frameworks.

First, the integration of technology in elementary education has been shown to enhance student engagement and conceptual understanding. Digital media such as videos, simulations, and educational games provide multimodal learning experiences that support cognitive processing. This is consistent with the multimedia learning theory, which suggests that students learn more effectively when information is presented through both visual and verbal channels (Mayer, 2009). Empirical studies also support this claim, indicating that interactive digital platforms significantly increase students' motivation and attention during the learning process (Saifuddin &

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Putra, 2023). However, while these studies emphasize increased engagement, they often do not address whether such engagement leads to sustained learning outcomes, indicating a gap for further research.

Second, technology contributes to more effective instructional planning. The use of Learning Management Systems (LMS) and digital platforms enables teachers to organize teaching materials, manage instructional time, and align learning objectives with assessment strategies. Hutagalung and Purbani (2021) found that teachers who utilize LMS are better able to structure their lessons and monitor student progress systematically. Nevertheless, the effectiveness of digital planning tools depends on how they are used. Without adequate pedagogical knowledge, technology may be limited to administrative functions rather than enhancing instructional quality.

Third, the role of technology in increasing student motivation and engagement is widely supported across the literature. Gamification strategies, such as quizzes, rewards, and interactive challenges, encourage students to participate more actively in the learning process. Research on platforms such as Quizizz and Kahoot shows that students become more confident, competitive, and engaged (Rahmi, 2021). However, this raises a critical concern regarding the overreliance on extrinsic motivation. According to constructivist perspectives, meaningful learning should be driven by intrinsic motivation and active knowledge construction (Jonassen, 1999). Therefore, teachers must carefully design learning activities that balance engagement with deeper cognitive processes.

Furthermore, technology plays a crucial role in strengthening formative assessment practices. Digital tools such as Google Forms and Live Worksheets allow teachers to provide immediate feedback and monitor student progress in real time. This aligns with the principles of formative assessment, which emphasize the importance of timely feedback in improving learning outcomes (Black & Wiliam, 2018). Compared to traditional assessment methods, technology-based assessment is more efficient and provides richer data for instructional decision-making. However, its effectiveness depends on teachers' ability to interpret and act upon the data, which again highlights the importance of teacher competence.

Despite these advantages, the integration of technology in Indonesian elementary schools is still constrained by infrastructure limitations and the digital divide. Access to digital resources remains uneven, particularly in 3T (remote, frontier, and outermost) regions. Lestari (2020) argues that disparities in internet access and technological facilities create a significant gap between urban and rural schools. This finding suggests that while technology has the potential to enhance educational quality, it may also exacerbate inequality if access is not equitably distributed. Therefore, addressing infrastructure challenges is essential for ensuring inclusive digital learning.

Another key finding of this study is the critical role of teacher digital competence. Teachers' ability to effectively integrate technology is a major determinant of teaching effectiveness. This finding is strongly supported by the TPACK framework, which emphasizes the integration of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). Teachers with strong TPACK are better able to select appropriate digital tools, design meaningful learning activities, and manage digital classrooms effectively. Conversely, teachers with limited digital competence tend to use technology superficially, limiting its impact on student learning (Susilowati &

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Haryono, 2021). This highlights the need for continuous professional development that focuses not only on technical skills but also on pedagogical integration.

In addition, the findings confirm the relevance of constructivist learning theory in technology-enhanced education. Digital tools support active and collaborative learning by allowing students to interact with content, peers, and teachers. Jonassen (1999) emphasizes that technology can create rich learning environments that facilitate knowledge construction through exploration and collaboration. However, without proper instructional design, technology may lead to distraction rather than meaningful learning. Therefore, effective integration requires careful alignment between technology use and pedagogical goals.

The study also indicates that technology has a positive impact on student learning outcomes across various subjects. For example, educational games have been shown to improve problem-solving skills in mathematics, while animated videos enhance students' understanding of scientific concepts (Ningsih, 2022; Wahyudi, 2021). However, the magnitude of this impact varies depending on the quality of implementation, suggesting that technology alone is not sufficient to guarantee improved outcomes.

Moreover, technology supports differentiated learning by enabling teachers to tailor instruction to individual student needs. Digital platforms allow for flexible content delivery, adaptive learning pathways, and personalized feedback. This is consistent with Tomlinson's (2017) concept of differentiated instruction, which emphasizes the importance of addressing diverse learning needs. As a result, technology can contribute to more inclusive and equitable learning environments.

Finally, institutional support and school-level policies play a crucial role in sustaining technology integration. Schools with clear digital strategies, ongoing teacher training, and adequate technical support tend to achieve more effective implementation (Padmadewi et al., 2021). Without such support, technology use often remains inconsistent and limited in scope. This finding highlights the importance of a systemic approach to digital transformation in education. Overall, this study demonstrates that technology integration is a complex and multidimensional process. While it offers significant potential to improve teaching effectiveness, its success depends on the interaction between teacher competence, infrastructure availability, pedagogical strategies, and institutional support. These findings reinforce the view that technology in education should be understood not merely as a tool, but as part of a broader systemic transformation in teaching and learning.

CONCLUSION

Study This aim For analyze role technology in increase effectiveness teaching at school base through study literature. Based on results synthesis to various journal national and international, can concluded that digital technology provides contribution real to improvement involvement students, reinforcement assessment formative, as well as effectiveness delivery materials. Various digital media— such as interactive videos, simulations, applications learning, and online assessment platforms —proven capable enrich experience Study students and strengthen achievement objective learning.

In addition, the study This produce main points thinking new, namely that success integration technology No only determined by availability digital devices and media, but also by the readiness teacher pedagogical support policy school, and culture

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adaptive learning. Findings This show that transformation learning based technology must viewed as a systemic process involving teachers, infrastructure, leadership schools, and sustainable digital ecosystems. With Thus, optimization utilization technology in learning school base need three step strategic : improvement digital competence of teachers, equality facilities and infrastructure school, and compilation policy integrative that encourages innovation learning.

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