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Exploring the Use of Interactive Digital Media Applications to Enhance Literacy and Numeracy Skills in Elementary Education

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Abstract

The rapid advancement of digital technologies has fundamentally transformed educational practices, particularly in Islamic Religious Education (PAI), where technology integration must balance pedagogical innovation with moral and spiritual values. This study explores digital transformation in PAI learning by reviewing and synthesizing relevant scholarly literature published between 2020 and 2025. Drawing on peer-reviewed journal articles, conference proceedings, and academic publications sourced from Google Scholar and nationally accredited journals, the review focuses on themes of digital pedagogy, teacher competence, ethical considerations, and the application of the TPACK framework in value-based education. The synthesis highlights three key dimensions: (1) opportunities, where technology enhances learning accessibility, student engagement, and instructional personalization through interactive media and digital platforms; (2) challenges, including infrastructural limitations, varying levels of teacher digital competence, and ethical concerns regarding content authenticity and data privacy in religious contexts; and (3) strategic solutions, emphasizing continuous TPACK-based professional development, the creation of religiously aligned digital content, and supportive institutional policies. This review contributes a conceptual understanding of how digital transformation can be sustainably integrated into PAI, underscoring that successful implementation requires holistic alignment of technology, pedagogical competence, ethical governance, and systemic support. The findings offer practical recommendations for educators

Keywords: interactive digital media, literacy and numeracy, elementary education

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Introduction

Education is a fundamental pillar of national development and plays a crucial role in enhancing the quality of human resources in the global era (Afandi et al., 2024). In the Indonesian context, characterized by a large population and diverse socio-cultural backgrounds, the need to strengthen foundational competencies such as literacy and numeracy has become increasingly urgent. These competencies are widely recognized as essential determinants of educational quality and long-term national competitiveness (Mutaqin et al., 2023).

Despite their importance, numerous studies indicate that literacy and numeracy achievement among Indonesian students remains relatively low. International assessments such as the Programme for International Student Assessment (PISA) consistently place Indonesia below the OECD average in reading, mathematics, and science performance (Chalik & Cahyani, 2024; Janul & Sunendar, 2024). Although there have been slight improvements in recent years, the overall performance still reflects significant gaps compared to global standards. This condition is further exacerbated by learning loss during the COVID-19 pandemic, which has widened educational disparities and hindered student achievement (Fazalani et al., 2022; Kartono et al., 2023; Riyadi et al., 2021).

Several factors contribute to the low level of literacy and numeracy skills among students. These include traditional teaching practices that emphasize rote learning, limited student engagement, inadequate learning resources, and insufficient teacher competence in implementing innovative instructional strategies (Chalik & Cahyani, 2024; Kusumastuti et al., 2023). Additionally, disparities in access to educational resources across regions, particularly between urban and rural areas, further intensify the inequality in learning outcomes (Yudiana et al., 2023).

In response to these challenges, the integration of digital technology in education has emerged as a promising solution. The rapid advancement of digital transformation, particularly in the era of Industry 4.0 and Society 5.0, has reshaped educational practices and created new opportunities for interactive and student-centered learning (Pratiwi & Riyana, 2023). Digital learning environments, including interactive applications, multimedia tools, and online platforms, have been shown to enhance student engagement, motivation, and understanding by providing visual, auditory, and interactive learning experiences (Yusuf et al., 2023).

Previous studies by Yusuf et al (2023) and Mariati et al (2023) have examined the effectiveness of digital media in improving learning outcomes, while Nsabayezu et al (2023) and Syahfitri & Safitri (2024) have demonstrated the positive impact of digital-based learning modules on literacy development. However, none of these studies has specifically explored the implementation process of interactive digital media applications in Indonesian elementary school classrooms, particularly regarding how these tools are integrated into daily teaching practices to enhance both literacy and numeracy skills simultaneously. Therefore, this study aims to explore the use of interactive digital media applications in enhancing literacy and numeracy skills in elementary education, with a particular focus on the learning process, student engagement, and implementation challenges.

However, despite the potential benefits of digital media, its implementation in primary education remains suboptimal. Many teachers still use digital tools as supplementary resources rather than integrating them systematically into instructional design. Moreover, challenges such as limited infrastructure, inadequate digital competence among teachers, and unequal access to technology hinder the effective use of interactive digital media in classrooms (Afandi et al., 2024; Apriatni & Khaeroni, 2023; Hermila & Bau, 2023; Yulista, 2021).

Method

This study employed a qualitative descriptive design conducted at SD Negeri 48 Palembang over four months (January–April 2025). Participants were selected through purposive sampling, comprising 8 teachers, 24 students (stratified as 8 from grades 1–2, 8 from grades 3–4, and 8 from grades 5–6), and 2 school administrators. The school was chosen based on specific criteria: it has implemented digital-based learning for at least two academic years, utilizes a comprehensive suite of interactive applications (e.g., educational videos, digital storytelling tools, and math simulations), serves as a district pilot school for digital transformation, and demonstrates strong institutional commitment to technology integration. Data were collected using three primary instruments: an observation guide (applied twice weekly for 32 sessions across grade levels), semi-structured interview protocols (administered three times for teachers and twice for students), and a documentation checklist (used continuously to gather lesson plans, student artifacts, and policy documents). These tools were systematically deployed to capture media utilization patterns, implementation processes, impacts on literacy and numeracy, and contextual challenges.

Data analysis followed Miles and Huberman's interactive model, comprising data reduction, data display, and conclusion drawing. Data reduction was conducted by coding interview transcripts and field notes into five thematic categories: media types, teacher implementation strategies, student responses and engagement, technical and pedagogical challenges, and supporting factors. For instance, codes such as "interactive quiz applications" and "animated math simulations" were grouped under media types, while references to "scaffolding techniques" and

"differentiated pacing" were categorized under teacher strategies. Reduced data were then organized into narrative matrices to identify cross-grade patterns, followed by iterative conclusion drawing to align emerging themes with the study's input–process–output framework. To ensure trustworthiness, methodological and data source triangulation was applied, and member checking was conducted by sharing preliminary interpretations with participants to verify accuracy and contextual relevance.

Results and Discussion

Results

1. Implementation of Interactive Digital Media in Elementary Classrooms

The findings of this study reveal that the implementation of interactive digital media applications in elementary classrooms has been conducted in a structured yet adaptive manner. Teachers utilized various digital platforms such as learning applications, multimedia presentations, and interactive quizzes to support literacy and numeracy instruction. These tools were integrated into daily lesson plans and aligned with curriculum objectives, particularly those emphasizing student-centered learning. The use of digital media was not limited to content delivery but extended to facilitating interaction and engagement among students. This reflects a shift from traditional teaching methods toward more dynamic and technology-enhanced pedagogy.

As one teacher (Grade 4) explained during the interview: *"I use interactive quiz apps like Quizizz and Wordwall almost every week. Students seem more engaged than when I only use textbooks. They even ask each other questions if they don't understand something."* A student from Grade 5 also shared*: "I prefer learning using apps because they have pictures and sound. If I just read a book, I get bored quickly. But using an app feels like playing but still learning."*

Furthermore, the implementation process demonstrated flexibility depending on classroom conditions and student needs. Teachers adjusted the complexity of digital tools based on students' grade levels and prior exposure to technology. In lower grades, simpler applications with visual and audio elements were prioritized to support foundational literacy skills. In contrast, higher grades engaged with more complex applications that required problem-solving and critical thinking, especially in numeracy tasks. This differentiation ensured that digital media usage remained inclusive and effective across diverse student groups.

In addition, classroom observations indicated that digital media fostered a more interactive learning environment. Students were more actively involved in answering questions, participating in quizzes, and collaborating on tasks. The presence of gamification elements such as rewards and scores increased motivation and sustained attention during lessons. Teachers also reported that students showed higher enthusiasm compared to conventional textbook-based instruction. This suggests that interactive digital media can enhance both cognitive and affective aspects of learning.

However, the implementation was not without challenges. Some teachers experienced difficulties in managing classroom activities when students were highly engaged with digital devices. Additionally, technical issues such as unstable internet connections occasionally disrupted learning processes. Despite these obstacles, teachers demonstrated adaptability by preparing alternative offline activities. Overall, the implementation of interactive digital media can be considered effective, although continuous support and infrastructure improvement are necessary.

Figure 1. Classroom Implementation of Digital Media

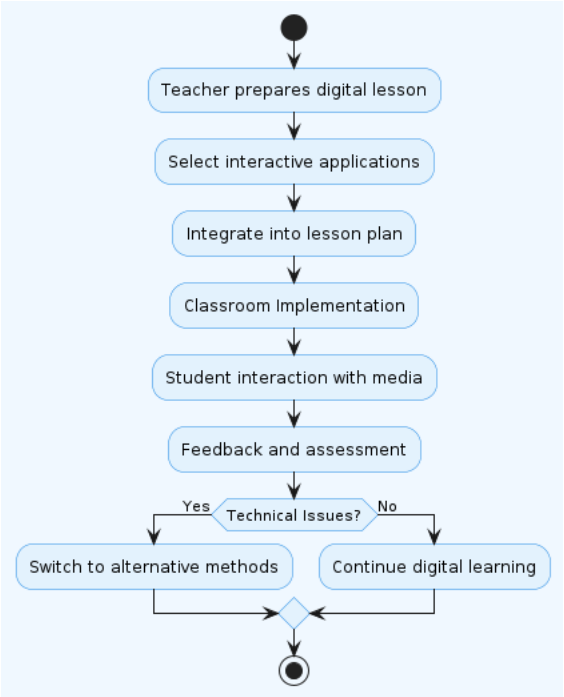

Figure 2. Process of Implementing Interactive Digital Media in Elementary Classroom Learning

Table 1. Types of Digital Media Used

No	Type of Media	Purpose	Grade Level
1	Interactive Quiz Apps	Assessment and engagement	3–6
2	Educational Videos	Concept explanation	1–6
3	Digital Storytelling Tools	Literacy development	1–4
4	Math Simulation Apps	Numeracy practice	4–6

The diagram illustrates the flow of digital media implementation in classroom settings, beginning from lesson preparation to evaluation. The table complements this by identifying the types of digital tools used and their instructional purposes. Together, they demonstrate how structured planning and tool selection contribute to effective integration of technology in elementary education.

2. Impact on Students' Literacy Skills

The results indicate that the use of interactive digital media noticeably contributes to the improvement of students' literacy skills. Students demonstrated enhanced reading comprehension, vocabulary acquisition, and writing abilities after consistent exposure to digital learning tools. Multimedia elements such as images, animations, and audio narration supported students in understanding textual content more effectively. This multimodal approach aligns with contemporary literacy frameworks that emphasize meaning-making through multiple representations.

A Grade 3 teacher noted: *"The most visible change is in the students' vocabulary. After using the digital storytelling app, they've found themselves using new words more frequently in their writing. They used to write only 2-3 sentences, but now they can write 5-6 sentences with clearer ideas."* One student from Grade 4 expressed: *"I used to be reluctant to read because the text was long. But now there are apps that have pictures and let me listen to the story, so I read more often. I even borrow my sister's tablet at home to read digital stories."*

Moreover, students showed increased motivation to engage with reading materials presented through digital platforms. Unlike traditional printed texts, digital content often includes interactive features that encourage exploration and active participation. Students were more willing to read longer passages and complete comprehension tasks when presented in digital formats. Teachers observed that reluctant readers became more engaged when using applications that included gamified reading activities.

Another notable finding is the improvement in students' writing skills. Digital platforms provided opportunities for students to create their own texts, such as short stories and reflections, using structured templates. The availability of instant feedback and editing tools allowed students to revise their work more effectively. This iterative process contributed to better writing quality and increased confidence among learners.

Despite these positive outcomes, some challenges were identified. Not all students possessed equal digital literacy skills, which affected their ability to fully utilize the applications. Additionally, excessive screen time raised concerns among teachers regarding students' health and attention span. One teacher candidly shared: *"On the one hand, students are getting better at writing. But on the other hand, I've noticed that their eyes get tired quickly. Some students are just playing with their tablets, not really reading. So I have to constantly walk around the class to make sure they're focused."* Therefore, balanced integration of digital and traditional literacy practices remains essential.

Figure 3. Student Literacy Activities Using Digital Media

Table 2. Literacy Skill Improvements

Indicator	Before Implementation	After Implementation	Measurement Basis
Reading Comprehension	Moderate	High	Observation rubric, student work analysis
Vocabulary	Low	Moderate-High	Teacher assessment, vocabulary checklist
Writing Ability	Moderate	High	Writing portfolio, rubric scoring

Figure 4 highlights the progression from digital engagement to literacy improvement, emphasizing the reading and writing processes. Table 2 provides comparative evidence of skill enhancement, demonstrating measurable progress across literacy indicators after the use of digital media.

3. Impact on Students' Numeracy Skills

The findings also show a meaningful improvement in students' numeracy skills through the use of interactive digital applications. Students demonstrated better understanding of mathematical concepts, particularly in operations, problem-solving, and data interpretation. Digital tools provided visual representations that made abstract concepts more concrete and accessible. For example, simulations and animations helped students grasp mathematical relationships more intuitively.

A Grade 5 teacher explained: *"Kids now have an easier time understanding the concept of fractions because there are apps that display them visually. They used to be confused about why 1/2 equals 2/4, but now, with images they can slide around, they understand immediately."* A student from Grade 6 shared: *"I've become more confident working on math problems. If I get it wrong, the app immediately tells me, and I can try again. I'm not afraid of being scolded or teased by my friends. In fact, I often practice alone at home."* In addition, interactive exercises allowed students to practice numeracy skills repeatedly with immediate feedback. This feature enabled students to identify errors and correct them independently. Teachers reported that students became more confident in solving mathematical problems and were less anxious during assessments. The gamification elements in numeracy applications further enhanced engagement and persistence.

Collaborative learning was also observed during numeracy activities. Students often worked in pairs or small groups to solve problems using digital tools. This collaboration encouraged discussion and exchange of ideas, which contributed to a deeper understanding. The use of digital media thus supported both individual and social learning processes. However, challenges such as varying levels of mathematical ability and digital proficiency affected learning outcomes. Some students required additional guidance to navigate applications effectively. As one teacher pointed out, *"Not all students develop at the same pace. Some learn right away, while others take longer. What worries me is that students who are already behind become even more frustrated because they feel their peers are ahead of them. I have to pay extra attention to them."* Teachers played a crucial role in facilitating learning and providing scaffolding when necessary. Overall, the integration of digital media proved beneficial in enhancing numeracy skills, though individual differences must be carefully addressed.

Figure 4. Numeracy Learning with Digital Applications

4. Challenges in Implementing Digital Media

The study identified several challenges in the implementation of interactive digital media. One major issue was the limitation of technological infrastructure, including unstable internet connections and insufficient devices. These constraints affected the continuity of digital learning activities and sometimes caused delays in instruction. Schools with limited resources faced greater difficulties in adopting technology-based learning.

A teacher expressed frustration: *"The internet at this school is often intermittent. I've prepared digital materials, but then the connection suddenly disappears. In the end, I have to go back to the old method, using a whiteboard. This really disrupts the rhythm of learning and confuses students."* Another teacher added: *"The number of tablets available is not proportional to the number of students. One tablet must be shared by two or three students. As a result, students who don't have a tablet become passive and less engaged in learning."*

Another challenge was related to teachers' digital competence. Although teachers showed willingness to use digital tools, not all of them possessed adequate technical skills. Some required additional training to effectively integrate applications into their teaching practices. This highlights the importance of professional development programs focused on digital pedagogy. One senior teacher admitted: *"I feel left behind. Younger teachers are quicker to master new applications. It takes me longer to learn, and I'm sometimes embarrassed to ask questions. I really want to use this technology effectively for my students."*

Student-related challenges were also observed, particularly differences in digital literacy levels. While some students adapted quickly to technology, others struggled with basic operations. This disparity required teachers to provide additional support, which increased instructional workload. Furthermore, managing classroom behavior during digital activities became more complex. Despite these challenges, the study found that continuous adaptation and collaboration among teachers contributed to overcoming obstacles. Schools that fostered a supportive environment were more successful in implementing digital media. Therefore, addressing these challenges requires a comprehensive approach involving infrastructure, training, and policy support.

Figure 5. Challenges in Digital Learning Implementation

5. Supporting Factors for Successful Implementation

The study also identified several supporting factors that contributed to successful implementation. Strong teacher commitment and willingness to innovate played a crucial role in integrating digital media. Teachers who actively explored new tools were more effective in engaging students and improving learning outcomes. Collaboration among teachers further enhanced the sharing of best practices. A motivated teacher shared: *"I often study on my own at home, watching YouTube tutorials on how to use new apps. I'm also not shy about asking younger teachers. The important thing is that students benefit from this technology."*

School support in terms of infrastructure and policy also influenced implementation success. Schools that provided access to devices and internet connectivity enabled smoother learning processes. Additionally, administrative support encouraged teachers to adopt innovative teaching methods. This created a positive environment for digital transformation.

Parental involvement was another important factor. Parents who supported their children's use of technology contributed to better learning experiences. Home environments that facilitated access to digital tools reinforced school-based learning. This synergy between school and home environments strengthened the overall impact of digital media. One parent mentioned during an informal conversation: *"I try to ensure my child has access to a tablet or laptop at home. I see he's more enthusiastic about learning now. He even teaches me how to use certain apps."* Finally, student motivation emerged as a key factor. Students who were interested in technology showed higher engagement and better learning outcomes. Interactive digital media aligned with students' preferences, making learning more enjoyable. Therefore, leveraging student interest in technology can enhance educational effectiveness.

Discussion

The findings of this study demonstrate that the use of interactive digital media applications significantly enhances students' literacy and numeracy skills in elementary education. This result is consistent with prior research by Yusuf et al (2023), which highlights that digital learning environments increase student engagement and facilitate deeper understanding through interactive and multimodal content. Similarly, Mariati et al (2023) found that digital media integration improves student motivation and participation, particularly when learning materials are presented in visually engaging formats. The present study reinforces these findings by showing that students become more active and enthusiastic during lessons involving digital applications. However, unlike some studies that emphasize fully digital environments, the findings from this study indicate that a blended approach (combining digital and traditional methods) has the potential to yield more balanced outcomes, although further research is needed to test this hypothesis.

In terms of literacy development, the results align with the work of *Janul & Sunendar (2024)*, who argue that literacy in the 21st century extends beyond basic reading and writing to include digital and multimodal competencies. The improvement in students' reading comprehension and writing skills observed in this study supports the notion that digital storytelling and interactive reading platforms can enhance literacy acquisition. Moreover, Nsabayezu et al (2023, See et al (2022), and Syahfitri & Safitri (2024) found that digital-based learning modules significantly improve students' literacy outcomes, particularly when combined with formative feedback. Nevertheless, some studies, such as Han & Kumwenda (2025) and Imran (2023), caution that unequal access to digital resources may limit the effectiveness of such interventions, a concern also partially reflected in the challenges identified in this study.

Regarding numeracy skills, the findings are supported by research conducted by Yayuk et al (2023) and Syauqi et al (2023), which emphasize that interactive and contextual learning approaches improve students' ability to apply mathematical concepts in real-life situations. The use of simulations and visual tools in this study helped students better understand abstract

mathematical concepts, confirming the arguments of Huda et al (2023) that numeracy is not merely about computation but about applying mathematical reasoning. Furthermore, the improvement in problem-solving skills observed in this study is in line with findings from Tyaningsih et al (2023), who demonstrated that technology-supported learning environments enhance higher-order thinking skills. However, this study also reveals that not all students benefit equally, particularly those with lower digital literacy, indicating a gap that is less emphasized in previous research.

The challenges identified in this study, particularly related to infrastructure and teacher competence, are widely documented in the literature. Pratiwi & Riyana (2023) argue that the success of digital transformation in education depends more on human factors than on technology itself. This aligns with the current findings, where teachers' digital competence played a crucial role in determining the effectiveness of implementation. Additionally, Hasrianti & Hidayati (2023) emphasize that teacher training in digital pedagogy is essential for optimizing technology use in classrooms. On the other hand, Bonok et al (2024) highlight the issue of digital divide, which is also evident in this study through disparities in student access and technological readiness. These findings suggest that systemic support is necessary to ensure equitable implementation.

Finally, the supporting factors identified in this study, such as teacher innovation, school support, and parental involvement, are consistent with previous studies emphasizing collaborative educational ecosystems. Afandi et al (2024) highlight the importance of teacher collaboration and adaptive strategies in overcoming educational challenges, particularly in resource-limited settings. Similarly, Kartono et al (2024) stress the role of parental support in reinforcing literacy and numeracy practices at home. The present study extends these findings by demonstrating that successful digital learning implementation requires alignment between school, home, and technological environments. However, unlike some prior studies that focus primarily on institutional factors, this research underscores the importance of student motivation as a central driver of success in digital learning contexts.

Conclusion

This study concludes that the integration of interactive digital media applications in elementary education effectively enhances students' literacy and numeracy skills while increasing classroom engagement and motivation. Digital tools facilitated differentiated learning, supported the development of higher-order thinking, and encouraged active participation across grade levels. However, this study is limited by its qualitative descriptive design and focus on a single elementary school in one urban district, which may restrict the generalizability of the findings to broader educational contexts with varying resource availability and policy frameworks.

Based on the findings, schools are recommended to implement targeted professional development programs, particularly for lower-grade teachers, focusing on the pedagogical integration of proven interactive applications such as Quizizz, Wordwall, and digital storytelling tools. Additionally, educational institutions should prioritize strengthening basic technological infrastructure and establishing peer-mentoring systems to support teachers with varying levels of digital competence. Future research should expand the scope by employing quantitative or mixed-method designs across multiple regions to further examine the long-term impact of digital media integration on foundational skill development and to develop scalable implementation models.

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