

Digital Literacy, the Use of Educational Technology, Student Engagement, and Learning Quality in Elementary and Islamic Elementary Education

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ABSTRACT

Digital transformation in elementary education has increased the importance of digital literacy and educational technology, yet previous studies have often examined digital literacy, technology use, student engagement, and learning quality as separate dimensions. This study aimed to synthesize the relationships among these four dimensions in elementary and Islamic elementary education and to identify contextual factors shaping their interaction. A qualitative literature review was conducted using 40 selected scholarly studies published within the most recent ten-year period, 2016–2025, covering international, national, and local Indonesian contexts. Relevant literature was identified according to its alignment with digital literacy, educational technology, student engagement, learning quality, and elementary or Islamic elementary education. Data were organized through a literature-recording matrix and analyzed thematically by comparing findings across studies. The results indicate that digital literacy provides a foundational capacity for meaningful and responsible educational technology use, extending beyond basic operational skills to critical evaluation, information management, communication, and digital participation. Educational technology supports behavioral, cognitive, emotional, and social engagement and can contribute to learning quality when integrated with appropriate pedagogy, learning objectives, and student needs. The synthesis further identifies student engagement as an important process connecting purposeful technology use with learning quality, while teacher competence, motivation, infrastructure, learning environment, and parental support shape this relationship. The study concludes that digital transformation should be understood as an interconnected pedagogical process rather than technology adoption alone, providing an integrated framework for strengthening learning in elementary and Islamic elementary education.

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INTRODUCTION

The rapid expansion of digital technology has transformed the way knowledge is accessed, communicated, and constructed in elementary education. In this context, digital literacy has become an increasingly important educational competence because students are expected not only to operate digital devices but also to evaluate information, communicate responsibly, solve

problems, and participate critically in digital environments. Digital literacy is therefore multidimensional, encompassing technical skills, information and media literacy, critical abilities, digital safety, digital citizenship, creativity, and digital well-being (Ilomäki et al., 2023). This broader understanding indicates that technology integration in elementary education should not be reduced to the availability or frequency of device use. Instead, students need opportunities to develop responsible, critical, and reflective forms of digital participation (Tadlaoui-Brahmi et al., 2022).

At the same time, the educational value of technology depends substantially on how it is implemented. Teachers' readiness, confidence, self-efficacy, and previous experience influence whether digital technologies are used meaningfully in classroom practice (Stringer et al., 2022). When technology is pedagogically integrated, it can provide opportunities for students to participate actively in learning and develop behavioral, affective, and cognitive engagement (Wong et al., 2024). Similarly, emerging technologies may enhance students' attention, effort, and perceived engagement when they are connected to meaningful learning activities rather than introduced merely as technological innovations (Maričić & Lavicza, 2024). These findings suggest that digital literacy, technology use, and student engagement should be understood as interconnected dimensions of contemporary elementary education rather than as independent educational concerns.

The Indonesian context presents similar challenges and opportunities. Empirical studies have associated students' digital literacy with learning outcomes in elementary schools, suggesting that the ability to understand and use digital resources can contribute to learning achievement (Arima et al., 2022; Wulandari & Aslam, 2022). Digital literacy among teachers and the quality of the learning environment are also related to student learning outcomes, emphasizing the importance of teacher competence in creating supportive technology-mediated learning environments (Yuliana et al., 2023). Beyond academic achievement, digital literacy can facilitate students' critical thinking when digital resources are used to obtain, evaluate, process, and apply information critically (Husaeni et al., 2023). Digital learning environments, including e-learning platforms, can consequently provide more flexible learning experiences while simultaneously supporting students' digital literacy development (Maharani et al., 2024). Interactive digital media, including digital comics and multimodal texts, have likewise been associated with more interactive learning experiences and improved elementary students' learning outcomes (Putri et al., 2023).

However, the Indonesian evidence also indicates that the implementation of digital education is uneven across contexts. Research conducted in Lombok found that digital literacy contributes to the development of students' learning behaviors and helps students adapt their learning habits to digital learning environments (Syafari et al., 2023). Nevertheless, classroom-based literacy practices in Lombok have continued to encounter limitations, while digital technology represents an opportunity for optimization when accompanied by teacher capacity and effective relationships among schools, families, and communities (Musaddat & Marhaeni, 2020). Teacher preparation is consequently an important component of technology integration. Training in the development and use of information-technology-based learning media can strengthen teachers' readiness to utilize technology in elementary education (Tahir et al., 2024). In mathematics education, digital media have been reported to facilitate visualization, classroom interaction, and conceptual understanding, although sustained implementation requires the development of teachers' technological capabilities (Junaidi et al., 2025). Similarly, the use of videos, interactive presentations, Kahoot, and Wordwall has been positively perceived by teachers and students because such media can support motivation, activity, and understanding, while limitations in

internet access, devices, and teacher digital literacy remain significant barriers (Nur & Iswatiningsih, 2025).

These findings are consistent with broader research emphasizing that educational technology produces meaningful effects when embedded within appropriate pedagogical practices. Digital technology can help address engagement gaps, but its contribution depends on how teachers incorporate it into instructional strategies and learning activities (Rizk & Davies, 2021). In Madrasah Ibtidaiyah, information and communication technology has also been associated with students' learning interest, indicating that students' attention and responses should be considered when implementing technology-based learning (Achmad & Pramudiani, 2022). From the teacher perspective, technology should be integrated with pedagogical and content knowledge rather than treated merely as an additional instructional device (Zakiah et al., 2021). Technology-integrated learning in Madrasah Ibtidaiyah can also support students' productivity and independence, although its implementation is influenced by device availability, network quality, and parental support (Prasetiyo & Prastowo, 2022). Blended learning similarly provides opportunities to combine learning activities, digital materials, and technology-based assessment while strengthening students' digital literacy (Nasir et al., 2022).

The relationship between technology and learning quality, however, is not linear. Digital learning models can promote interactive experiences and support students' understanding and learning interest when technology is used to strengthen visualization and learning activities (Putra Ali Akbar et al., 2024). Interactive digital learning media can also support learning motivation and academic achievement when appropriately incorporated into instructional design (Bintoro et al., 2024). In Islamic elementary education, the success of online learning depends not only on technology itself but also on implementation factors, learning support, and the surrounding learning environment (Zurqoni et al., 2022). Moreover, student engagement in digital learning should be viewed as a multidimensional construct rather than simply as attendance or technology use. It encompasses the quality and forms of students' participation in learning activities (Nkomo et al., 2021). Recent evidence further indicates that active, creative, and collaborative technology-based activities can support students' motivation and engagement across behavioral, cognitive, emotional, and social dimensions (Nikou, 2024).

Teacher competence and contextual conditions further complicate these relationships. Digital technology integration requires teachers to combine technological, pedagogical, and content knowledge so that technology can contribute meaningfully to the learning process (Bentri et al., 2025). Digital literacy and teacher motivation are likewise associated with the development of Technological Pedagogical Content Knowledge (TPACK), indicating that successful digital transformation requires both competence and motivational readiness (Harmadi et al., 2025). At the student level, integrating STEAM and connected learning can strengthen digital literacy and twenty-first-century skills when activities are connected to students' interests and experiences (Mansour et al., 2025). Conversely, infrastructure remains a contextual constraint, particularly in Madrasah Ibtidaiyah, where limitations in computers, projectors, devices, and internet access can restrict the quality and consistency of technology integration (Arif et al., 2025).

Previous literature has therefore established that digital literacy is important for students' learning capabilities, that educational technology can support engagement and learning outcomes, and that teacher competence and infrastructure influence the effectiveness of technology integration. Nevertheless, the existing literature remains fragmented. Many studies examine digital literacy and learning outcomes, technology use and engagement, teacher digital competence, or specific digital media separately. Other studies focus on particular technologies, individual learning

subjects, or specific implementation contexts. Although systematic reviews have synthesized digital literacy and digital technology research in elementary education (Tamborg et al., 2018; Audrin & Audrin, 2022; Wijayanti et al., 2024; Saifuddin & Putra, 2024), and research on digital personalized learning has examined how technology can support differentiated learning experiences (Van Schoors et al., 2021), these strands have not sufficiently been synthesized around the interconnected relationship among digital literacy, educational technology use, student engagement, and learning quality. Research has also demonstrated the importance of teachers' digital competence (Falloon, 2020; Tzafilkou et al., 2023), while recent research on children's engagement with digital technology indicates continuing conceptual and measurement inconsistencies in how engagement is defined and examined (Harverson et al., 2025). Recent systematic evidence likewise reports that digital technology can improve engagement and academic outcomes in primary education but emphasizes the continuing importance of teacher readiness, infrastructure, and implementation conditions (Prihatini et al., 2025).

This limitation is important because treating these variables independently may obscure the mechanisms through which technology contributes to meaningful learning. Digital literacy may shape students' ability to use digital resources, but access to technology alone does not guarantee engagement; similarly, engagement may contribute to learning quality, but its development depends on pedagogical design, teacher competence, motivation, and contextual support. The literature therefore requires an integrative synthesis that explains how these dimensions are connected across elementary and Islamic elementary education.

Accordingly, this literature review offers an integrative conceptual contribution by bringing digital literacy, educational technology use, student engagement, and learning quality into a single analytical framework. Rather than treating these variables as isolated constructs, the study synthesizes evidence concerning their interrelationships while considering teacher competence, motivation, infrastructure, learning environment, and parental support as important contextual conditions. Its contextual contribution also lies in bringing together evidence from international, Indonesian, and particularly Islamic elementary education settings, thereby providing a more comprehensive understanding of technology-mediated learning across diverse educational environments. The study therefore focuses on examining how digital literacy contributes to educational technology use, how technology use relates to student engagement and learning quality, and how these dimensions are interconnected in elementary and Islamic elementary education. Through this synthesis, the review aims to provide a coherent evidence-based foundation for understanding digital transformation and for informing the development of more engaging and higher-quality learning practices in elementary and Islamic elementary schools.

METHODS

1. Research Approach and Design

This study employed a qualitative literature review approach to examine the relationships among digital literacy, educational technology use, student engagement, and learning quality in elementary and Islamic elementary education. A qualitative approach was considered appropriate because the study aimed to interpret, compare, and synthesize findings from previous studies rather than statistically estimate an effect size. Qualitative inquiry enables researchers to understand patterns and meanings across a body of evidence and to organize findings according to the characteristics of the research problem (Creswell & Poth, 2024). Similarly, Sugiyono (2025) explained that qualitative research was appropriate for examining phenomena comprehensively through systematic interpretation of relevant data.

The review was organized around three research questions: (1) how digital literacy contributed to the use of educational technology in elementary and Islamic elementary education; (2) how educational technology influenced student engagement and learning quality; and (3) how digital literacy, educational technology use, and student engagement were interconnected in supporting learning quality. The review therefore did not treat the four variables as isolated topics but examined their conceptual and empirical relationships. The synthesis was directed toward identifying recurring findings, differences among studies, contextual factors, and areas that remained insufficiently explored.

2. Scope, Sources, and Selection of Studies

The literature sources consisted primarily of peer-reviewed journal articles and relevant scholarly publications concerning elementary education, Islamic elementary education, digital literacy, educational technology, student engagement, and learning quality. The literature analyzed in this study was limited to 40 selected studies published within the most recent ten-year period, 2016–2025. The literature was selected to represent international, national, and local Indonesian contexts so that broader trends could be compared with educational conditions in Indonesia. Particular attention was given to studies published in recent years, while several earlier methodological or conceptual sources were retained when they provided important foundations for interpreting the reviewed evidence.

The selection process considered the relevance of each publication to the research questions, the educational level examined, the relationship to at least one of the main concepts, and the availability of sufficient methodological or empirical information. Studies were excluded when they were unrelated to elementary or Islamic elementary education, focused exclusively on higher education without conceptual relevance to the present review, or did not provide sufficient information for meaningful synthesis. The selection of literature was conducted systematically to maintain a clear connection between the research questions and the evidence included in the review. Such systematic organization was important because qualitative research requires clear boundaries concerning the data sources and their relevance to the research objectives (Moleong, 2021).

3. Data Collection and Instruments

Data collection was conducted through documentary retrieval and systematic reading of selected scholarly publications. The researcher identified relevant studies using combinations of keywords related to digital literacy, educational technology, technology integration, student engagement, learning quality, elementary education, and Islamic elementary education. Searches were directed toward studies discussing relationships among these concepts rather than studies addressing only technological tools without educational implications.

A literature-recording matrix was used as the principal instrument for organizing the retrieved evidence. The matrix recorded the author and year, research context, educational level, research objectives, methodological approach, major findings, digital-literacy dimensions, forms of educational technology, indicators of student engagement, learning-quality outcomes, and relevant contextual factors. The use of a structured recording procedure helped ensure that information from different studies could be compared consistently. Brinkmann and Kvale (2018) emphasized the importance of systematic procedures in collecting and organizing qualitative evidence, particularly when researchers needed to interpret information from multiple sources. In the Indonesian methodological context, Hardani et al. (2020) also emphasized that qualitative data collection required systematic procedures so that information could be organized according to the focus of the research.

4. Data Analysis and Synthesis

The collected literature was analyzed thematically. First, the researcher read the selected studies repeatedly to identify findings relevant to the three research questions. Second, relevant information was extracted and grouped into preliminary categories. Third, similar findings were compared and combined into broader themes. The main themes included digital literacy and technology readiness, educational technology integration, student engagement, learning quality and learning outcomes, and contextual factors affecting technology use.

The analysis then examined relationships among the themes. Digital literacy was interpreted as a foundational learner and teacher capacity that could support meaningful educational technology use. Educational technology use was subsequently examined in relation to behavioral, cognitive, emotional, and social dimensions of student engagement. Finally, the literature was synthesized to determine how these interconnected dimensions contributed to learning quality. Braun and Clarke (2021) described thematic analysis as a flexible approach for identifying and interpreting patterned meanings across qualitative data, while Miles et al. (2020) emphasized the importance of data condensation, data display, and conclusion drawing in systematic qualitative analysis.

The final synthesis compared similarities and differences across international, Indonesian, and local studies. Rather than simply listing previous findings, the analysis connected individual results into an integrated conceptual relationship: digital literacy → educational technology use → student engagement → learning quality. Contextual conditions such as teacher competence, infrastructure, motivation, learning environment, and parental support were also considered when they appeared consistently in the reviewed literature. This process allowed the study to identify both established knowledge and areas requiring further investigation.

5. Trustworthiness and Research Ethics

The trustworthiness of the review was maintained through careful source selection, comparison of findings across studies, transparent recording of extracted information, and repeated checking of interpretations against the original publications. Studies reporting similar findings were compared to determine recurring patterns, while contradictory findings were retained rather than removed so that the synthesis could represent the complexity of the existing literature. Sidiq and Choiri (2019) noted that qualitative research required systematic attention to data credibility and consistency throughout the research process.

Ethically, the study relied on properly acknowledged scholarly sources and maintained accurate attribution of authorship and findings. The researcher avoided changing the meaning of findings when synthesizing evidence and distinguished the findings of previous researchers from the researcher's own interpretation. The methodological procedure was documented sufficiently to make the literature identification, organization, and synthesis process transparent and reproducible. The overall procedure followed the principle that qualitative research should be conducted systematically while maintaining credibility, transparency, and responsible interpretation of evidence (Fiantika et al., 2022).

RESULTS

1. Contribution of Digital Literacy to Educational Technology Use

The synthesis of the 40 reviewed studies indicated that digital literacy functioned as a foundational condition for the meaningful use of educational technology in elementary and Islamic elementary education. Across the literature, digital literacy was not limited to the ability to operate digital devices or access online information. Rather, it encompassed the ability to locate, evaluate, manage, communicate, create, and use digital information appropriately for learning purposes. The

reviewed studies consistently suggested that technology availability alone did not automatically produce meaningful educational use. Instead, the educational value of technology depended substantially on the digital competencies of teachers and students, their ability to evaluate digital resources, and their capacity to connect technology with learning objectives. This pattern was also evident in recent systematic reviews, which identified digital competence, teacher preparation, digital content, and pedagogical integration as recurring components of digital literacy in primary education.

a. Digital Literacy as a Foundation for Meaningful Technology Use

1) Digital Skills and Information Management

The reviewed literature showed that digital skills provided the initial foundation for educational technology use. Students needed basic abilities to access devices, navigate digital platforms, search for information, manage digital materials, and use online learning resources. Studies by Arima et al. (2022), Wulandari and Aslam (2022), Syafari et al. (2023), and Maharani et al. (2024) indicated that stronger digital literacy was associated with students' ability to participate more effectively in technology-supported learning activities. Digital literacy therefore operated not merely as an additional learning competency but as an enabling capacity that allowed students to benefit from available digital resources.

This finding was reinforced by the international literature. Ilomäki et al. (2023) conceptualized digital competence as a multidimensional construct involving technical, cognitive, social, and ethical dimensions rather than simple technological operation. Similarly, Tadlaoui-Brahmi et al. (2022) emphasized the importance of critical, responsible, and reflective digital practices in primary education. The synthesis therefore indicated that students who possessed functional digital skills were better positioned to access and organize information, while higher-order digital abilities enabled them to use that information for learning and problem solving.

The evidence from Indonesian elementary and madrasah contexts further demonstrated that digital literacy was connected with learning behavior and academic development. Syafari et al. (2023) found that digital literacy contributed to students' learning behavior, while Husaeni et al. (2023) connected digital literacy with critical-thinking development. Maharani et al. (2024) similarly demonstrated the potential of e-learning environments to develop students' digital literacy. These findings suggest that digital literacy supported technology use by transforming students from passive users of digital content into more active participants in technology-mediated learning.

2) Critical and Responsible Use of Digital Resources

The second pattern concerned students' and teachers' ability to use digital resources critically and responsibly. The reviewed studies indicated that meaningful technology use required more than the ability to find information. Users needed to determine whether information was relevant, reliable, appropriate, and useful for particular learning purposes. This dimension was particularly important in elementary education because students increasingly encountered large quantities of online information while still developing their ability to evaluate digital content.

Tadlaoui-Brahmi et al. (2022) emphasized digital citizenship as an important component of primary education, particularly through critical, responsible, reflective, and ethical technology use. Ilomäki et al. (2023) similarly positioned digital competence as a broader capability that included information and media literacy, digital safety, citizenship, creativity, and well-being. The reviewed Indonesian studies supported this broader interpretation. Husaeni et al. (2023) linked digital literacy with critical thinking, while Syafari et al. (2023) highlighted its relationship with learning behavior.

The evidence also indicated that critical digital use remained a challenge. The systematic review by Wijayanti et al. (2024), for example, reported that elementary students still experienced difficulties evaluating the reliability of online information and required assistance when using digital learning materials. Cyberbullying and insufficient digital competence were also identified as continuing challenges. Thus, the contribution of digital literacy to educational technology use was not simply determined by access or frequency of use but by the quality, safety, and purposefulness of digital engagement.

3) Teacher and Student Digital Competence

A third consistent finding was that digital literacy involved both students and teachers. Students required digital competencies to participate in learning, whereas teachers needed broader professional and pedagogical competencies to select, design, manage, and evaluate technology-supported learning activities. The reviewed studies showed that teacher digital competence frequently determined whether available technologies were integrated meaningfully into classroom instruction.

Stringer et al. (2022), Zakiah et al. (2021), Tzafilkou et al. (2023), Bentri et al. (2025), and Harmadi et al. (2025) collectively indicated that teacher digital competence involved more than technical proficiency. Teachers needed to connect technological knowledge with pedagogical strategies and subject content. This finding is consistent with the TPACK-oriented literature, in which technology becomes educationally meaningful when integrated with pedagogy and content rather than used as an isolated instructional tool.

The international evidence further strengthened this interpretation. Wohlfart and Wagner's umbrella review of 23 systematic reviews and 1,062 primary studies identified teacher digital literacy and technology integration as closely interconnected areas and highlighted the prominence of TPACK in understanding teachers' roles in educational digitalization. Similarly, research on teacher digital competence has shown that teacher competence encompasses planning digital lessons, using technology for instruction, supporting students' use of technology, and developing students' digital skills. Therefore, the literature indicated that meaningful technology use emerged from the interaction between student digital competence and teacher digital-pedagogical competence.

b. Digital Literacy and Technology Integration in Learning

1) Readiness to Use Digital Learning Media

The reviewed studies indicated that digital literacy contributed directly to readiness for educational technology integration. Readiness included teachers' confidence in using technology, students' familiarity with digital environments, willingness to use digital learning resources, and the availability of supporting infrastructure. Studies by Stringer et al. (2022), Tahir et al. (2024), Nur and Iswatiningsih (2025), and Arif et al. (2025) showed that technology integration was influenced by the preparedness of users and the conditions of the learning environment.

The Indonesian evidence was particularly clear regarding teacher readiness. Tahir et al. (2024) demonstrated the relevance of IT-based instructional-media training for elementary teachers in North Lombok, while Nur and Iswatiningsih (2025) reported positive perceptions of digital media such as videos, interactive presentations, Kahoot, and Wordwall in elementary learning. At the same time, Arif et al. (2025) identified limitations related to devices, projectors, computers, and internet access in an Islamic elementary school. These findings demonstrate that digital literacy and technological readiness were mutually connected with infrastructure.

The systematic literature also showed that teacher preparation remained an important condition. Wijayanti et al. (2024) identified teacher training, technological preparedness, and

infrastructure as continuing challenges in post-pandemic primary education. Consequently, digital literacy should be understood as part of a broader readiness system involving competence, confidence, access, and institutional support.

2) Selection and Adaptation of Appropriate Technologies

The synthesis further showed that digital literacy enabled teachers to select and adapt technologies according to instructional objectives rather than simply use technology because it was available. The reviewed studies reported the use of e-learning platforms, digital comics, digital storytelling, interactive presentations, games, Nearpod, Blogger, Google Forms, Wordwall, Kahoot, and other digital resources. Putri et al. (2023), Nasir et al. (2022), Bintoro et al. (2024), Maharani et al. (2024), and Putra Ali Akbar et al. (2024) demonstrated that different technologies served different instructional purposes.

This pattern suggests that technology integration was more effective when the selected resource was aligned with the learning content and students' characteristics. Digital comics and multimodal texts, for example, could support the presentation of information visually, whereas interactive platforms could support participation and formative assessment. Similarly, technology-based mathematics media could assist conceptual visualization. Junaidi et al. (2025) reported that digital media helped visualize mathematical concepts and support interaction and conceptual understanding in elementary schools in East Lombok.

The international literature supported the same pattern. Maričić and Lavicza (2024) found that emerging technologies in STEAM education could support engagement when meaningfully integrated into learning activities. Wong et al. (2024) similarly demonstrated that technology-supported activities could facilitate algorithmic thinking and debugging in primary schools. These findings suggest that digital literacy involved an important selection-and-adaptation competence, through which users matched digital tools with pedagogical needs.

3) Pedagogical Use of Digital Resources

The final pattern concerned the transformation of digital resources into pedagogically meaningful learning experiences. Across the 40 studies, the contribution of digital literacy became most visible when technology was integrated into teaching strategies, classroom interaction, student activities, assessment, and independent learning. Technology was therefore not treated as an end in itself but as a medium for achieving particular educational objectives.

Zakiah et al. (2021), Stringer et al. (2022), Tzafilkou et al. (2023), Bentri et al. (2025), and Harmadi et al. (2025) indicated that effective integration required the combination of technological, pedagogical, and content knowledge. This finding was consistent with the broader evidence that teachers' digital competence is multidimensional and that research has increasingly distinguished basic technology use from pedagogically purposeful integration.

The reviewed studies also demonstrated that pedagogical integration could take different forms. Nasir et al. (2022) showed how blended learning could strengthen digital literacy through Blogger and Google Forms. Putri et al. (2023) demonstrated the potential of digital comics and multimodal texts, while Bintoro et al. (2024) showed how Nearpod could support motivation and academic achievement. Nikou (2024) further indicated that technology-supported maker activities could promote active, creative, collaborative, and engaging learning experiences. These findings suggest that the educational value of technology was closely associated with how digital resources were embedded in meaningful learning tasks.

Overall, the synthesis demonstrated a progressive relationship between digital skills, critical digital literacy, digital competence, technology readiness, technology selection, and pedagogical integration. Digital literacy first enabled teachers and students to access and manage digital

resources; it then supported critical and responsible use; and finally, it facilitated the pedagogical integration of technology into learning. The evidence therefore positioned digital literacy as a foundational enabling factor rather than an isolated learning outcome. In elementary and Islamic elementary education, meaningful educational technology use appeared to depend on the extent to which teachers and students possessed the competencies necessary to select, evaluate, adapt, and use digital resources in accordance with learning objectives. This finding provides the foundation for the second research question, concerning how educational technology use subsequently influences student engagement and learning quality.

2. Influence of Educational Technology on Student Engagement and Learning Quality

The synthesis of the 40 reviewed studies indicated that educational technology influenced both student engagement and learning quality, although the magnitude and form of these influences varied according to how technology was integrated into instructional practices. Across international, Indonesian, and Islamic elementary education contexts, digital platforms, interactive media, multimedia resources, educational applications, and technology-supported learning activities were generally associated with increased opportunities for participation, active learning, motivation, interaction, and understanding. However, the reviewed evidence also showed that technology did not automatically improve learning. Its educational contribution depended on pedagogical design, teacher competence, technological access, students' digital readiness, and the learning environment.

a. Educational Technology and Student Engagement

1) Behavioral Engagement and Learning Participation

The reviewed studies showed that educational technology supported behavioral engagement by creating additional opportunities for students to participate in learning activities. Digital learning platforms, interactive media, educational applications, online exercises, and technology-supported classroom activities enabled students to perform tasks, respond to questions, access learning materials, complete assignments, and interact with instructional content. These forms of participation were reported in studies involving blended learning, e-learning, digital media, interactive presentations, and digital learning models (Nasir et al., 2022; Maharani et al., 2024; Putra Ali Akbar et al., 2024).

The evidence suggested that behavioral engagement was particularly visible when technology transformed students from passive recipients into active participants. For example, the use of Blogger and Google Forms in blended learning provided opportunities for students to access materials and complete learning activities digitally (Nasir et al., 2022). Similarly, digital learning models and interactive media were associated with increased student activity and participation in elementary classrooms (Putra Ali Akbar et al., 2024; Nur & Iswatiningsih, 2025). Rizk and Davies (2021) likewise found that digital technology could contribute to classroom engagement when it was incorporated into meaningful pedagogical activities rather than simply added to existing instruction.

The synthesis therefore indicated that educational technology expanded the ways in which students could participate in learning. Nevertheless, participation was not determined by technology alone. Students' digital literacy, confidence, access to devices, and teachers' instructional strategies influenced whether technological opportunities were translated into sustained behavioral engagement.

2) Cognitive Engagement and Active Learning

A second pattern concerned cognitive engagement. The reviewed literature indicated that educational technology could encourage students to think, explore, solve problems, process information, and construct understanding through active learning. Rather than merely consuming

digital content, students could use technology to investigate concepts, manipulate information, complete problem-solving activities, create products, and receive immediate feedback.

Wong et al. (2024), for example, demonstrated the potential of technology-supported algorithmic thinking and debugging activities to engage primary students in cognitively demanding learning processes. Similarly, Maričić and Lavicza (2024) reported that emerging technologies in STEAM education could support students' attention, effort, and active involvement when integrated meaningfully into learning tasks. Nikou (2024) also showed that technology-supported maker activities encouraged active and creative participation among primary students.

Indonesian studies demonstrated comparable patterns. Digital comics, multimodal texts, digital learning platforms, and technology-supported mathematics media provided alternative ways for students to visualize, process, and apply learning content (Putri et al., 2023; Junaidi et al., 2025). Husaeni et al. (2023) further linked digital literacy with critical-thinking ability, suggesting that students' cognitive engagement could be strengthened when they possessed the competencies required to process digital information critically.

The synthesis thus showed that cognitive engagement emerged most clearly when technology was used as a tool for exploration, problem solving, creation, reflection, and knowledge construction, rather than as a replacement for conventional presentation.

3) Emotional and Social Engagement

The third dimension involved emotional and social engagement. The reviewed studies indicated that interactive and multimedia technologies could increase students' interest, enjoyment, confidence, and willingness to participate, while collaborative digital activities could facilitate communication and social interaction. These dimensions were particularly apparent in studies involving games, interactive platforms, maker activities, digital media, and collaborative learning.

Bintoro et al. (2024) reported positive relationships between Nearpod-based digital learning and students' motivation and academic achievement. Nur and Iswatiningsih (2025) similarly found positive teacher and student perceptions of videos, interactive presentations, Kahoot, and Wordwall, with reported improvements in motivation, activity, and understanding. Nikou (2024) showed that maker activities supported multiple dimensions of engagement through active and collaborative technology-based learning.

The broader literature conceptualized engagement as multidimensional rather than exclusively behavioral. Nkomo et al. (2021), through a systematic review, identified behavioral, cognitive, emotional, and social dimensions of student engagement with digital technologies. Although their review focused primarily on higher education, its conceptual framework was useful for interpreting elementary-school evidence because it demonstrated that engagement involved students' actions, thinking, feelings, and interactions.

Overall, the reviewed evidence indicated that technology could support emotional and social engagement when students experienced digital activities as meaningful, interactive, collaborative, and appropriately challenging. Conversely, technology that was used mainly for passive consumption offered fewer opportunities for deeper engagement.

b. Educational Technology and Learning Quality

1) Improved Understanding and Learning Outcomes

The reviewed literature showed that educational technology was frequently associated with improved understanding of learning content and, in several studies, improved learning outcomes. Digital media provided opportunities to visualize abstract concepts, present information through multiple modes, repeat learning materials, and provide interactive experiences. These

characteristics were particularly relevant to elementary learners who often benefited from concrete, visual, and activity-based learning.

Arima et al. (2022) and Wulandari and Aslam (2022) reported relationships between digital literacy and elementary students' learning outcomes, while Putri et al. (2023) demonstrated the potential of digital comics and multimodal texts to support elementary learning outcomes. Junaidi et al. (2025) found that digital media in elementary mathematics learning helped visualize concepts, strengthen interaction, and support conceptual understanding. Bintoro et al. (2024) also reported positive effects associated with Nearpod-based learning on motivation and academic achievement.

The international literature showed similar tendencies. Maričić and Lavicza (2024) found that technology-supported STEAM activities could facilitate engagement and learning processes, while Wong et al. (2024) demonstrated that digital activities could support higher-order thinking through algorithmic problem solving. These findings suggest that technology contributed to learning quality partly by providing learning experiences that were difficult to achieve through static instructional materials alone.

However, the synthesis did not indicate that technology universally produced higher achievement. Rather, improvements appeared more consistently when digital tools were aligned with content, instructional objectives, and students' learning needs.

2) Increased Motivation and Learning Interest

Another recurring finding was the relationship between educational technology and students' motivation and learning interest. Interactive platforms, multimedia, educational games, digital simulations, and technology-supported activities were frequently reported to make learning more attractive and varied. Such characteristics could encourage students to participate and sustain attention during learning activities.

Achmad and Pramudiani (2022) examined students' interest in ICT-related learning during online education in an Islamic elementary-school context, while Bintoro et al. (2024) reported relationships between Nearpod-based learning, motivation, and academic achievement. Putra Ali Akbar et al. (2024) likewise found that digital learning models could enhance students' understanding and interest in learning. Nur and Iswatiningsih (2025) reported positive perceptions of several digital media and associated these media with increased motivation and classroom activity.

The international evidence supported this pattern. Nikou (2024) found that technology-supported maker activities encouraged motivation and engagement through active and creative learning. Maričić and Lavicza (2024) similarly indicated that meaningful emerging-technology integration could support students' attention, effort, and engagement in STEAM learning.

The synthesis nevertheless showed that novelty alone was insufficient to sustain motivation. Students' interest was more likely to be maintained when technology was combined with meaningful tasks, interaction, collaboration, appropriate challenge, and clear learning purposes.

3) More Interactive and Learner-Centered Learning

The reviewed studies also indicated that educational technology contributed to learning quality by enabling more interactive and learner-centered instructional practices. Digital tools allowed students to access resources independently, receive feedback, explore content, communicate with teachers and peers, and participate in activities at different levels of complexity.

Nasir et al. (2022) illustrated this through blended learning, while Maharani et al. (2024) demonstrated the use of e-learning to support digital literacy in elementary education. Digital learning models, interactive media, and multimodal resources similarly expanded students' opportunities to engage directly with learning materials (Putra Ali Akbar et al., 2024; Putri et al.,

2023). Van Schoors et al. (2021), in their systematic review of digital personalized learning, emphasized the potential of digital technologies to facilitate more individualized learning processes when appropriately designed.

The synthesis therefore positioned learner-centeredness not as a direct consequence of technology but as an outcome of purposeful pedagogical integration. Technology supported learner-centered learning when students were given meaningful opportunities to explore, make decisions, solve problems, create, communicate, and receive feedback.

c. Factors Shaping the Effectiveness of Educational Technology

1) Teacher Digital and Pedagogical Competence

Teacher competence emerged as one of the strongest contextual factors affecting the effectiveness of educational technology. The reviewed literature showed that teachers needed both technical proficiency and pedagogical knowledge to determine when, why, and how technology should be used. Stringer et al. (2022) found that teachers' self-efficacy, confidence, and readiness influenced their experiences with digital technologies. Zakiah et al. (2021) and Tzafilkou et al. (2023) similarly emphasized the integration of technological, pedagogical, and content knowledge.

Recent Indonesian evidence reinforced this finding. Bentri et al. (2025) examined teacher digital pedagogical competence in elementary education, while Harmadi et al. (2025) highlighted the relationship among digital transformation, literacy, motivation, and TPACK. Tahir et al. (2024) further demonstrated the relevance of professional training for strengthening teachers' ability to develop IT-based learning media.

Thus, teacher competence shaped whether technology functioned as an instructional resource or merely as a technical accessory. Effective integration required teachers to align digital tools with learning objectives, student characteristics, content, classroom interaction, and assessment.

2) Infrastructure and Internet Accessibility

Infrastructure and internet accessibility constituted another major factor. The reviewed studies showed that access to devices, stable internet connections, computers, projectors, and appropriate digital platforms influenced the extent to which students and teachers could participate in technology-supported learning.

Arif et al. (2025) identified limitations involving devices, projectors, computers, and internet access in Islamic elementary education. Nur and Iswatiningsih (2025) similarly identified internet and device limitations as barriers to digital-media implementation. Prasetyo and Prastowo (2022) reported that network conditions, technological facilities, and parental support influenced the implementation of integrated ICT learning in Madrasah Ibtidaiyah.

Evidence from Lombok also indicated that technological innovation was closely related to the availability of supporting resources. Junaidi et al. (2025) demonstrated the potential of website-based digital media in elementary mathematics learning, while Tahir et al. (2024) highlighted the importance of teacher preparation for technology-based instructional media in North Lombok.

These findings indicated that digital technology could not be separated from material conditions. Even when teachers and students possessed adequate digital competencies, insufficient devices or unreliable connectivity could restrict actual technology use and consequently limit its potential contribution to engagement and learning quality.

3) Learning Environment and Parental Support

The final factor concerned the broader learning environment, including school support, classroom conditions, family involvement, and parental assistance. The reviewed literature indicated that technology-supported learning extended beyond the teacher–student relationship.

Students' ability to benefit from digital learning was also influenced by the support they received outside the classroom.

Prasetyo and Prastowo (2022) identified parental support as one of the factors influencing ICT-integrated learning in Madrasah Ibtidaiyah. Zurqoni et al. (2022) similarly demonstrated that successful online learning in Islamic elementary education depended on multiple conditions rather than technology alone. Musaddat and Marhaeni (2020), in the context of elementary education in Lombok, emphasized the importance of relationships among teachers, schools, families, and communities in optimizing digital technology for literacy development.

The synthesis further indicated that a supportive learning environment could reinforce students' motivation and engagement by providing consistent expectations, guidance, access to learning resources, and opportunities to practice digital skills. Conversely, limited family support, inadequate learning facilities, or weak institutional support could reduce the effectiveness of technology-based learning.

Overall, the 40 reviewed studies demonstrated that educational technology influenced student engagement and learning quality through multiple interconnected pathways. Technology created opportunities for behavioral participation, cognitive activity, emotional involvement, and social interaction, while also supporting understanding, motivation, learning interest, interaction, and learner-centered practices. However, these contributions were conditional rather than automatic. Teacher digital-pedagogical competence, infrastructure and internet accessibility, and the learning environment including parental support shaped the extent to which technology produced meaningful educational outcomes. The findings therefore indicate that educational technology should be understood as an instructional enabler whose effectiveness depends on the interaction between digital resources, pedagogical practices, learner characteristics, and contextual conditions. This synthesis provides the basis for the third research question, which examines the integrated relationship among digital literacy, educational technology use, student engagement, and learning quality.

3. Interconnection of Digital Literacy, Educational Technology, and Student Engagement in Supporting Learning Quality

The synthesis of the 40 reviewed studies indicated that digital literacy, educational technology, student engagement, and learning quality were interconnected rather than functioning as independent educational factors. The findings from the first two research questions showed that digital literacy provided the competencies required to use technology meaningfully, while educational technology created opportunities for students to participate actively in learning. The third-stage synthesis further indicated that student engagement represented an important pathway through which technology-supported learning could contribute to learning quality. The relationship was therefore best understood as a connected educational process in which learner competencies, technological resources, pedagogical practices, and contextual conditions interacted with one another.

a. Interrelationships among Digital Literacy, Technology Use, and Engagement

1) Digital Literacy as an Enabling Capacity

The reviewed evidence positioned digital literacy as an enabling capacity that allowed students and teachers to transform access to digital resources into meaningful educational practices. Studies examining elementary education consistently indicated that digital literacy involved more than operational skills. It included the ability to access, evaluate, manage, communicate, and create digital information and to use digital resources critically and responsibly (Ilomäki et al., 2023; Tadlaoui-Brahmi et al., 2022).

The Indonesian evidence demonstrated a similar pattern. Arima et al. (2022) and Wulandari and Aslam (2022) associated digital literacy with learning outcomes, while Husaeni et al. (2023) linked it with critical-thinking ability. Syafari et al. (2023) further indicated that digital literacy contributed to students' learning behavior. These findings suggest that digital literacy established the conditions under which students could use educational technologies productively. Without adequate digital competence, access to technology could remain largely technical and might not develop into purposeful learning participation.

Digital literacy therefore functioned as a prerequisite for meaningful technology use. It supported students' ability to navigate digital learning environments and helped teachers determine how digital resources could be connected with instructional purposes. The evidence consequently positioned digital literacy at the beginning of the broader relationship between technology and learning quality.

2) Educational Technology as a Mediating Learning Resource

The second element in the relationship was educational technology itself. The reviewed studies indicated that technology operated as a mediating resource between digital competence and students' learning experiences. Digital platforms, interactive media, multimedia resources, e-learning environments, educational applications, and technology-supported activities provided concrete spaces in which digital competencies could be applied.

Nasir et al. (2022), Maharani et al. (2024), Putra Ali Akbar et al. (2024), and Putri et al. (2023) demonstrated how digital platforms and media could facilitate access to learning materials, interaction, visualization, and learning activities. Similarly, Wong et al. (2024), Maričić and Lavicza (2024), and Nikou (2024) showed that technology-supported learning could create opportunities for problem solving, active participation, creativity, and engagement.

The synthesis indicated, however, that technology should not be interpreted as an independent determinant of learning quality. Its contribution was mediated by how it was selected, adapted, and integrated into instruction. Technology became educationally meaningful when digital resources were connected with learning objectives, student characteristics, pedagogical strategies, and opportunities for interaction.

3) Student Engagement as a Pathway toward Learning Quality

Student engagement emerged as an important pathway connecting technology-supported learning with learning quality. The reviewed literature identified behavioral, cognitive, emotional, and social dimensions of engagement. Technology could encourage participation, attention, effort, problem solving, collaboration, motivation, and interaction when students were actively involved in meaningful learning tasks (Nkomo et al., 2021; Rizk & Davies, 2021).

The empirical evidence from elementary education supported this relationship. Bintoro et al. (2024) reported relationships between digital learning media, motivation, and academic achievement, while Nur and Iswatiningsih (2025) found that digital media was associated with increased motivation, activity, and understanding. Junaidi et al. (2025) similarly showed that digital media could support interaction and conceptual understanding in elementary mathematics learning.

The synthesis therefore indicated that technology did not necessarily improve learning quality simply through its presence. Rather, technology created opportunities for students to become more engaged, and this engagement was associated with deeper learning processes and improved educational outcomes. Engagement consequently represented a connecting mechanism between technological opportunities and learning quality.

b. Complementary Roles of Learner and Instructional Factors

1) Digital Competence and Student Readiness

The findings showed that student digital competence and readiness complemented the availability of educational technology. Students needed sufficient digital skills to access platforms, navigate learning materials, search for information, complete digital tasks, and communicate through technology. Arima et al. (2022), Syafari et al. (2023), and Maharani et al. (2024) indicated that students' digital capabilities influenced their ability to participate in technology-supported learning.

Student readiness also involved motivation, confidence, familiarity with digital environments, and willingness to participate. When students possessed these characteristics, technology provided broader opportunities for active learning. Conversely, limited digital competence could reduce the educational value of available technologies. The evidence therefore suggested that technology integration required simultaneous attention to both technological provision and student capacity.

2) Teacher Competence and Pedagogical Integration

Teacher competence represented the instructional counterpart of student readiness. The reviewed studies showed that teachers played a central role in determining how technology was incorporated into classroom activities. Stringer et al. (2022), Zakiah et al. (2021), Tzafilkou et al. (2023), and Bentri et al. (2025) emphasized the importance of teachers' technological and pedagogical knowledge.

The evidence from Indonesia further indicated that teacher training and professional competence affected technology integration. Tahir et al. (2024) demonstrated the relevance of IT-based instructional-media training, while Harmadi et al. (2025) highlighted the relationship between digital transformation, literacy, motivation, and TPACK. These findings showed that teacher competence complemented student digital readiness by translating technological possibilities into appropriate learning activities.

Thus, student competence and teacher competence operated as complementary factors. Students needed to know how to engage with digital resources, while teachers needed to know how to design learning experiences in which those resources became educationally meaningful.

3) Motivation, Learning Environment, and Infrastructure

The synthesis also identified motivation, learning environment, infrastructure, and parental support as contextual factors that strengthened or constrained the relationship among the four central concepts. Bintoro et al. (2024), Nikou (2024), and Putra Ali Akbar et al. (2024) demonstrated the relevance of motivation and learning interest to technology-supported engagement. At the same time, Arif et al. (2025), Nur and Iswatiningsih (2025), and Prasetyo and Prastowo (2022) identified technological facilities, internet access, and parental support as important conditions.

Studies conducted in Lombok and other Indonesian contexts further illustrated that digital learning depended on the broader educational environment. Musaddat and Marhaeni (2020) highlighted the importance of school, family, and community relationships in optimizing technology for literacy development, while Junaidi et al. (2025) demonstrated the potential of digital innovation when supported by appropriate instructional implementation.

These findings indicated that digital literacy and technology use could not be separated from the conditions in which learning occurred. A technologically competent student might still experience limited engagement when internet access was unstable, devices were unavailable, or family and school support was inadequate. Consequently, learner, teacher, technological, and environmental factors needed to operate together.

c. Integrated Synthesis of the Reviewed Evidence

1) Digital Literacy → Educational Technology Use

The first link in the integrated model was the relationship between digital literacy and educational technology use. The 40 reviewed studies showed that digital literacy provided the knowledge and skills necessary to access, evaluate, select, and use digital resources. This relationship was evident in studies connecting digital literacy with learning behavior, critical thinking, learning outcomes, teacher competence, and technology integration (Arima et al., 2022; Husaeni et al., 2023; Ilomäki et al., 2023; Syafari et al., 2023).

The evidence therefore suggested that digital literacy operated as an enabling foundation. It increased the capacity of students and teachers to use technology purposefully rather than merely operate digital devices.

2) Educational Technology Use → Student Engagement

The second link connected technology use with student engagement. The reviewed studies indicated that appropriately integrated digital media and platforms could increase participation, interaction, attention, motivation, active learning, and collaborative activities. Evidence from Nearpod, e-learning, digital comics, maker activities, STEAM technologies, and interactive digital media illustrated this relationship (Bintoro et al., 2024; Maričić & Lavicza, 2024; Nikou, 2024; Putri et al., 2023).

However, the relationship was conditional. Technology produced stronger engagement when students were actively involved in meaningful tasks and when teachers used digital tools as part of appropriate pedagogical strategies. The evidence therefore did not support a simple assumption that greater technology use automatically resulted in greater engagement.

3) Student Engagement → Learning Quality

The third link connected student engagement with learning quality. Across the reviewed literature, active participation, cognitive involvement, motivation, interaction, and sustained attention were associated with better understanding and learning outcomes. Digital learning environments could support these processes by providing opportunities for students to explore, practice, receive feedback, collaborate, and apply knowledge.

Studies such as Bintoro et al. (2024), Putri et al. (2023), Junaidi et al. (2025), and Wong et al. (2024) illustrated different ways in which engagement-related processes were connected with learning outcomes, conceptual understanding, and higher-order learning activities. The synthesis consequently indicated that student engagement represented an important pathway through which educational technology could contribute to learning quality.

d. Implications for Elementary and Islamic Elementary Education

1) Strengthening Digital Literacy

The findings indicated that strengthening digital literacy should constitute an important component of elementary and Islamic elementary education. Digital literacy programs should move beyond basic device operation and include information evaluation, critical thinking, responsible digital behavior, communication, content creation, and safe technology use. Such competencies could provide students with the capacity to participate more effectively in technology-supported learning.

For Islamic elementary education, the reviewed evidence also suggested the importance of integrating digital competence with responsible and ethical learning practices. The emphasis should therefore be placed on developing students who are not only technically capable but also critical, responsible, and purposeful users of digital information.

2) Improving Meaningful Technology Integration

The synthesis further indicated that schools should focus on meaningful technology integration rather than simply increasing the number of digital devices or platforms. Teachers

should select technologies according to learning objectives, content characteristics, student needs, and opportunities for interaction. Evidence from digital mathematics media, multimodal learning, blended learning, STEAM activities, and interactive platforms demonstrated that different technologies served different pedagogical purposes (Junaidi et al., 2025; Maričić & Lavicza, 2024; Nasir et al., 2022; Putri et al., 2023).

Professional development was therefore important. Teachers required opportunities to develop technological, pedagogical, and content knowledge so that technology could become an integrated part of instructional design rather than an additional classroom activity.

3) Developing an Integrated Approach to Learning Quality

Finally, the findings suggested that learning quality should be approached as an integrated outcome rather than measured exclusively through academic achievement. The reviewed evidence connected technology-supported learning with participation, critical thinking, motivation, collaboration, understanding, independence, and learning outcomes. A comprehensive approach should therefore consider both academic and engagement-related dimensions of learning.

Overall, the synthesis of the 40 studies answered the third research question by demonstrating that digital literacy, educational technology use, and student engagement were interconnected components in supporting learning quality. Digital literacy established the capacity for purposeful technology use, educational technology provided the instructional medium through which that capacity could be enacted, and student engagement connected technology-supported activities with meaningful learning processes and outcomes. The relationship was strengthened when teachers possessed appropriate digital-pedagogical competence and when students, schools, families, and technological infrastructure provided adequate support. The findings consequently support an integrated perspective in which learning quality emerges from the interaction of learner competence, technological resources, pedagogical integration, engagement, and educational context, rather than from technology alone.

DISCUSSION

1. Results Analysis

a. Digital Literacy as the Foundation of Meaningful Educational Technology Use

The first major finding indicates that digital literacy should be understood not simply as students' or teachers' ability to operate digital devices, but as a foundational capacity that determines whether educational technology can be transformed into meaningful learning practice. The synthesis of the 40 studies shows that digital skills, information management, critical evaluation, responsible use, teacher competence, technology readiness, technology selection, and pedagogical integration constitute interconnected dimensions of digital literacy. This finding directly addresses the first research question concerning how digital literacy contributes to the use of educational technology in elementary and Islamic elementary education. The central meaning of the finding is that technology use becomes educationally significant only when users possess the competencies required to interpret, evaluate, select, adapt, and apply digital resources according to learning purposes.

This finding can be interpreted through the distinction between access to technology and capacity to use technology educationally. The availability of devices, platforms, and digital materials creates technological possibilities, but digital literacy determines how those possibilities are enacted. Students with stronger digital competencies are better positioned to navigate digital learning environments, identify relevant information, and participate in technology-supported activities. At the same time, teachers require a more complex form of digital competence because they must determine not only how a technology works but also why it should be used, for whom,

and for which learning objective. Thus, the synthesis suggests that digital literacy operates at both the learner and instructional levels. This interpretation is consistent with the multidimensional conception of digital competence proposed by Ilomäki et al. (2023), in which digital competence incorporates technical, cognitive, social, ethical, and responsible dimensions. It is also consistent with the emphasis of Tadlaoui-Brahmi et al. (2022) on critical, responsible, reflective, and ethical digital participation in primary education.

The findings further indicate that digital literacy functions as a transformative capacity rather than a static skill set. Basic operational competence allows students and teachers to enter digital environments, whereas critical information literacy and pedagogical competence determine what they do after entering those environments. This distinction explains why technology availability alone does not necessarily result in meaningful technology integration. The evidence from Indonesian contexts, including the relationships between digital literacy, learning behavior, critical thinking, and learning outcomes, reinforces the interpretation that digital literacy affects the quality of technology-mediated participation rather than merely the frequency of technology use (Arima et al., 2022; Husaeni et al., 2023; Syafari et al., 2023; Wulandari & Aslam, 2022). In this sense, digital literacy provides the cognitive and practical conditions through which technology becomes a learning resource.

A further analytical implication concerns the relationship between digital literacy, teacher competence, and pedagogical integration. The synthesis indicates that student digital competence and teacher digital-pedagogical competence should not be treated as separate components. They operate as complementary capacities within the same learning system. Students need the ability to navigate, evaluate, and use digital resources, whereas teachers need the ability to design learning situations in which those resources are educationally productive. This interpretation is supported by the literature emphasizing technological, pedagogical, and content knowledge as essential to meaningful technology integration (Stringer et al., 2022; Tzafilkou et al., 2023; Zakiah et al., 2021). Consequently, the first research question can be answered through an integrated proposition: digital literacy enables educational technology use by connecting technological access with critical judgment, pedagogical purpose, and purposeful learning activity.

The critical synthesis therefore extends the conventional understanding of digital literacy in elementary education. Rather than positioning digital literacy as one competency among many, the findings suggest that it functions as an enabling infrastructure of educational technology use. The resulting conceptual sequence is not simply *digital literacy* → *technology use*, but rather digital literacy → critical and purposeful technology selection → pedagogical integration → meaningful learning opportunities. This sequence represents an important analytical contribution because it explains why similar technologies may generate different educational experiences across classrooms and schools. The difference may lie less in the technological tool itself than in the digital and pedagogical capacity available to use it.

b. Educational Technology as a Conditional Mechanism for Student Engagement and Learning Quality

The second major finding demonstrates that educational technology can contribute to student engagement and learning quality, but its contribution is conditional rather than automatic. The synthesis identified behavioral, cognitive, emotional, and social engagement as important dimensions through which technology-supported learning may influence educational experiences. At the same time, improvements in understanding, motivation, interaction, learner-centeredness, and learning outcomes were more evident when technology was deliberately integrated into meaningful instructional activities. This finding directly addresses the second research question

concerning how educational technology influences student engagement and learning quality. Its central implication is that technology functions less as an independent cause of learning improvement than as a pedagogical mechanism whose effects depend on the quality of its integration.

The interpretation of this finding begins with the multidimensional nature of engagement. Technology expands opportunities for students to participate, interact, explore information, receive feedback, collaborate, and produce learning outputs. These opportunities can strengthen behavioral engagement by increasing participation, cognitive engagement by encouraging problem solving and knowledge construction, and emotional engagement by making learning activities more interactive and meaningful. Social engagement can also be strengthened when digital environments facilitate communication and collaboration. This interpretation is consistent with Nkomo et al. (2021), who conceptualized engagement with digital learning as multidimensional, and with Rizk and Davies (2021), who emphasized that the contribution of digital technology to engagement depends on how it is embedded within pedagogical practices.

The synthesis further suggests that the relationship between technology and learning quality is mediated by the quality of students' engagement with learning activities. Digital tools can provide visualization, multimodal representation, interaction, feedback, and opportunities for exploration, but these affordances become educationally meaningful only when students actively use them to think, practice, communicate, create, or solve problems. Thus, the analytical pathway emerging from the findings is technology affordances → meaningful learning activity → student engagement → learning processes → learning quality. This interpretation helps explain why technology may improve motivation or participation in one context but produce limited learning benefits in another. The difference is associated with how technological affordances are translated into learning activity rather than with the presence of technology itself.

The findings also indicate that learning quality should not be reduced to test scores or academic achievement. The reviewed evidence connects technology-supported learning with understanding, motivation, critical thinking, interaction, independence, creativity, participation, and learning outcomes. This broader interpretation is particularly relevant to elementary and Islamic elementary education, where learning quality encompasses both academic and developmental dimensions. Digital learning environments may support students' cognitive development while also providing opportunities for collaboration, communication, and independent learning. The findings concerning digital media, blended learning, interactive platforms, mathematics technologies, and multimodal resources reinforce this interpretation (Bintoro et al., 2024; Junaidi et al., 2025; Maharani et al., 2024; Nasir et al., 2022; Putri et al., 2023).

However, the synthesis shows that engagement itself is shaped by instructional and contextual conditions. Teacher digital-pedagogical competence determines whether technological affordances are converted into appropriate learning tasks, while infrastructure determines whether students can access and sustain participation. Motivation, learning environment, and parental support further influence the continuity of technology-supported learning. This interpretation is consistent with evidence emphasizing teacher self-efficacy, technological readiness, TPACK, and professional development as important dimensions of effective technology integration (Harmadi et al., 2025; Stringer et al., 2022; Tahir et al., 2024; Tzafilkou et al., 2023). It also corresponds with Indonesian and Islamic elementary education evidence identifying device availability, internet connectivity, and parental support as contextual conditions affecting technology-supported learning (Arif et al., 2025; Prasetyo & Prastowo, 2022; Zurqoni et al., 2022).

Accordingly, the second research question can be interpreted through a conditional-effect perspective. Educational technology does not produce engagement and learning quality independently; rather, it creates affordances that become educationally productive when mediated by pedagogical design and supported by learner readiness and contextual conditions. This analytical interpretation moves beyond the simple assumption that more technology produces better learning. Instead, the critical synthesis indicates that the educational value of technology depends on the interaction among technological affordances, instructional design, student engagement, and contextual support.

The resulting analytical contribution is therefore a shift from a technology-centered model to an engagement-mediated model. Technology should be understood as a mechanism that creates possibilities for participation and learning, while engagement represents the process through which those possibilities are translated into meaningful educational experiences. Learning quality subsequently emerges from the depth and quality of this process. In conceptual terms, the relationship can be represented as educational technology → meaningful learning activities → multidimensional student engagement → improved learning processes and quality, with teacher competence, infrastructure, motivation, and learning environment functioning as enabling or constraining conditions.

c. An Integrated Relationship among Digital Literacy, Educational Technology, Student Engagement, and Learning Quality

The third major finding provides the central synthesis of the review: digital literacy, educational technology use, student engagement, and learning quality are best understood as components of an interconnected educational system rather than as independent variables. The synthesis addresses the third research question by demonstrating that digital literacy establishes the capacity for purposeful technology use, technology provides the learning affordances through which digital competence can be enacted, student engagement constitutes a central process connecting technology-supported activities with learning, and learning quality represents the broader educational outcome of this interaction. The significance of this finding lies in the integration of four dimensions that are frequently examined separately in the existing literature.

The integrated relationship begins with digital literacy because meaningful participation in technology-mediated learning requires both students and teachers to possess appropriate digital competencies. However, digital literacy alone is insufficient to produce learning improvement. It must be activated through educational technology that is appropriately selected and pedagogically integrated. Technology subsequently provides opportunities for students to engage behaviorally, cognitively, emotionally, and socially. The resulting engagement creates conditions for deeper learning processes, including exploration, problem solving, interaction, reflection, knowledge construction, and application. Learning quality therefore emerges not from any single component but from the interaction among competence, technology, pedagogy, engagement, and context.

This integrated interpretation provides a theoretical explanation for the relationships identified across the first two research questions. The first finding establishes digital literacy as an enabling foundation for technology use, while the second demonstrates that technology contributes to learning quality primarily when it generates meaningful engagement. The third finding connects these two relationships into a single process. Thus, the synthesis can be expressed as:

Digital Literacy → Purposeful Educational Technology Use → Student Engagement → Learning Quality with teacher digital-pedagogical competence, motivation, infrastructure, learning environment, and parental support operating as contextual conditions across the pathway. This

model should not be interpreted as a rigid linear causal chain because the reviewed literature also indicates reciprocal and interactive relationships. For example, meaningful technology-supported learning may further strengthen students' digital literacy, while positive engagement may reinforce students' willingness to develop additional digital competencies. The model therefore represents a dominant analytical pathway rather than an exclusively one-directional process.

The theoretical significance of this synthesis is that it connects the concept of digital literacy with the pedagogical function of technology and the process dimension of student engagement. Digital literacy provides the capacity, educational technology provides the affordance, engagement provides the learning process, and learning quality represents the educational consequence. This interpretation extends the multidimensional understanding of digital competence proposed by Ilomäki et al. (2023), the pedagogical integration perspective reflected in TPACK-oriented studies (Harmadi et al., 2025; Tzafilkou et al., 2023; Zakiah et al., 2021), and the multidimensional conception of engagement described by Nkomo et al. (2021). Rather than positioning these perspectives independently, the synthesis connects them within one explanatory framework.

The integrated model also explains the importance of contextual conditions identified throughout the review. Teacher competence determines whether digital resources are translated into pedagogically appropriate activities; infrastructure determines whether those activities can be implemented consistently; motivation influences willingness to participate; and family and school support can reinforce students' opportunities to engage with digital learning. Evidence from Indonesia and Islamic elementary education demonstrates that these contextual conditions remain particularly important because technological implementation varies considerably across schools and communities (Arif et al., 2025; Musaddat & Marhaeni, 2020; Prasetyo & Prastowo, 2022; Zurqoni et al., 2022). Thus, the integrated model should be understood as context-sensitive rather than technology-deterministic.

A further critical insight concerns the distinction between availability, use, engagement, and quality. The review indicates that these four conditions represent different levels of educational transformation. Technology may be available without being used; it may be used without being pedagogically integrated; it may be pedagogically integrated without generating sustained engagement; and students may be highly engaged without necessarily achieving deeper learning if instructional objectives are unclear. Consequently, educational quality requires progression across these levels rather than the mere presence of digital technology. This provides a more precise interpretation of the fragmented literature identified in the Introduction, where digital literacy, technology use, engagement, teacher competence, and learning outcomes have often been investigated as separate concerns.

The critical synthesis therefore produces a broader conceptual proposition: digital transformation in elementary and Islamic elementary education is a process of converting digital capacity into pedagogically purposeful technology use, purposeful use into multidimensional engagement, and engagement into meaningful learning quality under appropriate contextual conditions. This proposition represents the principal analytical contribution of the review. It explains not only whether technology is associated with learning but also the conditions and processes through which such an association becomes educationally meaningful. In this framework, technology is neither the starting point nor the final determinant of learning quality. Instead, learning quality emerges from the coordinated functioning of learner competence, teacher competence, technological affordances, engagement processes, and educational context.

2. Comparison with Previous Studies

The findings of this review are broadly consistent with previous literature, but they also extend existing interpretations by bringing digital literacy, educational technology, student engagement, and learning quality into a single analytical relationship. Rather than treating the reviewed evidence as uniformly supportive of technology integration, the comparison reveals three important patterns: convergence, where the present synthesis confirms established findings; qualification, where the present synthesis specifies the conditions under which previous relationships appear to operate; and extension, where previously separated strands of research are connected into an integrated explanatory framework.

a. Convergence between Digital Literacy and Meaningful Technology Integration

The present finding that digital literacy constitutes a foundation for meaningful educational technology use is consistent with previous systematic reviews of digital literacy in elementary education. Wijayanti et al. (2024), for example, identified digital content, digital games, hardware, and digital competency development as major components of post-pandemic digital literacy practices, while also emphasizing teachers' roles as facilitators, curriculum implementers, collaborators, and digital content creators. Similarly, Saifuddin and Putra (2024) found that digital literacy in elementary education was associated with the use of interactive media and digital storytelling and highlighted teacher preparedness, parental support, and infrastructure as important conditions for implementation. These findings converge with the present synthesis in showing that digital literacy involves more than operational skills and must be supported by pedagogical and contextual capacities.

The present review, however, provides a more explicit explanation of how digital literacy becomes connected to technology use. Previous reviews have tended to organize digital literacy around competencies, strategies, resources, and implementation challenges. The current synthesis connects these components into a progressive relationship: digital competence enables access and evaluation of digital resources; critical competence supports appropriate selection; and pedagogical competence enables those resources to be transformed into meaningful learning activities. This interpretation is also compatible with the broader emphasis in the reviewed literature on teachers' technological and pedagogical knowledge (Stringer et al., 2022; Tzafilkou et al., 2023; Zakiah et al., 2021). Thus, the present findings do not contradict previous studies but refine their implications by positioning digital literacy as an enabling mechanism between technological availability and pedagogically meaningful use.

This interpretation is particularly relevant to elementary education because younger learners may have access to digital technologies without necessarily possessing the cognitive and evaluative capacities required to use them productively. The recent systematic review by Wijayanti et al. (2024) similarly identified continuing issues concerning teacher preparation, digital content, evaluation, and digital competence in primary schools. The consistency between these findings suggests that the central issue is not simply whether technology is present but whether educational actors possess the competencies needed to convert technological access into learning opportunities.

b. Technology, Engagement, and Learning Quality: Consistency with Previous Evidence

The present finding that educational technology can support student engagement and learning quality is also consistent with previous reviews. Salam et al. (2024), reviewing digital learning media in primary education, reported that digital media such as videos, Android applications, and interactive multimedia were associated with improvements in academic performance as well as affective, language, critical-thinking, and knowledge-related outcomes.

More recent systematic evidence likewise reports positive relationships between digital learning and primary students' academic outcomes and engagement, particularly when interactive media and digital platforms are integrated into instruction. These findings correspond closely with the present synthesis, particularly the interpretation that digital technology can provide opportunities for participation, interaction, visualization, feedback, and active learning.

The comparison becomes more significant, however, when considering the conditions under which these effects occur. Recent systematic research on digital game-based learning in elementary education indicates that effectiveness is strongly associated with pedagogical alignment, explicit learning objectives, feedback, scaffolding, and student-centered design rather than technological complexity alone. This finding closely corresponds with the present conclusion that educational technology should be regarded as a conditional instructional mechanism rather than an automatic determinant of learning quality. The convergence suggests that the educational value of technology depends substantially on the instructional structure surrounding its use.

The present synthesis also corresponds with the systematic review of student engagement with digital technologies by Nkomo et al. (2021), which emphasized that engagement is multidimensional and that the relationship between digital technology and engagement varies according to technological and contextual conditions. The current review extends this point to elementary and Islamic elementary education by connecting engagement explicitly to learning quality. Rather than considering engagement as an endpoint of technology use, the present synthesis positions it as an intermediate educational process through which technological affordances may be translated into meaningful learning.

Recent evidence concerning children's digital engagement provides an important qualification to this interpretation. Harverson et al. (2025), in a scoping review of 88 studies, found substantial variation in how children's engagement with digital technology was defined and measured; only a minority of the reviewed studies explicitly defined, theorized, or measured engagement. This observation is relevant to the present review because it supports the decision to conceptualize engagement as multidimensional rather than equating it with simple participation or technology use. At the same time, it indicates that relationships between technology and engagement should be interpreted cautiously because differences in conceptualization and measurement can produce differences across studies.

c. From Fragmented Relationships to an Integrated Educational Pathway

The most distinctive aspect of the present synthesis emerges from comparison with previous literature that has generally examined individual relationships. Earlier studies have investigated digital literacy and learning outcomes, educational technology and engagement, teacher digital competence, or particular digital media separately. Existing reviews have also focused on specific dimensions, such as digital literacy in elementary schools, digital learning media, or children's engagement with digital technologies (Salam et al., 2024; Wijayanti et al., 2024; Harverson et al., 2025).

The present review brings these strands together and identifies a more integrated pathway: digital literacy → purposeful educational technology use → student engagement → learning quality. This does not imply that the relationship is strictly linear. Rather, the pathway represents the recurring analytical sequence emerging from the reviewed evidence. Digital literacy provides the capacity to use technology; technology provides learning affordances; engagement represents students' active response to those affordances; and learning quality reflects the resulting learning processes and outcomes. Teacher competence, infrastructure, motivation, learning environment, and parental support operate across this pathway as contextual conditions.

This integrated interpretation extends rather than replaces previous conceptualizations. The literature on digital competence explains the capacity dimension, the TPACK-oriented literature explains the pedagogical integration dimension, and engagement research explains the participatory dimension. The present synthesis connects these dimensions to the learning-quality dimension. In this respect, the contribution is not the identification of a completely new variable but the theoretical integration of relationships that have frequently been studied independently.

The comparison with recent systematic evidence further strengthens this interpretation. Prihatini et al. (2025) reported that digital learning in primary education was associated with improvements in academic outcomes and engagement, while also emphasizing the importance of interactive media, digital platforms, and implementation conditions. Similarly, recent reviews of interactive learning media have continued to emphasize the role of teacher digital competence in shaping technology-supported learning outcomes. These findings are compatible with the present synthesis but do not by themselves establish a complete explanatory pathway among digital literacy, technology use, engagement, and learning quality.

Accordingly, the comparison with previous studies indicates both substantial consistency and an analytical extension. The consistency lies in the repeated finding that digital competence, appropriately designed technology, student engagement, teacher competence, and contextual support are important to technology-mediated learning. The extension lies in interpreting these elements as interconnected components of one educational process rather than as isolated predictors or outcomes. The resulting synthesis provides a more comprehensive explanation of why technology-supported learning produces different educational experiences across elementary and Islamic elementary contexts: the relevant issue is not technology alone, but the degree to which digital competence, pedagogical integration, engagement, and contextual support operate together to produce meaningful learning quality.

3. Implications of Findings

The findings have both theoretical and practical implications for elementary and Islamic elementary education. Theoretically, this review contributes an integrated understanding of digital literacy, educational technology, student engagement, and learning quality as interconnected components rather than independent factors. The proposed relationship—digital literacy enabling purposeful technology use, technology supporting student engagement, and engagement contributing to learning quality—extends previous discussions that have often examined these dimensions separately. The findings also emphasize that the educational value of technology depends on pedagogical integration, teacher digital competence, infrastructure, motivation, and the learning environment. Thus, digital transformation in elementary education should be understood as a contextual and pedagogical process rather than simply an increase in technology use.

Practically, the findings suggest that schools should develop digital literacy beyond basic operational skills by emphasizing information evaluation, responsible digital behavior, communication, creativity, and critical use of digital resources. Teacher professional development should similarly strengthen the integration of technological, pedagogical, and content knowledge so that digital tools are selected according to learning objectives and students' needs. For elementary and Islamic elementary schools, improvements in infrastructure and internet access should be accompanied by supportive learning environments and appropriate parental involvement. These implications indicate that sustainable technology integration requires coordination among students, teachers, schools, families, and the wider educational context.

4. Research Limitations

Several limitations should be acknowledged. First, this study employed a qualitative literature review of 40 selected studies rather than a systematic review with statistical synthesis or meta-analysis; therefore, the findings provide an interpretive synthesis rather than effect-size estimates or causal conclusions. Second, the selected literature varied in educational context, research design, definitions of digital literacy and student engagement, and indicators of learning quality, which may limit direct comparison across studies. Third, the selection of international, national, and local literature may involve publication, database, language, and selection biases. Finally, the proposed relationship among digital literacy, educational technology, student engagement, and learning quality represents an analytical framework derived from the literature and should not be interpreted as a confirmed causal pathway. Future empirical studies using longitudinal, mixed-method, or comparative designs could further test and refine these relationships across diverse elementary and Islamic elementary education contexts.

CONCLUSION

This literature review demonstrates that digital literacy, educational technology, student engagement, and learning quality are closely interconnected in elementary and Islamic elementary education. First, digital literacy functions as a foundational capacity that enables students and teachers to use educational technology critically, appropriately, and purposefully rather than merely operationally. Second, educational technology can support behavioral, cognitive, emotional, and social engagement and contribute to learning quality when its use is aligned with learning objectives, pedagogical strategies, learner needs, and contextual conditions. Third, the synthesis indicates that student engagement represents an important process through which purposeful technology use can contribute to learning quality. These findings support an integrated framework in which digital literacy → educational technology use → student engagement → learning quality, while teacher competence, motivation, infrastructure, learning environment, and parental support operate as important contextual conditions. This interpretation is consistent with recent reviews emphasizing the importance of teacher preparedness, infrastructure, parental support, and multidimensional engagement in elementary digital learning.

The study is subject to several limitations. As a qualitative literature review of 40 selected studies, it provides an interpretive synthesis rather than statistical estimates of effect size or causal relationships. The reviewed studies also differ in educational contexts, definitions, research designs, and indicators of digital literacy, engagement, and learning quality, which limits direct comparison. In addition, literature selection may be affected by database, language, publication, and researcher-selection biases. Future research should therefore test the proposed integrated framework through systematic reviews with explicit quality appraisal, meta-analyses where sufficient quantitative evidence is available, and empirical longitudinal or mixed-method studies. Further research should also examine how the framework operates across different elementary and Islamic elementary contexts, particularly under varying levels of teacher digital competence, technological infrastructure, family support, and students' digital literacy.

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