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Interactive Application Learning Technology in Mathematics in Elementary Schools

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Abstrak

Penerapan teknologi dalam pembelajaran matematika di sekolah dasar menjadi kebutuhan medesak dalam menghadapi tantangan pendidikan abad-21 yang menuntut literasi digital, kreativitas, dan berpikir kritis. Meskipun berpotensi meningkatkan kualitas pembelajran, integrasi teknologi masih menghadapi hambatan dalam praktiknya. Penelitian ini bertujuan mengidentifikasi jenis teknologi pembelajaran yang digunakan, dampaknya terhadap proses dan hasil belajar, serta tantangan dan peluang implementasinya dalam konteks pembelajaran matematika di sekolah dasar. Dengan metode *Systematic Literature Review* (SLR) terhadap 16 artikel terbitkan 2020–2025, kajian ini menawarkan kontribusi teoritis berupa pemetaan tren dan kesenjangan riset terkait efektivitas teknologi pembelajaran. Hasil analisis menunjukkan bahwa teknologi seperti *puzzle-based learning*, e-modul interaktif, aplikasi gamifikasi (*Kahoot, Quizizz*), media visual (*Canva*), dan *Augmented Reality* (AR) terbukti meningkatkan motivasi, pemahaman konsep dan hasil belajar siswa. Namun, keterbatasan infrastruktur, literasi digital guru, dan aspek tidak merata masih menjadi kendala utama. Secara praktis, temuan inni memberikan arah bagi gguru dan pemuat kebijakan untuk merancang strategi pembelajaran matematika berbasis teknologi yang adaptif, inklusif, dan relevan dengan tuntutan pendidikan masa kini.

Kata Kunci : teknologi pembelajaran, matematika, sekolah dasar.

Abstract

The application of technology in mathematics learning in elementary school is an urgent need in facing the challeges of 21st-century education, which demand digital literacy, creativity, and critical thinking. Although it has the potential to improve the quality of learning, the integration of technology still faces obstacles in practice. This study aims to identify the types of learning technologies used, their impact on the learning procesess and outcomes, as well as the challenges and occasions for their immplementation in the context of mathematics learning in elementary school. Using the systematic literature review method on 16 articles published between 2020 and 2025, this study offers a theoretical contribution in the form of mapping trends and gaps in research telated to the effectiveness of learning technology. The result of the analysis show that technologies such as puzzle-based learning, interactive e-modules, gamification applications (Kahoot, Quizizz), visual media (Canva), and augmented reality (AR) have been proven to increase student motivation, conceptual understanding, and learning outcomes. However, limitations in infrastructure, teacher digital literacy, and uneven distribution remain major obstacle. Practically speaking to design adaptive, inclusive, and relevant technology-based mathematics learning strategies that meet the demands of today's education.

Keywords: *learning technology, mathematics, elementary schools.*

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INTRODUCTION

Education holds a vital role in developing high-quality and competing human resources. In the era of the Industrial Revolution 4.0, the system education sued For transform in a way comprehensive with utilise technology as the main instrument learning (Hakim, 2021). One implications of technologoical advancements is a shift in the educational paradigm from conventional learning toward interactive, collaborative, and adaptive digital learning. The request teachers to not only act as facilitators of learning but also as learning designers capable of effectively integrating technology into the teaching and learning process (Naibaho & Banurea, 2024).

Digital transformation in education is getting stronger with government policies in different countries, including Indonesia, that push for integrating information and communication technology (ICT) (Nashrullah et al., 2025) , into practices at all levels of education. In the context of basic education, particularly in elementary school, the use of technology has become an unavoidable necessity in addressing the callenges of 21st century education, such as critical thinking, collaboration, communication, and creativity (Aulia Nur Jannah & Putri Salma N, 2023). Educational technology is not merely understood as visual aids or hardware alone, but as a learning ecosystem encompassing software, teaching strategies, and data-driven evaluation systems (Nurhayani et al., 2023).

One subject that is particularly strategic and challenging to integrate with technology is mathematics (Safinah, 2020). As one of the core subjects in elementary school, mathematics hold a crucial function in evolving logical and systematic thinking skills in students. However , the reality on the ground shows that mathematics is still perceived as a difficult, abstract, and uninteresting subject by most students (Rodiyah & Siregar, 2024). Many students experience mathematics anxiety, which negatively impacts their academic performance. In this context, educational technology emerges as a potential solution to address various challenges in mathematics education. The apply of interactive learning operation, educational software, digital visual media, and gamification platforms has been evident to increase students' motivation and understanding of basic mathematical theory (Nursyahira, 2024).

Previous studies have shown that the incorporation of technology in mathematics learning has a positive impact on student learning outcomes. For example, (Gusteti et al., 2023) in their study stated that the use of Augmented Reality (AR)-based technology has been proven to significantly improve students' understanding of geometric concepts. Meanwhile, (Astuti & Ulia, 2025) state that mathematics learning through gamification platforms such as Kahoot can increase students' engagement and interest in learning. However, the use of educational technology at the elementary school level still faces several challenges, such as infrastructure limitations, teacher competencies, and resistance to changes in teaching methods. Meanwhile, (Alyusfitri et al., 2024) found that the use of interactive multimedia e-modules had a positive impact on student learning outcomes through attractive and interactive visual presentations.

In the Indonesian context , studies related to the use of mathematics learning technology in elementary schools are still sporadic or uneven and have not been systematically documented (Yulianti, 2024b). However, mapping the trends, methods, and results of various studies that have been conducted is very important to supply a finish picture of the effectiveness and challenges of

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implementing technology in mathematics learning. Therefore, the Systematic Literature Review (SLR) approach is an appropriate technique for collecting, evaluating, and analyzing previous research results in a comprehensive and structured manner (Shafira & Timur, 2023)This method allows researchers to identify research gaps, assess the effectiveness of the technology used, and evaluate relevant pedagogical methods.

This research has an urgency regarding the urgent need for learning strategies that are more contextual and responsive to the challenges of the 21st century, considering the importance of modernizing mathematics learning practices through technology-based approaches. Amidst the global trend of digitalization, teachers and education stakeholders need to have a deep understanding of effective technology integration strategies in mathematics learning that are tailored to the characteristics of elementary school students. Additionally, the outcome of this study are expected to supply theoretical and practical contributions, both for the academic world and education practitioners. Theoretically, the results of this SLR will enrich the literature on mathematics learning technology, while practically, the results can serve as a reference for teachers, school principals, curriculum developers, and policymakers in designing innovative and technology-based learning plans.

Thus, this study aims to answer the following questions: What types of learning technologies are used in mathematics education at elementary school?, How does the use of these technologies impact the learning process and outcomes of students?, What are the defiance and occasions in implementing learning technologies in the elementary education environment?.

METHOD

This study used the Systematic Literature Review to examine research on the use of technology in elemantary mathematics education. Keywords were grouped into three categories-"technology" OR "educational technology", "mathematics" OR "mathematics education" and "elementary school"-and combined using the Boolean "AND". Searches were conducted in databases such as ScienceDirect, Scopus, ProQuest, Google Scholar, and other accredited journals. The selection process followed the PRISMA protocol consisting of identification, screening, and inclussion stages. Selected studies were coded into four thematic categories: (1) technology type, (2) learning outcomes, (3) implementation challenges, and (4) pedagogical implications. Thematic analysis was used to identify trends and research gaps. Researcher bias was managed through reflextive documentation and peer debriefing to enchance transparency. Academic ethics were ensured by employing citation management software (Mendeley) and plagiarism detection tools (Turnitin), aligning the study with intenational publication standars.

RESULT AND DISCUSSION

Here are some reviews of educational technology in mathematics in elementary schools

Table 1 Review of Mathematics Learning Technology

Reference	Objects Study	Results
(Tuningsih	Misconceptions and changes in	Helping students

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Reference	Objects Study	Results
et al., 2020)	concepts regarding parallelogram after puzzle-based learning	understand shapes and properties through manipulative activities
(Alyusfitri et al., 2024)	The effectiveness of interactive multimedia e- modules on students academic performance and the correlation between student feedback and their learning achievements	E-Module can improve student learning outcomes, mainly due to their attractive visuals and direct interaction
(Mahdalena, 2022)	Level of technology use in mathematics learning	Technology is beginning to be integrated, but there are obstacles in term of infrastructure and teacher training
(Rijal & Maharani, 2025)	The Kahooot gamification learning model to improve mathematics learning outcomes	Kahoot increases students motivation and competitiveness in solving math problems
(Aziz et al., 2024)	The use Kahoot app on critical thinking levels in mathematics	Kahoot can support the strengthening of students HOTS questions through challenging and interactive questions
(Janah et al., 2023)	The Canva app as a medium for learning mathematics	Canva is effective in helping to present attractive visuals to clarify mathematical concepts
(Rahayu et al., 2024)	The Quizizz application to improve mathematics learning outcomes	Quizizz can increasestudentts interest and learning outcomes because it is game-based and adaptive
(Yulianti, 2024a)	The role of technology in mathematics learning	Technology makes it easier for teachers to access teaching resources and develop innovative learning for students
(Purwati, 2024)	Technology-based learning for understanding mathematical concepts	Understanding of mathematical concepts improves with the help of visual and interactive technology
(Mufida & Nurtjahyani , 2024)	Model team games tournament (TGT) in mathematics	Technology-based TGT media encourages collaboration, healthy competition, and student engagement
(Sitorus &	The role of technology and	Technology greatly assists

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Reference	Objects Study	Results
Marina, 2025)	learning media in mathematics	teachers in conveying abstract mathematical concepts to students
(Khoirunisa et al., 2022)	Drill and practice model to improve mathematics learning outcomes	Technology-based exercises improve students speed and accuracy in solving problems
(Ranisa et al., 2024)	The benefits of technological interrity in mathematics	Technology integration makes learning more adaptive and tailored to the needs of students
(Rahmawati & Fathoni, 2024)	The effectiveness of digital technology in mathematics	The use of digital learning expands the scope and flexibility of mathematics learning
(Ripadli & Erpansyah, 2024)	Augmented reality technology in mathematics	AR greatly aids in the visualization of geometry, improving students understanding and interest in learning
(Gusteti et al., 2023)	The use of augmented reality in mathematics	AR encourages active student engagement and facilitates the understanding of abstract concepts

Previous research (Gusteti et al., 2023) investigated the apply of Augmented Reality and found that it significantly improved students' understanding of mathematical concepts, learning motivation, and engagement in elementary schools, especially for geometry and algebra material. In this study, we included a set of additional search provision especially related to elementary education. The keywords apply are a mix of the following three provision, with the Boolean “OR” used to combine provision within a set and the Boolean “AND” apply to connect the three sets as follows: (1) Technology, educational technology, (2) Mathematics, mathematics education, learning mathematics, (3) Elementary school. To select suitable articles, we used the PRISMA 2020 flowchart, which includes three stages of the extractionprocedure: identification, screening, and inclusion. As shown in Figure 1.

The criteria included were as follows: (1) The study used empiricist research (2) The study was associated to educational technology (3) The research objective was associated to mathematics learning (4) The participators were elementary school students (5) The publication date was among 2020 and 2025.

Articles excluded from the review due to excluded criteria include: (1) Research not related to learning technology (2) Research not associated to mathematics (3) Participators not elementary school students (4) Specific participants, such as children with special needs or gifted students.

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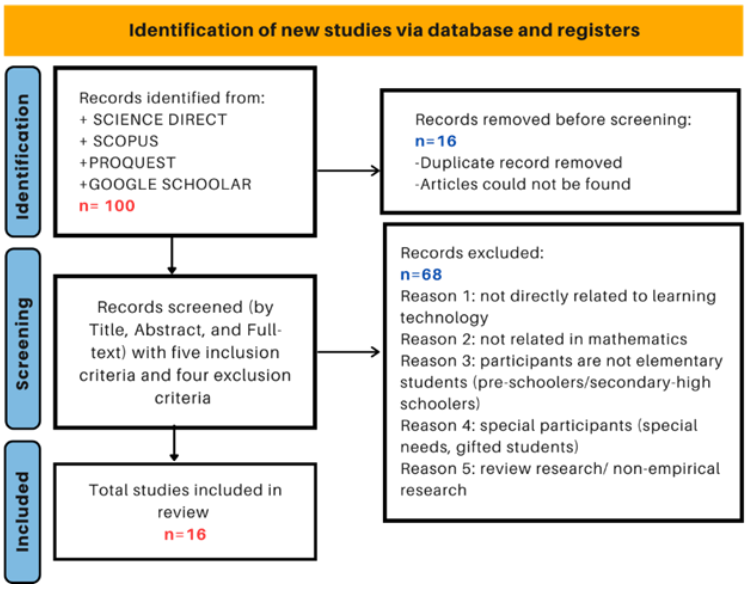

Figure 1 PRISMA flowchart

Of the 100 articles obtained, only 16 that encountered all the inclusion and exclusion standars were chosen for review. Appendix A shows the 16 articles apply in this review.

Coding Strategy & Data Analysis. The 16 articles were analyzed based on the following 7 factors: (1) Year of publication (2) Region where the research was conducted (3) Technology topic (4) Mathematics learning topic (5) Research problem (6) Research approach (7) Research design. For each research topic, there were always numerous research problems related to learning technology.

The section synthesizes findings from sixteen studies published between 2020 and 2025 and discusses their theoritical, practical, and contextual implications for elementary mathematics educations in Indonesia. The articles used in this study were published between 2020-2025. There were several early works during this period, but there was a significant surge in 2024, making it a trend in latest years. The focus of this study is on the context of Indonesia. The technologies used in mathematics education are diverse, including puzzle-based learning, interactive multimedia-based e-modules, projector-based media, gamification using applications such as Kahoot, Canva, Quizizz, Teams Games Tournament (TGT), and the use of augmented reality (AR). In the selected research, the dominant topics in mathematics were geometry (parallelograms), spatial figures, geometry & algebra, concept understanding, general/basic mathematics, problem solving, and critical thinking. Most of the research problems aimed to determine the intervention of learning technology in mathematics in elementary schools. How does technology influence conceptual understanding in mathematics learning, and how effective are technology-based learning models in helping students improve their conceptual understanding. Based on the 16 identified articles, the most commonly used approach was qualitative (8 articles), followed by quantitative (5 articles), literature review (2 articles), and mixed methods (1 article). Looking more closely at the research design, we found one article using an explanation sequential design, one using a one-shot case study, one using a descriptive design, two using quasi-experimental designs, two using experimental designs, two using case study designs, and seven using literature review designs.

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Based on the review of 16 articles above, it can be concluded that the learning technologies used in mathematics education in elementary schools are very diverse. The technologies used by teachers include puzzle-based learning, interactive multimedia e-modules, gamification applications such as Kahoot and Quizizz, visual media such as Canva, interactive game-based media (TGT, Mathplayground) , and the use of Augmented Reality (AR).

Puzzle-Based Learning helps students understand geometric theory through concrete and enjoyable manipulative activities. This method has been proven to increase enthusiasm, creativity, and meaning in the learning process, especially in the concept of parallelograms (Tuningsih et al., 2020). Additionally, multimedia-based e-modules equipped with visually appealing animations enable students to access materials independently, adapt to their individual learning styles, and create an authentic learning environment. This has a positive impact on learning outcomes, with positive responses reaching up to 85% and an average improvement of 69.17% (Alyusfitri et al., 2024). Gamification applications such as Kahoot, Quizizz, and Mathletics also play a role in creating an interactive and competitive learning atmosphere, which has proven effective in enhancing critical thinking, motivation, active participation, conceptual understanding, and learning outcomes (Rahayu et al., 2024) (Aziz et al., 2024). For example, the use of Kahoot resulted in a significant expand in median scores from 51.25 to 73.33 (Rijal & Maharani, 2025). Digital media such as Canva has been widely used recently and has demonstrated effectiveness in enhancing interest, motivation, understanding of abstract concepts, and mathematics learning outcomes (Jannah et al., 2023). Meanwhile, Augmented Reality (AR) technology offers a dynamic learning experience, enhances motivation, material retention, and develops critical thinking skills, ultimately positively impacting students' conceptual understanding and learning outcomes (Ripadli & Erpansyah, 2024) (Uriarte-Portillo et al., 2023).

However the implementation of technology faces a number of challenges. For example, limited infrastructure, uneven internet access, and a lack of teacher training in the use of technology (Mahdalena, 2022). There are still teachers who have difficulty operating digital devices, and not all students have the necessary devices to support digital learning at home. On the other hand, there are also opportunities to create more flexible, collaborative, personalized, and visual learning that aligns with the characteristics of 21st-century learning. The integration of technology in mathematics education can also accommodate various learning styles of students by helping to visualize abstract concepts in a more understandable way (Yulianti, 2024b). Therefore, teachers should be able to adapt by participating in adequate training on technological developments and their implementation in education (Rahmawati & Fathoni, 2024).

From a theoretical perspective, the synthesis of findings affirms the constructivist view that meaningful learning occurs when students actively construct knowledge through interaction with digital media. Beyond constructivism, the discussion also draws upon the theory of educational equality. In this context, learning is not merely process of receiving information but an active construction of knowledge through student interaction with digital media. In line with this approach, the application of the principle of equality in education is important to ensure that every student has same opportunity to obtain quality learning services. Educational equality should not merely be understood as providing identical treatment but as ensuring proportional support according to individul neds, allowing every learner to develop optimally. Thus, the concept of equality must be

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integrated with the principle of equality, which is the provisions of proportional assistance based on the conditions, potential, and learning obstacle of each student. This approach is in line with the goal of inclusive education, which treats all student as individuals who are entitled fo fair access, participations, and learning outcomes in the educational process. In addition, the application of equality in learning can prevent discrimination, increase learning participation, and create a classroom enviroment that values diservity. Therefore, the theory of educational, and create equality is an important basis for designing policies and learning practices that are humanistic and oriented towards educational justice. This aligns with inclusive education principles, which emphasize fairness, participation, and recognition of learner diversity (International Commission on the Futures of Education, 2021).

Digital transformation in education should not only be understood as technology chaneg but as a systematic effort to ensure equitable acess and meaningful learning for all student. Digital transformation in education should be understood not only as a change in the use technology in learning, but also as an effort to realize equal access and learning opportunities for all student. The integrations of digital technology enables teachers to provide diverse and flexible learning resources so that student with different abilities, backgrounds, and learning styles still have the same opportunity to understand the material. Thus, digital transformation should not stop at the provision of devices, but must be followed by equity oriented pedagogical practices, namely providing support and adjusting learning according to the needs of each student. This approach is in line with the principle of educational equality, which emphasizes that fairness in learning is achieved when every student can participate fully and obtain meaningful learning outcomes. Therefore, a successful digital transformation is one that is not only technologically modern, but also inclusive, humanistic, and equitable (Puspitasari et al., 2025).

Overall, this discussion highlight that technology-enhanced mathematics learning in Indonesian elementary school requires not only access to digital tools but also systemic support in teacher training, curriculum development, and equitable resource distribution. These aspects are crucial for developing future oriented mathematics curricula that embody the principles of digital transformation, inclusivity, and educational equality.

CONCLUSION

This study systematically reviewed sixteen national and international publications from 2020-2025 to explore the application of digital learning technologies in elementary mathematics education. Their impact on learning outcomes, and the contextual challenges of their impacts on learning outcomes, and the contextual challenges of their implementation. The findings reveal that a wide range of technologies such as puzzle-based learning, interactive e-modules, gamification applications such as Kahoot! and Quizizz, visual media such as Canva, and augmented reality (AR) have been effectively utulized to enhance students motivation, conceptual understanding, critical thinking, and learning achievement. The novelty of this study lies in its comprehensive and structured mapping of technology enhanced mathematics learning, specifically framed within the Indonesian elementary education context. Unlike previous provides a systematic synthesis that integrates theorrtical and practical perspectives, emphasizing the principles of educational equility and digital transformation.

These perspectives highlight that equitable access to digital resources, proportional teacher suppotr, and context sensitive pedagogical design are essential to ensure that all student regradless og background can participatr meaningfully in mathematics learning. The result of this review also offer practical implications for teachers, curriculum developers, and policymakers. Strengthening digital literacy and ICT competence among teachers, improving infrastructure in under resourced schools, and developing inclusive digital curricula are crucial steps to ensure sustainable and equitable technology integration in mathematics education. At the policy level, digital transformation must be accompanies by continous capacity building and equitable funding strategies so that every elementary school can benefit equally from digital learning innovation. In conclusion, integrating technology into mathematics education not only improves students learning experiences and outcomes but also contributes to achieving broader educational equity in the digital era. Therefore, enhancing digital readiness, ensuring equitable access, and supporting human reseource development across Indonesia's elementary schools are urgent priorities for building an inclusive an d future ready education system.

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