

Opportunities and Challenges in Integrating Technology in Mathematics Learning in Elementary Schools

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ABSTRACT

There are several ways to improve learning standards when integrating technology into mathematics learning in elementary schools (SD). Technology can enhance learning materials, increase students' enthusiasm for learning, and make learning more dynamic and efficient. However, there are several obstacles to technology integration, including limited access to technology, a lack of teacher expertise, and a lack of funding. The government and other stakeholders must make more significant efforts to address these issues. Increasing access to technology, improving teacher competence, increasing resources, and integrating technology into the curriculum are possible solutions. As a result, integrating technology into mathematics learning in elementary schools can be successful and improve student learning outcomes. This study aims to identify the advantages and disadvantages of using technology to enhance mathematics learning in elementary schools. This study uses a qualitative library research methodology. Library research is a method of collecting research data that involves organising and collecting various information about the research subject, such as from research abstracts, indexes, reviews, journals, and reference books available online or offline.

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1. INTRODUCTION

Rapid technological advances have created excellent opportunities to improve the standard of teaching in primary schools, particularly in mathematics, a subject that most students consider challenging and abstract. More engaging, interactive, and contextual information can be presented when technology is used in teaching and learning. This can increase students' interest in learning and help them understand difficult mathematical ideas. It has been shown that various digital resources, including interactive films, learning software, visual simulations, and educational games, can help students develop a more realistic understanding of the subject matter they are learning. [1].

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Students can explore mathematical ideas independently or in groups in a fun learning environment thanks to the visual approach and hands-on experience of technology. However, instructors benefit greatly from technology because it makes creating different teaching methods easier, distributing resources more effectively, and carrying out direct assessments of student learning. As a result, using technology in elementary school mathematics teaching improves teaching strategies and encourages the development of a more dynamic, flexible, and student-focused learning environment. [2] . However, several complex issues related to integrating technology into elementary school mathematics learning must be carefully considered. Lack of access to technology is one of the biggest challenges communities often face, especially in rural areas where infrastructure, such as digital devices and reliable internet, is still lacking. Students in metropolitan areas are more likely to have access to contemporary and engaging learning environments than those living in remote areas, which can lead to gaps in the quality of education. This leads to a digital divide that can exacerbate regional disparities in education. [3] .

In addition, a significant barrier to technology integration initiatives is the consideration of teacher competency. Not all educators have the skills, knowledge, and confidence necessary to successfully integrate technology into their lesson plans. A lack of relevant and ongoing training and heavy administrative workloads sometimes hampers teachers' ability to experiment and adopt new technologies in the classroom. As a result, even when gadgets and applications are available, their use is suboptimal and cannot have the greatest possible impact on student learning outcomes. Therefore, methodical efforts to eliminate these barriers by expanding access to infrastructure or enhancing teacher professional competency are critical to technology integration in primary education. [4] .

When integrating technology into elementary school mathematics learning, it is important to consider how ready students are to use it as a learning tool. Not all students have the same background regarding access to digital devices such as computers, tablets, or smartphones, or basic knowledge of how to use them. These differences can lead to gaps in the teaching and learning process, with some students able to keep up with the material. In contrast, others fall behind due to technological difficulties or a lack of support at home. Technology use in the classroom can exacerbate learning gaps if not planned with inclusive and adaptive learning approaches and strategies. Furthermore, the lack of relevant, high-quality digital information appropriate to elementary school students' characteristics is another equally important challenge. [5] .

Many digital resources currently in use are still too general or even too complex, and are not adapted to the national curriculum or the cognitive development of primary school students, which requires a straightforward, visual, and contextual approach. This deficiency is a problem for educators who want to successfully incorporate technology because they must be able to select or even produce relevant learning materials and be skilled at using them. Therefore, to ensure that the digital content that is currently accessible truly encourages meaningful, interesting, and simple mathematics learning for all students, collaboration is needed between the government, educational technology producers, and educators. Comprehensive and long-term strategic actions are needed from several

stakeholders, especially the government and education stakeholders, to overcome the various obstacles in integrating technology into mathematics learning in primary schools. Expanding access to technical infrastructure, such as reliable internet networks and adequate digital devices, must be a top priority for the government, especially in rural areas that are technologically disadvantaged.

Regular teacher training focused on practical application should also be prioritised so that teachers can not only learn how to use technology but also develop and implement technology-based learning in ways that are innovative, efficient, and responsive to the needs of their students. For content delivered through technology to truly improve learning outcomes and cognitive development of elementary school students, it is also important to establish a digital curriculum that is relevant, contextual, and in line with the national curriculum. [8] .

Collaboration between educational institutions, digital content creators, and the teacher community must be equally enhanced to build an inclusive and sustainable digital learning ecosystem. By addressing these issues, using technology in mathematics learning can successfully improve the standard of basic education in Indonesia. In addition to deepening students' understanding of mathematical ideas, technology encourages the growth of 21st-century skills such as critical thinking, problem solving, teamwork, and digital literacy, all essential to navigating the dynamics of a rapidly changing modern world. [9] [10] .

Although there are several opportunities to improve the quality of education through technology in primary school mathematics teaching, the integration process still faces several major obstacles. The main problems include the lack of infrastructure and availability of technical devices, especially in rural areas; the inability of teachers to utilise technology effectively; and challenges in integrating technology with relevant curricula. The success of technology integration is also hampered by the lack of resources and students' readiness for digital-based learning. Thus, it is important to identify the main problems: what opportunities arise from integrating technology in primary school mathematics teaching? What are the main obstacles faced during this procedure? And what approaches can be used to overcome specific barriers and help technology integration in mathematics education be successful?

The purpose of this study is to list and explain the various benefits that can be obtained from integrating technology into elementary school mathematics learning, including improved conceptual understanding, increased learning interest, improved learning quality, and time efficiency. This study also investigates the main barriers to the integration process, such as limited access to technology, lack of instructor proficiency in digital tools, limited resources, and problems integrating technology into the curriculum. In addition, this study seeks to determine the right way to overcome these challenges, including expanding access to technology resources, educating teachers, strengthening support from various stakeholders, and creating a technology-centred curriculum that is accessible and relevant. Thus, it is possible to obtain the best results from integrating technology into

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mathematics teaching in elementary schools, which will help improve the standard of education in Indonesia.

This research has theoretical and practical benefits. Theoretically, this research can contribute to scientific studies in education, especially related to the use of technology in teaching mathematics in elementary schools. It can serve as a guide to creating creative and flexible learning models that utilise new technological advances. Arguments about the value of technology in improving educational standards and curriculum implementation in the digital era are further supported by this research. In practice, the findings of this study can be considered by educators, principals, and education policy makers when creating strategies to integrate technology into mathematics classes. These strategies can include creating teacher training curricula, providing infrastructure and supporting facilities, and creating curricula that adapt to new technologies. In addition, educational institutions and the commercial sector should use this study as a guide to forming alliances to improve access and equity of technology in elementary schools, especially in areas with digital limitations. [9].

2. METHOD

This study aims to determine the opportunities and challenges in integrating technology into mathematics learning in elementary schools. This study uses a qualitative library research methodology. Library research is a method of collecting research data that involves organising and collecting various information about the research subject, such as from research abstracts, indexes, reviews, journals, and reference books available online or offline. Data collection techniques include editing, organising, and searching for research results, which require further analysis of the results of organising data using previously established rules, theories, and methods to arrive at certain conclusions that are the results of solutions to the formulation of the problem. Research that thoroughly examines the contents of written or printed materials and concludes that the data collected and examined is known as content analysis. [10].

The literature study research method is a technique that examines various related publications to understand the advantages and disadvantages of integrating technology into mathematics learning in elementary schools (SD). Researchers can find various technological innovations and strategies, including educational software, interactive learning applications, and digital media, which have been proven to improve students' understanding of mathematical concepts by searching for scientific journals, books, research reports, and other trusted sources. Thanks to this literature review, researchers can also develop a solid theoretical framework and gain a thorough understanding of best practices in elementary education. [14].

This study aimed to identify the advantages and disadvantages of using technology to improve mathematics learning in elementary schools (SD). This study combines library research methods with a qualitative approach. The process of collecting data and information from various textual sources, including scientific journals, reference books, research papers, internet articles, and other materials related to the research topic, is known as library

research. Content analysis, which involves reviewing the contents of several sources to draw conclusions based on patterns, correlations, and trends found in the data, is the analytical method used in this study.

There are five main interrelated phases in the literature research process used in this study. Planning is the initial step, where the researcher creates a problem statement, specific topic, focus of the study, keywords, and selection criteria for relevant materials. In addition, during the literature search phase, the researcher searches for reliable and up-to-date references on the use of technology in elementary school mathematics teaching by searching various scientific databases, digital libraries, and other online sources. The researcher then moves on to the literature selection and evaluation stage, which involves selecting sources based on their applicability, reliability, and contribution to the research objectives. The researcher also ensures that the literature is of high academic quality and is in line with the framework of elementary education. The fourth step is analysis and synthesis, where the researcher examines the content of the selected literature to determine the possibilities and problems of technology integration before synthesising the results to create a coherent and well-organised argument. Finally, the researcher develops findings that address the problem statement and offer suggestions for integrating technology into elementary school mathematics instruction. [12] .

3. RESULTS AND DISCUSSION

There are now many opportunities to improve educational standards through technology in primary school mathematics teaching, including the ability to personalise instruction and access interactive learning materials. [11]. However, there are drawbacks, such as students' varying access to technology, teachers' lack of technological literacy, and potential attention problems in children caused by using digital devices. The right approach is needed to optimise technology's positive effects while minimising its negative effects. [12]

Integrating technology into mathematics learning in elementary schools (SD) has several benefits. Digital technologies such as e-learning platforms and learning software can improve student participation and interaction in the learning process. [13] This allows for the delivery of information more engagingly and facilitates the understanding of difficult mathematical ideas. In addition, having access to online learning tools increases the references for instructors and students, making learning more flexible and tailored to each student's needs. [14] .

However, many obstacles must be overcome when using technology to teach arithmetic in primary schools. Limited infrastructure, including uneven internet access and the availability of appropriate technical devices, is one of the major challenges. [15] . In addition, there is still room to improve teachers' skills in using technology and integrating it into the classroom. Another challenge is the resistance to shifting from conventional to digital techniques, especially if instructors are not given proper training and guidance. [16]

A comprehensive solution is needed to address these constraints. The government can contribute by providing adequate and equitable regional technology infrastructure. Instructors should also be trained extensively in using instructional technology to enhance

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their proficiency. To facilitate the successful integration of technology into the educational process, it is also important to prepare a curriculum that is adaptable and responsive to technological advances. Governments, academic institutions, and the corporate sector working together can accelerate the digital transformation of education and ensure that technology is a useful instrument for improving the standard of mathematics teaching in primary schools. [17].

3.1. Opportunities to Integrate Technology in Mathematics Learning in Elementary Schools

There are many opportunities to use technology in elementary school mathematics learning. Students can understand complex and difficult mathematical ideas more easily using technology. [18] Technology can also make mathematics learning more interesting and dynamic, increasing students' enthusiasm for the subject. As a result, using technology in elementary school mathematics learning can improve students' learning outcomes and equip them to face the challenges of the 21st century. [19]. [20]. The use of technology in mathematics learning in elementary schools has several significant opportunities, including:

1) Increase Interest in Learning

There are many opportunities to increase students' enthusiasm for learning while using technology in elementary school math classes. Unlike traditional approaches, which are sometimes considered boring, interactive programs and software can present math topics in an interesting and fun way. Students can be actively involved in learning and improve their understanding of the subject matter by using educational games, simulations, and visualisations. As a result, technology serves as a powerful tool and motivation for students to develop a love of math.

2) Improving the Quality of Learning

When technology is used in elementary school mathematics instruction, there are several opportunities to improve learning standards. Teachers can deliver more in-depth and relevant mathematics content when they access appropriate digital resources. Animated films, simulation programs, and online learning platforms allow students to understand complex ideas visually and interactively. Technology also makes it easy to personalise instruction, allowing teachers to modify lesson plans and teaching strategies to suit the needs and skills of each student. As a result, technology enhances educational content and makes learning more successful and efficient.

3) Improving Students' Abilities

Using technology in elementary school math classes allows children to understand mathematical ideas better. Interactive simulations offered by educational software and learning programs allow students to play with and control mathematical objects, giving them a real-world method of seeing and understanding abstract ideas. Online learning systems also offer practice problems tailored to each student's level of understanding, allowing them to learn at their own pace and identify areas where they need to improve. As a result, technology is a powerful tool and facilitator for the growth of students' mathematical thinking skills.

4) Improve Time Efficiency

Technology is used in elementary school mathematics teaching, and opportunities arise for increasing time efficiency. Teachers can save time when creating lesson plans and providing feedback to students by accessing fast and accurate digital tools. Students can study independently and determine improvement areas with the help of automated practice test software and online learning platforms. Teachers can also promptly intervene and track student progress using technology. As a result, technology serves as a useful tool and time saver for learning mathematics. [6] .

The study's findings support the constructivist hypothesis that learning is more successful when students actively create knowledge through experience and interaction. Interactive technology in elementary school mathematics instruction supports Piaget and Vygotsky's theories on the value of contextual and authentic learning experiences. Furthermore, as outlined in humanistic learning theory, which highlights the need to adapt teaching tactics to each student's needs, technology-supported learning customisation encourages a student-centred learning approach. These results confirm the theory's applicability in education in the 21st century. [19] .

3.2. Challenges of Integrating Technology in Elementary School Mathematics Learning

Integration of technology into mathematics learning in elementary schools still faces several obstacles. [21] One of the biggest problems is the lack of access to adequate infrastructure and technology, especially in rural areas. In addition, instructors continue to struggle to incorporate technology into mathematics lessons because they lack the necessary technological skills and understanding. [22] . To overcome these obstacles and ensure the success of technology integration into mathematics learning in elementary schools, the government and other stakeholders must make more concerted efforts. The use of technology in mathematics learning in elementary schools also has several challenges that need to be overcome, including:

1) Limited Access to Technology

Limited access to technology is one of the biggest obstacles to its use in elementary school mathematics teaching. Schools still struggle to obtain equipment such as laptops or tablets, reliable internet connectivity, and other supporting infrastructure in many parts of Indonesia, especially in rural areas. These limitations make it difficult for educators to use technology in the classroom, which makes it difficult to achieve the promise of improving the quality and effectiveness of arithmetic teaching.

2) Lack of Teacher Skills

Another major barrier to using technology effectively in elementary mathematics instruction is teachers' inability to use it effectively. Many teachers lack the skills to support mathematics instruction with educational software, learning apps, or online platforms. Therefore, they may feel uncomfortable or anxious about incorporating

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technology into the classroom or be unsure how to use it to enhance students' understanding of mathematical ideas. This lack of expertise may hamper the potential of technology to enhance elementary mathematics instruction.

3) Limited Resources

Limited resources are a major barrier to incorporating technology into primary school arithmetic teaching. Large investments in hardware, such as PCs or tablets, reliable and fast internet connections, and relevant and high-quality educational software and apps are all necessary for efficient use of technology. Many schools find it difficult to provide these tools, especially in places where education finances are tight. Without adequate infrastructure, the digital divide between schools with and without adequate resources will widen, and the promise of technology to improve mathematics education will not be fully realised.

4) Difficulties in Integrating Technology with the Curriculum

Aligning technology with the current curriculum is a major obstacle to using technology in mathematics learning in elementary schools. Technology must be integrated smoothly with the learning objectives and competencies of the curriculum, not simply added to or replaced by conventional teaching techniques. This requires careful preparation, appropriate software and applications selection, and modification of learning materials to meet curriculum requirements and student needs. Efforts to improve the standard of mathematics learning in elementary schools can be hampered by the use of technology that is inefficient or even harmful if not well integrated. [23].

Paulo Freire's critical educational systems theory, which emphasises access gaps and structural constraints in education, is supported by the results on curriculum constraints, teacher competencies, and infrastructure issues. These constraints also imply that, as digital divide theory warns, introducing technology before systems are ready can exacerbate educational inequalities. Therefore, while technology has much good potential in theory, its actual use must include social, economic, and cultural factors that influence teacher and school readiness. [21].

3.3. Solutions to Overcome the Challenges of Integrating Technology in Elementary School Mathematics Learning

Improving teachers' technological skills and expertise and providing access to adequate infrastructure and technology can help primary schools overcome the difficulties associated with using technology in mathematics teaching. [24] Furthermore, the government and other stakeholders should offer more substantial technical support, training, and adequate funding. As a result, integrating technology into mathematics teaching in primary schools can be successful and improve student learning outcomes. [25]

To overcome the existing challenges, some solutions that can be done are:

1) Increasing Access to Technology

Collaboration between the government and schools is needed to address the issue of limited access to technology in teaching mathematics in primary schools. The government can ensure the provision of reliable internet connections in schools, especially in rural areas, and set aside sufficient budgets to purchase technology such as PCs or tablets. In addition, schools can develop alliances with non-governmental groups or the commercial sector to obtain assistance in teacher training programs or technology contributions. It is hoped that by working together, the government and educational institutions can achieve equitable access to technology, so that every student has an equal opportunity to benefit from learning mathematics through technology.

2) Improving Teacher Skills

Ongoing training and mentoring programs are essential to address the issue of teachers' inability to incorporate technology into elementary mathematics instruction. This training aims to provide teachers with the knowledge and practical skills they need to use learning programs, educational software, and internet resources relevant to the elementary mathematics curriculum. Teachers can also address their challenges when incorporating technology into the classroom with support from experienced colleagues or educational technology specialists. Through this method, teachers will feel more knowledgeable and confident in using technology to improve the quality of mathematics instruction.

3) Increasing Resources

By forming strategic alliances, elementary schools can proactively address the issue of scarce resources when incorporating technology into math instruction. Dedicated budget allocations for purchasing technology devices, upgrading network infrastructure, and subscribing to teaching software can be secured through partnerships with the city or federal governments. Additionally, schools can partner with digital businesses, charities, or non-governmental organisations to gain access to online learning platforms, teacher training, or device donations. Schools can leverage their resources by working together effectively, allowing for more efficient and sustainable use of technology in math instruction.

4) Integrating Technology with the Curriculum

Teachers and schools must work closely to overcome the barriers to integrating technology into the elementary mathematics curriculum. Teachers must be actively involved in designing and developing technology-based curricula to determine how technology can achieve the stated learning objectives. Schools can also provide teachers with the tools and training to improve their skills in integrating technology into their lesson plans. This method transforms technology into a valuable component of the learning process aligned with the elementary mathematics curriculum, rather than just an additional tool.

The suggestions for improvement in this study reinforce Everett Rogers' diffusion of innovation theory, which states that institutional support, user competence, and

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infrastructure all impact how well technology is adopted. The technology pedagogy content knowledge (TPACK) hypothesis, which highlights the importance of balancing content, pedagogy, and technology in creating successful learning, is also supported by teacher preparation programs and technology integration into the curriculum. As a result, the findings of this study not only lend credence to these hypotheses but also offer useful guidance for creating implementation strategies at the elementary school level. [24] .

The conclusion of this study provides an important contribution to the advancement of science in education, especially in the field of technology integration in mathematics teaching in elementary schools. First, by showing how the use of digital devices can increase student engagement, learning efficiency, and understanding of mathematical ideas, the findings of this study support constructivist learning theory and learning technology. Second, in line with the needs of the 21st century, these findings encourage the creation of a more flexible and learner-centred educational approach. [22] .

In addition, particularly in the context of primary education in low-income countries, this study creates an opportunity to create new pedagogical frameworks (such as the TPACK model) that consider the synergies between content, technology, and pedagogy. A greater research focus on technology-based teacher training and equitable digital access in primary school settings is encouraged by this study, which also emphasises the importance of teacher infrastructure and readiness as critical to successful technology adoption. In addition to being practically applicable, these findings broaden the scope of technology education science in more sustainable and inclusive local contexts and offer an empirical basis for future theoretical research and educational strategies. [22] .

4. CONCLUSION

There are several ways to improve learning standards when integrating technology into mathematics learning in elementary schools (SD). Technology can enhance learning materials, increase student enthusiasm in learning, and make learning more dynamic and efficient. However, there are a number of obstacles to technology integration as well, including limited access to technology, lack of teacher expertise, and lack of funding. The government and other stakeholders must make more significant efforts to address these issues. Increasing access to technology, improving teacher competency, increasing resources, and integrating technology into the curriculum are all possible answers. As a result, the use of technology in mathematics learning in elementary schools can be successful and improve student learning outcomes.

To improve teachers' capacity in integrating technology into learning and expanding access to technology, it is suggested that the government, educational institutions, and communities work together more closely. In addition, schools, especially those in rural areas, need to have more infrastructure and technical resources. As a result, the integration of technology into mathematics learning in elementary schools can be successful and improve student learning outcomes.

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