

The Role of Digital Technology in Improving Learning Outcomes: A Literature-Based Analysis

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Abstract: This literature-based study examines the effectiveness of technology integration in education to improve student learning outcomes. Drawing from a wide range of scholarly sources, the study highlights how technological tools such as multimedia applications, e-learning platforms, and augmented reality enhance cognitive development, engagement, and critical thinking. While digital technology offers substantial benefits, the effectiveness of its implementation depends on factors such as teacher competency, infrastructure, and learning design. The study concludes that strategic, student-centered, and contextually relevant use of technology is essential for maximizing learning outcomes.

Keywords: Effectiveness Using Technology, Improving Learning Outcomes, Learning Process

A. Introduction

Education serves as a fundamental driver for individual and societal development. In the 21st century, digital technology has reshaped the landscape of teaching and learning, providing innovative tools that enhance interactivity, accessibility, and learner engagement (Agbedahin, 2019). Amid this transformation, questions arise regarding the actual effectiveness of such tools in improving learning outcomes (Nuriansyah, 2020). This study seeks to analyze how technology contributes to learning outcomes and the conditions that enable or hinder its success (Dermawan et al., 2023).

The rapid development of the era, and almost all of it is technology-based, the world of education is not inferior to others. There are so many technology-based teaching media that can be utilized in the learning process for students. Media formed from the combination of technologies presents innovation by integrating various forms of media controlled by computers. This combination of technologies is considered the most advanced method, especially when supported by sophisticated computers that have extraordinary capabilities. Through this kind of media exploration, new opportunities are opened for creative and dynamic learning, providing challenges and opportunities for students to understand and master the material in a more interesting and in-depth way. The rapid advancement of digital technology has had a major impact on the education sector. The use of digital technology in learning opens the door to active

learning experiences, building knowledge, encouraging problem-solving skills, and exploring knowledge in greater depth for students. More than just a tool for conveying information, digital technology creates a learning space that connects teachers and students from various physical locations (Agbedahin, 2019). Technology comes from the word *techne*, which means expertise, and *logia*, which means knowledge. Technology is currently used by children to adults. In this era of digitalization, humans are very dependent on technology, including during the learning process.

Global demands require the world of education to be able to keep up with technological developments in improving the quality of education in the learning process. According to Belousova et al. (2021), the application and adaptation of technology in learning activities is a must in facing the challenges of change in the era of globalization because the development of information and communication technology has influenced the learning process. Along with the development of the era, technology is also developing rapidly. This technology provides many benefits in various fields, one of which is in education. According to Haleem et al. (2022), all forms of learning activities can be done easily in the current technological era. Technology in education is used as a means to support the learning process, both as a means to access information and as a support in implementing learning and completing assignments. The use of technology-based or digital learning media helps to enliven the atmosphere in the classroom so that active communication and discussion occur, makes it easier for teachers to deliver material and is also easy for students to understand, and provides a more interesting learning dimension so that learning is more effective and efficient (Samidass et al., 2022).

In the context of formal education, learning outcomes are usually measured using tests or other academic evaluations. These learning outcomes include students' understanding of the subject matter, their ability to apply the concepts in everyday life, and their ability to solve problems. However, student learning outcomes are not limited to academic assessments. Student learning outcomes also include the development of social skills, such as the ability to work with others, communicate ideas clearly, and lead a team (Sidabutar, 2021). In addition, learning outcomes also include the development of attitudes, such as a positive attitude towards oneself and others, the ability to work hard, and responsibility. Good education must be able to produce optimal learning outcomes. To achieve this, educational institutions must use learning methods that are effective and relevant to students' needs and provide appropriate support and guidance for each individual. Through effective education, students will get good learning outcomes and will be ready to face future challenges. By implementing these various efforts effectively, it is hoped that it can improve student learning outcomes and create a generation that is more qualified and ready to face future challenges. The use of technology in education can be one effort to improve student learning outcomes. Technology can help students to more easily understand course materials and improve their skills. Some ways of using technology in education that can improve learning outcomes include (Affandi et al., 2020):

1. **Interactive learning**
Technology can be used to create interactive and engaging learning experiences for students, such as learning through videos, gamification, or web-based learning;
2. **Accessibility of learning materials**
Technology can be used to make learning materials more accessible to students. Students can access learning materials online from anywhere and at any time;
3. **Use of learning aids**
Technology can also be used to create more interactive and engaging learning aids, such as learning applications, simulations, or learning games;
4. **Learning evaluation**
Technology can be used to conduct more effective and efficient learning evaluations, such as online tests or automatic evaluations;
5. **Collaboration and communication**
Technology can be used to facilitate collaboration and communication between students and teachers, as well as between students and fellow students. This can increase student interaction and activeness in learning.

Based on the theories of experts, the author is interested in conducting research on the analysis of the effectiveness of using technology in education to improve learning outcomes.

B. Methods

This study employs a qualitative literature review approach. Relevant sources including peer-reviewed journals, academic books, and conference proceedings were systematically identified, selected, and analyzed based on their relevance, credibility, and contribution to understanding the use of technology in education. The analysis focused on extracting findings related to the impact of educational technology on learning outcomes, while considering mediating factors such as accessibility, teacher competence, and instructional design.

C. Results and Discussion

Technological tools, such as multimedia presentations, simulations, and learning management systems (LMS), have shown to improve student motivation and cognitive engagement (Papanastasiou et al., 2019; Ferri et al., 2020). These tools facilitate individualized learning, foster collaboration, and support formative assessment. However, disparities in access and digital literacy remain key challenges. Without proper infrastructure and teacher training, the full benefits of educational technology may not be realized.

Education is a teaching and learning process that takes place formally in educational institutions. Education aims to provide knowledge, skills, and attitudes to students so that they can develop their potential and be ready to face future challenges. In the

education process, student learning outcomes are an indicator of the success of the learning process. Student learning outcomes can be measured through several aspects, such as knowledge, skills, and attitudes acquired by students during the learning process (Pujiastutik, 2019). Therefore, efforts to improve student learning outcomes are a major concern in learning. One way to improve student learning outcomes is to utilize technology in education. Technology can be an effective means to enrich learning and provide a more interactive and enjoyable learning experience for students. Some technologies that have been used in education include multimedia, e-learning, and augmented reality. The use of multimedia in education allows the use of various media such as images, sound, video, and text in one presentation, making it easier for students to understand the material being taught (Dermawan et al., 2023).

E-learning, on the other hand, allows students to learn online, which allows access to more varied and flexible learning resources. Augmented reality, a technology that combines real-world objects with virtual objects, can provide a more realistic and interactive learning experience for students (Papanastasiou et al., 2019). However, the use of technology in education also has challenges that need to be considered, such as limited access to technology and the unequal technological skills of students and teachers. In addition, the effectiveness of the use of technology in education also depends on the design of learning and its proper use. In this case, several theories can be used to develop the use of technology in effective education. Constructivist theory states that learning occurs through interactions between students and the learning environment, so technology can be a tool to enrich students' learning experiences (Wijayanti et al, 2021). Student-centered learning theory emphasizes that learning must be adjusted to the needs and abilities of students so that technology can be used to provide a more personal and flexible learning experience for students. In addition to developing the use of technology in effective education, it is also necessary to pay attention to the right learning model in the use of technology to improve student learning outcomes (Rahma, 2021). Several learning models that have been developed in the use of technology include collaborative learning models and problem-based learning models.

Collaborative learning models allow students to work together to solve problems or achieve common goals through discussion and sharing of ideas. In the use of technology, collaborative learning models can be carried out through online platforms that allow students to interact and collaborate even though they are not in the same location. Problem-based learning models allow students to learn by solving relevant and complex problems in authentic contexts. In the use of technology, problem-based learning models can be carried out through simulations and virtual environments that can simulate relevant and complex situations for students (Dasmo et al., 2020). In addition to these learning models, the flipped classroom model can also be used in the use of technology to improve student learning outcomes. The flipped classroom model allows students to obtain learning materials through videos or online learning resources before entering the classroom so that in the classroom students can focus on discussions and applications of previously learned concepts. In developing an effective learning model in the use of

technology to improve student learning outcomes, student-centered learning theory and problem-based learning theory can be used.

Student-centered learning theory emphasizes the importance of learning that is tailored to the needs and abilities of students, while problem-based learning theory emphasizes the importance of learning related to relevant and complex problems in authentic contexts (Desrinelti et al., 2021). In addition to effective learning models, there are other factors that can also influence the effectiveness of the use of technology in education to improve student learning outcomes. Some of these factors include technology accessibility, quality of learning content, teacher technology skills, and institutional support (Wajong et al., 2020). Accessibility of technology is an important factor in the effectiveness of the use of technology in education to improve student learning outcomes. Students who do not have adequate technology accessibility will have difficulty accessing online learning materials, which can affect their learning outcomes (Haeruman et al., 2021). Therefore, efforts need to be made to improve technology accessibility for all students, including those from underprivileged families.

The quality of learning content is also an important factor in the effectiveness of the use of technology in education to improve student learning outcomes. Quality learning content will help students understand the concepts taught more easily and effectively. Therefore, efforts need to be made to ensure that online learning content is of adequate quality and in accordance with the applicable curriculum. Teachers' technological skills are also an important factor in the effectiveness of the use of technology in education to improve student learning outcomes. Teachers who have good technological skills will be able to help students access and understand online learning materials more effectively (Ferri et al., 2020). Therefore, efforts need to be made to improve teachers' technological skills through appropriate training and development. Institutional support is also an important factor in the effectiveness of the use of technology in education to improve student learning outcomes. Educational institutions need to provide adequate support in the use of technology for learning, including in terms of planning, developing, and implementing online learning. In addition, there needs to be support from the principal and other stakeholders to ensure that the use of technology in education can run effectively. The use of technology in education has several advantages that can help improve student learning outcomes. One of the advantages of using technology is the ability to provide more flexible and personal learning access (Noormiyanto, 2020). With technology, students can access learning materials anytime and anywhere, according to their learning needs. This can help students who are busy outside of school or who live in remote areas to still be able to access learning materials easily. In addition, the use of technology in education can also help increase student engagement in learning.

Learning materials presented in an interactive and interesting form can help increase students' interest and motivation to learn. This can help improve the effectiveness of learning and student learning outcomes. However, the use of technology in education also has several disadvantages that need to be considered. One of the disadvantages of using technology is the digital divide. Students from underprivileged families or remote

areas may not have adequate access to technology, making it difficult to access online learning materials. This can affect student learning outcomes and reinforce educational inequality. In addition, the use of technology in education can also affect students' social interactions. In online learning, students may not have the opportunity to interact with classmates or teachers directly. This can affect students' social and emotional development. The use of technology in education is considered one of the solutions to improve student learning outcomes. Based on the results of a literature study, it was found that the use of technology in education has the potential to improve student learning outcomes, but its effectiveness is influenced by several factors.

One factor that influences the effectiveness of the use of technology in education is the learning design that is adapted to student characteristics. Learning that is tailored to students' learning needs can increase students' interest and motivation in learning, thus strengthening the effectiveness of the use of technology in education. In addition, the effectiveness of the use of technology in education is also influenced by the quality of the technology used. The technology used must be adequate and able to accommodate students' learning needs. Inadequate technology can affect student learning outcomes because students cannot access learning materials effectively. The use of technology in education must also be accompanied by appropriate learning strategies. Appropriate learning strategies can help improve the effectiveness of the use of technology in education. One strategy that can be used is project-based learning (PBL). Project-based learning can help students learn actively and be directly involved in learning, thus strengthening the effectiveness of the use of technology in education. However, the effectiveness of the use of technology in education is also influenced by the digital divide. Students from underprivileged families or remote areas may not have adequate access to technology, making it difficult to access online learning materials.

This can affect student learning outcomes and reinforce educational inequality. In addition, the use of technology in education can also affect students' social interactions. In online learning, students may not have the opportunity to interact with classmates or teachers directly. This can affect students' social and emotional development. In the context of the use of technology in education, the role of teachers is also very important. Teachers can help students optimize the use of technology in learning, as well as overcome problems that arise during the learning process. Therefore, training and development of teacher competencies in using technology in learning also need to be considered so that they can be in accordance with the learning needs and characteristics of students, meaning they are appropriate. This technology learning is currently developing very rapidly according to the theories of several experts and researchers above, which have significant results so that technology-based learning is effective in improving.

D. Conclusions

This study confirms that technology, when implemented effectively, enhances learning outcomes by fostering engagement, interactivity, and accessibility. However, its success

is contingent on several factors, including pedagogical alignment, teacher competency, and technological infrastructure. Thus, integrating technology must go hand-in-hand with supportive policies, ongoing teacher training, and equitable access. Future research should focus on longitudinal studies and comparative analyses to explore the sustained impact of technology across various educational contexts.

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