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Learning transformation with digital technology: The era of education 4.0

Khusnul Khotimah[1], Khoirul Anam[2], Muthiah Afifah[3] , Ratih Handayani[4]
[1, 4] Universitas Muhammadiyah Kotabumi
[2] Universitas Negeri Malang
[3] Universitas Negeri Yogyakarta

Correspondence: khusnul.khotimah@umko.ac.id

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ABSTRACT

This study explores the application of digital technology in education by teachers in Indonesia and its impact on learning quality. Using qualitative research methods, in-depth interviews were conducted with 8 teachers who integrate digital tools such as Canva, Quizizz, ChatGPT, Google, and YouTube in their lessons. The findings reveal that digital technologies enhance the creation of engaging and interactive learning materials, significantly boosting student engagement and motivation. Tools like Quizizz and YouTube have proven effective in deepening students' understanding of the material, while ChatGPT provides immediate feedback. However, challenges such as limited infrastructure, technological access, and students' digital skills gap remain. This study emphasizes the need for educational policies that promote equal access to technology and suggests more comprehensive training for both teachers and students to optimize the use of digital tools in education. The findings contribute to the ongoing discourse on digital transformation in the era of Education 4.0.

INTRODUCTION

Education 4.0 is a concept that integrates digital technology in the learning process to answer the demands of the fourth industrial revolution era. In this era, technologies such as application-based learning, e-learning platforms, artificial intelligence (AI), and the Internet of Things (IoT) provide a great opportunity to change the way education is delivered and understood (Calp & Bütüner, 2022). The impact of this transformation is not only limited to improving the efficiency of the learning process, but also to improving the quality of more inclusive and data-driven learning (Sergi et al., 2022). Digital technology is becoming an important component in shaping the future of education, increasingly focusing on developing 21st-century skills such as creativity, critical thinking, and collaboration.

However, although digital technology offers various potentials to improve the quality of learning, its implementation in education in Indonesia faces a number of complex challenges (Fatmawati & Safitri, 2020). One of the main problems faced is the inequality of access to technology in different regions, which includes lack of adequate infrastructure and limited internet access, especially in rural and remote areas. In addition, teachers' ability to integrate technology in learning is also still low, both in terms of software utilization and understanding technology-based pedagogy (Listiyoningsih et al., 2022). These challenges cause gaps in the implementation of digital education that risk widening the disparity in education quality between developed and disadvantaged regions.

Various previous studies have shown that the use of technology in learning can bring significant benefits, such as increasing students' motivation to learn, providing wider access to educational resources, and creating a more interactive and enjoyable learning experience (Alenezi, 2023; Amarulloh et al., 2020; Benavides et al., 2020). For example, e-learning platforms and game-based learning applications have proven to be effective in improving students' understanding of learning materials. Additionally, technologies such as adaptive learning and artificial intelligence (AI) allow for a more personalized learning experience tailored to each student's needs (Yankouskaya et al., 2024). However, although many studies have underlined the benefits of using technology, very few studies have in-depth identified the contextual challenges faced by Indonesia in the application of such technologies.

Although previous studies have revealed the great potential of technology in education (Suryanto et al., 2025), in-depth research on the application of digital technology in Indonesia is still very limited. Many studies have focused more on positive outcomes and technological advantages, while practical implementation issues and local contexts are often overlooked (Firdaus & Ritonga, 2024; Syamsuar & Reflianto, 2019). This gap is important to bridge, because the challenges faced in integrating digital technology in Indonesia are greatly influenced by unique social, cultural, and economic factors. It is important to understand the specific Indonesian context and how technology can be implemented effectively, given the diverse challenges that exist.

The main objective of this study is to analyze the application of digital technology in education in Indonesia, focusing on the challenges and their impact on the quality of learning. This research aims to provide practical recommendations for governments, educators, and education policy makers to optimize the use of technology in learning, taking into account existing local characteristics and conditions. Thus, the results of this research are expected to contribute to the development of education policies that support the achievement of the goals of Education 4.0, which include learning that is technology-based, creative, and relevant to future needs.

METHODS

Research Approach and Design

This study uses a qualitative approach with a descriptive-exploratory study design. The qualitative approach was chosen because this study aims to explore in depth the experiences, challenges, and perceptions of teachers related to the application of digital technology in learning in schools. The descriptive-exploratory design allows researchers to gain deeper insights into how digital technologies are used in the classroom, as well as the factors that affect their effectiveness. With this approach, this research not only aims to describe the current situation, but also to explore various dynamics related to the application of digital technology in education.

Research Subject and Location

The subjects in this study are 8 teachers who teach at the elementary and secondary school levels and have integrated digital technology in the learning process. The selection of subjects was carried out using a purposive sampling technique, where the selected teachers must meet several criteria, namely: (1) they have used digital technology in learning, either through e-learning platforms, learning applications, or other technology-based methods, (2) have teaching experience using digital technology for at least one year, and (3) are willing to provide in-depth interviews about their experiences and challenges in application of this technology. This research will be conducted in several schools that have applied digital technology in their learning, both at the primary and secondary school levels, to obtain a more comprehensive picture of the application of technology in various contexts.

Data Collection Techniques

The main technique in data collection is in-depth interviews. Interviews were conducted in a semi-structured manner, using interview guidelines that were compiled based on the main focus of the research. The interview guidelines cover various topics, such as: the form of application of digital

technology in learning, the benefits and challenges felt by teachers, and strategies used by teachers in dealing with technology implementation obstacles. Interviews were conducted with selected teachers, both in person and online according to the conditions and availability of informants. All interviews will be recorded and transcribed for further analysis. The semi-structured approach allows for flexibility in digging deeper into the informant's personal experience.

Research Instruments

In this qualitative research, the researcher himself plays a key role in data collection and analysis. The auxiliary instrument used is a semi-structured interview guide, which is designed to explore various perspectives of teachers regarding the application of digital technology in learning. This interview guide was prepared based on a literature review on educational technology and technology-based learning, with the aim of exploring information related to the process, challenges, and impacts of using digital technology. The guidelines are also designed with openness in mind, allowing researchers to explore unexpected aspects during interviews.

Data Analysis Techniques

The data obtained through interviews will be analyzed using a thematic analysis approach. The first stage in analysis is data reduction, which is the process of selecting and simplifying interview data that has been transcribed to focus on information relevant to the research objectives. Furthermore, the data that has been selected will be compiled in the form of data presentation that makes it easier for researchers to see patterns and themes that emerge from the interview. The presentation of this data will be in the form of a thematic narrative that describes the teacher's experience in using digital technology. In the final stage, the researcher will draw conclusions, namely the interpretation of the results of the analysis to identify findings related to the challenges, benefits, and impacts of the application of technology in learning.

RESULTS

Application of Digital Technology in Learning

This research aims to explore how digital technologies, especially applications such as Canva, Quizizz, ChatGPT, Google, and YouTube, are used in learning by teachers. Based on interviews with 8 teachers, all teachers interviewed used some of these applications to improve the quality of learning in the classroom. Digital technology is not only used to deliver material, but also to measure student understanding, provide instant feedback, and increase student engagement in learning.

Most teachers use Canva to create more visually appealing teaching materials. All of the teachers interviewed revealed that Canva helped them create engaging presentation slides, infographics, and learning posters that were easy for students to understand. Quizizz, a game-based app, is also widely used by these teachers to create interactive quizzes that increase students' motivation to participate in learning. Meanwhile, the ChatGPT application is used by some teachers to compile learning materials, provide additional explanations, and answer students' questions automatically, facilitating direct interaction even in an online format. Google is used to store and share materials, while YouTube is chosen by most teachers to display learning videos that are relevant to the teaching material.

Table 1. The application used by the teacher

No.	Teacher	Types of Applications Used
1	Teacher A	Canva, Quizizz, Google, YouTube
2	Teacher B	Canva, ChatGPT, Google, YouTube
3	Teacher C	Quizizz, Google, YouTube
4	Teacher D	Canva, Quizizz, Google
5	Teacher E	Canva, Quizizz, Google, ChatGPT
6	Teacher F	Canva, Quizizz, Google
7	Teacher G	Canva, ChatGPT, Google, YouTube
8	Teacher H	Canva, Quizizz, Google, YouTube

Methods of Using Technology by Teachers

The teachers interviewed used these apps for a variety of purposes. Canva, which is used by all teachers, plays an important role in designing teaching materials that are more engaging and easy for students to digest. Some teachers, such as Teacher A and Teacher D, state that the use of Canva allows them to create presentation slides that are not only informative but also visual, which greatly helps students in understanding difficult concepts. As Teacher A said:

> "Using Canva, I can create teaching materials that are more lively and less boring. Students are more interested when the material presented is visual and colorful. It really helps them understand the concepts that I teach."

Teacher A's statement shows that visual technologies like Canva can increase student engagement in learning. Previous research has also shown that material visualization can help students process information better and improve comprehension. This is in line with research results that show that visually appealing teaching materials can increase students' focus and motivation, especially in learning that involves more complex concepts.

Quizizz is used by most teachers to conduct interactive quizzes that not only test students' knowledge but also increase their engagement in the learning process. Teacher B and Teacher F reported that the healthy competition in these game-based quizzes motivated students to study harder. Teacher B explains:

> "Students are more excited when I use Quizizz. They feel like they're playing, but they're actually learning. This makes them more focused and quick to remember the material they have learned."

This quote confirms the finding that gamification in education, as found in the use of Quizizz, can increase student motivation and engagement. The use of game elements in learning has been proven to increase student interest and speed up the learning process. The use of Quizizz, with elements of competition and direct feedback, supports the theory that games can be an effective tool in improving student learning outcomes.

ChatGPT is used to provide additional explanations and answer students' questions directly. Teacher E revealed that they often use ChatGPT to generate explanations or additional teaching materials that can help students understand more difficult material. Teacher E revealed:

> "ChatGPT has been very helpful for me in explaining difficult concepts. Students also feel more comfortable asking questions through ChatGPT without feeling embarrassed."

The use of ChatGPT as a tool to explain material indicates the importance of artificial intelligence in supporting more personalized learning. Students can access answers and explanations at any time, which allows them to learn more independently without embarrassment or burden. This confirms the importance of AI-based technology in creating a more adaptive learning experience and in accordance with the individual needs of students.

Google is widely used to collaborate and share materials. All teachers stated that Google Drive and Google Docs were very helpful for them in storing, sharing, and editing teaching materials collaboratively with students. YouTube is chosen by most teachers to show learning videos that clarify or delve into certain material. For example, Teacher C states:

> "YouTube gives me a huge selection of videos that are relevant to the subject matter. Students can watch the videos at home or in class, which makes them better understand the lesson."

This excerpt highlights the important role of learning videos in helping students understand the material visually. Video is a medium that can enrich teaching materials by providing a real picture or demonstration that is difficult to achieve with just the lecture method. A number of studies have shown

that learning videos can speed up students' comprehension and improve memory, and the results of this study reinforce these findings in the context of YouTube apps in the classroom.

The Influence of Technology Use on Student Engagement and Learning Outcomes

The use of digital technology in learning has a positive impact on student engagement. All teachers interviewed reported an increase in student motivation to participate in learning activities. Technology makes learning more interactive and engaging, which increases students' focus during lessons. Teacher F and Teacher G noted that students who were initially passive in learning became more active thanks to the use of game- and video-based applications.

The teachers' statements show that the use of games and video-based apps can increase students' intrinsic motivation, which is in line with the theory that a fun learning experience can increase student participation and engagement in learning. Therefore, technology is not only a learning tool, but also a means to create a more dynamic and student-oriented learning experience. A positive impact can also be seen on student learning outcomes. Teacher D and Teacher E reported that after using apps like Quizizz and YouTube, students showed a faster improvement in understanding of the material, especially on complex topics. Teacher D explained:

> "Students who used to have difficulty understanding math concepts now understand faster after they watch videos on YouTube and take quizzes on Quizizz. The visualization videos are very helpful for them in understanding the material I teach."

This quote underscores how visualization videos and interactive quizzes can improve students' conceptual understanding. This is in line with the multimedia learning theory which states that the combination of text, images, and video can enrich the learning experience and improve student understanding.

Challenges in the Application of Digital Technology

Although the application of digital technology provides great benefits, there are several challenges faced by teachers. One of them is the limited infrastructure. Some teachers report that unstable internet access and device limitations are the main obstacles. Teacher H states:

> "In our area, internet access is often intermittent, which makes it difficult for students to follow online learning. In addition, some students do not have adequate devices to access the material."

Limited access to the internet and adequate devices shows that although technology can improve the quality of learning, equal access remains a major obstacle in the implementation of digital-based education. The digital divide in Indonesia leads to inequality in access to quality education, especially in areas that lack adequate infrastructure.

Teacher Adaptation Strategy

Teachers face these challenges with creative adaptation strategies. Teacher A and Teacher B, for example, provide learning materials in offline formats, such as PDFs and downloadable videos, so that students who have difficulty with an internet connection can still access the material. Teacher F also uses lighter platforms like Google Classroom to reduce reliance on apps that require fast internet access.

This strategy describes teachers' efforts to expand the accessibility of learning materials by overcoming internet connection constraints. This approach highlights the importance of flexibility in teaching methods, by providing students with a range of options with technological limitations, which in turn ensures that all students can continue to engage in the learning process.

DISCUSSION

The application of digital technology in learning has been proven to have a significant impact on the quality and effectiveness of the teaching and learning process. Based on the results of this study, the use of applications such as Canva, Quizizz, ChatGPT, Google, and YouTube allows teachers to present learning materials in a more interactive and interesting way. Canva, for example, gives teachers the

opportunity to create teaching materials that are not only informative but also visual, which greatly influences students' understanding, especially on concepts that are difficult to understand through text alone. This is in accordance with previous findings that show that visual materials can increase students' absorption in learning (Listiyoningsih et al., 2022). The use of Canva has been shown to support a more holistic educational goal, which is to improve students' skills in critical and creative thinking.

In addition, the Quizizz app provides advantages when it comes to learning evaluation. Teachers who use Quizizz report that these interactive game-based quizzes increase students' motivation and encourage them to participate more actively in learning (Cheng, 2019). This is in line with gamification theory in education which emphasizes the use of game elements to increase student engagement (Smiderle et al., 2019). With the competition and instant feedback offered by this app, students not only feel more interested but also understand the material taught faster. Additionally, the use of ChatGPT to provide additional explanations and automatically answer students' questions allows the learning process to be more flexible and affordable, especially for students who need further help outside of school hours (Ali et al., 2024; May et al., 2024).

However, while digital technology offers many benefits, the biggest challenges in its implementation remain, especially related to infrastructure limitations and technological accessibility. Some teachers revealed that unstable internet access and device limitations are the main obstacles to using this technology effectively. This is in line with previous findings that show that unequal access to technology in Indonesia can exacerbate education disparities (Firdaus & Ritonga, 2024). These limitations create a gap in the quality of learning between schools that have good access to technology and those that do not, which ultimately affects student learning achievement.

On the other hand, the digital skills gap among students is also a significant challenge. Although digital technology is increasingly used evenly in the classroom, not all students have the same skills in operating digital applications and platforms (Listiyoningsih et al., 2022). Some students find it difficult when they first use apps like Google Classroom or Quizizz, which shows that there is a digital literacy gap that must be addressed immediately. For this reason, intensive training needs to be provided not only to teachers but also to students, especially in preparing them to face future digital literacy needs. Given the importance of these skills, the integration of digital literacy in the educational curriculum is indispensable to ensure all students have the basic abilities to use technology effectively (Aprillia et al., 2023).

In addition to infrastructure and skills challenges, this study also shows that digital applications such as YouTube have helped students in deepening teaching materials visually. The use of learning videos helps students to understand difficult concepts that are difficult to explain with text alone. Visualization videos can improve students' conceptual understanding, especially in subjects that are practical in nature such as science and math. Previous research has shown that the use of video in learning can accelerate comprehension and improve memory (Salehudin, 2020). The use of YouTube in education has been proven to enrich teaching materials and help students overcome learning difficulties (Chomsum, 2020).

However, despite the many advances that have been made with the use of technology in education, there is still a lot of homework to be done to overcome the difficulties of access and limitations of technology. Teachers have adapted various strategies, such as providing offline materials or using lighter applications, but challenges related to the equitable distribution of technology remain a major obstacle in Indonesia's education system. Therefore, there is an urgent need for more inclusive policies and support equitable access to technology throughout Indonesia, especially in areas that have not been fully reached by digital technology. This includes improving internet infrastructure and more equitable distribution of devices across schools in Indonesia.

CONCLUSION

The use of digital technologies in learning, such as Canva, Quizizz, ChatGPT, Google, and YouTube, has a positive impact on student engagement, their motivation to learn, and improved learning outcomes, especially in the context of more visual and interactive learning. However, challenges related to infrastructure limitations and digital divide among students and teachers need to be addressed with more targeted strategies. Digital education in Indonesia must pay attention to equal access and digital skills so that the benefits of technology in learning can be felt by all levels of society, without exception.

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