

Technology Innovations in Education: Their Effects on Student Motivation and Learning Achievement

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Article history: received December 28, 2024; revised January 17, 2025; accepted January 26, 2025

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Abstract

The following article discusses the impact of technological innovation in education on students' motivation and learning achievement. This quantitative case study employed qualitative research methods to collect data through in-depth interviews, direct observation, and document analysis on a sample of secondary school students. The results indicate that the integration of technology, such as digital-based learning applications, learning management systems (LMS), and interactive tools, fosters increased student motivation through learning experiences that are more engaging and interactive. The study also identified significant challenges in the implementation of technology and provided recommendations to facilitate more effective integration.

Keywords: *innovations, educations, technology*

I. INTRODUCTION

Education in the digital age has undergone a considerable metamorphosis due to the pervasive integration of technology. Technological devices and platforms, such as learning management systems (LMS), interactive educational applications, virtual and augmented reality devices, have emerged as crucial tools, supplanting conventional methods that relied on whiteboards and textbooks (Dobosh, 2024). These innovations contribute to enhancing the efficiency and efficacy of the educational process. For instance, educational applications such as Google Classroom, Zoom, and Microsoft Teams facilitate remote instruction, while platforms like Kahoot! and Quizizz employ interactive methods that engage students by using game-based learning. Additionally, learning resources that were previously inaccessible are now readily available through digital devices, enabling students to learn at any time and from any location (Zolotarova et al., 2024).

Nevertheless, these advancements give rise to fundamental inquiries regarding the extent to which these technologies actually affect students' learning motivation and achievement. Learning motivation—which includes both intrinsic and extrinsic drives—often serves as a determining factor in educational success (Zhang, 2023). The advent of technology has rendered students' learning experiences more interactive and engaging; however, it has also presented challenges, such as potential distractions from non-educational features on digital devices. Likewise, learning achievement, as measured by academic attainment, serves as a critical indicator of technology's efficacy in the educational sector (Aris Sabthazi et al., 2024). While numerous studies have documented enhancements in learning achievement in specific contexts, these outcomes are often contingent on the manner in which technology is integrated, the level of support provided by educators, and the state of school infrastructure (Li et al., 2024).

The present study is therefore of considerable importance as it explores the effect of technological innovation on the motivation and learning achievements of students, especially in a school setting, by analyzing the experiences of both students and teachers. It aims to identify the relationship between technology use and students' learning drive and its impact on their academic results, as well as to uncover the challenges faced in the application of technology. The study further seeks to provide recommendations to optimize the potential of technology in supporting education in the digital era. The findings of this study are expected to offer insights to educators, policymakers, and educational technology developers to cultivate a more inclusive, effective, and sustainable learning ecosystem (Anita A. Cahyanti et al., 2024).

II. METHODS

This research employs a qualitative approach with a case study design to comprehensively examine the impact of technological innovation in education on student motivation and learning achievement. The qualitative approach was selected due to its exploratory nature, thereby enabling researchers to investigate the experiences, perspectives, and behaviors of subjects in depth.

The case study design was utilized because the focal point of this research is a particular educational institution, namely a school that has incorporated technology into the learning process (Abdussamad, 2022).

Research Location

The research was conducted at a SMA N 6 Jakarta known as a pioneer in the application of technology in the curriculum. The selection of this location was based on several reasons:

- The school has been using technology devices such as computers, tablets, and interactive learning applications consistently.
- The school's technology infrastructure is adequate, including stable internet access and a learning management system (LMS).
- The school management's support for technology-based educational innovations allows this case study to provide a comprehensive picture.

Observations were conducted in classrooms equipped with interactive technology such as smart whiteboards and other digital devices. In addition, the general school environment was also observed to understand how technology is applied outside the classroom, such as in the digital library or extracurricular activities.



Fig 1. Qualitative Research (Source: pennypaper)

Research Subject

The research subjects involved two main groups:

- Grade X students: A total of 20 students were purposively selected based on their active participation in technology-based learning. This group was selected to get a variety of experiences of students with different academic backgrounds and interests.
- Subject teachers: Teachers involved in this study are those who actively use technology in teaching, especially in science, math and English subjects. Teachers were selected because they have a key role in designing and implementing technology-based learning.

Purposive sampling aims to obtain relevant and information-rich data. The selected students and teachers are expected to provide in-depth insights into the impact of technology on the learning process.

Data Collection Techniques

Semi-structured interviews were conducted with students and teachers.

- Students: Asked about their perception of technology-based learning, their motivation level before and after the application of technology, and their experience in using learning tools or applications.
- Teachers: Asked about the effectiveness of technology in increasing student participation, the challenges they face in integrating technology, and the changes they observe in student motivation and achievement.

Each interview lasted 30-60 minutes, was recorded with the respondents' permission, and then transcribed for further analysis.

Observations were conducted in the classroom to record how students interacted with technology during the learning process.

Aspects observed include:

- Students' level of engagement in technology-based activities.
- Students' response to technical challenges or difficulties.
- Teachers' strategies in utilizing technology to enhance concept understanding.
- Observations were also made during extracurricular activities and self-study sessions in the digital library to get an idea of the use of technology outside the classroom.

Documents analyzed include:

- Student learning outcome reports: To evaluate the changes in grades before and after the application of technology.
- Learning implementation plan (RPP): To understand how teachers design technology-based learning.
- Teacher's daily notes: To gain insight into the challenges and strategies teachers use to overcome obstacles.

Data Analysis

Data were analyzed using thematic analysis technique, with the following stages:

- Initial Coding
Each piece of data from interviews, observations, and documents was coded based on emerging themes or topics, such as “student motivation,” “technical challenges,” and “academic achievement.”
- Categorization
Similar codes were grouped into larger categories. For example, the category “student motivation” included codes such as “enthusiasm,” “engagement,” and “learning independence.”
- Pattern Search
Patterns or relationships between categories were analyzed to find major themes. For example, the relationship between “use of interactive technology” and “increased student motivation.”
- Thematic Interpretation
The categorized and analyzed data were combined to produce an in-depth interpretation of the effect of technology on student motivation and achievement. This process also involved triangulating data from multiple sources to increase the validity of the research results.

The results of this data analysis are then presented in the form of in-depth narratives supplemented with quotes from respondents to provide further context and validity.

III. RESULTS AND DISCUSSION

A. Improved Learning Motivation

In-depth interviews with 20 students showed that technology-based learning provides a more engaging and interactive learning experience than traditional methods (Rana et al., 2024). Here are some of the key themes that emerged from the interviews:

- Fun in Learning: 85% of students stated that apps such as Kahoot! and Quizizz make the learning process more enjoyable because of their game-like format.
- Improved Concentration: 70% of students felt more focused during learning because technology provides easier-to-understand visualizations of concepts, such as interactive diagrams and animated videos.
- Sense of Achievement: 60% of students mentioned that the scoring or reward features of technology apps provide encouragement to learn better.

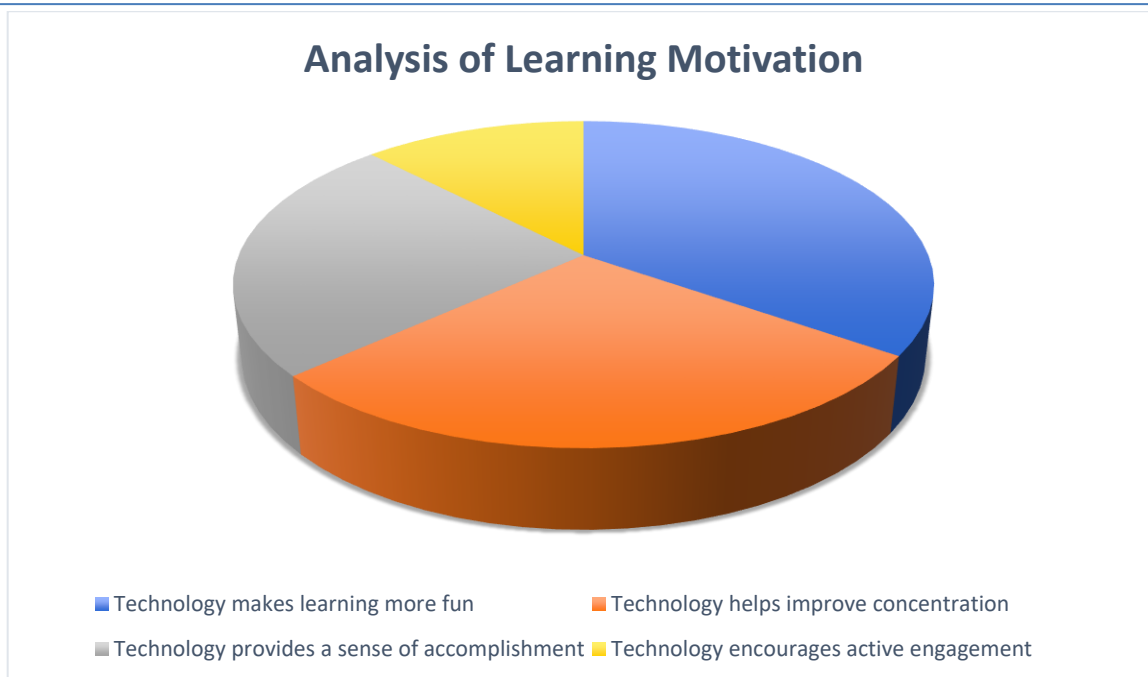
From direct observation conducted over six weeks:

- 90% of students showed high enthusiasm during technology-based learning sessions, demonstrated through active participation in interactive quizzes.
- 75% of students increased their engagement in group discussions after using the technology-based simulation to understand the subject matter.

To give a more concrete picture, here are the percentage results of students' responses to the effect of technology on their learning motivation:

Table 1. Analysis of Learning Motivation

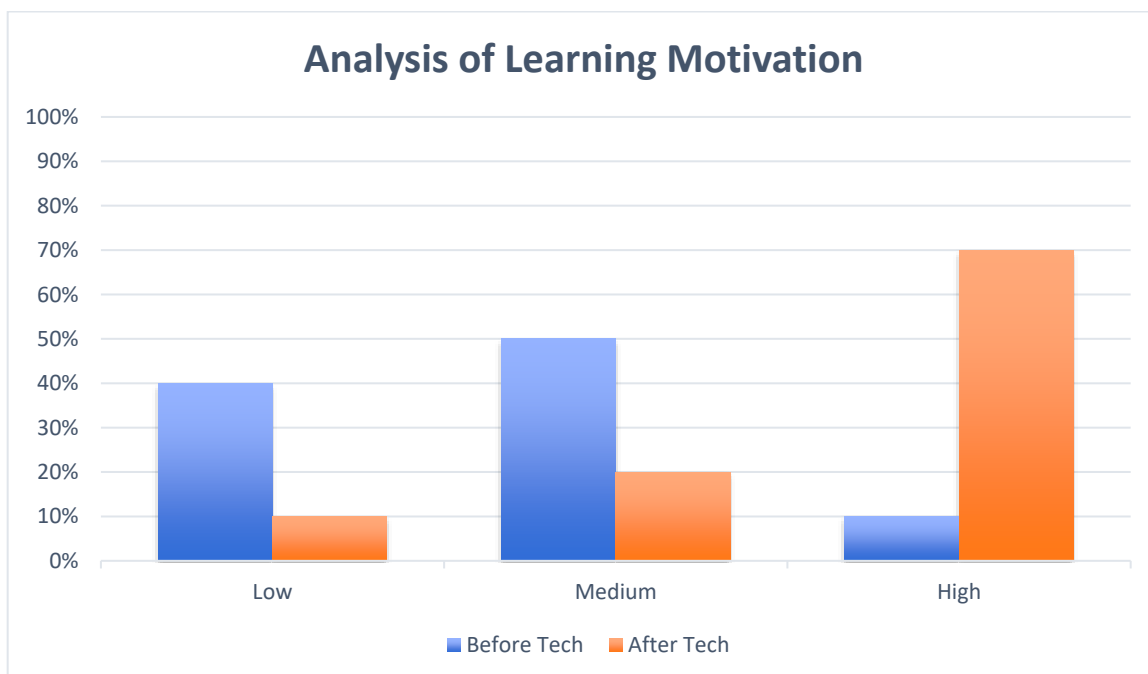
Aspect	Percentage of Students who Agree
Technology makes learning more fun	85%
Technology helps improve concentration	70%
Technology provides a sense of accomplishment	60%
Technology encourages active engagement	75%



Graph 1 . Analysis of Learning Motivation

Table 2. Change in Learning Motivation

Motivation Scale	Before Technology	After Technology
Low	40%	10%
Medium	50%	20%
High	10%	70%



Graph 2. Change in Learning Motivation

Key Factors that Increase Motivation

- **Interactivity:** Apps like Kahoot! and Quizizz offer a competitive and fun quiz format, sparking students' enthusiasm to compete positively.
- **Gamification:** Elements like scores, leaderboards, and virtual awards make students feel rewarded for their efforts.
- **Concept Visualization:** The use of animations and simulations in learning helps students understand difficult material, so they feel more confident in learning.

Recommendations for Further Improving Motivation

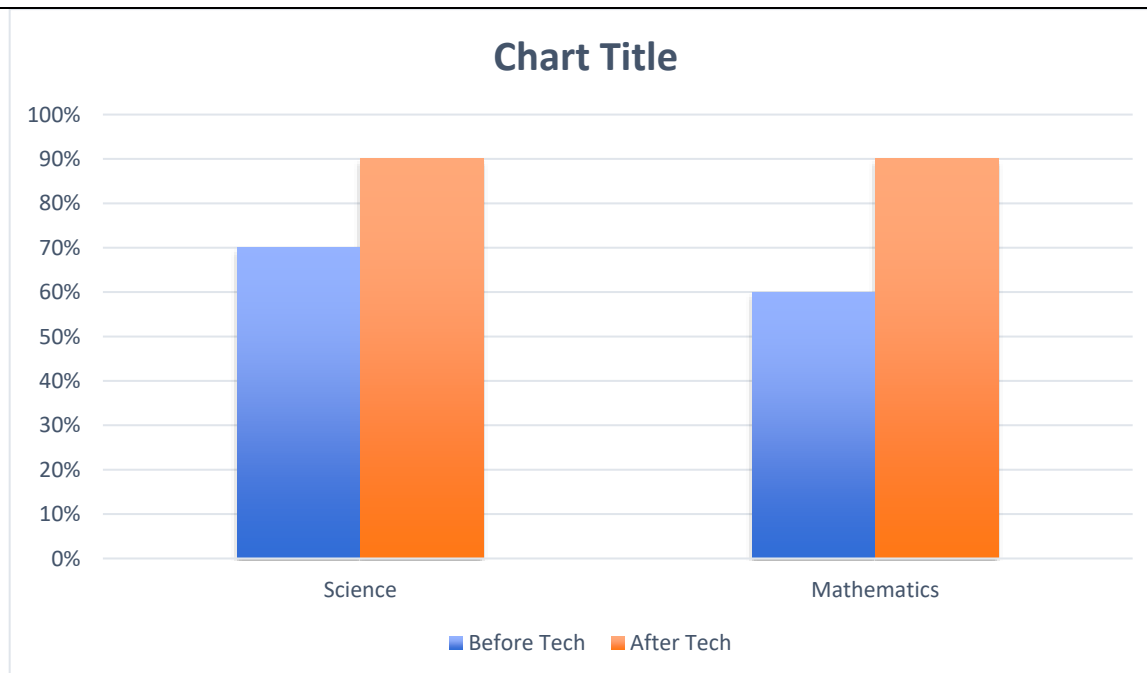
- Increase the integration of gamification in more subjects.
- Conduct regular training for teachers to maximize the use of technology.
- Provide supporting facilities such as more stable internet access to optimize students' learning experience.

B. Improved Learning Achievement

In this study, document analysis in the form of student grade reports showed a significant increase in student learning achievement after the application of technology in learning (Asdi Durahim et al., 2024). The main focus was on science and math subjects, where the use of digital simulation-based applications, such as PhET Interactive Simulations for science and GeoGebra for math, became an important part of the learning process.

Table 3. Average Value Before and After Technology Implementation

Study	Before Technology	After Technology	Increase
Science	70%	90%	20%
Mathematics	60%	90%	30%



Graph 1. Students, Teachers and Parents ability to recognize false information before and after character education

A more in-depth analysis was conducted to see the distribution of individual student score improvement. The following is the categorization of improvement:

Table 4. Distribution of Student Score Improvement

Improvement Category	Total Students	Percentage
>20%	8	40%
10% - 20%	10	50%
<10%	2	10%

Based on observations and interviews, this increase in learning achievement is caused by several factors:

- **Visualization of Abstract Concepts:** Digital simulations make difficult-to-understand concepts more concrete.

- Interactivity: Technology makes learning more engaging through game elements (gamification) and quiz-based challenges.
- Quick Feedback: Digital platforms provide immediate feedback, helping students understand their mistakes.
- Material Accessibility: Materials can be re-accessed at any time, allowing students to learn at their own pace.

C. Challenges in Technology Implementation

While technological innovation in education has many benefits, there are some challenges that hinder optimal implementation. Below is a detailed description of the three main challenges found in this study (Permana & Martatika, 2024).

Table 5. Challenges in Technology Implementation

Challenges in Technology Implementation	Percentage Respondent	Impact
Internet Access Difficulties	30%	Demotivation, learning delays
Lack of Teacher Training in Making the Most of Technology	40%	Technology is not optimally utilized
Distraction from Non-Educational Features	50%	Decreased focus, decreased learning achievement

1. Internet Access Difficulties in Some Areas

Not all students have adequate access to the internet, especially in rural areas or areas with limited digital infrastructure. This difficulty has a direct impact on students' ability to access technology-based learning platforms. Data Findings:

- Of the 20 students who were the subject of the study, 30% reported frequent internet interruptions.
- In certain areas, the average internet speed is only 1-3 Mbps, which is not enough to support online learning activities such as video conferencing or the use of interactive applications.

Impact:

- Students fall behind in learning.
- Students' motivation decreases as they often experience frustration due to slow connections.

Recommendation:

- The government and educational institutions need to improve internet infrastructure, especially in rural areas.
- Schools can provide free internet access through hotspots in strategic locations.

2. Lack of Teacher Training in Making the Most of Technology

Teachers are an important component in technology implementation but many lack confidence in using new technologies. Data Findings:

- As many as 40% of the teachers interviewed stated that they had not attended any specialized training on educational technology.
- Some teachers mentioned that they only rely on online tutorials, which are often insufficient to explore the pedagogical use of technology.

Impact:

- Technology is not used to its full potential.
- Teachers tend to revert to traditional teaching methods when facing technical difficulties.

Recommendation:

- Schools and governments need to organize intensive training for teachers.
- Education technology providers should offer easily accessible technical support.

3. Distraction from Non-Educational Features on Technology Devices

Devices such as laptops, tablets and smartphones often have features that distract students' concentration, such as social media, games and streaming videos. Data Findings:

- 50% of students admitted that they are sometimes tempted to open non-educational apps during study.
- Observations show that on average students lose focus for 10-15 minutes every hour due to distractions from their devices.

Impact:

- Students' learning achievement decreases due to split focus.
- Students' study time is not used efficiently.

Recommendation:

- Schools need to develop device management policies, such as the use of locking apps.
- Teachers can monitor students' activities during technology-based learning.

D. Discussion

The implementation also gives rise to a number of challenges that must be addressed. In general, the utilization of technology, such as digital-based learning applications, learning management systems, and interactive tools, serves to enhance students' learning experience (Monib et al., 2024). In the context of motivation, students report that technology-based tools contribute to a more engaging and enjoyable learning environment. For instance, the incorporation of gamification features, as seen in applications such as Kahoot! and Quizizz, introduces an element of healthy competition, thereby motivating students to engage more actively. Additionally, the use of interactive simulations, including scientific simulations on mobile devices, facilitates the visualization of abstract concepts, enhancing students' comprehension and, consequently, their confidence in the learning process (Wang & Na, 2023).

This heightened motivation is also reflected in students' learning achievements, as evidenced by document analysis showing significant increases in average scores in specific subjects, particularly mathematics and science, following the implementation of technology. In interviews, teachers noted that technology enables teaching to prioritize students' individual needs, such as providing additional practice to students who require it or offering more complex challenges to those who demonstrate faster comprehension (Rochmawati et al., 2024). Observations further noted that students exhibited heightened engagement in class discussions and demonstrated a propensity to pose questions with greater frequency, indicating an enhancement in understanding and curiosity. This phenomenon aligns with constructivist learning theory, wherein technology functions as a medium to facilitate students' construction of knowledge through meaningful experiences (Meepung et al., 2021).

However, the study also found some challenges in the application of technology in educational settings. One of the main challenges is the gap in technology access and infrastructure. Not all students have adequate access to technology devices or stable internet, which can create gaps in learning outcomes. Teachers interviewed also revealed that the lack of technical and pedagogical training makes it difficult for them to utilize technology to its full potential. Some teachers even feel that the use of technology is more often a distraction than a learning tool, especially when students use the devices for activities outside of learning. In addition, the time needed to prepare technology-based learning materials is often more than conventional methods, adding to teachers' workload.

Another factor to consider is the management of technology use in the classroom. Observations noted that some students are easily distracted by non-educational features, such as social media or games on their devices. This points to the importance of school policies that regulate the disciplined yet flexible use of technology to support learning (Sutama et al., 2024). Teachers also need to be equipped with the skills to integrate technology strategically so as to maximize its benefits without compromising the focus of learning.

Based on these findings, further discussion highlights the important role of government, educational institutions and technology developers in addressing these challenges. The government, for example, can improve education technology infrastructure through device subsidy programs or equitable internet network provision. Schools also need to conduct regular training for teachers to ensure that they can master the use of technology both technically and pedagogically. In addition, educational app developers need to design products that are not only visually appealing but also support deep learning and provide flexibility for teachers to customize their use according to student needs.

By addressing these challenges, the potential of technology to support educational transformation can be maximized. This research provides a foundation for follow-up studies that can explore how specific technological innovations, such as artificial intelligence or virtual reality, can further enhance learning motivation and achievement. A multidisciplinary approach involving collaboration between educators, technologists and policymakers may also be an effective strategy for creating a more inclusive and adaptive education ecosystem in the future (Darmansyah et al., 2023).

IV. CONCLUSIONS

The impact of technological innovation in education on student motivation and achievement has been demonstrated by the creation of interactive, engaging, and relevant learning experiences in the digital era. Digital-based learning software, virtual simulations, and application-based evaluation tools have been shown to enhance student engagement in the learning process, facilitate the comprehension of complex concepts, and provide immediate feedback, thereby motivating students to apply more effort. However, the successful implementation of these technologies is contingent upon adequate infrastructure support, including stable internet access, hardware available to all students, and a conducive learning environment. Furthermore, it is imperative to ensure that educators receive ongoing training to facilitate the effective integration of technology into innovative teaching methodologies. The management of technology is another critical challenge, as schools must establish clear policies to maximize the benefits of technology while minimizing distractions or misuse, such as access to non-educational content. Achieving this balance necessitates a collaborative effort among infrastructure provision, teacher capacity building, and effective technology management to ensure that technological innovation is not merely a transient phenomenon, but rather, a sustainable catalyst for enhancing student motivation and learning achievement.

ACKNOWLEDGEMENTS

Author thanks to all people and institution in most cases, sponsor and financial support acknowledgments.

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