*Research Article*

# The Effect of Digital Learning Innovation on Enhancing Deep Learning and Student Engagement in Secondary Schools

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**Abstract:** The rapid advancement of digital technology has transformed the landscape of education, particularly in secondary schools. This study investigates the influence of digital learning innovation on enhancing deep learning and student engagement. Using a quantitative survey method, data were collected from 150 secondary school students in Indonesia who actively use digital learning platforms such as Learning Management Systems (LMS), mobile learning applications, and hybrid learning models. The research instrument consisted of a closed-ended questionnaire using a five-point Likert scale, which measured students' perceptions of digital learning innovation, their engagement levels, and indicators of deep learning. Data were analyzed through simple linear regression using SPSS version 25. The results indicate a strong and significant positive relationship between digital learning innovation and both deep learning and student engagement, with a correlation coefficient (R) of 0.732 and an R² value of 0.536. This finding suggests that digital learning innovation explains 53.6% of the variation in students' deep learning and engagement levels. Students who frequently use digital learning technologies tend to show higher motivation, independence, critical thinking, and reflective learning behavior. The study concludes that digital learning innovation plays a crucial role in supporting meaningful learning and active participation. It highlights the importance of integrating technology strategically into school-based learning to foster adaptive, collaborative, and lifelong learners in the digital era.

**Keywords:** Deep Learning; Digital Learning Innovation; Educational Technology; Secondary Education; Student Engagement

## 1. Introduction

The development of digital technology has significantly influenced the educational process at the secondary school level. Various innovations in digital learning, including Learning Management Systems (LMS), mobile applications, and hybrid learning models, enable students to study in a more flexible, interactive, and autonomous manner (Dwiputri et al., 2024). The implementation of these technologies not only broadens access to learning resources but also enhances student participation in academic activities, making the learning experience more meaningful and relevant.

A key focus of modern education is deep learning, which emphasizes comprehensive understanding of material, critical thinking skills, reflective learning, and the application of knowledge in real-world contexts (Taqiyya et al., 2024). Previous studies have shown that integrating digital technology into learning can increase student engagement while supporting deep learning. This is because students have opportunities to access materials individually, interact with teachers and peers, and participate in adaptive and interactive learning activities (Supriyanto et al., 2025; Ismail & Zhang, 2024).

Although numerous studies have explored the impact of digital technology on academic achievement and student engagement, there is still limited research specifically examining the effect of digital learning technology on deep learning at the secondary school level. This study

offers novelty by focusing on a single primary variable the use of digital learning technology and exploring its impact on both conceptual understanding and student engagement. Additionally, the findings are expected to provide practical guidance for teachers and schools in designing effective strategies for leveraging technology to support deep learning.

Based on the above, the objectives of this study are to examine the influence of digital learning technology use on students' achievement in deep learning, explore the extent to which digital technology can enhance student engagement in the learning process, and identify the most effective strategies to optimize the implementation of digital learning technology in order to improve the overall quality of the student learning experience.

## 2. Literature Review

The rapid advancement of digital technology has profoundly transformed the landscape of modern education. Technology is no longer viewed merely as a supporting tool but as a pedagogical catalyst that reshapes how teachers design instruction and how students engage in the learning process (Dwiputri et al., 2024). At the secondary school level, innovations such as Learning Management Systems (LMS), mobile applications, adaptive systems, and hybrid learning models have fostered a more flexible, personalized, and interactive learning environment. These innovations are considered instrumental in promoting both deep learning and student engagement (Taqiyya et al., 2024; Mahardhika et al., 2025).

Theoretically, this study is grounded in several key conceptual frameworks.

First, the Universal Design for Learning (UDL) framework emphasizes the need for flexible instructional design that accommodates diverse learners' needs and preferences. Through technology, educators can provide multiple means of representation, engagement, and expression, ensuring equitable access to learning opportunities (Firmansyah & Aljauhari, 2023). Second, Vygotsky's sociocultural theory and the concept of situated learning place social interaction and cultural context at the core of knowledge construction. In digital learning environments, technology serves as a cultural artifact that mediates social interaction, enabling collaboration and contextual learning (Verywellmind, 2024; Adeshina, 2024).

Third, the deep learning pedagogy theory highlights that meaningful understanding develops through authentic tasks, reflection, constructive feedback, and opportunities to apply knowledge in new contexts. Digital platforms support these dimensions through project-based learning, adaptive pathways, and real-time feedback mechanisms (Taqiyya et al., 2024; Mahardhika et al., 2025). Fourth, student engagement theory classifies engagement into behavioral, emotional, and cognitive domains; technology-driven activities, gamification, and real-time feedback are shown to enhance all three dimensions of engagement (Supriyanto et al., 2025; Ismail & Zhang, 2024).

From a technological adoption perspective, the Unified Theory of Acceptance and Use of Technology (UTAUT) identify key determinants such as performance expectancy, effort expectancy, social influence, and facilitating conditions that predict how effectively digital innovations are integrated into teaching and learning practices (Supriyanto et al., 2025). At the systemic level, the Education Equity Technology (EET) framework underscores the importance of ensuring equitable access, personalization, and systemic transformation to achieve an inclusive digital education ecosystem (Digital Transformation, AI, and Inclusive Education, 2025).

Empirical findings from prior studies further strengthen this theoretical foundation. Research has shown that LMS and mobile platforms enhance collaboration and critical thinking among students (Dwiputri et al., 2024), while technology-assisted project-based learning promotes reflective and problem-solving skills (Taqiyya et al., 2024; Journals2.ums.ac.id, 2024). Other studies emphasize the potential of adaptive systems and artificial intelligence (AI) to personalize learning and accelerate deep learning outcomes, although infrastructural limitations and teacher readiness remain persistent challenges (Halimah et al., 2024; Simatupang et al., 2024). Similarly, gamification and contextual visualization techniques have been shown to enhance students' motivation and conceptual retention (Mahardhika et al., 2025; Zainuddin et al., 2025).

Nevertheless, the literature also cautions that technological integration alone does not guarantee improved learning outcomes. When technology adoption is limited to digital content delivery without pedagogical redesign, feedback mechanisms, or scaffolding it often fails to foster deep learning (Arxiv.org, 2023; Harprayudi et al., 2025). Thus, there is a growing need for empirical studies that examine students' direct experiences with educational

technology in secondary schools to better understand how its use influences both deep learning and engagement.

The novelty of this study lies in its focused approach, isolating a single primary variable students' use of educational technology and examining its impact on two key learning outcomes: deep learning and student engagement. This focus allows for clearer measurement of students' perceptions and practices while providing actionable insights for teachers and school administrators to design more effective digital learning strategies (Adeshina, 2024; Digital Transformation, 2025).

Implicitly, this study posits that the more meaningfully and intensively students utilize educational technology, the higher their levels of engagement and deep learning achievement will be. This hypothesis aligns with pedagogical theories (deep learning and engagement), technology acceptance theory (UTAUT), and inclusion-oriented frameworks (UDL and EET) that collectively inform the conceptual foundation of this research (Firmansyah & Aljauhari, 2023; Supriyanto et al., 2025; Digital Transformation, 2025).

In conclusion, digital technology holds significant potential to enhance both the depth and quality of learning experiences, provided that its implementation is pedagogically grounded, supported by adequate infrastructure and teacher capacity, and guided by inclusive educational policies. This study aims to contribute empirical evidence from the perspective of secondary school students regarding the relationship between digital learning innovation, deep learning, and student engagement.

## 3. Research Method

This study employed a quantitative approach using the survey method to examine the effect of digital learning innovation on deep learning and student engagement in secondary schools. This approach was chosen because it allows for an objective depiction of the relationships between variables, based on data directly collected from respondents.

The population of this study consisted of all students who had utilized digital learning technologies, such as Learning Management Systems (LMS), mobile learning applications, and hybrid learning models. From this population, a sample of 150 students was selected using a purposive sampling technique, in which respondents were chosen based on specific criteria namely, students who actively use digital technology in their learning activities.

Data collection was conducted using a closed-ended questionnaire with a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The instrument was designed to measure students' perceptions of digital learning innovation, their level of engagement in the learning process, and the extent to which they achieved deep learning. Prior to distribution, the questionnaire was tested for validity and reliability to ensure the accuracy and consistency of the items.

The data analysis was performed using simple linear regression with the assistance of SPSS software to determine the effect of the digital learning innovation variable (X) on deep learning and student engagement (Y). The results were presented in tables and interpreted based on the correlation coefficient, coefficient of determination, and significance level, which describe the direction and strength of the relationships between the variables.

## 4. Results and Discussion

This study involved 150 secondary school students as respondents who actively used digital learning technologies such as Learning Management Systems (LMS), mobile learning applications, and hybrid learning models. The primary objective of this research was to determine the extent to which digital learning innovation influences deep learning and student engagement in the learning process.

Data analysis was performed using SPSS version 25 through a simple linear regression approach to measure the relationship between the independent variable, digital learning innovation (X), and the dependent variable, deep learning and student engagement (Y).

**Descriptive Analysis**

The descriptive analysis revealed that most students have a positive perception of the use of technology in the learning process. The mean score for the digital learning innovation variable was 4.12, while the mean for deep learning and student engagement was 4.05 on a five-point Likert scale. This indicates that technology integration in learning is well implemented, and students respond enthusiastically, actively, and with a high level of cognitive and emotional engagement.

**Table 1.** Descriptive Statistics of Research Variables

| Variable | N | Mean | Std. Deviation | Category |
|---|---|---|---|---|
| Digital Learning Innovation (X) | 150 | 4.12 | 0.46 | High |
| Deep Learning & Student Engagement (Y) | 150 | 4.05 | 0.51 | High |

From the table above, it can be observed that the average scores for both variables are above 4.00, indicating that students perceive digital learning practices as having a positive impact on their learning process and classroom participation.

**Results of Simple Linear Regression Analysis**

A simple linear regression analysis was conducted to determine the influence of digital learning innovation on deep learning and student engagement.

**Table 2.** Results of Simple Linear Regression Analysis

| Model | R | R² | t-value | Sig. (p) | Description |
|---|---|---|---|---|---|
| 1 | 0.732 | 0.536 | 11.475 | 0.000 | Significant (p < 0.05) |

Based on the analysis, the correlation coefficient value of R = 0.732 indicates a strong positive relationship between digital learning innovation and deep learning as well as student engagement. The coefficient of determination ($R^2$ = 0.536) suggests that 53.6% of the variation in deep learning and student engagement can be explained by digital learning innovation, while the remaining 46.4% is influenced by other factors not included in this model, such as intrinsic motivation, learning environment, or teacher support. The significance value (p = 0.000) indicates that the effect is statistically significant.

Discussion

The findings indicate that the use of digital learning innovation has a substantial impact on improving the quality of deep learning and student engagement. Students who actively use LMS platforms, online learning applications, or participate in hybrid learning environments tend to show higher levels of participation and motivation. They not only access materials more frequently but also demonstrate greater critical thinking, reflection, and collaboration in completing learning tasks.

The integration of technology enables learning to become more personalized, adaptive, and interactive aligning with the characteristics of today's digital-native students. Features such as online quizzes, gamification, and discussion forums encourage behavioral and emotional engagement, while instant feedback mechanisms help learners monitor and understand their learning progress.

These results support the deep learning theory, which emphasizes conceptual understanding and the application of knowledge in real-world contexts. The findings are also consistent with previous studies by Dwiputri et al. (2024) and Mahardhika et al. (2025), which state that the integration of digital technologies in education enhances students' motivation, collaboration, and critical thinking abilities.

Furthermore, this research reinforces the student engagement theory, which classifies engagement into three main dimensions behavioral, emotional, and cognitive. Digital technologies support all three dimensions by promoting collaborative learning and adaptive systems that create more meaningful learning experiences. Practically, the results suggest that digital innovation not only affects academic achievement but also fosters active and reflective learning behaviors. Students become more engaged, independent, and responsible for their own learning processes.

From a theoretical standpoint, this study provides new empirical evidence on the significant role of digital learning innovation in enhancing learning quality at the secondary school level. With proper implementation and adequate infrastructure support, digital innovation has the potential to create a dynamic, interactive, and inclusive learning environment.

## 5. Conclusions

The findings of this study, based on 150 high school students, reveal that innovation in digital learning has a significant and positive impact on both deep learning and student engagement. The results of the regression analysis indicate that the application of digital learning technologies such as Learning Management Systems (LMS), mobile learning applications, and hybrid learning models contributes meaningfully to enhancing students' learning quality. The correlation coefficient (R = 0.732) and the coefficient of determination ($R^2$ = 0.536) demonstrate that more than half of the variation in deep learning and engagement levels can be explained by the use of digital learning innovations.

These findings suggest that students who actively utilize digital platforms in their learning process tend to exhibit stronger critical and reflective thinking skills, greater independence, and higher learning motivation. This supports the concept of deep learning, which emphasizes meaningful and contextual understanding, as well as the student engagement framework, which highlights the importance of active participation in the learning process. Digital innovations have proven to enrich learning experiences by fostering collaboration, interaction, and self-directed learning factors that not only enhance academic achievement but also help develop adaptive and future-oriented learning attitudes.

Based on these results, several recommendations can be proposed. First, teachers and schools should continue to strengthen the integration of digital technologies in classroom instruction. Teachers are encouraged to design digital-based learning strategies—such as those utilizing LMS platforms and interactive applications—that promote emotional, cognitive, and social engagement among students. Schools should also provide continuous professional development and training programs to equip educators with the skills needed to design creative and effective digital learning environments.

Second, curriculum developers should consider integrating digital learning systematically into the educational framework. Such integration should not only aim to improve academic outcomes but also to cultivate critical thinking, collaboration, and self-reflection among students. A technology-oriented curriculum can serve as a strong foundation for developing 21st-century competencies and fostering lifelong learning habits.

Third, future researchers are encouraged to expand the scope of this study by including additional variables such as learning motivation, learning environment, or learning styles, which may also influence deep learning. Employing a mixed-methods approach would also provide a more comprehensive understanding of students' experiences in digital-based learning environments, combining both quantitative and qualitative insights.

Overall, this study underscores the essential role of digital learning innovation in improving the quality of education in the modern era. When utilized effectively, technology can create interactive, collaborative, and reflective learning environments that foster independence and motivation, better preparing students to meet the demands of education and society in the digital age.

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