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Digital Competency and Student Engagement: A Literature Review on Deep Learning Integration in Primary Education

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ABSTRACT: This research presents a literature review that investigates how digital competencies relate to student engagement, particularly in the integration of deep learning in primary education. Drawing on findings from a diverse range of peer-reviewed studies published between 2018 and 2025, this review highlights that digital proficiency, including digital literacy, skills, and creativity, is closely associated with students' cognitive, emotional, and behavioral engagement. The effective use of digital resources, such as artificial intelligence, virtual reality, and adaptive learning systems, promotes critical thinking and facilitates deep learning. The findings show that students with advanced digital capabilities demonstrate greater concentration and enthusiasm, whereas those with limited skills and autonomy are more likely to disengage and exhibit off-task behaviors online. Additional factors, such as personalized learning, social and emotional engagement, and teacher's digital expertise also influence this relationship. Identified challenges include digital disparities, insufficient teacher preparation, and distractions from non-educational digital activities. To address these challenges, targeted digital literacy initiatives and improvements in curriculum design are recommended. In summary, this review highlights the complex relationship between digital competencies and student engagement, emphasizing the importance of comprehensive curriculum integration and teacher support to enhance learning outcomes through deep learning approaches in primary education.

KEYWORDS: Digital competency, student engagement, deep learning, Technology enhanced learning, Primary education

I. INTRODUCTION

In light of changes in education brought about by technological progress, the ability to use digital resources and student engagement have become essential elements in fostering effective and meaningful learning in the 21st century, particularly in primary education. The increasing importance of technology, AI, and advanced learning models is altering the ways in which students acquire knowledge, connect with material, and communicate (Zheng, 2018). As schools shift toward teaching that relies on digital methods, it is becoming increasingly important to understand how students' digital skills relate to their level of engagement, particularly in the integration of deep learning into the primary school curriculum. Despite growing research on technology-enhanced learning, few studies have systematically reviewed how digital competencies directly influence student engagement in deep learning at the primary level. This review addresses this gap by mapping the multidimensional interactions among digital skills, types of engagement, and educational technologies in primary school settings.

Digital competence encompasses a range of abilities beyond technical skills; it also includes digital understanding, problem-solving skills, effective online communication, teamwork, and Student engagement is complex, incorporating cognitive, emotional, and behavioral aspects (ElSayary et al., 2022; Girdzijauskienė et al., 2022). Cognitive engagement relates to how mentally involved students are in their learning activities, emotional engagement pertains to their feelings of interest and motivation, while behavioral engagement denotes their active involvement and persistence in tasks. These types of engagement are closely connected to the development of digital competencies, creating a mutually beneficial relationship in which engagement encourages the development of digital skills and vice versa (ElSayary et al., 2022). Behavioral involvement is the dimension most frequently influenced by educational technology, followed by emotional and cognitive engagement (Bond et al., 2020).

Incorporating deep learning approaches into the primary education curriculum, supported by digital technologies such as adaptive learning systems and immediate feedback tools, has great potential to enhance students' learning experiences. Deep learning

fosters critical thinking, innovation, and the ability to apply knowledge in various situations (Zheng, 2018; Yaseen et al., 2025). Advanced technologies, such as virtual reality, artificial intelligence, and smart learning platforms, can enhance deep learning by personalizing lessons and promoting immersive interactions (Svoboda and Knihová, 2025; Girdzijauskienė et al., 2022). The Python-based deep learning model developed by Zou and Chen (2024) demonstrates how innovative teaching methods can build digital literacy while also encouraging deep learning. Computational thinking, which is closely associated with digital skills, is influenced by both personal and external factors, including the availability of technology and programming experience (Gutiérrez-Aguilar et al., 2024).

Despite these encouraging advancements, inequalities in access to technology and levels of digital proficiency create notable challenges, especially for students in underfunded communities. Oyetade et al. (2024) found that students' participation in mobile learning was primarily influenced by their digital literacy and perceived usefulness, while their access to technology and sense of autonomy had a lesser effect. This highlights the need for targeted strategies that promote equity in digital access and skill development across diverse educational environments. A significant gap in technology access remains between students in urban and rural areas, affecting their opportunities to develop higher-level digital skills (Borisov et al., 2020).

Furthermore, teachers' abilities to effectively use digital resources are critical in influencing student engagement. Langat (2024) pointed out that the transition from traditional to digital education requires educators not only to be proficient in technology but also to design lessons that address diverse engagement needs. The effectiveness of incorporating digital tools is rooted in personalized learning experiences, effective classroom management, and ongoing professional development for educators. The digital skills of educators, evaluated through six main dimensions, play a crucial role in influencing students' educational experiences and outcomes in the era of Industry 4.0 (Dang et al., 2024).

Recent studies have also revealed that students who are highly engaged in digital learning outside the classroom may lose interest when school settings fail to adequately support or incorporate digital tools (Hietajärvi et al., 2020). This disconnect between informal digital learning habits and formal school settings could impede sustained student engagement unless it is addressed through integrated learning frameworks that connect experiences both inside and outside school.

Given these complexities, this research provides a systematic examination of the existing literature to gain insights into how digital skills and student engagement interact during the implementation of deep learning at the primary level. By analyzing a wide range of peer-reviewed studies from 2018 to 2025, this research emphasizes the various dimensions of digital engagement, the factors that contribute to the successful integration of deep learning, and the obstacles that need to be overcome to enhance learning outcomes. The uniqueness of this research stems from its comprehensive approach, which connects student behaviors, teacher preparedness, technological resources, and instructional design strategies.

In conclusion, this review contributes to the advancement of educational practices by clarifying how improving digital skills can promote meaningful engagement and facilitate deep learning among young learners. The findings provide guidance for policymakers, teachers, and curriculum developers regarding the key factors necessary for creating digitally competent, enthusiastic, and actively engaged learners who are prepared to operate in an increasingly complex digital landscape.

II. METHODS

This research employed a literature-based approach using the Systematic Literature Review (SLR) method, which is a systematic approach for identifying, examining, and synthesizing previous research to answer specific research questions in a transparent and reproducible manner (Moher et al.). The review process began by establishing the research focus, with an emphasis on investigating the relationship between digital competencies and student engagement in the context of deep learning implementation in primary education. An extensive literature search was conducted using online databases such as Scopus, supported by Scopus AI and the Publish or Perish (PoP) tool to identify relevant articles. The selected keywords included "digital competency," "student engagement," "deep learning," "technology-enhanced learning," and "primary education." The articles were screened based on specific inclusion criteria, including publication between 2018 and 2025, English language, full-text availability, and direct relevance to the research themes. Following a two-stage screening process, 12 relevant articles were selected. Data were extracted from these articles and analyzed thematically, focusing on the authors, research objectives, participant characteristics, indicators of digital competence, dimensions of student engagement, and technological resources used. This synthesis identified key themes, trends, and challenges related to the research topic. The research process is illustrated in Figure 1.

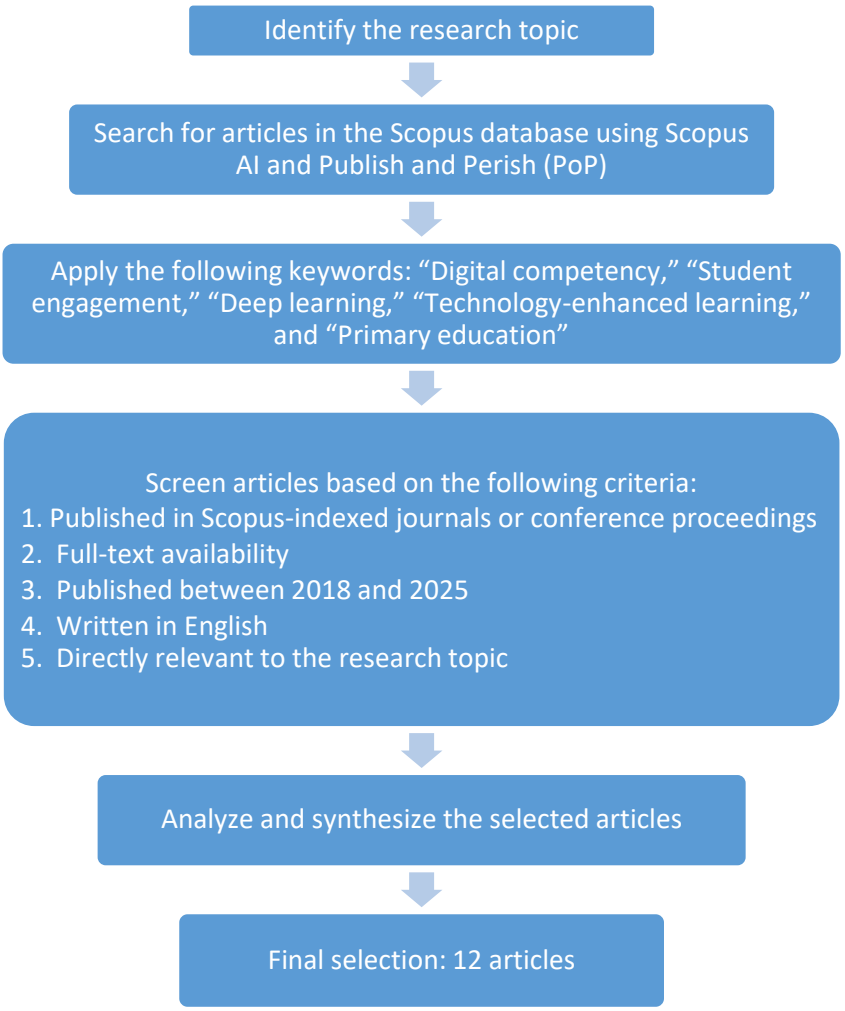


Figure 1 The Research Steps

Table 1. Characteristics and Findings of the Selected Studies Retrieved from Scopus

Author & Year	Title	Results
Nina Bergdahl, Jalal Nouri, Uno Fors (2020)	Disengagement, engagement and digital skills in technology-enhanced learning	The study revealed a considerable positive relationship between students' digital technology skills and their engagement in technology-enhanced learning (TEL). Disengagement was not significantly associated with digital skills, suggesting that some degree of disengagement may occur among all students. Engagement and disengagement were identified as indicators of student success, as reflected in final grades.
Hietajärvi, L., Lonka, K., Hakkarainen, K., Alho, K., & Salmela-Aro, K. (2020)	Are Schools Alienating Digitally Engaged Students? Longitudinal Relations between Digital Engagement and School Engagement	The study revealed that pupils with a greater inclination toward digital learning demonstrated increased engagement in school assignments over time, suggesting the potential of connected learning. In contrast, students who favored digital learning but lacked sufficient opportunities to connect it with their academic activities experienced a decline in school engagement. These findings emphasize the importance of schools recognizing and supporting students' informal digital learning practices to promote connected learning.

Bergdahl, N., Nouri, J., Fors, U., & Knutsson, O. (2020)	Engagement and Performance when Learning with Technologies in Upper Secondary School	The study indicated that high-performing students were better able to maintain focus and use digital tools effectively for educational purposes, whereas lower-performing students were more likely to become distracted and use digital tools to avoid boredom. Furthermore, strong associations were identified between the amount of time spent on social media and poorer academic outcomes. These findings highlight the importance of developing students' digital competencies to promote engagement and improve educational outcomes.
Heidari, E., Mehrvarz, M., Marzooghi, R., & Stoyanov, S. (2021)	The role of digital informal learning in the relationship between students' digital competence and academic engagement during the COVID-19 pandemic	The study revealed a notable positive relationship between students' digital competence and their engagement in academic activities, with digital informal learning (DIL) serving as a mediating factor. Students with higher levels of digital competence were more proficient in engaging in DIL, which subsequently contributed to greater academic engagement. The findings suggest that enhancing students' digital competencies and providing effective DIL resources may increase academic engagement, particularly during the COVID-19 pandemic.

III. RESULT AND DISCUSSION

1. The Study Results

A thorough examination of 33 articles, of which 12 studies met the inclusion criteria and were published between 2018 and 2025, indicates significant and complex relationships between digital skills and student engagement, particularly in the context of deep learning integration in primary education. The results show that digital proficiency, including digital literacy, skills, and creativity, is an important factor associated with students' cognitive, emotional, and behavioral engagement, particularly when digital resources are effectively incorporated into educational practices (ElSayary et al. , 2022; Bergdahl et al. , 2020; Hidayat-Ur-Rehman, 2024).

Various studies underscore the essential role of social and emotional engagement, which is positively associated with both cognitive and behavioral engagement (ElSayary et al., 2022). The interconnected nature of these dimensions contributes to the development of digital skills, particularly among preservice educators and young learners as they navigate digital learning environments. Higher levels of digital literacy and strong motivation are also associated with improved academic outcomes and student retention, as reported by Tian et al. (2023).

The application of digital resources, such as virtual reality, personalized learning systems, the metaverse, and artificial intelligence, can enhance student engagement and support higher-order thinking. As indicated by Zheng (2018) and Svoboda and Knihová (2025), these resources foster immersive learning environments that support deep learning by facilitating critical analysis, deductive reasoning, and knowledge transfer.

Furthermore, high-achieving students are observed to use digital technologies more effectively for academic purposes, maintaining their focus and concentration, whereas lower-performing students are more likely to become distracted and disengaged through non-academic uses of digital media, including unauthorized multitasking and social media use (Bergdahl et al., 2020; Wiseman et al., 2019). It suggests that digital competence alone may not be sufficient. Factors such as digital autonomy, motivation, and thoughtful instructional design may also play important roles in shaping student engagement.

Crucially, personalized learning approaches, supported by digital feedback and adaptive learning technologies, can substantially enhance engagement and address diverse learner needs (Yaseen et al., 2025; Girdzijauskienė et al., 2022). These systems may be particularly effective when they are aligned with students' digital capabilities and learning progress, thereby emphasizing the important role of digital literacy in optimizing engagement.

Moreover, additional research indicates that connected learning across formal and informal environments can support sustained engagement. Students who participate in digital activities outside the classroom are more likely to demonstrate increased engagement at school, particularly when digital integration is incorporated into the curriculum (Hietajärvi et al., 2020). However, a lack of opportunities to connect these experiences with formal learning may contribute to disengagement and declining motivation over time.

2. Implementation of Digital Competency and Engagement in Deep Learning

Effective implementation of digital competency within the primary curriculum requires careful coordination among teaching objectives, the use of digital tools, and strategies for fostering engagement. Zou and Chen (2024) emphasize that advanced learning models developed using smart systems, including those involving Python programming, can assist students in developing digital innovation skills in authentic learning environments.

In practice, the use of AI-powered tools, metaverse experiences, and mobile learning applications has demonstrated potential for enhancing student engagement, particularly among students from low-income or disadvantaged backgrounds (Oyetade et al., 2024; Langat, 2024). Collaborative learning through social media has also been reported to improve students' analytical thinking, problem-solving abilities, and enthusiasm by encouraging peer collaboration and connections with industry (Son, Sun, and Lee, 2019). These resources promote interactive learning, encourage learner autonomy, and provide immediate feedback, all of which are important for developing engaged and digitally competent learners.

Problem-solving activities can further enhance student engagement and support the development of digital skills in early childhood education (Pöntinen and Räty-Záborszky, 2020). In this context, integrating technical and creative skills through interdisciplinary approaches has been shown to support student engagement, motivation, and skill development (Blanco-García, Serrano, and Casanova, 2025). Additionally, user participation can be collected and analyzed in online learning environments, providing valuable information about how students interact with digital platforms (Balasooriya, Mor, and Rodríguez, 2018). Teacher support and technological proficiency also play important roles in students' motivation to learn and their success in online learning environments (Homyamyen et al., 2025).

Teachers are crucial to this integration process. Research by Posavec (2020) and León-Sandobal et al. (2025) indicates that teacher training and support for digital teaching practices are essential for providing students with meaningful learning opportunities. Without adequate preparation, even well-designed technologies may not engage all students effectively or equitably. Job-embedded professional development supported by digital tools can strengthen educators' digital skills and improve student engagement (Murphy and Lebans, 2019).

3. Challenges in the Integration Process

Despite favorable findings, numerous obstacles may impede the successful integration of digital competencies and student engagement strategies. These challenges include: (a) the digital divide, in which unequal access to devices and internet connectivity limits opportunities for some students, particularly those in low-income or rural areas (Oyetade et al. , 2024); (b) educator preparedness, as many teachers may lack the necessary digital skills or training to use emerging technologies effectively (Langat, 2024); (c) digital distractions, particularly those associated with smartphones and social media, which can disrupt focused learning (Bergdahl et al. , 2020; Hidayat-Ur-Rehman, 2024); and (d) the absence of individualized approaches, as one-size-fits-all educational settings may not adequately address the flexible and learner-centered nature of deep learning supported by technology (Girdzijauskienė et al., 2022). Moreover, technostress has been reported to mediate the relationship between perceptions of hybrid learning environments and students' academic success, suggesting that abrupt transitions to digital education may negatively affect student outcomes (Abbas, Wang, and Siddiqui, 2023).

These challenges highlight the need for thoughtful educational reforms, including targeted digital literacy initiatives, policies promoting equitable access, and professional development programs focused on engaging and adaptable digital teaching practices.

4. Evidence of Impact and Future Directions

The findings indicate that promoting digital competencies can support student engagement and may contribute to deep learning outcomes, including critical analysis, problem-solving abilities, and creativity (Zheng, 2018; Tian et al., 2023). Nevertheless, sustainable integration requires comprehensive support, including improvements to school-wide infrastructure, curriculum modifications, and ongoing assessment processes.

Future studies should investigate the long-term effects of digital engagement, the influence of cultural and sociodemographic factors, and the implementation of digital learning approaches across different educational contexts to promote inclusive and holistic development within educational systems (López-Bustamante and Vargas-D'uniam, 2025).

IV. CONCLUSION

The literature review indicates that integrating digital competencies with student engagement in deep learning contexts can enhance educational outcomes in primary education. Digital competencies, including digital literacy, creativity, and technical skills, are important factors associated with cognitive, emotional, and behavioral engagement, particularly when supported by personalized, flexible, and AI-driven technologies. Although strong digital competencies can enhance concentration and academic

outcomes, challenges such as unequal access to technology, inadequate teacher training, and technology-related distractions remain significant barriers. Therefore, comprehensive support, ongoing teacher professional development, and thoughtful integration of digital technologies are crucial for maximizing the potential of deep learning practices and fostering meaningful engagement among primary school students.

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