Implementation Of Digital Technology-Based Deep Learning in Elementary Schools: A Qualitative Study of Teacher Strategies and School Policies

Diki Riyadi[1*], Izzah Muyassaroh[2]

[1,2] *Universitas Pendidikan Indonesia, Bandung*
[*]Corresponding author. Email: dikiriyadi05@upi.edu

ABSTRACT

Technological developments in the digital era have brought significant transformations in the world of education, but learning in elementary schools is still largely focused on achieving grades without experiencing a deep and meaningful learning process. Deep learning has emerged as an alternative learning approach that emphasizes comprehensive conceptual understanding, contextual learning, and the development of 21st-century skills. This study aims to explore the learning strategies implemented by teachers, identify supporting school policies, investigate the obstacles faced, and design solutions for implementing digital technology-based deep learning in elementary schools. The study used a qualitative approach with a case study method. The research subjects were teachers, principals, and vice principals in the curriculum field who were selected using a purposive sampling technique with the principle of data saturation. Data collection was carried out through participant observation, semi-structured interviews, and documentation. Data validity was guaranteed through technical triangulation and source triangulation. Data analysis used the Miles and Huberman interactive analysis model consisting of data collection, data reduction, data presentation, and conclusions. The study results show that teachers implemented five main strategies: project-based learning, class discussions, teaching aids, contextual learning, and problem-based learning, with the integration of digital technology through instructional videos, digital simulations, and collaboration platforms. School policies supported this by providing ICT infrastructure, training, and comprehensive evaluation. Challenges faced included limited devices, unstable internet connections, limited device ownership, and diverse digital literacy. Solutions were developed through the use of rotating devices, offline applications, alternative non-digital materials, parent collaboration, and ongoing training. This study recommends strengthening digital teacher competencies, increasing infrastructure investment, developing adaptive policies, and building multi-stakeholder partnerships to support the implementation of digital technology-based immersive learning in elementary schools.

Keywords: *deep learning, elementary school, learning strategies, school policy keyword.*

1. INTRODUCTION

Technological developments in the digital era have had a significant impact on education, including at the elementary school level. Technology has accelerated the learning process, increased accessibility, and introduced new learning methods such as e-learning and blended learning (Almira, 2025). However, in schools, especially elementary schools, most students focus solely on grades and completing the curriculum, without truly experiencing in-depth and meaningful learning. This situation can be called "schooling without learning." In today's digital era, student-centered

learning is essential. One such concept is deep learning. Deep learning emphasizes contextual and meaningful learning (Khasanah et al., 2025). Deep learning also emphasizes learning based on students' real-life experiences. Furthermore, deep learning emphasizes the importance of metacognitive awareness, namely students' ability to monitor and control their own learning process (Khasanah et al., 2025). Deep learning emerged as a learning strategy that encourages students to think critically, reflect on experiences, and relate material to real life (Hardian et al., 2025). This concept also emphasizes a comprehensive understanding of concepts, the ability to relate new knowledge to previous experiences, apply knowledge in various contexts, and develop metacognitive skills. In deep learning, students not only answer "what," but also "why" and "how," and explore the relationships between concepts (Khasanah et al., 2025).

The implementation of deep learning in elementary schools is becoming increasingly crucial, given that the foundation of learning at this level will determine the quality of education at subsequent levels. Elementary school students are in the golden age phase of child development. During this period, children experience rapid cognitive, affective, and psychomotor growth (Susanti et al., 2025). Therefore, because children are in a period of good growth, in-depth learning is needed that is integrated with digital technology, because it seeks to increase the effectiveness of activities in the classroom (Sari & Munir, 2024). Furthermore, it has the potential to maximize the development of students' overall potential, as it can transcend conventional learning, which tends to be transmission-oriented and memorization-oriented, and foster curiosity, reflection, and critical thinking skills, also due to the positive developmental period. By fostering curiosity, reflection, and critical thinking skills, students can become lifelong learners (Sarnoto, 2025).

Several elementary schools in Indonesia, both public and private, have begun adopting a digital technology-based immersive learning approach in their teaching and learning processes. These schools also integrate various digital platforms, interactive learning applications, and technological devices to support deeper and more meaningful learning processes. However, much research has examined deep learning in depth. However, most of these studies focus on theoretical aspects or general technology implementation, without delving specifically into how teachers design learning strategies and how school policies support or hinder this process. However, the success of deep learning implementation depends heavily on the readiness and competence of teachers as learning facilitators, as well as conducive school policies that provide infrastructure, training, and support to the school community. This research gap raises important questions about real-world practice: what strategies teachers employ in implementing digital technology-based deep learning, what school policies support this implementation, what obstacles they encounter in the process, and what solutions can be developed to address these challenges. A thorough understanding of

these aspects is essential for providing practical recommendations for improving the quality of deep learning implementation in elementary schools.

Based on this background, this study aims to analyze teachers' learning strategies in implementing digital technology-based deep learning in elementary schools, examine supporting school policies, identify challenges faced by teachers and schools, and formulate alternative solutions to address these challenges. Specifically, the study seeks to explore the learning strategies applied, the role of school policies, the obstacles encountered, and the solutions developed in implementing digital technology-based deep learning. Using a qualitative approach, this study is expected to provide a comprehensive understanding of current practices and contribute both theoretically and practically to the development of elementary education in Indonesia.

2. METHODOLOGY

This research uses a qualitative approach with a case study method. This approach was chosen because this research aims to understand and describe in depth the phenomenon of implementing digital technology-based immersive learning in elementary schools. According to Sugiono qualitative research is research that is used to examine the conditions of natural objects, where the researcher is the key instrument (Ardiana, 2022). Qualitative research methods are grounded in post-positivist philosophy and conducted in natural settings, with the researcher as the main instrument. Data sources are selected purposively or through snowball sampling, data are collected using triangulation, and analysis is conducted inductively to emphasize meaning rather than generalization (Muhajirin et al., 2024). The case study method was used in this research to intensively and comprehensively explore teacher strategies and school policies in a real context in an elementary school environment. The case study research method is a type of research that can answer several issues or objects regarding a phenomenon (Yona, 2006). Case study research is a form of qualitative research that is based on events or situations, understanding and human behavior based on human opinion (Ilhami et al., 2024).

Through case studies, researchers can explore detailed and holistic information about how digital technology-based immersive learning is implemented, the challenges faced, and the efforts made by teachers and schools. The research subjects included teachers implementing digital technology-based deep learning, the principal, and the vice principal for curriculum. Subjects were selected using purposive sampling, a technique based on specific considerations aligned with the research objectives (Santina et al., 2021). The main objective of sampling is to reduce bias (perceptual deviation) and ensure that the selected sample represents the population well so that the research results can be applied more generally with the level of accuracy expected and planned by a researcher (Asrulla et al., 2023). Subject selection criteria included

teachers who had implemented digital technology-based learning for at least one year, schools with written programs or policies regarding the use of technology in learning, and subjects' willingness to participate in the research. The number of subjects was not determined in advance but was determined based on the principle of data saturation, which occurs when the information obtained no longer yields significant new findings.

Data collection in this study employed three main techniques observation, interviews, and documentation which were conducted simultaneously and complemented one another to obtain comprehensive and in-depth data. Observations were carried out using passive participant observation to examine classroom learning processes, including teachers' implementation of digital technology-based deep learning strategies, teacher–student and student–student interactions, the use of digital media, and the learning atmosphere. Data were recorded using observation guides, field notes, and visual documentation with school permission. Interviews were conducted using a semi-structured format to obtain deeper insights into teacher strategies and school policies related to immersive learning. Participants included teachers, the principal, and the vice principal for curriculum. Interview guides were used to ensure focus on key themes, and data were recorded using audio devices and supporting notes with informant consent. Documentation was collected to support and strengthen observational and interview data, including lesson plans, syllabi, school policy documents, curriculum files, digital learning media, student work, and photographs of learning activities. Documentation guidelines and checklists were used to ensure data completeness.

To ensure the validity and credibility of research data, triangulation techniques are used. Triangulation is a data checking technique that utilizes something other than the data itself for checking or as a comparison against the data itself (Husnullail et al., 2024). In this study, the triangulation used was technical triangulation and source triangulation. Technical triangulation was conducted by comparing data obtained from different data collection techniques on the same subject. For example, data on learning strategies obtained from interviews with teachers would be compared with the results of classroom learning observations and lesson plan documents prepared by the teachers. If these three data sources showed consistency, then the data were considered valid. If discrepancies were found, the researcher would double-check through discussions with the research subjects for clarification. Source triangulation was conducted by comparing data obtained from different sources using the same techniques. For example, information on school policies related to digital technology implementation obtained from interviews with the principal would be compared with information obtained from interviews with teachers and vice-principals, as well as with existing written policy documents. By comparing data from these various sources,

researchers could obtain a more comprehensive and credible picture of the phenomenon being studied.

Data analysis in this study used the interactive analysis model from Miles and Huberman. Miles and Huberman argue that qualitative data analysis must be carried out interactively and continuously until complete (Muliaan et al., 2024). Consists of data collection, data reduction, data presentation, and drawing conclusions or verification (Wandi et al., 2013). Data were collected simultaneously through observation, interviews, and documentation to obtain comprehensive information, with initial analysis conducted through reflective notes. Data reduction was carried out continuously by selecting, simplifying, and summarizing relevant information to identify key themes and patterns. The reduced data were then organized and presented clearly to support analysis. Conclusions were drawn iteratively and verified through additional data collection, field note review, member checking, and data triangulation. In qualitative research, conclusions represent new findings that clarify previously unclear phenomena.

3. RESULT AND DISCUSSION

Based on interviews with elementary school teachers, key findings were obtained regarding the implementation of digital technology-based immersive learning. These findings were then analyzed and discussed in accordance with the formulated research questions.

Learning Strategies Applied by Teachers in Implementing Digital Technology-Based Deep Learning in Elementary Schools

Interview results indicate that teachers understand deep learning as a process in which students not only memorize information but are able to connect it to their experiences, apply concepts to new situations, and demonstrate meaningful understanding. This understanding aligns with the concept of deep learning proposed by various education experts, where learning does not stop at the stage of remembering or understanding, but continues to the stages of applying, analyzing, evaluating, and creating. They learn to transfer knowledge to new contexts, solve real-world problems, and build 21st-century skills such as creativity, communication, collaboration, and critical thinking (Fatmawaty, 2024). At the elementary school level, deep learning is defined as students' ability to ask questions, explore, and create meaning from what they learn, rather than simply passively receiving information. This concept positions students as active constructors of meaning, rather than passive recipients of information, according to Zhao et al., in a 2022 study (Sappaile, 2025). I

n implementing immersive learning, teachers use a variety of varied and complementary learning strategies. The first strategy implemented is project-based

learning. Project-based learning provides opportunities for students to actively engage in exploration, collaboration, and problem-solving, which in turn stimulates their creativity (Taliak et al., 2024). This strategy allows students to develop critical thinking, collaboration, communication, and creativity skills in an integrated manner. Furthermore, by involving students in project planning and implementation, they learn to think critically, overcome obstacles, and develop innovative solutions (Yolanda & Mulyani, 2023). The second strategy is the use of class discussions and open-ended question-and-answer sessions. Teachers encourage students to ask questions, express their opinions, and discuss them with their classmates to build shared understanding. Teachers who are able to ask open-ended questions that stimulate students to think more deeply and discuss various perspectives successfully create an active and productive discussion atmosphere (Arifah et al., 2025). This method creates a dialogic and participatory learning environment, where students are not only recipients of information but also constructors of knowledge.

The third strategy used is the use of props or simple experiments. Learning with props provides concrete experiences for students, especially in elementary school, where students are still in the concrete operational stage. By using props, students can see the connection between the knowledge they gain and their surroundings, preventing them from becoming verbal (Latukau, 2023). The fourth strategy is connecting the material to students' daily lives. Teachers consistently strive to make learning contextual and relevant to students' experiences, so that the material learned has meaning and can be applied in real life. By improving students' ability to see material in everyday life, it is hoped that this will be one of their first steps in implementing the material taught in school in their social lives (Anissa & Lutfi, 2024). The fifth strategy is the problem-based learning model. In this strategy, students are presented with authentic problems that they must solve through investigation, analysis, and synthesis of information. Learning through the problem-based learning model is expected to empower students to become independent individuals and be able to face any challenges in their lives later in life (Ratnawati, 2021).

The integration of digital technology into these learning strategies is achieved through various means. Teachers utilize instructional videos to provide visualizations of concepts that are difficult to explain verbally or through text. Instructional videos help students understand processes, phenomena, or abstract concepts in a more engaging and accessible way. This medium is considered effective because it helps teachers deliver material in a way that is engaging and easy for students to understand (Astiyanah & Mastoah, 2025). Digital technology thus serves not only as a means of conveying information, but also as a medium that enriches the learning experience, facilitates deeper exploration of concepts, and provides a richer and more diverse range of learning resources. Therefore, technology is seen as facilitating access to diverse

learning resources and facilitating collaborative communication between students and teachers (Fatimah et al., 2024).

To encourage students to think critically, analyze, and solve problems, teachers use a learning approach based on higher-order thinking questions. These provocative questions go beyond memorizing or understanding, encouraging students to analyze, evaluate, and create. Teachers also present real-world problems to be solved collaboratively, enabling students to apply their knowledge in meaningful contexts. Furthermore, teachers encourage students to explain their understanding in their own words, an important indicator of deep understanding. Comparing, classifying, and predicting activities are also routinely integrated into learning to cultivate students' higher-order thinking skills. This aims to enhance students' critical and creative thinking abilities (Pasaribu et al., 2025)..

Students' in-depth understanding is assessed through a comprehensive range of methods. Teachers rely not only on written tests that measure factual knowledge but also assess students through project results, presentations, and their ability to re-explain concepts in their own words. Students' ability to apply knowledge to new situations and generate more in-depth questions is also an important indicator of in-depth understanding. Formative assessments such as rubrics and portfolios are used to document students' ongoing learning progress and provide constructive feedback. This holistic assessment approach aligns with the principles of authentic assessment, which measures not only final outcomes but also the student learning process.

School Policies in Supporting the Implementation of Digital Technology-Based Deep Learning

School policies play a crucial role in supporting the implementation of digital technology-based immersive learning. Technology-based education policies aim to improve the quality of learning through the integration of digital tools (Darmansah et al., 2025). Interview results indicate that the school has taken various strategic steps to create a learning ecosystem conducive to the implementation of deep learning. The primary support provided by the school is providing access to information and communication technology devices. This benefit includes facilitating access to knowledge and opening up opportunities for innovation in various fields such as education, economics, and government (Muhibuddin, 2023). The school has provided a variety of technological devices accessible to teachers and students, including computers, laptops, tablets, and projectors. The school also provides a computer laboratory as a dedicated space for technology-based learning. This computer laboratory is not only used for ICT subjects, but can also be utilized by teachers of other subjects to integrate technology into their teaching. The existence of a computer laboratory provides opportunities for students to interact directly with technology and

develop their digital literacy. Furthermore, the computer laboratory plays a crucial role as a supporting tool in the Information and Communication Technology (ICT)-based learning process (Siahaan et al., 2025).

In addition to providing infrastructure, schools also provide freedom and space for teachers to experiment with various learning applications. This relaxed policy, which allows for innovation, is crucial for fostering teacher creativity in designing effective and engaging learning. Schools also encourage the use of digital platforms for administrative and learning purposes. The use of platforms such as Google Classroom, learning management systems, or school communication applications is facilitated and supported by school policy. Schools also occasionally invite external speakers or facilitate teachers' participation in training provided by the education office. This collaboration with external parties enriches teachers' perspectives and knowledge about best practices in immersive learning and the use of technology. This ongoing and integrated training demonstrates the school's understanding of the importance of ongoing professional development in the digital age. The school comprehensively evaluates the success of learning programs oriented toward in-depth understanding. In addition to providing infrastructure, schools also provide freedom and space for teachers to experiment with various learning applications. This relaxed policy, which allows for innovation, is crucial for fostering teacher creativity in designing effective and engaging learning. Schools also encourage the use of digital platforms for administrative and learning purposes. The use of platforms such as Google Classroom, learning management systems, or school communication applications is facilitated and supported by school policy. Schools also occasionally invite external speakers or facilitate teachers' participation in training provided by the education office. This collaboration with external parties enriches teachers' perspectives and knowledge about best practices in immersive learning and the use of technology. This ongoing and integrated training demonstrates the school's understanding of the importance of ongoing professional development in the digital age. The school comprehensively evaluates the success of learning programs oriented toward in-depth understanding.

Obstacles Faced by Teachers and Schools in Implementing Digital Technology-Based Deep Learning

Despite the implementation of various strategies and policies, the implementation of digital technology-based immersive learning in elementary schools still faces various obstacles. The first obstacle is the limited availability of technological devices. Limited access to technological devices, such as laptops and smartphones, is the main obstacle (Lestari et al., 2025). Several interconnected obstacles hinder the implementation of digital technology-based learning. First, the limited number of devices in schools is often disproportionate to the number of students, requiring device rotation and

restricting learning effectiveness as well as the range of possible activities. Second, unstable internet connectivity disrupts access to online resources and digital platforms, particularly in areas with limited infrastructure. Third, unequal device ownership among students creates a digital divide, limiting learning opportunities outside school and potentially affecting learning outcomes. Fourth, varying levels of digital literacy among students and teachers require additional time for basic technical instruction and result in uneven technology integration. These challenges highlight the complex and interrelated nature of barriers to digital learning implementation. In addition to pedagogical challenges, infrastructure is a major obstacle to implementing deep learning in schools. Limited access to high-powered computers, stable internet connectivity, and cloud-based learning platforms are factors that slow down the integration of AI into education (Zahrok et al., 2025). These challenges require a systemic approach involving not only teachers and schools, but also parents, government, and other stakeholders. A thorough understanding of these constraints is essential as a foundation for developing effective and sustainable solutions.

Solutions to Overcome Obstacles to Implementing Digital Technology-Based Deep Learning

Based on experience and practice, teachers and schools have developed various solutions to overcome the obstacles they face. The first solution to overcome device limitations is to utilize existing devices in rotation. Teachers set schedules and learning strategies that allow students to use devices alternately or in groups, so that despite limited resources, all students still have the opportunity to access technology. Collaborative learning in small groups can also be a strategy to maximize the use of limited devices, where a single device is used by a group of students to work together to complete a task. Collaborative learning is a learning strategy that emphasizes cooperation between students or students and teachers in achieving better understanding, solving problems, or producing a product or outcome (Anwar et al., 2024). The second solution is to use offline applications. To anticipate the problem of unstable internet connections, teachers prepare learning materials and applications that can be run offline. Video materials, documents, or learning applications are downloaded in advance when a connection is available, so they can be used during learning without relying on a real-time internet connection. Because the materials can be prepared in advance by educators at home, internet use at the institution is limited to when needed, such as when searching for additional materials or incomplete materials (Candra & Susilo, 2022). The third solution is providing alternative non-digital learning materials, as teachers view technology as a support tool rather than the primary goal of learning. Printed textbooks, worksheets, physical props, and manual experiments are used to ensure inclusive learning for students with limited access to

technology. The fourth solution involves collaboration with parents to support technology use at home through effective communication, enabling teachers to understand students' home conditions and design learning that aligns with real-world contexts. The fifth solution is continuous teacher participation in professional development activities, such as workshops, webinars, learning communities, and independent online learning, to enhance digital competencies and maintain effective teaching practices in the digital era.

From a broader policy perspective, teachers emphasized the need for systemic support, including continuous training in educational technology and digital pedagogy, adequate access to devices and internet connectivity, reduced administrative burdens, and clear school policies that encourage innovation. Sufficient physical and digital infrastructure is essential to support effective learning implementation. Overall, the findings indicate that digital technology-based immersive learning in elementary schools is a complex process requiring synergy among teacher competence, supportive school policies, adequate infrastructure, and stakeholder collaboration. Despite existing challenges, teachers and schools demonstrated strong commitment and creativity in developing practical solutions, which can serve as a foundation for best practices and more effective policies in supporting immersive learning at the elementary level.

4. CONCLUSION

Based on the findings and discussion above, the conclusions that can be obtained include: Teachers have implemented digital technology-based deep learning through varied and complementary strategies that emphasize meaningful understanding, knowledge integration, and real-life application over rote memorization. These strategies including project-based learning, problem-solving, and contextual learning are integrated with digital tools such as simulations, interactive quizzes, and online collaboration platforms to boost engagement. This approach is mirrored in assessment practices that focus on higher-order thinking skills through portfolios and presentations, all of which are supported by school policies that provide ICT infrastructure and teacher autonomy. However, the transition faces challenges like unstable internet access and varying levels of digital literacy. To counter this, schools utilize device-sharing, blended learning, and continuous teacher training. Ultimately, the effective implementation of this model requires a synergy between teacher competence, supportive policies, and stakeholder collaboration to successfully foster 21st-century skills in students.

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