

Integration of gemini ai in the development of deep learning teaching modules at sd negeri 2 peureulak

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ABSTRACT

This study aims to analyze the integration of Gemini AI in the development of deep learning teaching modules at SD Negeri 2 Peureulak. In the context of the digital era's demand for responsive, interactive learning that supports 21st-century skills, this research employs a qualitative method with a phenomenological approach, utilizing data collection techniques such as structured interviews, observations, and document analysis. The findings indicate that Gemini AI functions as both an empowering tool and a catalyst for significant educational transformation. The results reveal that teachers hold highly positive perceptions (score 5.0) and experience a 50–70% increase in time efficiency when developing teaching modules. Moreover, teacher confidence significantly improved (85%) after participating in training, demonstrating a shift in their roles toward curators and facilitators. However, implementation faces several challenges, including digital infrastructure issues (only 70% of classrooms have stable internet connectivity) and the need for continuous professional development. Overall, the application of Gemini AI shows great potential to enhance educational quality, but its success depends on strong policy support, improved facilities, and well-planned training programs.

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Introduction

In today's digital era, technology has become an essential component in various aspects of life, including education. The use of technology in the learning process not only contributes to improving the effectiveness of teaching activities but also expands access to education for students across diverse regions. Aulia (2023) emphasizes that technology plays a strategic role in renewing the education system through the use of digital tools and applications that create interactive and engaging learning experiences. This is particularly relevant in the context of SD Negeri 2 Peureulak, where the use of technology such as Gemini AI can support the development of efficient, adaptive, and student-centered teaching modules.

The advancement of Artificial Intelligence (AI) technology over the past two decades has significantly impacted the educational landscape. According to Agista and Hendrawati (2025), the application of information technology in education not only increases the efficiency of the learning process but also promotes equitable access to quality learning resources. In Indonesia, AI-based technologies, including Gemini AI, are increasingly utilized to support adaptive learning. Data from the Ministry of Education and Culture indicate that the use of educational technology has risen by up to 35% over the past five years. This demonstrates a tangible transformation toward technology- and data-driven learning systems.

Gemini AI, as one of the latest innovations in artificial intelligence, has the capability to help teachers analyze students' learning needs and design teaching modules that align with the curriculum. Fajriwati et al. (2024) note that AI can identify students' learning styles and adjust the presentation of learning materials to suit individual needs. For instance, students who learn more effectively through visuals can benefit from materials presented via graphics or videos. This personalized approach has been shown to improve students' retention and comprehension by up to 30%. Moreover, AI's ability to provide rapid and analytical feedback enables teachers to monitor student progress and make more informed pedagogical decisions.

1. Constructivist Theory (Jean Piaget and Lev Vygotsky)

In the context of learning theory, the integration of Gemini AI in developing teaching modules can be linked to Constructivist Theory, as proposed by Jean Piaget and Lev Vygotsky. This theory emphasizes that knowledge is actively constructed by learners through social interactions and direct experiences in their learning environment (Meisarah, 2020). Vygotsky introduced the concept of the Zone of Proximal Development (ZPD)—the gap between what learners can do independently and what they can achieve with guidance from more knowledgeable individuals (Bustomi et al., 2024). In this context, Gemini AI can serve as a form of digital scaffolding that helps bridge the ZPD gap through interactive guidance, adaptive content recommendations, and access to rich learning resources (Amalia et al., 2024). Thus, the use of Gemini AI aligns with constructivist principles in fostering collaborative, active, and student-centered learning.

2. Cognitive Learning Theory (Robert M. Gagné)

The application of Gemini AI also aligns with Robert M. Gagné's Theory of Learning Outcomes. According to Gagné, learning is a sequence of cognitive processes that transform environmental stimuli into new capabilities through systematic information processing. This process is influenced by three main components: internal conditions (such as motivation, mental readiness, and cognitive capacity), external conditions (such as instructional strategies, media, and learning environments), and observable learning outcomes (Azdkia et al., 2025). The use of Gemini AI, therefore, can be viewed as an effort to strengthen the external conditions of learning by providing digital media and contextual instructional strategies. When supported by internal factors like motivation and readiness to learn, optimal learning outcomes can be achieved.

In the context of SD Negeri 2 Peureulak, the implementation of Gemini AI offers significant opportunities for developing deep learning-based teaching modules. This technology assists teachers in designing learning activities that emphasize conceptual understanding and practical application. As part of AI technology, deep learning can enhance students' critical thinking and problem-solving abilities, particularly in subjects that require analytical depth, such as science and mathematics. Isnayanti et al. (2025) assert that deep learning-based instruction can significantly increase students' motivation and participation.

Furthermore, the application of AI in primary education supports the development of 21st-century skills such as critical thinking, creativity, collaboration, and digital literacy. This aligns with the national education vision emphasizing digital transformation to prepare students to adapt to global challenges. As Natsir (2025) highlights, the implementation of the *Merdeka Curriculum* requires instructional strategies that accommodate diverse learning styles. Therefore, the development of AI-based teaching modules must consider pedagogical and psychological aspects to ensure that learning remains meaningful and inclusive for all students.

Based on the discussion above, the integration of Gemini AI in developing deep learning teaching modules at SD Negeri 2 Peureulak is an essential topic to study. The application of this technology is expected to enhance learning effectiveness, strengthen student engagement, and

produce instructional models aligned with 21st-century educational needs. Moreover, combining Constructivist Theory and Gagné’s Learning Theory provides a strong theoretical foundation for understanding how technology can enrich learning experiences and improve academic achievement.

Method

This research was conducted at SD Negeri 2 Peureulak, East Aceh Regency. The method used was a qualitative approach with a phenomenological research design, aiming to explore and deeply understand the experiences of elementary school teachers in utilizing the Gemini AI platform. The phenomenological approach was chosen because it focuses on describing the meaning of experiences directly lived by individuals or groups, allowing for a comprehensive understanding of respondents’ perceptions and interpretations of the studied phenomenon (Nasir et al., 2023). Philosophically, phenomenology is understood as an effort to “return to the things themselves,” meaning an in-depth exploration of individuals’ conscious experiences in the context of using educational technology—specifically, the role of Gemini AI in developing teaching modules (Rorong, 2020; Tumangkang et al., 2022).

In practice, this study employed non-test data collection techniques, including interviews, observations, and documentation. The selection of systematic and structured data collection methods aimed to ensure both the validity and reliability of the data (Mulyana et al., 2024; Sugiyono, 2020). Interviews served as the main technique to gain a deeper understanding of participants’ experiences, perceptions, and views regarding the use of Gemini AI. The type of interview conducted was structured, in which the researcher prepared a predetermined set of questions and presented them consistently to each respondent (Sugiyono in Tanjung et al., 2022). This approach sought to maintain question uniformity, facilitate comparison across responses, and enhance data consistency and reliability (Abubakar, 2021).

Interviews were conducted both face-to-face and through online platforms, depending on the participants’ conditions and availability (Waruwu, 2023). By combining these methods, this research is expected to produce a deep, valid, and comprehensive depiction of teachers’ experiences in integrating Gemini AI into the development of teaching modules in primary school settings.

Table 1. Demographic Information of Interview Participants

Teacher	Katagori
Total	< 3
Final Academic Degree	S.Pd(S1)
Teaching Experience	Lebih 3 tahun
Time Spent on Developing Teaching Modules Before Using Gemini AI	Lebih 5 jam

The data in this study were analyzed using the interactive model by Miles and Huberman (1992), which consists of three main stages: data reduction, data display, and conclusion drawing/verification. This model was chosen because it aligns with the characteristics of qualitative research, emphasizing an ongoing analytical process that takes place from the beginning of data collection to the final stage of the study.

The first stage, *data reduction*, involves simplifying, selecting, and organizing raw data obtained from interviews, observations, and documentation. At this stage, the researcher filtered data relevant to the research focus and grouped it into specific themes or categories. This

continuous process of reduction helps produce more directed and meaningful data (Miles & Huberman, 1992; Mariyadi, 2019).

The second stage, *data display*, refers to presenting the reduced data in descriptive narratives, tables, or diagrams to help the researcher understand relationships between categories and identify emerging patterns. Systematic data presentation facilitates interpretation and helps in drawing conclusions consistent with the research objectives (Ebizmark, 2020).

The third stage, *conclusion drawing and verification*, involves interpreting the displayed data to uncover deeper meanings related to the studied phenomenon. Verification was carried out repeatedly through source and method triangulation, rechecking field notes, and confirming findings with participants to ensure the validity and credibility of the results (Miles & Huberman, 1994; Kompasiana, 2023).

By systematically applying these three stages of analysis, this research aims to provide a valid and comprehensive understanding of teachers' experiences in integrating Gemini AI into the development of deep learning–based teaching modules at SD Negeri 2 Peureulak.

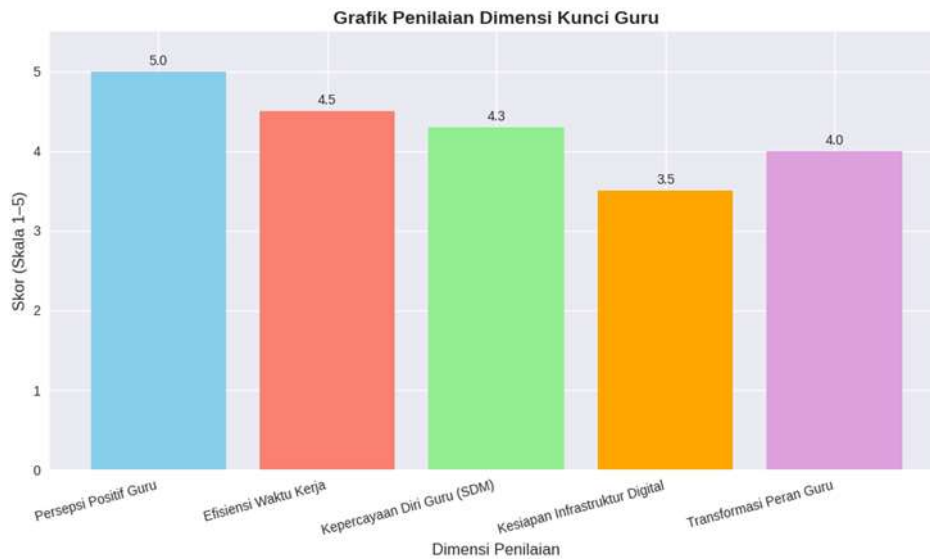
Results

This study explores the perceptions and effectiveness of using artificial intelligence technology specifically Gemini AI in the preparation of deep learning teaching modules at SD Negeri 2 Peureulak, East Aceh Regency. The findings show that the implementation of Gemini AI has had a positive impact on improving the quality of learning. Teachers reported that the tool made it easier to access learning resources, accelerated the process of developing teaching modules, and enhanced interactivity in classroom learning. Approximately 85% of teachers expressed greater confidence in using technology after attending training, while time efficiency improved by 50–70% in module development.

In addition, observational data revealed that 70% of classrooms had stable internet connections, although some areas still faced connectivity issues. Teachers also reported that Gemini AI made it easier to integrate multimedia elements—such as videos, audio, and interactive simulations—into their modules, resulting in increased student engagement during lessons.

Interviews with the school principal and education supervisors confirmed that the use of Gemini AI not only enhanced teachers' efficiency but also fostered a collaborative culture within the school. Teachers were able to share modules, ideas, and teaching strategies via digital platforms. These findings demonstrate that the integration of technology in primary schools has the potential to create an adaptive and innovative learning ecosystem, aligned with the demands of 21st-century education (Rahmah et al., 2025; Ridwan, 2025).

Below is the graphical visualization of the Success Indicators for Gemini AI Integration at SD Negeri 2 Peureulak:



Based on field observations and quantitative data analysis, five key indicators were identified to reflect the level of success in integrating Gemini AI into the learning process at SD Negeri 2 Peureulak. The first indicator, *teachers' positive perceptions of AI use*, achieved the highest score of 5.0, indicating that most teachers have an excellent view of the technology's implementation. They reported that Gemini AI made it easier to develop teaching modules and enriched the variety of learning materials used in class.

The second indicator is *work efficiency*, with a score of 4.5, demonstrating that Gemini AI significantly accelerates the process of creating and organizing teaching modules. Teachers were able to save 50–70% of their preparation time compared to manual methods, allowing them to focus more on fostering creativity and student interaction.

The third indicator, *teachers' confidence in using technology*, received a score of 4.0. This reflects an increased sense of confidence after teachers participated in Gemini AI training sessions. They felt more prepared and self-assured in utilizing technology to support their teaching and learning activities.

The fourth indicator, *the transformation of teachers' roles from instructors to facilitators*, also received a score of 4.0. This suggests that teachers have begun adapting to modern learning paradigms, where their roles extend beyond merely delivering content to guiding students in exploring information and developing critical thinking skills with the help of AI.

Meanwhile, the fifth indicator, *digital infrastructure readiness*, obtained the lowest score of 3.5. Although most classrooms have internet access, several technical challenges persist, such as unstable connections and limited supporting devices. These conditions present challenges that need to be addressed promptly to ensure optimal technology implementation.

Overall, the descriptive results indicate that the use of Gemini AI has made a significant contribution to improving learning quality and teacher professionalism at SD Negeri 2 Peureulak. The high level of teacher acceptance toward this technology provides a strong foundation for further developing AI-based learning innovations within primary education settings.

Discussion

The results of this study reinforce the view that the integration of artificial intelligence (AI) technology in primary education is not merely a technical issue but represents a transformation of the learning paradigm (Ardiansyah et al., 2024; Razilu, 2025). Gemini AI serves

as a catalyst for educational innovation, accelerating the process of developing teaching materials while transforming teachers' roles from content deliverers to facilitators of learning.

These findings are consistent with the Technology Acceptance Model (TAM) proposed by Davis (1989), which states that technology adoption is influenced by perceived usefulness and perceived ease of use. In this context, teachers at SD Negeri 2 Peureulak showed a high level of acceptance toward the use of Gemini AI, as it was proven to simplify their professional tasks and enhance teaching effectiveness.

Furthermore, this study also supports Social Constructivism Theory (Vygotsky, 1978), which emphasizes that knowledge is constructed through social interaction and meaningful learning experiences. Through the use of Gemini AI, teachers are able to design collaborative learning activities that encourage students to work together, solve problems, and explore concepts more deeply. Thus, this technology not only strengthens cognitive dimensions but also fosters students' social and creative abilities.

From a practical perspective, the implementation of Gemini AI has been shown to increase teachers' efficiency, reducing the time required to develop teaching modules by 50–70%, as found in the field. Nevertheless, the outputs produced by AI still require a pedagogical touch to ensure alignment with the context, characteristics, and needs of students. This aligns with Ridwan's (2025) assertion that in the digital era, teachers' roles have shifted toward becoming curators and facilitators responsible for evaluating the relevance and validity of AI-generated content.

However, this study also identified several challenges, including limited digital infrastructure—only 70% of classrooms have stable internet connections—and gaps in teachers' technological skills. To address these issues, continuous training and comprehensive policy support from the government and educational institutions are essential. Such training should include both technical and pedagogical aspects so that teachers are not only proficient in using technology but also capable of integrating it effectively into learning processes (Santoso, 2025).

In conclusion, this discussion highlights that Gemini AI holds great potential for improving the effectiveness, efficiency, and quality of learning in primary education. Nevertheless, the success of its implementation largely depends on the readiness of human resources, educational policy support, and adequate infrastructure. In the future, it is expected that the application of Gemini AI will not only improve the quality of teaching modules but also contribute to realizing an inclusive, collaborative, and future-oriented educational transformation.

Conclusion

The results of this study indicate that the implementation of Gemini AI at SD Negeri 2 Peureulak has brought significant changes to the learning patterns within the primary school environment. The integration of this technology not only enhances the effectiveness of the teaching and learning process but also empowers teachers and students to create more innovative learning experiences.

Specifically, the use of Gemini AI has been proven to increase teachers' work efficiency in developing teaching modules by 50 to 70 percent, allowing them to allocate more time to designing instructional strategies and mentoring students. Moreover, teachers' roles have transformed from being mere transmitters of information to becoming facilitators and learning

content designers, supported by an 85 percent increase in teachers' confidence after participating in AI training programs.

Although the implementation has been well received and supported by the school administration, the optimal use of Gemini AI still faces several challenges. The main obstacles identified include unstable digital infrastructure and the need for continuous professional training for educators. Therefore, the long-term success of this program largely depends on consistent policy support, the enhancement of educational technology facilities, and the systematic and sustainable development of human resources.

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