

Developing Pedagogical Innovation: AI-Based Deep Learning Training in Elementary Education

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Abstract

Teacher readiness in addressing the challenges of 21st-century education requires a strong understanding of Deep Learning approaches as well as the ability to utilize artificial intelligence technology to enhance instructional quality. This community service program was designed to broaden teachers' knowledge of the concepts and implementation of Deep Learning, which include meaningful, mindful and reflective, and joyful learning, while simultaneously equipping them with practical skills in the use of digital technology, particularly ChatGPT, as a learning support tool. The training was conducted on 27–28 October 2025 at SD IT Ar Rasyid Makassar with 25 participating teachers. The training methods included material delivery, group discussions, hands-on practice, case studies, and continued mentoring after the face-to-face sessions. Evaluation was carried out through pretests and post-tests, observations of participant engagement, and assessments of learning design outputs developed during the program. The evaluation results indicate improvements in teachers' understanding of Deep Learning principles, the strengthening of 21st-century competencies, and enhanced ability to design context-based learning with artificial intelligence integration. An increase in the average score from 67.25 to 84.10 demonstrates that this program was effective in enhancing teachers' capacity to implement more interactive, innovative, and learner-relevant instruction in the digital era. Therefore, this training provides a significant contribution to supporting learning transformation in schools.

Keywords: Deep learning, Artificial intelligence, Teacher training.

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1. Introduction

Education serves as a fundamental foundation for developing excellent and competitive human resources in the global era (Akbar et al., 2025). In facing the challenges of the 21st century, which are characterized by the rapid advancement of science, technology, and digitalization, the education sector is required to transform in order to produce learners who not only master cognitive knowledge but also possess critical thinking, creativity, communication, collaboration, and strong character (Fullan et al., 2018; Trilling & Fadel, 2009). Therefore, conventional teacher-centered approaches that rely heavily on rote learning must be replaced with more active, in-depth, and meaningful learning practices.

To address this necessity, the Ministry of Primary and Secondary Education of the Republic of Indonesia promotes the Deep Learning approach in educational practice. It is important to emphasize that this approach differs from the term "Deep Learning" in artificial intelligence, which refers to data processing using artificial neural networks (Budhiarti et al., 2025a). In the context

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of education, Deep Learning refers to learning processes that foster comprehensive conceptual understanding, strong competency mastery, as well as active, reflective, and enjoyable student engagement (Mansyur et al., 2025).

This approach is grounded in three complementary core elements. First, Meaningful Learning, which connects learning materials to students' real-life contexts and experiences, ensuring that concepts taught are not merely memorized facts but contextual knowledge applicable to daily life (Fullan et al., 2018). Second, Mindful Learning, which emphasizes full student engagement in the learning process. In this element, students act as active participants who not only receive information but also reflect and evaluate their learning strategies to achieve optimal outcomes (Shamboul, 2022). Third, Joyful Learning, which creates a positive emotional atmosphere in the learning environment, stimulates curiosity, and builds intrinsic motivation for continuous knowledge exploration and personal development (Budhiarti et al., 2025b).

These three principles form a strategic framework for holistic learning, focusing not only on academic achievement but also on character building and competency development (Mansyur et al., 2025). For instance, in Meaningful Learning, students connect learning to real-world issues such as environmental concerns in their local communities. In Mindful Learning, they are guided to reflect, engage in discussions, and explore problem-solving ideas actively. Joyful Learning then reinforces these efforts by cultivating a learning climate that motivates rather than pressures students.

However, despite its significance, the implementation of Deep Learning in schools continues to face challenges (Mutawadia et al., 2023). One major issue is the limited capacity of teachers to design and carry out learning models that integrate the three elements effectively. Many teachers still rely primarily on lectures, memorization tasks, and test-based assessments (Rahmandani et al., 2025). On the other hand, advancements in digital technology, including artificial intelligence, offer great potential to support more meaningful, mindful, and joyful learning experiences.

Artificial intelligence can enrich learning through adaptive platforms, gamified learning applications, and digital assistants that help teachers manage and enhance learning processes (Rusman et al., 2024). When properly utilized, AI can serve as a catalyst in optimizing the implementation of Deep Learning in education (Nasution, 2023; Zheng et al., 2023). Based on this premise, the present community service program was designed as a training initiative to support teachers in integrating artificial intelligence technology into learning practices aligned with the Deep Learning approach. This program aims not only to introduce Deep Learning concepts theoretically but also to equip educators with practical skills to design, manage, and evaluate learning that is meaningful, active, and enjoyable through the use of AI-based tools.

It is expected that through this training, participants will gain a comprehensive understanding of the philosophy of Deep Learning and be able to integrate technology innovatively in classroom instruction. Therefore, this program contributes to advancing educational transformation in Indonesia toward a more adaptive, transformative system that responds to societal changes and focuses on students as lifelong learners.

2. Method

This community service activity was designed as an integrated training program targeted at teachers of SD Ar-Rasyid Makassar. Its primary objective was to enhance teachers' understanding of Deep Learning concepts in the educational context and equip them with practical skills in utilizing artificial intelligence technology to support the teaching and learning process. The program was conducted over two days, from October 27 to 28, 2025, at the hall of SD IT Ar-

Rasyid Makassar.

This training applied a combination of learning methods, including interactive material delivery, group discussions, hands-on practice, and intensive mentoring. The sessions were carried out both offline and online. Prior to the training, an initial assessment was conducted to measure participants' understanding of Deep Learning concepts in education and their current level of AI utilization in teaching. The results served as a basis for adjusting the training content. The program then proceeded with material delivery.

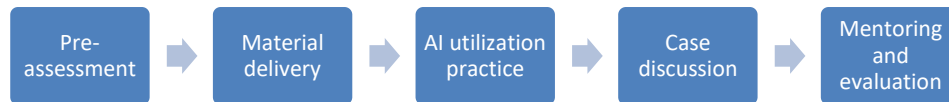


Figure 1. Implementation Stages of the Program

The core content was delivered using interactive presentations and guided discussions. The topics covered included Deep Learning concepts (Meaningful Learning, Mindful Learning, and Joyful Learning), strategies for implementing 21st century learning, and the introduction of the role of AI technology in education. Participants were then provided with hands-on experience using AI platforms such as ChatGPT, as well as adaptive learning tools and applications that support instructional material development and automated assessment. The practical activities were focused on applications relevant to participants' school contexts.

The next stage involved case discussions and reflection. Through group discussions and case studies, participants shared challenges encountered in classroom practice and developed solutions based on Deep Learning principles. Each group designed a learning plan integrating Meaningful, Mindful, and Joyful elements supported by AI. Upon completion of the face-to-face sessions, participants received continued mentoring (online or offline) to support their classroom implementation. Training effectiveness was evaluated through post-tests, satisfaction questionnaires, and assessments of the learning designs developed during the program.

The target participants were teachers from various subject areas, particularly science, mathematics, and technology teachers interested in improving the quality of learning. The number of participants was limited to ensure effective training and mentoring, resulting in a total of 25 teachers. The program was facilitated by a team of academics and practitioners from several universities, including STKIP Melawi, Universitas Muhammadiyah Mataram, and Universitas Sawerigading Makassar. The team was further supported by digital learning media practitioners to ensure both technical and pedagogical aspects were well accommodated.

3. Results

The two-day training program demonstrated encouraging outcomes in enhancing teachers' knowledge and skills related to the implementation of Deep Learning approaches in education, as well as their ability to utilize artificial intelligence technology to support more effective and innovative learning processes. The evaluation was conducted through pretests and post-tests, observations during the sessions, analysis of instructional products, and participant feedback.

The training consisted of five main sessions systematically designed to strengthen teachers' understanding and ability to implement Deep Learning supported by artificial intelligence technology. In the first session, participants were introduced to the concept of Deep Learning in education, including its definition, philosophy, and distinctions from surface learning, which

focuses solely on memorization. This session also covered the three core elements of Deep Learning: Meaningful Learning, Mindful Learning, and Joyful Learning, which serve as the foundation for deep and relevant learning experiences.

The second session focused on strategies for applying Deep Learning in classroom instruction. Participants practiced meaningful activities based on real-world contexts, learned mindful learning techniques such as reflection and self-regulated learning, and explored joyful learning methods including ice-breaking activities to foster emotional engagement and motivation among students.

In the third session, teachers were introduced to the basics of AI in education, specifically emphasizing the use of ChatGPT. Discussions addressed the benefits of ChatGPT in supporting teachers in designing learning materials, generating instructional ideas, and developing assessment instruments. Participants also gained an understanding of ethical considerations in AI usage, particularly in maintaining academic integrity and strengthening students' digital literacy. The fourth session involved hands-on practice, where teachers developed instructional materials and assessments using ChatGPT, followed by simple analysis of the outputs produced. Case studies were also used to explore the application of AI in more realistic classroom contexts. The fifth and final session was conducted as a workshop in which participants developed lesson plans or learning modules based on Deep Learning principles integrated with AI support through ChatGPT. They then presented their designs and received feedback from peers and facilitators to refine implementation in their respective schools.

Before the training, the pretest showed that most teachers had limited understanding of Deep Learning concepts and minimal ability to utilize AI as a learning support tool. The implementation of this community service program focused on improving teacher knowledge of the Deep Learning approach. Evaluation was carried out using instruments based on four key indicators: (1) understanding of Deep Learning concepts, (2) understanding of 6C competencies, (3) ability to design contextual learning based on project or inquiry approaches, and (4) understanding of assessment for learning.

Based on pretest and post-test scores of the 25 participants, there was an increase in the average scores across all indicators. Before the training, the overall average score was 67.25 (categorized as fair), increasing to 84.10 after the training (categorized as good). The highest improvement was observed in the indicator of contextual learning design ability, which increased by 20.8 points, while the smallest improvement was recorded in the indicator of assessment for learning, which increased by 13.5 points. These results indicate that the training program had a positive impact on teachers' knowledge related to the implementation of Deep Learning. The four areas of evaluation provide a comprehensive picture of teachers' readiness to implement meaningful learning that enhances students' engagement, creativity, and global competencies.



Figure 2. Training Conducted Through a Blended Approach (Online and Offline)

In addition to increasing knowledge, there was a positive shift in attitudes toward AI.

Teachers began to perceive AI as a learning support tool rather than a replacement or threat. This awareness is crucial, as an open mindset is a prerequisite for successful adoption of technology in education. Most participants were able to independently practice the use of AI tools and integrate them into their lesson plans. This indicates that a hands-on training approach is highly effective in improving teachers' technical abilities.

The resulting lesson plans demonstrate that teachers were able to adapt Deep Learning approaches and AI according to the subject matter and student characteristics. This is important to ensure that learning innovations are not merely theoretical but applicable. The majority of participants were satisfied and found the material highly relevant, though they suggested expanding the training with continued mentoring to deepen technical skills and pedagogical innovation.

4. Discussion

The execution of this community service initiative demonstrates notable growth in teachers' pedagogical capabilities across four major areas which include comprehending the principles of Deep Learning, developing creative instructional designs, integrating artificial intelligence (AI) into teaching practices, and applying competency-oriented assessment approaches. This progress is evident through the shift from teaching that mainly focuses on content delivery toward an approach that prioritizes higher-level thinking, contextual relevance, and collaborative learning.

Deep Learning requires students to construct meaning through the connection of concepts, critical analysis, and application to real-world contexts. Mu'ti (2025) stress that Deep Learning goes beyond memorization by fostering deep conceptual understanding. Similarly, Vygotsky's (1978) constructivist theory highlights the importance of social interaction and scaffolding in developing new knowledge. Thus, the transformation in teachers' practices is moving toward more dialogic, exploratory, and student-centered learning (Akbar et al., 2023; Blegur et al., 2017).

A significant change was also seen in teachers' understanding of New Pedagogies for Deep Learning (Fullan et al., 2018), particularly related to the 6Cs competencies (character, citizenship, collaboration, communication, creativity, and critical thinking). Through problem-based project approaches, teachers began designing activities that enable students to develop global literacy and 21st-century life skills. Rosa and Clark (2011) strengthens this view, emphasizing that concrete experience, reflection, and action are essential foundations for meaningful learning. The integration of AI in learning also influences the role of teachers. AI does not replace teachers but helps enable personalization and learning analytics that support evidence-based teaching (Joksimovic et al., 2023). The TPACK framework (Li, 2024) guides that technological use should align with pedagogical competence and content knowledge. Teachers who can balance these aspects will produce learning that is more adaptive, differentiated, and inclusive.

However, challenges remain in the area of assessment for learning. Although teachers' understanding has improved, some still struggle to design instruments that measure non-cognitive competencies such as creativity and collaboration. Wiggins (1998) emphasizes that authentic assessment must be holistic and represent students' capabilities in real contexts. Thus, teachers need to strengthen their ability to provide ongoing formative feedback (Black & Wiliam, 2009). From an ecosystem perspective, teachers face limited digital infrastructure readiness and confidence in using technology. This aligns with UNESCO's (2021) report, which notes that the digital divide continues to hinder education in many developing regions. Meanwhile, the Technology Acceptance Model (Adiguzel et al., 2023) state that perceived ease of use and usefulness significantly influence motivation to adopt technology. Therefore, competency enhancement must be accompanied by systemic support such as continuous training,

infrastructure availability, and a collaborative school culture.

Program sustainability is a primary concern. Change cannot be achieved through short-term interventions alone. Continuing professional development (CPD) based on teacher learning communities can potentially strengthen this transformational practice. Overall, this training provides an important foundation for supporting learning transformation at the school level. As teachers' competencies in applying Deep Learning and AI continue to improve through strong policy support and learning infrastructure, education will become more relevant to the dynamics of 21st-century life. By positioning students as active agents, schools can become ecosystems that liberate and empower every individual's potential to contribute to society.

5. Conclusion

This training program on the implementation of Deep Learning and artificial intelligence in primary school education successfully enhanced teachers' pedagogical competencies. Improvements were evident in their understanding of Deep Learning principles, their ability to design contextual and innovative learning activities, their skills in utilizing AI as a learning support tool, and their implementation of competency-based assessment. The increase in average pretest to post-test scores reflects teachers' growing readiness to conduct meaningful learning that promotes student engagement, creativity, and global competencies.

Beyond knowledge and skills development, a positive shift in teachers' attitudes toward AI was observed. Participants began recognizing AI as a valuable tool that strengthens instruction rather than a threat to the teacher's role. The lesson plans produced further demonstrate teachers' capacity to align Deep Learning practices and AI integration with subject needs and student characteristics. However, challenges remain regarding authentic assessment and the consistent measurement of non-cognitive competencies. Continued support and mentoring will be essential to ensure sustained transformation beyond the duration of the training. With strengthened infrastructure, continuous professional development, and supportive school policies, this initiative can serve as a catalyst for creating learning environments that are more adaptive, collaborative, and responsive to the needs of 21st-century learners. By positioning students as active participants, schools are better equipped to empower every learner to contribute meaningfully to society.

6. References

- Adiguzel, T., Kaya, M. H., & Cansu, F. K. (2023). Revolutionizing education with AI: Exploring the transformative potential of ChatGPT. *Contemporary Educational Technology*, 15(3). <https://doi.org/10.30935/cedtech/13152>
- Akbar, A., Herman, T., & Suryadi, D. (2023). Culture-Based Discovery Learning and its Impact on Mathematical Critical Thinking Skills. *Jurnal Ilmiah Sekolah Dasar*, 7(3), 436–443. <https://doi.org/10.23887/jisd.v7i3.59921>
- Akbar, A., Herman, T., Suryadi, D., & Haruna, N. H. (2025). Development of Didactical Design in Volume Teaching : Efforts to Improve Critical Thinking Abilities. *Jurnal Pedagogi Dan Inovasi Pendidikan*, 1(1), 39–51. <https://jurnal-pip.com/index.php/jpip/article/view/7/5>
- Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability*, 21(1), 5–31.
- Blegur, J., P. Wasak, M. R., & Manu, L. (2017). PENILAIAN FORMATIF PESERTA DIDIK ATAS KOMPETENSI PENDIDIK DALAM PROSES PEMBELAJARAN. *Satya Widya*, 33(2), 117–127. <https://doi.org/10.24246/j.sw.2017.v33.i2.p117-127>
- Budhiarti, Y., Mytra, P., & Slow, L. (2025a). The Role of Deep Learning in Elementary Education : Pedagogical Insights from a Literature Study. *Jurnal Pedagogi Dan Inovasi*

- Pendidikaninovasi Pendidikan*, 1(2), 42–51.
- Budhiarti, Y., Mytra, P., & Slow, L. (2025b). The Role of Deep Learning in Elementary Education : Pedagogical Insights from a Literature Study. *Jurnal Pedagogi Dan Inovasi Pendidikaninovasi Pendidikan*, 1(2), 42–51. <https://jurnal-pip.com/index.php/jpip/article/view/14%0Ahttps://jurnal-pip.com/index.php/jpip/article/download/14/11>
- Fullan, M., Quinn, J., & Mceachen, J. (2018). *Deep Learning: Engage the World Change the World*. Corwin Press, A SAGE Company.
- International Commission on the Futures of Education Commission. (2021). *Reimagining our futures together: a new social contract for education*. UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000379707>
- Joksimovic, S., Ifenthaler, D., Marrone, R., De Laat, M., & Siemens, G. (2023). Opportunities of artificial intelligence for supporting complex problem-solving: Findings from a scoping review. *Computers and Education: Artificial Intelligence*, 4, 100138. <https://doi.org/10.1016/j.caeai.2023.100138>
- Li, M. (2024). Integrating Artificial Intelligence in Primary Mathematics Education: Investigating Internal and External Influences on Teacher Adoption. *International Journal of Science and Mathematics Education*, 0123456789. <https://doi.org/10.1007/s10763-024-10515-w>
- Mansyur, M., Firandhi, V. Y., Sulestry, A. I., Arianti, I., & Bahar, B. (2025). Mental Acts Developed in Deep Learning : A Literature Review. *Jurnal Pedagogi Dan Inovasi Pendidikan*, 1(2), 52–61.
- Mu'ti, A. (2025). *Pendekatan Pembelajaran Mendalam dalam Transformasi Pendidikan [Kuliah umum]*. <https://www.youtube.com/watch?v=EflpZj3zA1g>
- Mutawadia, M., Jawil, J., & Farisi, S. Al. (2023). Penerapan Metode Pembelajaran Mendalam Sebagai Upaya Pembentukan Karakter Siswa. *Journal of Instructional and Development Researches*, 3(6), 279–284. <https://doi.org/10.53621/jider.v3i6.283>
- Nasution, N. E. A. (2023). Using artificial intelligence to create biology multiple choice questions for higher education. *Agricultural and Environmental Education*, 2(1), em002. <https://doi.org/10.29333/agrenvedu/13071>
- Rahmandani, F., Rifqi Hamzah, M., Handayani, T., & Wahyu Kurniawan, M. (2025). Integrasi Pembelajaran Mendalam (Deep Learning) dalam Mewujudkan Pembelajaran yang Bermutu dan Bermakna bagi Peserta Didik. *Jurnal Sosial Humaniora Dan Pendidikan*, 4(September), 769–781.
- Rosa, M., & Clark, D. (2011). Ethnomathematics: The Cultural Aspects of Mathematics. *Revista Latinoamericana de Etnomatemática*, 4(2), 32–54. <http://www.redalyc.org/articulo.oa?id=274019437002>
- Rusman, I., Nurmala, Nurasti, Rahmadania, Wahyuni, & Qadrianti, L. (2024). Peran Kecerdasan Buatan dalam Pembelajaran di Era Digital. *Prosiding Seminar Nasional Fakultas Tarbiyah Dan Ilmu Keguruan IAIM Sinjai*, 3, 42–46. <https://doi.org/10.47435/sentikjar.v3i0.3138>
- Shamboul, H. A. E. (2022). The Importance of Critical Thinking on Teaching Learning Process. *Open Journal of Social Sciences*, 10(01), 29–35. <https://doi.org/10.4236/jss.2022.101003>
- Trilling, B., & Fadel, C. (2009). *21ST Century Skills: Learning for Life in Our Times* (First Edition). Jossey-Bass A Wiley Imprint.
- Wiggins, G. (1998). *Educative assessment: Designing assessments to inform and improve student performance*. Jossey-Bass.
- Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
- Zheng, L., Niu, J., Zhong, L., & Gyasi, J. F. (2023). The effectiveness of artificial intelligence on learning achievement and learning perception: A meta-analysis. *Interactive Learning Environments*, 31(9), 5650–5664. <https://doi.org/10.1080/10494820.2021.2015693>