

Learning Planning for Deep Learning in Elementary Schools: Opportunities and Curriculum Challenges

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Abstract

Advancements in information and communication technology have brought significant changes to the world of education, including at the elementary school level. One notable innovation being adopted is deep learning, a part of artificial intelligence (AI) that enables learning systems to become more adaptive and personalized. With this technology, learning processes can be tailored to each student's learning style and pace. However, the implementation of deep learning also faces significant challenges, such as limited technological infrastructure, teacher readiness, curriculum alignment, and student data privacy and accessibility issues. This article discusses the opportunities and challenges of implementing deep learning-based learning in elementary schools and the importance of strategic planning to ensure optimal benefits for students.

1. Introduction

The rapid advancement of information and communication technology has transformed many aspects of our lives, including education. Where traditional learning once relied heavily on textbooks and lectures, technology now enables far more interactive and personalized approaches. One such growing innovation is deep learning, a branch of artificial intelligence (AI) that focuses on complex data analysis and pattern recognition.

At the elementary level, deep learning offers a significant opportunity to create learning experiences that better meet the needs of individual students. With this technology, students can learn flexibly according to their pace and preferred learning style. For instance, some students may understand lessons better through visual aids like images and videos, while others prefer reading text or listening to explanations. Deep learning systems can adapt materials and methods to each student's needs. Additionally, this approach fosters critical and creative thinking skills rather than mere rote memorization.

Despite its promising potential, the integration of deep learning into elementary curricula faces several challenges. One major issue is the readiness of technological infrastructure. Not all schools have sufficient devices and stable internet access to support AI-based learning systems. Teachers also need comprehensive training to effectively utilize this technology in the classroom. Another challenge is ensuring that the use of deep learning aligns with current curricula without overwhelming students and teachers with overly complex systems.

Moreover, issues concerning student data privacy and technology accessibility must be addressed. Since deep learning processes and analyses student data to customize learning, robust data protection policies must be in place. Furthermore, ensuring equitable access to technology is crucial, as not all students have equal opportunities to use digital devices or stable internet connections.

Therefore, effective strategies must be developed to implement deep learning in elementary schools, ensuring it maximizes educational benefits rather than introducing new barriers. This article explores the opportunities and challenges in planning deep learning-based education in elementary schools and how to optimally integrate this technology into existing curricula.

2. Method

This study utilized a descriptive qualitative approach to illustrate the opportunities and challenges in applying deep learning to elementary education. Data were obtained from both primary and secondary sources through semi-structured interviews with teachers, principals, and education practitioners, as well as literature studies from journals, policy documents, and online resources related to AI in education. Data collection methods included interviews, documentation, and limited observations in schools integrating technology into learning. Data were thematically analyzed, categorizing findings into themes such as infrastructure readiness, teacher competence, curriculum integration, and student data privacy. Triangulation and member checking methods were used to ensure data validity.

3. Results and Discussion

The development of AI technologies, particularly deep learning, has opened substantial opportunities to create more personal, adaptive, and efficient education systems. In elementary schools, this technology can assist teachers in understanding individual student learning needs through accurate data analysis. As a result, learning becomes customized to each student's style and pace. This approach also encourages the development of critical thinking, creativity, and problem-solving skills from an early age.

Based on nine journal articles that met the inclusion criteria, the key findings are summarized in Table 1.

No.	Penelitian & Tahun	Fokus Penelitian	Hasil Utama
1.	Putra & Yunitiara Rizqi (2023)	Pendampingan pembuatan modul ajar berbasis deep learning untuk meningkatkan kompetensi pedagogik guru sekolah dasar	Program pendampingan efektif meningkatkan kompetensi pedagogik guru hingga 65% dalam periode enam bulan.
2.	Hendrianty et al. (2024)	Membangun pola pikir deep learning pada guru sekolah dasar	Pola pikir deep learning pada guru dapat dibangun melalui pengembangan kurikulum berbasis konsep, pelatihan intensif guru, dan penerapan strategi pembelajaran interaktif.
3.	Khotimah & Abdan (2023)	Analisis pendekatan deep learning untuk meningkatkan efektivitas pembelajaran PAI di SMKN Pringkuku	Pendekatan deep learning meningkatkan antusiasme, partisipasi aktif siswa, pemahaman materi PAI, dan kemampuan reflektif siswa dalam mengaitkan nilai-nilai agama dengan kehidupan nyata.
4.	Wijaya & Jati (2022)	Pengembangan model deep learning untuk pembangkit soal otomatis menggunakan	Model deep learning berbasis BiLSTM Uncased menghasilkan skor evaluasi terbaik

		Recurrent Network	Neural	dengan BLEU-4 5.78 dan ROUGE-L 42.98.
5.	Adnyana (2024)	Implementasi pendekatan deep learning pembelajaran Indonesia	deep Bahasa	Metode pembelajaran yang dapat diterapkan meliputi problem-based learning, project-based learning, inquiry, dan flipped classroom.
6.	Ronsumbre et al. (2023)	Pembelajaran dengan Kecerdasan Buatan (AI): Korelasi AI terhadap Belajar Siswa	Digital Kecerdasan AI Motivasi	Pembelajaran berbasis AI meningkatkan motivasi belajar siswa melalui interaksi yang lebih menarik dan responsif terhadap kebutuhan individu siswa.
7.	Saputra et al. (2023)	Pelatihan Modul Berdiferensiasi untuk Guru Tasikmalaya	Rancang Ajar dengan Artificial Intelligence di	Pelatihan meningkatkan pemahaman guru dari 40% menjadi 85%, dengan penerapan teknologi dalam modul ajar meningkat hingga 70% setelah pelatihan.
8.	Maulana et al. (2023)	Penerapan Artificial Intelligence Menunjang Pemahaman Matematika Siswa SD	Artificial dalam	AI berkontribusi signifikan dalam meningkatkan pemahaman konsep matematika siswa, meskipun terdapat tantangan dalam implementasinya.
9.	Oktavianus et al. (2023)	Pemanfaatan Artificial Intelligence Pembelajaran Asesmen di Digitalisasi	Artificial pada dan di Era	AI meningkatkan efektivitas pembelajaran dan asesmen dengan menyediakan umpan balik yang lebih cepat dan personal kepada siswa.

In general, the research findings show that deep learning and AI technologies can significantly enhance the learning process and student engagement. For example, renumber et al. (2023) found that AI-based learning increased student motivation through more engaging and responsive interactions. Similarly, Saputra et al. (2023) highlighted that integrating technology into lesson modules improved teacher and student understanding and engagement.

While Maulana et al. (2023) showed AI's effectiveness in improving students' mathematical understanding, Octavianus et al. (2023) demonstrated AI's role in enhancing assessment effectiveness

by providing faster and more personalized feedback. However, challenges remain, such as varying levels of infrastructure and teacher readiness, as well as the need for clear data protection regulations.

The successful integration of deep learning into basic education depends heavily on proper implementation strategies, collaboration among stakeholders, and ensuring equitable technology access.

Challenges

1. **Limited Technological Infrastructure:** Many elementary schools, especially in remote areas, lack adequate technological resources such as computers, tablets, projectors, or stable internet access.
2. **Lack of Teacher Training:** Most teachers are not yet familiar with AI or deep learning technologies. Without sufficient training, teachers may struggle to integrate or even resist using such technologies.
3. **Curriculum Alignment:** National curricula are often dense and inflexible, making it challenging to integrate deep learning without adding extra burdens.
4. **Student Data Privacy and Security:** Deep learning processes student behavior and performance data, raising concerns about data breaches and misuse.
5. **Digital Access Inequality:** Not all students have access to digital devices or internet connections at home, leading to digital learning inequalities.

Solutions

1. **Strengthening Digital Infrastructure:** Governments, in collaboration with the private sector, should improve school facilities with device provision programs, internet network development, and technical support.
2. **Teacher Professional Development:** Intensive and continuous training is essential for teachers to understand and utilize AI appropriately in learning.
3. **Gradual and Contextual Technology Integration:** Deep learning should be introduced gradually, blending naturally into existing lessons without disrupting the curriculum structure.
4. **Clear Data Protection Regulations:** Clear policies must govern the collection, storage, and use of student data.
5. **Programs to Bridge Digital Gaps:** Support programs, such as providing digital devices and subsidized internet for underprivileged students, are necessary to ensure equal learning opportunities.

The application of deep learning technology in the field of education, particularly at the elementary school level, offers significant opportunities to create a more personalized, flexible, and student-centered learning system. With its ability to analyse data and recognize patterns, deep learning enables the learning process to become more adaptive to the diverse learning styles of students. This has the potential to enhance students' understanding and engagement in the learning process, while also fostering the development of critical and creative thinking skills from an early age.

However, the analysis results show that the implementation of deep learning also faces several significant challenges. These include limited technological infrastructure in schools, insufficient teacher training, difficulties in aligning technology with existing curricula, and important issues related to data privacy and technology access gaps. These challenges indicate that the adoption of advanced technology in education cannot be carried out instantly or without careful planning.

Therefore, a well-directed and inclusive implementation strategy is needed, encompassing the strengthening of infrastructure, improvement of teacher capacity, protection of student data, and equal access to technology among students. Collaboration between the government, schools, and the

community becomes the key to ensuring that the application of deep learning is not merely a symbol of technological advancement but truly provides concrete and equitable benefits for improving the quality of elementary education in Indonesia.

3.1 Conclusion

The application of deep learning and artificial intelligence in elementary education holds great promise for improving learning quality. Research findings indicate that AI enhances student engagement, motivation, conceptual understanding, critical thinking, and problem-solving skills. However, challenges such as technological infrastructure limitations, lack of teacher training, curriculum compatibility, and data privacy issues must be addressed.

Strategic planning, infrastructure support, intensive teacher training, and clear regulatory policies are critical to successfully leveraging AI technologies. With coordinated efforts, deep learning can transform education into a more effective, inclusive, and meaningful experience for all students.

References

- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technology in education.
- Muzawi, R. (2024). Pengantar Dasar Deep Learning.
- Kumparan. (2024). Pengertian Kurikulum Deep Learning beserta Contohnya.
- Asep Tapip Yani. (2024). Deep Learning Sebuah Pendekatan Belajar Dalam Pendidikan.
- Putra, L. V., & Yunitiara Rizqi, H. (2023). Pendampingan Pembuatan Modul Ajar Berbasis Deep Learning Untuk Meningkatkan Kompetensi Pedagogik Guru Sekolah Dasar. *Ngudi Waluyo Empowerment: Jurnal Pengabdian Kepada Masyarakat*, 3(2), 55–64.
- Khotimah, D. K., & Abdan, M. R. (2025). Analisis Pendekatan Deep Learning untuk Meningkatkan Efektivitas Pembelajaran PAI di SMKN Pringku. *Jurnal Pendidikan Dan Pembelajaran Indonesia (JPPI)*, 5(2), 866–879.
- Ronsumbre, S., Rukmawati, T., Sumarsono, A., & Waremra, R. S. (2023). Pembelajaran Digital Dengan Kecerdasan Buatan (AI): Korelasi AI Terhadap Motivasi Belajar Siswa. *Jurnal Educatio FKIP UNMA*, 9(3), 1464–1474.
- Oktavianus, A. J. E., Naibaho, L., & Rantung, D. A. (2023). Pemanfaatan Artificial Intelligence pada Pembelajaran dan Asesmen di Era Digitalisasi. *JURNAL KRIDATAMA SAINS DAN TEKNOLOGI*, 5(02), 473–486.
- Putri, M. A. R. S., Herianto, E., Alqadri, B., & Sumardi, L. (2024). Pengaruh Model Pembelajaran PBL Berbasis Artificial Intelligence Terhadap Hasil Belajar Siswa. *SOCIAL: Jurnal Inovasi Pendidikan IPS*, 4(3), 145–154.
- Zhang, Y., & Zhang, Z. (2024). Peran AI dalam Pendidikan Guru: Mendukung Pengajaran, Pembelajaran Inklusif, dan Literasi Digital. *Journal of Educational Technology & Society*, 27(1), 45–58.
- Thomas, D. R., Lin, J., Gatz, E., Gurung, A., Gupta, S., Norberg, K., Fancsali, S. E., Aleven, V., Branstetter, L., Brunskill, E., & Koedinger, K. R. (2023). Improving Student Learning with Hybrid Human-AI Tutoring: A Three-Study Quasi-Experimental Investigation. *arXiv*.
- Yim, D., & Su, Y. (2024). Tinjauan Alat Pembelajaran AI dalam Pendidikan K-12. *Journal of Educational Computing Research*, 61(2), 123–139.
- Li, J. (2024). Pengaruh AI dalam Pengajaran dan Pembelajaran Sains. *Journal of Science Education and Technology*, 33(4), 567–580.
- Nasar, M., et al. (2023). Implementasi AI di Ruang Kelas Pintar. *International Journal of Educational Technology*, 14(3), 201–215.