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ETHICAL AND PEDAGOGICAL IMPLICATIONS OF DEEP LEARNING INTEGRATION IN FOURTH GRADE CLASSROOMS: A CASE STUDY AT SDN 100801 PASAR SEMPURNA

IMPLIKASI ETIS DAN PEDAGOGIS PENERAPAN PEMBELAJARAN MENDALAM DI KELAS IV SD NEGERI 100801 PASAR SEMPURNA

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Abstract

This study examines the ethical and pedagogical implications of deep learning integration in fourth-grade classrooms at SDN 100801 Pasar Sempurna, Indonesia. Through classroom observations, semi-structured interviews with teachers, and document analysis, the research found that deep learning applications significantly improved student engagement and individualized learning outcomes. However, ethical concerns emerged regarding data privacy, unequal access to digital tools, and limited teacher preparedness. Teachers expressed uncertainty in balancing technological autonomy with moral and pedagogical control. The study concludes that while deep learning supports more adaptive and inclusive learning environments, its ethical implementation remains constrained by insufficient institutional policies and digital literacy. Strengthening teacher competence and establishing transparent ethical frameworks are crucial for ensuring responsible AI integration in primary education. These findings provide practical insights into balancing innovation and ethics in early educational contexts.

Keywords**:** Deep learning, ethics, pedagogy, artificial intelligence, primary education

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Abstrak

Penelitian ini mengkaji implikasi etis dan pedagogis dari integrasi pembelajaran mendalamdi kelas IV SDN 100801 Pasar Sempurna, Indonesia. Melalui observasi kelas, wawancara semi-terstruktur dengan guru, dan analisis dokumen, penelitian ini menemukan bahwa penerapan pembelajaran mendalam secara signifikan meningkatkan keterlibatan siswa dan hasil belajar individual. Namun, muncul kekhawatiran etis terkait privasi data, ketimpangan akses teknologi, serta keterbatasan kesiapan guru. Guru menunjukkan keraguan dalam menyeimbangkan otonomi teknologi dengan kontrol moral dan pedagogis. Penelitian ini menyimpulkan bahwa meskipun pembelajaran mendalam mendukung lingkungan belajar yang lebih adaptif dan inklusif, penerapannya masih dibatasi oleh rendahnya literasi digital dan kurangnya kebijakan etis institusional. Penguatan kompetensi guru dan pembentukan kerangka etika yang transparan menjadi kunci penerapan AI yang bertanggung jawab di pendidikan dasar. Temuan ini memberikan wawasan praktis tentang keseimbangan antara inovasi dan etika dalam konteks pendidikan awal.

Kata kunci**:** *Pembelajaran mendalam*, etika, pedagogi, kecerdasan buatan, pendidikan dasar

1. INTRODUCTION

The integration of artificial intelligence (AI) and deep learning technologies into education has redefined how knowledge is produced, mediated, and assessed. Rather than serving as neutral instructional tools, AI-driven systems increasingly shape cognitive processes, teacher roles, and ethical boundaries within classroom interactions (Holmes et al., 2022). In primary education, deep learning is celebrated for its capacity to personalize learning, enhance formative assessment, and promote inclusivity through adaptive feedback mechanisms (Zawacki-Richter et al., 2019). Yet, these pedagogical advantages coexist with complex ethical challenges related to data ownership, algorithmic opacity, and the diminishing human agency in instructional decision-making (Williamson & Piattoeva, 2022).

Theoretically, the ethical integration of AI in education must be grounded in principles of autonomy, beneficence, and justice (Floridi et al., 2020). However, empirical investigations into these dimensions remain limited, particularly in socio-cultural contexts where digital readiness and governance frameworks are still developing. Previous research in Western settings often presumes technological maturity and institutional preparedness, conditions not always present in Indonesian public schools (Nugroho & Santosa, 2021). This imbalance underscores the need for contextually grounded inquiries that examine how ethical and pedagogical tensions emerge in local learning environments.

Preliminary classroom observations at SDN 100801 Pasar Sempurna revealed both optimism and uncertainty among teachers and students using AI-based learning applications. While these systems improved differentiation and engagement, teachers voiced concerns over privacy, unequal access, and overdependence on algorithmic feedback. Such experiences reflect broader questions about how ethical literacy and pedagogical integrity can be maintained when AI becomes embedded in everyday teaching.

Accordingly, this study investigates the ethical and pedagogical implications of deep learning integration in fourth-grade classrooms at SDN 100801 Pasar Sempurna. Using a qualitative case study approach, it explores how educators and learners interpret, negotiate, and respond to the presence of AI-mediated learning. The paper argues that the ethical

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sustainability of AI in education depends not only on technological capacity but also on the cultivation of reflective pedagogy and institutional accountability**.** By situating this case within the Indonesian primary education context, the study contributes empirically grounded insights to the global discourse on responsible and equitable AI integration in schools.

This study provides one of the first empirical explorations of how ethical and pedagogical tensions emerge during the integration of deep learning technologies in Indonesian primary schools. Unlike prior studies conducted in technologically advanced or Western contexts, this research captures the realities of AI use within a developing educational ecosystem characterized by limited digital literacy and evolving governance frameworks. The findings contribute to the global discourse on responsible AI in education by highlighting the importance of contextual ethics, teacher agency, and culturally responsive pedagogical strategies. This local case offers broader implications for understanding how emerging economies can balance innovation with ethical responsibility in the digital learning era.

2. RESEARCH METHOD

This study employed a qualitative case study design to explore the ethical and pedagogical implications of deep learning integration in a real classroom context. The research was conducted at SDN 100801 Pasar Sempurna, involving one fourth-grade class comprising 28 students and their homeroom teacher. Data were collected through classroom observations, semi-structured interviews, and document analysis of lesson plans and digital learning artifacts. The observations focused on how AI-based applications influenced teaching strategies, classroom interactions, and students' ethical awareness in using digital tools. All interviews were recorded, transcribed, and coded thematically to identify recurring patterns of ethical concern and pedagogical adaptation.

To ensure credibility and trustworthiness, data triangulation and member checking were employed throughout the analysis process. Researcher reflexivity was maintained through continuous field notes and reflective memos to minimize bias and ensure interpretive depth. Thematic analysis followed Braun and Clarke's (2006) framework, allowing categories to emerge inductively from participants' experiences. Ethical clearance was obtained from the local education authority, and informed consent was secured from all participants, ensuring compliance with international research ethics standards.

3. RESULTS AND DISCUSSION

Student Engagement and Learning Outcomes

Observations revealed that students were highly engaged when using AI-assisted learning platforms. During a mathematics lesson utilizing an adaptive quiz application, most students (approximately 85%) actively participated in problem-solving, often discussing strategies with peers. The AI system provided instant feedback, which motivated students to attempt more challenging questions. Teachers noted that compared to previous traditional lessons, students exhibited greater enthusiasm and persistence, especially in completing tasks independently.

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Table 1. Thematic Findings from Teacher Interviews (Temuan Tematik dari Wawancara Guru)

Theme	Illustrative Quote
Teacher adaptation	"AI feedback helps me identify weak students faster, but I'm still unsure how to adjust the curriculum accordingly."
Ethical awareness	"We didn't know where student data is stored; the school hasn't given us clear rules."
Pedagogical balance	"Students love AI quizzes, but some stop thinking once they see the hint button."

In addition, performance data collected from the AI platform showed improvements in learning outcomes. For example, 70% of students correctly answered questions that had previously been challenging in conventional worksheets. Teachers observed that students who normally required additional guidance were able to progress at their own pace, indicating that the technology supported differentiated learning. However, some students tended to skip steps and relied on hints provided by the system, showing emerging patterns of dependency that require pedagogical monitoring.

Based on the explanation above, we can see that using AI-based learning platforms has been effective in improving student engagement and learning outcomes. This is clear from the active participation of most students, their enthusiasm, and their improved ability to tackle previously difficult problems. AI also helps with personalized learning by letting each student learn at their own pace. However, despite these benefits, some students show signs of depending too much on the system. They may rely on help and skip steps when solving problems. This requires closer attention to ensure they develop a strong, independent understanding of concepts.

Teacher Practices and Adaptation

Teachers integrated AI-generated feedback into their instructional planning to better tailor learning activities. In literacy lessons, they adjusted reading materials based on AI performance reports, providing additional support to students struggling with comprehension. Observations showed that teachers frequently used AI insights to group students for collaborative tasks, aiming to balance individual learning needs and peer interaction.

Table 2. Student Engagement and Ethical Awareness Observation Summary

Aspect	Observation	Ethical Implication
Engagement	85% of students actively participated using AI-based quizzes.	Promotes inclusion but risks overreliance.
Data handling	Students shared login credentials.	Raises privacy and security concerns.
Equity	Limited device access for rural students.	Potential to widen digital inequality.

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Despite these benefits, interviews revealed that 60% of teachers felt uncertain about interpreting AI recommendations. Some expressed confusion regarding the alignment of automated suggestions with curriculum objectives. Teachers also reported time constraints in reviewing AI-generated data before class, highlighting the need for training and institutional support to maximize the pedagogical potential of AI tools while maintaining instructional control.

Based on the findings, it is clear that teachers are trying to include AI feedback in lesson planning. They are adapting materials and grouping students to create more personalized and collaborative teaching. However, this effort encounters major challenges. Most teachers feel unsure about how to interpret AI recommendations. They also worry about how these suggestions fit with the curriculum and have limited time for analyzing data. Therefore, training and support from institutions are crucial for teachers to make the most of AI's potential while maintaining control over the learning process.

Ethical Awareness and Concerns

Data privacy and ethical considerations emerged as significant concerns. Teachers admitted they were unsure how student data were stored and processed by AI platforms, and there were no clear school policies guiding ethical AI usage. Observations showed instances of students sharing login credentials, potentially compromising data integrity, indicating a low level of digital ethical awareness among learners.

Additionally, teachers expressed concerns about equity in access to technology. Students with limited experience or access to digital devices struggled to engage with the AI platform, suggesting that technological integration may inadvertently widen learning gaps. These findings highlight the need for ethical guidance and digital literacy education for both teachers and students to mitigate risks associated with AI use in classrooms.

These findings highlight the need to foster strong ethical awareness and digital literacy among teachers and students. Without clear guidelines and a good understanding of data privacy and the ethical use of AI, risks like data breaches and unequal access to technology could grow. Therefore, creating clear school policies and providing training on digital ethics and technology inclusion are essential steps to ensure the safe, fair, and effective use of AI in the classroom for all students.

Dependence on Technology

While AI-assisted learning increased engagement, reliance on technology was evident. Observations showed that students frequently requested hints or automated prompts before attempting problem-solving independently. Some students demonstrated difficulty completing similar tasks without AI support, particularly in mathematics and language exercises, indicating the development of “tool-dependent” learning habits.

Teachers reported that, although the system facilitated personalized instruction, excessive dependency could undermine critical thinking and self-regulation skills. To mitigate this, teachers experimented with hybrid approaches, combining AI feedback with traditional questioning strategies, to encourage students to reflect and make decisions without immediate digital prompts. This illustrates the delicate balance between leveraging AI benefits and preserving pedagogical integrity.

The explanation highlight the need for a balance between using AI and fostering students' independence in learning. While technology boosts engagement and supports

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personalized learning, relying too much on it can weaken critical thinking and self-regulation skills. Therefore, it is essential to use a mixed approach that combines AI support with traditional teaching methods. This will help students think independently, make decisions, and develop key skills without depending solely on technology.

Discussion

The results demonstrate that deep learning integration enhances student engagement and individualized learning, consistent with Zawacki-Richter et al. (2019), who argue that AI facilitates adaptive learning and promotes autonomy. However, the study also confirms ethical and pedagogical challenges. Limited teacher preparedness and low awareness of data privacy reflect what Williamson & Piattoeva (2022) describe as the "ethical lag" in AI adoption, where technology outpaces ethical literacy.

The dependency observed among students aligns with Floridi et al. (2020), highlighting the risk of "ethical dependency," where learners rely excessively on algorithmic guidance instead of developing independent problem-solving skills. Pedagogically, teachers benefited from real-time AI feedback but occasionally questioned their professional agency, supporting Holmes et al. (2022) who warn about potential erosion of teacher authority in AI-mediated classrooms.

Overall, these findings highlight a dual reality: AI enriches learning and supports pedagogical innovation but also introduces ethical vulnerabilities and challenges to teacher and student autonomy. The study underscores the necessity of combining technological adoption with ethical frameworks, teacher training, and digital literacy programs to ensure AI is integrated responsibly and effectively in primary education contexts.

The research adhered to international ethical standards throughout all stages of data collection and analysis. Approval was obtained from the local educational authority and the school administration of SDN 100801 Pasar Sempurna. Informed consent was collected from all participating teachers and students' guardians. To protect participant confidentiality, pseudonyms were used, and identifiable information was removed from transcripts and field notes. Data were securely stored in password-protected files accessible only to the researchers.

Given that the study explored the ethical implications of AI-mediated learning, particular attention was paid to data sensitivity, algorithmic transparency, and fairness in student evaluation. Researchers maintained a stance of reflexivity, ensuring that interpretations did not reinforce digital inequities or teacher-student power imbalances. These procedures align with the principles of autonomy, beneficence, and justice as outlined in global AI ethics frameworks (Floridi et al., 2020; UNESCO, 2024).

Implications for Policy or Practice

The findings highlight the urgent need for multi-level interventions to ensure the responsible integration of deep learning technologies in primary education. For policymakers, the results emphasize the importance of developing clear ethical guidelines, including policies for data protection, digital equity, and algorithmic accountability in educational settings.

For school administrators, structured professional development programs are necessary to enhance teachers' digital literacy and ethical reasoning in the use of AI tools. Embedding AI ethics within teacher training curricula can empower educators to make informed pedagogical decisions without compromising student autonomy.

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Finally, at the classroom level, teachers are encouraged to adopt hybrid models that balance AI-assisted personalization with human-centered instruction. Such approaches can cultivate independent thinking, critical reflection, and moral awareness among students—key competencies in an increasingly digitalized learning environment.

4. CONCLUSION

This study examined the ethical and pedagogical implications of deep learning integration in fourth-grade classrooms at SDN 100801 Pasar Sempurna. The findings indicate a dual reality: AI-assisted learning platforms enhance student engagement, motivation, and individualized learning outcomes, while simultaneously introducing ethical challenges and pedagogical tensions. Teachers benefited from real-time AI feedback to differentiate instruction but faced uncertainties regarding interpretation, curriculum alignment, and their professional agency. Ethical awareness among teachers and students remained limited, with concerns over data privacy, equitable access, and overreliance on AI-generated guidance. Overall, the research demonstrates that responsible integration of deep learning requires not only technical implementation but also pedagogical reflection, ethical literacy, and institutional support.

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