

# The Role of Artificial Intelligence and Deep Learning in Transforming Primary Education Toward Meaningful and Character Based Learning: A Literature Review

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## ABSTRACT

Artificial Intelligence and Deep Learning in Primary Education. The transformation of primary education in the digital era demands a more personalized, adaptive, and character-oriented approach. Artificial Intelligence (AI) and Deep Learning are rapidly evolving technologies that are beginning to be implemented in the educational realm to optimize the learning process. This study aims to examine the role of AI and Deep Learning in transforming the learning process at the primary school level into a more meaningful experience that supports character education. A literature review method was employed by analyzing a variety of recent and relevant sources. The findings indicate that integrating AI and Deep Learning enables the creation of learning systems that not only adapt to and focus on individual students but also foster deep understanding, reflective awareness, and enjoyable learning experiences. These three principles form the foundation for creating more contextual, relevant, and character-oriented learning. Nevertheless, the implementation of these technologies still requires ethical oversight and the teacher's role as a facilitator of values and an emotional guide. Thus, AI and Deep Learning hold significant potential as strategic instruments for realizing transformative, humanistic, and character driven primary education.

**Keywords:** Artificial Intelligence, Deep Learning, Primary Education, Character Education

## 1. INTRODUCTION

Introduction contains background, rational, and/or urgency of research. References (The evolution of digital technology, with an emphasis on Artificial Intelligence and Deep Learning, has become an international phenomenon that has brought about revolutionary changes across various fields, including education [1,2]. In the context of education, AI enables adaptive learning systems that tailor content to students' needs, while Deep Learning supports learning processes that emphasize the interconnectedness of knowledge, reflective understanding, and the development of creativity. [3–5]. The integration of both is believed to create a meaningful, reflective, and enjoyable learning experience, while also serving as a foundation for mastering 21st-century skills and fostering students' character development [6–8].

However, field observations indicate a significant gap between the potential of technology and the practice of primary education in Indonesia. The 2022 PISA results show that Indonesian students' mastery of complex thinking skills remains relatively low. Approximately 99% of students in Indonesia can only solve questions at levels 1–3, which are classified as low-order thinking skills. Meanwhile, less than 1% reach levels 4–6, which correspond to the domain of higher-order thinking skills (HOTS). By subject area: Reading: 74.5% at level 1, 19.3% at level 2, 5.4% at level 3, and only 0.8% at levels 4–6. Mathematics: 81.7% at level 1, 14.1% at level 2, 3.8% at level 3, and only 0.4% at levels 4–6. Science: 65.8% at level 1, 26.3% at level 2, 7.0% at level 3, and 0.9% at levels 4–6. These data indicate that most students still struggle to solve problems requiring analysis, evaluation, and creativity.

In other words, their abilities remain confined to basic understanding, with few capable of engaging in critical thinking and complex problem-solving. This underscores that the quality of primary education in Indonesia is still lagging in developing global competencies [9]. Moreover, learning practices in primary schools tend to remain conventional, minimally personalized, and insufficiently focused on strengthening students' character [10,11]. Technical barriers, such as limited infrastructure, teacher preparedness, and the underdeveloped integration of pedagogical approaches, further exacerbate this situation [12,13].

International literature emphasizes the importance of deep learning–based pedagogical strategies that integrate mindfulness, meaningful learning, and joyful learning as an effective approach in primary education [14,15]. In various countries, innovations such as personalized learning, gamification, and project-based learning have been proven to strengthen students' intrinsic motivation and participation, as well as their critical thinking skills [16–18]. Furthermore, the use of AI in the context of adaptive learning has been proven effective in enhancing learning outcomes, particularly when developed through co-design between teachers and researchers to create interactive classrooms. (Parn et al., 2025; Strielkowski et al., 2025; Supriyatmoko, 2025; Adaptive Learning Studies, Wikipedia).

Nevertheless, research explicitly linking AI and Deep Learning to the creation of meaningful learning while simultaneously strengthening students' character remains limited. Previous studies have primarily focused on the technical effectiveness of AI, predicting learning outcomes, or integrating technology in online learning, without comprehensively connecting it to the dimension of character education. [1,2]. Thus, a research gap exists in the absence of a conceptual framework that unifies AI, deep learning pedagogy, and the meaningful, mindful, and joyful learning approach in primary education.

The novelty of this study lies in its integrative exploration of AI, Deep Learning, and character education within the context of primary education. This research views AI and Deep Learning not merely as technical innovations but as instruments for transforming education toward systems that are adaptive, reflective, and character-oriented. Its strength lies in the interdisciplinary approach, combining 21st-century pedagogy, educational technology, and character values, thereby providing a holistic perspective for designing primary learning models that are relevant to global challenges. [22].

Based on the above discussion, the research problem is formulated into three main questions: (1) How do AI and Deep Learning contribute to transforming primary education toward meaningful, reflective, and enjoyable learning? (2) How can the integration of these technologies strengthen character development in primary school students? (3) What are the opportunities and challenges in implementing AI and Deep Learning in the context of primary education?

Thus, this study focuses on a literature review examining the role of AI and Deep Learning in transforming primary education toward meaningful, reflective, enjoyable, and character oriented learning. Theoretically, this research enriches the literature on the integration of technology and deep pedagogy. Practically, the findings are expected to serve as a guide for teachers in designing adaptive learning, for schools in strengthening digital transformation, and for policymakers in formulating human-centered, technology-based education regulations. (Hesti, 2022; Amiroh, 2020).

The evolution of digital technology, with an emphasis on Artificial Intelligence, has brought significant changes to the field of primary education. AI can create learning systems that are more personalized, adaptive, and efficient, thereby supporting students' independent learning while also reducing teachers' administrative workload. Nevertheless, its implementation is not without challenges, such as ethical issues, the risk of dehumanization, and the digital divide. Therefore, the application of AI in primary education must be carefully designed with an emphasis on human values, spirituality, and national identity, while ensuring that teachers continue to serve as moral facilitators and mentors in character development [23–27].

In line with this, the deep learning pedagogy paradigm in education emphasizes the importance of meaningful, mindful, and enjoyable learning. Deep learning is not only focused on mastering factual knowledge but also encourages students to develop critical, reflective, creative, and collaborative thinking skills. [7,28,29]. Recent studies indicate that the integration of digital technology with a deep learning approach can enhance learning outcomes while addressing individual students' needs, particularly in the context of Education 4.0 and Society 5.0.[29–33]. Furthermore, the integration of pedagogy with local culture has also proven effective in strengthening character, for example, through learning based on Kamoro oral literature, Maluku culture, or reflective approaches in language learning [3,27].

In the context of primary education, character education remains a fundamental foundation. The strengthening of character education in Indonesia has been mandated through Presidential Regulation No. 87 of 2017, which emphasizes prophetic values such as religiosity, tolerance, forgiveness, and love for peace as part of basic learning [34]. Strategies to strengthen students' character include learning based on local wisdom. (Kinanti, 2022), Integration of Hadith values into the curriculum [35], as well as the use of religious and ethical wise words in school life [36]. In this regard, teachers play a central role, not only as masters of educational technology but also as moral exemplars who internalize character values in their daily practice [37].

The success of integrating AI, Deep Learning, and character education is highly dependent on teachers' competence. Teachers are required to possess both digital literacy and innovative pedagogy to design learning that combines technology with humanistic values. Professional development models such as Communities of Practice (CoP) and Professional Learning Communities (PLC) have proven effective in enhancing teachers' capacity in this context [38–41]. In addition to teacher-related factors, the success of deep learning is also influenced by students' internal factors, such as self-efficacy, emotional engagement, and the quality of teacher and student interactions. [5,17].

Based on the literature review, it can be understood that AI acts as a technological catalyst enabling personalized learning, deep learning serves as a pedagogical framework that promotes students' cognitive and affective engagement, while character education provides the moral foundation for primary education. The synergy of these three elements is expected to produce a transformation in primary education that goes beyond academic achievement, contributing to the development of a generation that is intelligent, critical, creative, adaptive, and strong in character, capable of facing the challenges of the 21st century and realizing the vision of Indonesia's Golden Generation 2045.

This study is grounded in several complementary key theories. First, the constructivist theory, derived from the ideas of Piaget and Vygotsky, emphasizes that knowledge is actively constructed through experiences and social interactions. In the context of primary education, this theory is relevant because Artificial Intelligence can provide personalized learning experiences, while the deep learning approach allows students to reflect on these experiences to develop critical and creative thinking skills. [13,42,43].

Second, the New Pedagogies for Deep Learning proposed by Fullan and Langworthy (2014) provide a pedagogical framework that emphasizes the connection of learning to the real world, personalization, collaboration, and the use of digital technology. [44,45]. Through this framework, AI and deep learning can be integrated to create meaningful, mindful, and joyful learning that promotes active student engagement. [29,46].

The conceptual framework of this study is based on the understanding that the implementation of AI at the primary education level offers significant potential for optimizing learning effectiveness. AI can support the personalization of the learning process, monitor students' progress adaptively, and provide timely and appropriate feedback. However, the presence of AI does not replace the role of teachers, as they continue to hold the primary responsibility as moral facilitators and character role models for students. [1,17,27,47].

Furthermore, the deep learning approach offers a pedagogical paradigm aligned with the needs of 21st-century learning. By emphasizing meaningful, reflective, critical, and creative learning, deep learning provides students with the opportunity to build deeper understanding, develop higher-order thinking skills, and cultivate independent learning [48–50]. On the other hand, character education remains a foundational element in primary education. Prophetic principles, such as religiosity, honesty, discipline, responsibility, tolerance, and love for peace, serve as the main guidance in shaping students' personalities. These values are internalized through learning practices, daily interactions, and the examples set by teachers and parents. [25,34].

The integration of AI, deep learning, and character education creates a unique synergy. AI functions as a technological catalyst that enables personalized learning; deep learning serves as a pedagogical approach that fosters cognitive, affective, and collaborative engagement; while character education acts as the moral foundation guiding students' development. This synergy is expected to produce a transformation in primary education that goes beyond emphasizing academic achievement, shaping a generation that is intelligent, adaptive, critical, creative, and strong in character to face the challenges of the 21st century.

As a long-term outcome, the integration of these three aspects is expected to realize a transformation in primary education oriented toward 21st-century skills, such as digital literacy, collaboration, creativity, and problem-solving abilities. Ultimately, this is anticipated to contribute to shaping Indonesia's Golden Generation 2045, excelling not only in the cognitive domain but also in the emotional, social, and spiritual domains.

Third, this study also refers to character education theories by Lickona and Lawrence Kohlberg, which assert that character is formed through the combination of moral knowledge, moral feelings, and moral actions. [51,52]. Prophetic values such as religiosity, tolerance, honesty, and responsibility serve as the primary foundation for shaping students' character. Thus, AI and deep learning are not only viewed as technological tools but can also be utilized as means to reinforce the internalization of character values in students' lives. [34,35,53].

Fourth, educational technology theories within the framework of Education 4.0 and 5.0 by Joseph E. Aoun and Yoshiharu Kawamura assert that modern education is not solely oriented toward mastering technology but also emphasizes collaboration between humans and machines. Education 4.0 highlights the integration of advanced technology to support personalized learning, while Education 5.0 emphasizes the harmony between digital technology and human values [31,54]. From this perspective, AI and deep learning are positioned not to replace teachers but as partners in enhancing human capacity. Based on these four theories, this study views the integration of AI, deep learning, and character education as a transformative strategy for shaping primary education that is both academically excellent and morally robust.

## **2. METHOD**

This study employs a literature review approach, which involves examining a variety of relevant sources, including books, journal articles, conference proceedings, and official documents, to obtain the theoretical and conceptual foundations supporting the research. [55].

This study is a descriptive qualitative research employing a literature review approach. Its purpose is to identify, analyze, and synthesize previous research findings related to the role of Artificial Intelligence (AI), deep learning, and character education in transforming primary education toward meaningful learning.

### **Focus and Problem Identification**

The initial step involved identifying the main issues that are the focus of the study, namely how the integration of AI, deep learning, and character education can synergize to transform primary education. This problem identification is essential to ensure that the researcher remains within the context of the study.

### **Sources and Data Collection Techniques**

The literature was collected from various academic sources, including articles in national and international journals, conference proceedings, academic books, and government policy documents. The databases used included Google Scholar, DOAJ, ResearchGate, and SpringerLink. In addition, national policy documents such as the Presidential Regulation of the Republic of Indonesia No. 87 of 2017 on the Strengthening of Character Education and the Ministry of Education and Culture Regulation No. 13 of 2025 were also used as primary references.

The collected literature was selected based on the following criteria: relevance to the topics of AI, deep learning, and character education; publication years 2021–2025 to ensure novelty and relevance to technological developments; and full-text availability to allow for in-depth content analysis. This selection was conducted to ensure that the literature used possesses adequate academic quality and aligns with the objectives of the study. [56,57]

## Data Analysis Techniques

The selected literature was then reviewed using content analysis through the following stages: (1) Data reduction: selecting information relevant to the research focus and categorizing themes by grouping findings under AI, deep learning, and character education; (2) Synthesis: connecting the analysis results from various sources to identify patterns and relationships. Content analysis enables the researcher to reveal the meaning, trends, and theoretical contributions of each piece of literature. [58,59].

## Findings Synthesis

After the analysis, a synthesis was conducted by integrating the findings from various literature sources. At this stage, AI is positioned as a technological catalyst. [1,29], Deep learning as a pedagogical approach [48,49], and character education as the moral foundation [34,35]. The synthesis results indicate that the integration of the three can strengthen the quality of primary education to be meaningful, reflective, and character-oriented.

## Conclusion Drawing and Recommendations

The final stage involves formulating research conclusions based on the synthesis of findings and providing theoretical and practical recommendations. The recommendations are directed toward teachers, schools, and policymakers to promote the transformation of primary education grounded in technology and character, making it relevant to the challenges of the 21st century.

## 3. RESULTS AND DISCUSSION

### 3.1. Results

Based on the literature review, several key findings were obtained: The Role of AI in Primary Education. AI is capable of providing personalized and adaptive learning tailored to students' needs [1,47]. AI facilitates monitoring of learning progress and provides automatic recommendations for learning materials. The use of AI can reduce teachers' technical workload, allowing them to focus more on character development.

Deep learning strategies in learning activities support meaningful, mindful, and joyful learning, enabling students to become more critical, creative, and reflective. [6–8]. The deep learning instructional model helps students connect prior knowledge with new knowledge and build deeper understanding. Project based learning, reflection, and collaboration have been shown to enhance motivation and learning outcomes. [60–62].

Character Education in Primary Schools. Character education based on Pancasila values, local culture, and religion strengthens students' morality and identity. [34,35,53]. Values such as tolerance, love for peace, religiosity, and responsibility can be integrated into AI- and deep learning-based learning. Character education cannot be separated from the roles of teachers, families, and the social environment.

Synchronization of AI, Deep Learning, and Character. The integration of these three elements creates a learning system that is adaptive, reflective, and value-based. AI serves as a technological tool, deep learning as a pedagogical approach, and character as the value foundation, forming a holistic educational framework.

### 3.2. Discussion

AI as a Support, not a replacement for teachers. Although AI can efficiently analyze students' learning data, the role of teachers remains central in providing moral guidance and character mentoring [47]. Teachers must transform from mere content deliverers to facilitators, mentors, and role models of character values. Deep Learning Promotes Meaningful Learning. The deep learning approach strengthens critical and creative thinking skills, which are essential demands of the 21st century [63]. Mindful and joyful learning engages students more, promoting calmness and enthusiasm, so that the learning process becomes not only cognitive but also emotional. [64].

Character education as the moral foundation. The integration of character education with AI and deep learning emphasizes that technology should not obscure human values [34]. Character education based on local wisdom helps preserve Indonesia's cultural identity amid the forces of globalization. [53]. Holistic Integration Toward the Golden Generation 2045. The collaboration of AI, deep learning, and character creates a learning ecosystem that is inclusive, innovative, and grounded in noble values. This integration supports Indonesia's educational vision to cultivate the Golden Generation 2045 intelligent and internationally competitive, yet firmly rooted in moral and cultural values.

#### 4. CLOSURE

Referring to the findings of the literature study, it can be concluded that the integration of Artificial Intelligence (AI), the deep learning approach, and character education plays a crucial role in transforming primary education. The use of AI has been shown to provide a more individualized, flexible, and effective learning process tailored to students' needs. Nevertheless, the role of teachers cannot be entirely replaced, as they remain central figures in instilling moral and character values. Furthermore, the deep learning approach, which emphasizes meaningful learning, mindful learning, and joyful learning, has been proven to enhance deep understanding, creativity, and student engagement in the learning process. Meanwhile, character education serves as the primary foundation, ensuring that learning is not solely focused on cognitive intelligence but also contributes to the development of attitudes, morals, and national identity. Thus, the synchronization of AI, deep learning, and character education forms a holistic, inclusive, and value-based learning model, capable of producing the Golden Generation 2045—intelligent, innovative, resilient, and strong in character.

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