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Deep Learning Design in Islamic Boarding School (Pesantren): Integration of Islamic Values, Digital Technology, and 21st-Century Competencies

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Abstract

General Background: The rapid advancement of digital technology and artificial intelligence has created new opportunities for enhancing learning quality, including within Islamic boarding schools (pesantren). **Specific Background:** Pesantren, as traditional Islamic institutions, increasingly face the need to integrate modern pedagogical approaches while safeguarding Islamic values. **Knowledge Gap:** Although research on technology-based education is expanding, studies focusing on the integration of deep learning, Islamic values, and digital technology specifically in pesantren remain limited. **Aims:** This study aims to conceptualize a deep learning model that harmonizes Islamic teachings, digital tools, and 21st-century competencies to strengthen both academic and character formation in pesantren. **Results:** Through a literature review, the study identifies three core dimensions of an integrated learning design: Islamic values as the moral-spiritual foundation, digital technology and AI as pedagogical enhancers, and 21st-century skills as essential competencies for santri. **Novelty:** This study proposes a holistic framework that positions deep learning not only as a cognitive process but as a spiritually grounded, technology-supported educational paradigm unique to pesantren. **Implications:** Successful implementation requires cultural adaptation, improved digital infrastructure, and continuous teacher training to ensure ethical and effective technology use.

Highlights:

- ♦ Integration of Islamic values, digital tools, and deep learning creates a holistic pesantren learning model.
- ♦ Digital technology enhances pedagogy but requires cultural adaptation and teacher training.
- ♦ The framework prepares santri with both spiritual grounding and 21st-century skills.

Keywords: Deep Learning, Pesantren, Islamic Values, Digital Technology, 21st-Century Competencies

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Introduction

The development of information and communication technology in the digital era has brought significant impacts on various aspects of life, particularly in the field of education. One of them is Deep Learning (DL), which is a component of artificial intelligence (AI). With its technological advancements, DL has influenced many industries. Deep learning enables computers to learn patterns or information from large amounts of data in a way that mimics the functioning of the human brain [1]. This offers great potential in improving the effectiveness of learning and teaching, including in the context of religious-based education such as Pesantren.

Pesantren, as a traditional Islamic educational institution in Indonesia, plays an important role in shaping the character and competencies of students, with the aim not only to study religious knowledge but also to form good moral character. However, with the rapid development of time and globalization, the education system in pesantren needs to adapt to remain relevant in producing spiritually competent generations who can compete in a technology-driven world. According to Al-Fahmi (2020), the transformation of pesantren education is essential to build character and 21st-century competencies [2], while Kurniawan and Siregar (2019) emphasize the integration of traditional values with technology in pesantren education [3]. Noor (2018) and Nasution (2021), argue that pesantren need to adjust to the changes of the times to stay relevant in Indonesia's education system [4], [5].

The integration of deep learning into the pesantren education framework offers a unique opportunity to combine Islamic values, digital technology, and 21st-century competencies. Digital literacy in pesantren is therefore very important as an effort to improve students' ability to access, analyze, and responsibly utilize digital information. Studies show that well-structured digital literacy programs significantly improve students' cognitive skills and practical literacy [6]. Digital applications have been explored to support the memorization of the Qur'an, but challenges such as inaccurate feedback and limited technology remain [7]. Furthermore, according to Rohmad (2024) the implementation of an effective curriculum and good leadership is crucial to improve the quality of learning and develop students' academic competencies, especially in critical thinking, creativity, and problem-solving [8].

Digital transformation in Islamic education, which involves the development of digital infrastructure, integration of Learning Management Systems (LMS), and the application of the flipped classroom model, while maintaining Islamic values, is necessary [9]. Although previous research has extensively discussed the application of technology in education, particularly in AI and Deep Learning-based learning [10], the implementation of technology in pesantren is still relatively rare. Most of the existing research tends to focus on formal education in general schools or universities [11], while in pesantren, the integration of digital technology while maintaining Islamic values is a major challenge. More studies are needed to explore effective strategies to achieve this balance [12]. Moreover, pesantren graduates often face difficulties in adapting to digital environments in higher education due to limited digital literacy during their time in pesantren [13].

The introduction above shows that this research is crucial to address the issues that arise when incorporating digital technology and deep learning into the education of pesantren, a traditional Islamic educational institution. Technology has great potential to improve the quality of learning, especially in creating 21st-century skills, but it is still underutilized in pesantren. It is hoped that this research will make an effective contribution to integrating digital technology with Islamic values and addressing the digital literacy gap in pesantren. The results of this study will also enrich educational methods in pesantren, help graduates adapt to digital-based higher education, and support the transformation of Islamic education towards a more relevant and contemporary direction.

Literature Review

1. Deep Learning in the Context of Islamic Education

Deep learning can be understood as the process of *tazkiyah al-nafs* (purification of the soul) and *tafaqquh* (deepening of meaning) through intellectual and spiritual reflection. According to Rahman (1980), ideal Islamic education integrates both intellect and faith to produce knowledgeable and ethical individuals [14]. Several studies Hasanah (2022) show that the application of deep learning based on Islamic values can enhance critical thinking and the spiritual awareness of students (santri) [15]. The implementation of this method is carried out through project-based learning, case studies, and daily reflection (learning journals), which cultivate self-awareness of the meaning of knowledge. On the other hand, pesantren, as the oldest Islamic educational institution in Indonesia, functions not only to instill religious, moral, and social values but also to build character and 21st-century skills [16]. In the modern context, pesantren no longer only serves as a religious educational institution but also as a place to develop character and 21st-century competencies. Pesantren continues to adapt to the changing times while maintaining its Islamic traditions, thanks to the integration of general curricula, administrative digitalization, and innovative teaching methods [17].

2. Modernization and Transformation of the Learning System in Pesantren

In the era of digitalization, the modernization of *pesantren* education has become inevitable. According to Wahid (2021), the transformation of the *pesantren* education system must focus on pedagogical innovation that combines Islamic values with contemporary approaches based on technology [18]. To enhance interaction and learning efficiency, many pesantren are utilizing Learning Management Systems (LMS), digital media, and hybrid classes. Furthermore, this transformation has led to an increase in digital literacy among students, including the ability to create digital content for religious outreach (dakwah) and an understanding of social media ethics from an Islamic perspective. According to Nurdin (2022), the current

goal of pesantren education is not only to produce religious scholars but also digital educators who can engage in dakwah using technology [19]. However, according to Al-Attas (1991), Islamic education aims to instill adab (etiquette), awareness of one's position, knowledge, and God. Therefore, education should focus on forming individuals who are both spiritually and intellectually equipped [20].

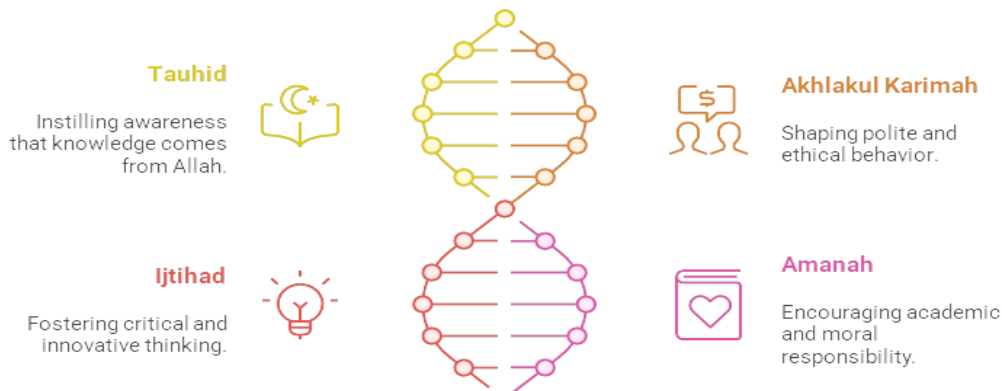


Figure 1. Islamic Values in Deep Learning.

The application of these values can be carried out through learning reflection, social-based projects, and character evaluation in addition to cognitive aspects. Therefore, deep learning is not merely an academic achievement, but also the formation of a civilized individual.

3. The Utilization of Digital Technology in *Pesantren* Education

Digital technology has tremendous potential to enhance the learning process in schools. According to Bates (2015), the digitalization of education allows for more flexible, collaborative, and interactive learning [21]. The use of applications such as Google Classroom, Edmodo, and digital *dakwah* videos in *pesantren* has increased student engagement in education. Technology is also aligned with the concept of *ijtihad* in Islam, which is the intellectual effort to find new ways to help the community. With the guidance of *kiai* and teachers, technology can serve as a means to enhance *dakwah* and the quality of learning, rather than undermine spirituality.

4. Development of 21st-Century Competencies in *Pesantren* Education

According to Dede (2010), 21st-century competencies, including critical thinking, creativity, collaboration, and communication, have become a top priority in education systems worldwide [22]. Strengthening these four competencies is directly supported by the implementation of deep learning, which emphasizes critical thinking and teamwork in learning.

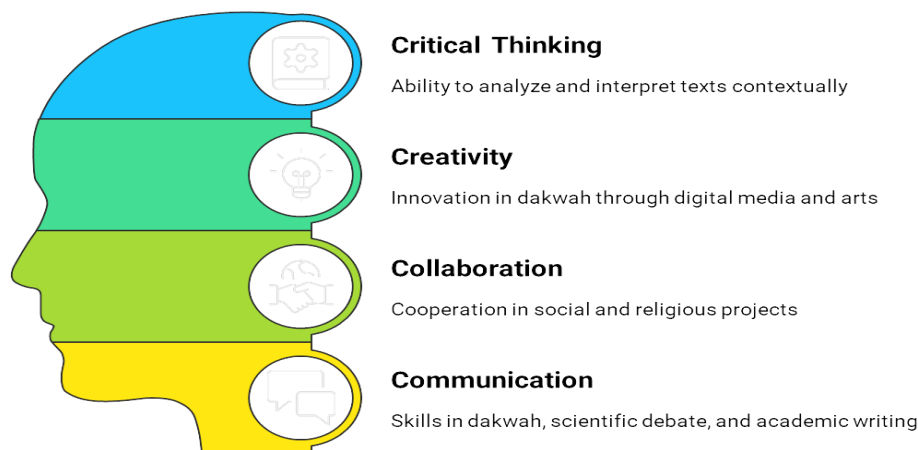


Figure 2. Enhancing 21st Century Skills in *Pesantren*.

The implementation of deep learning in *pesantren* not only enhances the students' understanding of Islamic teachings but also equips them with adaptive skills to contribute to modern society. The literature review above explains the formation of an integrative learning model: students learn deeply, based on Islamic values, while wisely utilizing technology to achieve spiritual, intellectual, and social competencies

Methods

This study uses a literature review approach to thoroughly examine the concept and implementation of deep learning in *pesantren* education. A literature review was chosen because this research focuses on conceptual analysis and synthesis of

theories from various relevant literatures without conducting empirical data collection in the field. According to Zed (2008), literature research aims to obtain theoretical and argumentative data through the review of scientific sources such as books, journals, and official documents [23]. The data sources consist of primary sources, such as scholarly works directly discussing the main research topic, and secondary sources such as journals and other supporting documents.

Data is collected through the processes of inventorying, classifying, and reviewing the content of the literature, then analyzed using the Miles and Huberman (1994) model, which includes three stages: data reduction, data presentation, and drawing conclusions [24]. Validity is maintained through source triangulation and literature credibility verification. The results of this study are expected to produce a conceptual model of deep learning that integrates Islamic values, digital technology, and 21st-century competencies within the pesantren education system.

Results and Discussion

A. Result

The main scope of this study is divided into four sections (refer to Table 1), including: Deep Learning Design in *Pesantren* Education (2 articles), Integration of Islamic Values with Technology (2 articles), Development of 21st-Century Competencies in *Pesantren* (2 articles), Challenges and Implementation Strategies (2 articles). These studies indicate that deep learning-based learning designs in *pesantren* encompass the integration of three major dimensions: Islamic values as the moral and spiritual foundation, digital technology and AI as modern pedagogical tools, and 21st-century competencies as the target for developing *pesantren* human resources. Thus, the synergy of these three elements forms the basis for a holistic learning design, rooted in Islamic values, adaptive to technological developments, and relevant to the global challenges of contemporary education.

Table 1. Summary of Deep Learning Design in Islamic Boarding Schools (Pesantren)

Authors	Title	Journal	Methodology	Findings
Novianto & Prihatin (2025)	Implementing Deep Learning through the Development of Eco-Pesantren at PPM Baitussalam	Jurnal Sosialita	Qualitative, interviews, observation, and documentation	Eco-Pesantren promotes sustainable learning environments that integrate deep learning, enhancing collaboration and critical thinking
Sulisno (2025)	Integrating Islamic Values and Technology for Holistic Character Education in Indonesian Islamic Schools	Al Hikmah: Journal of Education	Qualitative, case study at MA Jamilurrahman	The integration of Islamic values and technology in holistic education enhances the development of students' character, focusing on spiritual and social values
Fahrudin, A., & Malik, M.K. (2025)	A Pesantren Cultural Value-Based Learning Model: Integrating Islamic Values and 21st-Century Skills	Cendekia: Jurnal Kependidikan dan Kemasyarakatan	Qualitative, field study with observation, in-depth interviews, and documentation	The integration of pesantren cultural values with 21st-century skills can create an educational model that is relevant and holistic for the challenges of the times
Sugito (2024)	Hybrid Learning in Pesantren: Integrating Digital Pedagogy and Islamic Values o Enhance 21st-Century Competencies	Interdisciplinary Journal of Islamic Education	Qualitative, literature and thematic analysis	The hybrid learning model in Islamic boarding schools can enhance 21st-century competencies (digital literacy, collaboration, problem-solving) without compromising Islamic values
Taufikin (2025)	Redefining Islamic Pedagogy: A Transformative Approach to 21st-Century Education in Indonesian Pesantren	MAHAROT: Journal of Islamic Education	Qualitative, case study with in-depth interviews and observations	Islamic boarding schools that adopt transformational pedagogy successfully integrate Islamic values, entrepreneurial skills, and digital technology into their curriculum
Saridudin (2025)	Deep Learning in Islamic Religious Education: Optimizing a Deeper Learning Process	AL-AFKAR: Journal for Islamic Studies	Qualitative, case study, and literature analysis	Islamic boarding schools that adopt transformational pedagogy successfully integrate Islamic values, entrepreneurial skills, and digital technology into their curriculum
Barid et al. (2024)	Integration of Technology in Islamic Boarding School: Opportunities and Challenges for Islamic Education	Proceeding of International Conference on Education, Society and Humanity	Qualitative, interview, observation	The use of technology improves management efficiency and the quality of education, but challenges such as limited infrastructure and resistance to change still

Sholeh (2023)	Technology Integration in Islamic Education: Policy Framework and Adoption Challenges	Journal of Modern Islamic Studies and Civilization	Qualitative, literature study	exist The main challenges in integrating technology in Islamic education include limited infrastructure, lack of teacher training, and the need for supportive policies
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B. Discussion

Based on the collection of studies presented, the theme "Deep Learning Design in Islamic Boarding Schools: Integration of Islamic Values, Digital Technology, and 21st-Century Competencies" covers various interconnected areas. The goal of this theme is to create a better learning model in *pesantren* that combines traditional approaches with modern technology while maintaining fundamental Islamic values. The following is an in-depth analysis that includes the application of deep learning in *pesantren* education, the integration of Islamic values and technology, as well as the development of 21st-century competencies in *pesantren* settings:

1. Deep Learning Design in *Pesantren* Education

In *pesantren* education, deep learning is more than just the use of advanced technology. It is an educational method that emphasizes the ability of students to connect what they know with real-world situations and deep conceptual understanding. According to research by Prihatin and Novianto (2025) and Saridudin (2025), deep learning can be applied in *pesantren* to enhance a more interactive and profound learning experience [25], [26]. This will assess not only the cognitive aspects of the students but also their emotional and spiritual aspects. This method is essential as it will result in more reflective learning where students can not only memorize information but also internalize it in their daily lives. *Pesantren* has a learning culture that tends to be one-directional, which often hinders the use of more interactive and innovative teaching methods. To address this issue, changes are needed in the pedagogical approach and the development of a more flexible and adaptive curriculum.

2. Integration of Islamic Values with Technology

It is important for *pesantren* not only to provide academic education but also to build the character and ethics of students based on Islamic values. Studies by Fahrudin and Malik (2025) and Sulisno (2025) emphasize the importance of incorporating Islamic principles into contemporary learning technology to achieve this goal [27], [28]. If this integration is successful, there will be two main benefits. First, digital technology should support principles such as discipline, honesty, and responsibility. Second, technology should enhance the quality of learning, expand access, and allow for more contextual learning approaches. One issue that exists is that many *pesantren* are not fully prepared to monitor the use of technology by their students to maintain the integrity and religious principles. Therefore, clearer policies need to be made regarding the use of technology.

3. Development of 21st-Century Competencies in *Pesantren*

Critical thinking, creativity, collaboration, and communication are essential in the 21st century to prepare students for global challenges. According to Sugito (2024) and Taufikin (2025), *pesantren* curricula should integrate these skills with technology-based pedagogical approaches [29], [30]. Utilizing deep learning and hybrid learning (a blend of face-to-face and digital learning) allows students to enhance their skills in an environment that supports critical thinking, teamwork, and problem-solving. However, continuous teacher training in technology and 21st-century teaching methodologies remains an issue. Without adequate infrastructure and intensive professional development, achieving these competencies becomes difficult.

4. Challenges and Implementation Strategies

It is important to note that *pesantren* face difficulties in implementing technology and deep learning in their education systems. Sholeh (2023) and Barid et al. (2025) state that the main challenges *pesantren* face include a lack of infrastructure, insufficient teacher training, and resistance to cultural change [31], [32]. To overcome these issues, *pesantren* must create policies that are more aligned with technology and provide structured training for teachers. Developing a learning environment that supports the use of technology, providing teachers with continuous training facilities, and developing a curriculum that better meets the needs of the 21st century while maintaining the core values of *pesantren* are suggested strategic efforts.

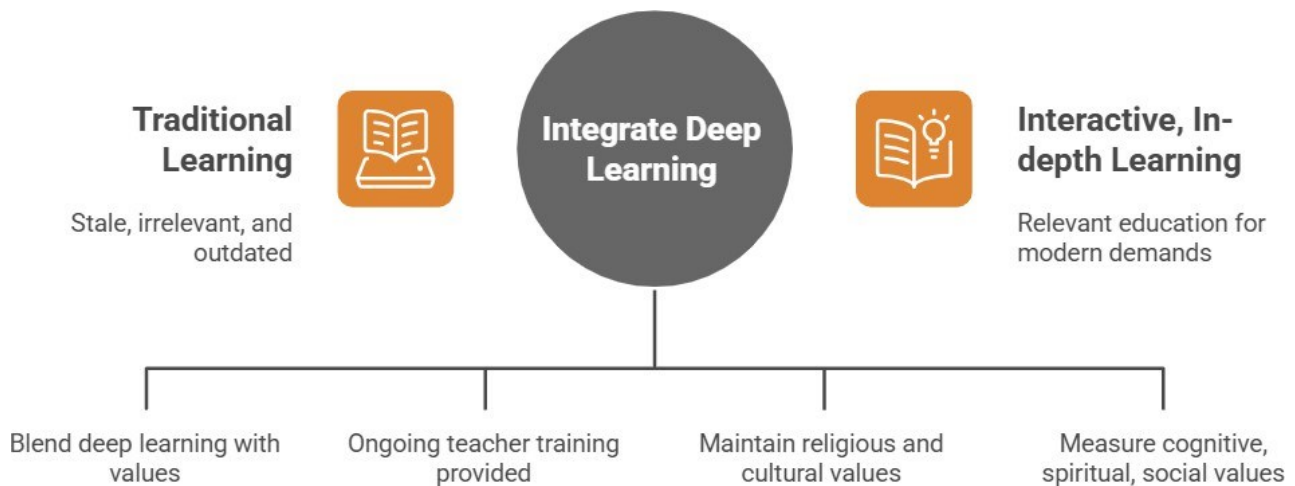


Figure 3. Transforming Islamic Education with Technology.

Conclusions

Based on the findings and discussions presented in the previous research, overall, the integration of deep learning, Islamic values, and digital technology in *pesantren* education offers great potential in creating more interactive, profound, and relevant learning that meets the demands of the times. However, its implementation requires changes in the educational culture of *pesantren*, improvements in technological infrastructure, and training for teachers to ensure effective and ethical use. Recommendations for further development (refer to Figure 3).

This image highlights the contrast between traditional learning approaches and modern deep learning in education. Traditional learning is depicted as outdated and irrelevant, while deep learning is portrayed as a more interactive and relevant method that aligns with the demands of modern education. The image emphasizes the importance of integrating deep learning with religious values, offering continuous teacher training, maintaining cultural values, and measuring not only cognitive growth but also spiritual and social development. This integration ensures that the learning process remains holistic and adaptive to the needs of today's students. With the right approach, *pesantren* can serve as an example of education that blends tradition with technological innovation, shaping future generations who are prepared to face global challenges while remaining committed to Islamic principles.

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