



# Pedagogical Transformation in Islamic Religious Education: Integrating Deep Learning and Coding for Elementary School Students

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## Abstract:

The rapid growth of digital technology has created challenges for Islamic Religious Education (IRE) in elementary schools, which often remain dominated by conventional, teacher-centered approaches. This study aimed to develop and examine the effectiveness of an Islamic Techno-Pedagogy model integrating Deep Learning and Coding to support students' cognitive, spiritual, and digital development. The research employed a Research and Development (R&D) approach, combining Design-Based Research (DBR) with a Pretest-Posttest Control Group Design. Data were collected through observations, interviews, questionnaires, tests, and documentation, and analyzed using qualitative and quantitative techniques. The findings revealed that the developed model significantly improved students' active participation from 42% to 85%, their understanding of Islamic concepts from 62% to 88%, and their interest in digital Islamic learning from 55% to 90% across three DBR cycles. Experimental testing also showed significant differences between the experimental and control groups, with a cognitive N-Gain score of 0.75. The study concludes that integrating Deep Learning and Coding into IRE effectively strengthens students' knowledge, character, and digital competencies. This research contributes a novel Islamic Techno-Pedagogy framework that bridges technological literacy and spiritual development in elementary education.

**Key Words:** *Islamic Techno-Pedagogy, Deep Learning, Coding*

## Abstrak:

Pesatnya pertumbuhan teknologi digital telah menciptakan tantangan bagi Pendidikan Agama Islam (IRE) di sekolah dasar, yang seringkali tetap didominasi oleh pendekatan konvensional yang berpusat pada guru. Penelitian ini bertujuan untuk mengembangkan dan mengkaji efektivitas model Tekno-Pedagogi Islam yang mengintegrasikan Deep Learning dan Coding untuk mendukung perkembangan kognitif, spiritual, dan digital siswa. Penelitian ini menggunakan pendekatan Penelitian dan Pengembangan (R&D), menggabungkan Penelitian Berbasis Desain (DBR) dengan Desain Kelompok Kontrol Pretest-Posttest. Data dikumpulkan melalui observasi, wawancara, kuesioner, tes, dan dokumentasi, serta dianalisis menggunakan

teknik kualitatif dan kuantitatif. Temuan mengungkapkan bahwa model yang dikembangkan secara signifikan meningkatkan partisipasi aktif siswa dari 42% menjadi 85%, pemahaman mereka tentang konsep Islam dari 62% menjadi 88%, dan minat mereka pada pembelajaran Islam digital dari 55% menjadi 90% di tiga siklus DBR. Pengujian eksperimental juga menunjukkan perbedaan yang signifikan antara kelompok eksperimental dan kontrol, dengan skor N-Gain kognitif 0,75. Studi ini menyimpulkan bahwa mengintegrasikan Deep Learning dan Coding ke dalam IRE secara efektif memperkuat pengetahuan, karakter, dan kompetensi digital siswa. Penelitian ini menyumbangkan kerangka Tekno-Pedagogi Islam baru yang menjembatani literasi teknologi dan pengembangan spiritual dalam pendidikan dasar.

**Kata Kunci:** *Tekno-Pedagogi Islam, Pembelajaran Mendalam, Pengkodean*

## INTRODUCTION

The rapid development of digital civilization has fundamentally transformed the way individuals learn, communicate, and construct knowledge in contemporary society (Amirudin et al., 2025; Muzaki & Nurhayati, 2026). Education is no longer limited to the transmission of information but has evolved into a dynamic process of meaning-making, identity formation, and cognitive development (Asril et al., 2023; Muthohar et al., 2026). In the twenty-first century, children are growing up in an environment dominated by digital technologies, artificial intelligence, visual communication, and algorithmic systems that shape their patterns of thinking and interaction (Alirahman et al., 2023). Consequently, educational institutions are expected to equip learners not only with disciplinary knowledge but also with critical thinking, creativity, digital literacy, and ethical awareness (Pahrudin et al., 2025; Widodo, 2025). This challenge is particularly significant for religious education, which plays a strategic role in developing students' moral and spiritual foundations. As societies become increasingly technology-driven, Islamic Religious Education (IRE) must respond to changing learning environments and student needs. Therefore, investigating innovative pedagogical approaches that integrate technological competencies with spiritual and moral development has become an important academic and societal concern (Azman, Hamzah, & Abd Razak, 2025). Such efforts are essential to ensure that future generations can navigate technological advancement while maintaining strong religious and ethical values.

Despite the growing importance of technology-oriented education, a significant problem remains within many elementary school learning environments, particularly in Islamic Religious Education (Abubakari et al., 2024; Azman, Hamzah, & Abd Razak, 2025). While children increasingly interact with digital platforms, educational applications, and algorithm-based technologies in their daily lives, religious instruction often remains dominated by conventional teaching approaches characterized by memorization, teacher-centered delivery, and textual interpretation (Cahyadi et al., 2025; Rokhimawan et al., 2025). This pedagogical mismatch creates a gap between students' lived experiences and the learning processes occurring in classrooms. As a result, religious education risks

becoming disconnected from the realities of contemporary learners, reducing students' engagement and limiting opportunities for meaningful reflection. Furthermore, the inability to integrate technological literacy within religious learning may hinder the development of essential twenty-first-century competencies, including computational thinking, problem-solving, and digital ethics (Murhayati et al., 2025; Siregar et al., 2025). This situation is particularly concerning because future citizens are expected to possess both technological capabilities and strong moral foundations. Therefore, educational stakeholders face an urgent challenge: how to redesign Islamic Religious Education so that it remains spiritually meaningful while simultaneously preparing students to participate responsibly in an increasingly digital society.

This challenge is increasingly evident in elementary schools, where students demonstrate high levels of engagement with digital technologies but encounter limited opportunities to connect these experiences with religious learning (Arim et al., 2024; Sahib et al., 2026). Classroom observations reported in recent studies indicate that many students are familiar with digital games, social media, animation platforms, and artificial intelligence-based applications. However, these technological experiences rarely become meaningful learning resources within Islamic Religious Education. In many schools, students continue to engage primarily in rote memorization of religious concepts without opportunities to explore, create, or apply Islamic values through technological activities (Febrini et al., 2024; Wedi & Mardiana, 2025). At the same time, educational policies in several countries, including Indonesia, increasingly encourage the introduction of coding, computational thinking, and deep learning approaches into school curricula. This creates a unique educational phenomenon: while technology education and religious education are developing simultaneously, they often operate as separate domains. Consequently, students experience a fragmented learning environment in which technological skills and spiritual development are not integrated (Azman, Hamzah, & Baharudin, 2025; Parinduri & Ibarra, 2025). This phenomenon underscores the need to develop innovative pedagogical models that bridge technological learning and religious education in elementary school contexts.

Previous studies have extensively discussed the role of digital technology in improving educational quality and student engagement. Research has demonstrated that coding activities positively contribute to computational thinking, creativity, logical reasoning, and collaborative problem-solving among elementary school students (Karwadi et al., 2025). Similarly, studies on deep learning approaches emphasize the importance of meaningful learning experiences that encourage reflection, critical thinking, and knowledge construction rather than superficial memorization. Within religious education, several scholars have explored the use of digital media, online learning platforms, and interactive educational technologies to enhance student participation and understanding of religious concepts. These studies collectively

suggest that technology can enrich learning experiences and support more active forms of student engagement (Abubakari et al., 2026; Başaran et al., 2024). However, most existing research treats technological innovation and religious education as separate areas of inquiry. The majority of studies focus either on technological competence development or on religious learning outcomes, with limited attention given to how both domains can be integrated within a coherent pedagogical framework (Obaid et al., 2024; Ruiz Recio et al., 2026). Consequently, opportunities to explore the intersection of digital literacy, coding, deep learning, and Islamic Religious Education remain underexplored.

Furthermore, existing literature reveals several important research gaps. First, studies investigating coding education primarily focus on STEM-related subjects, while its potential contribution to moral, ethical, and spiritual learning remains largely unexplored (Örün, 2025). Second, research on Islamic Religious Education continues to emphasize curriculum content, religious literacy, and character formation but rarely incorporates computational thinking as a pedagogical component (Jambula, 2025; Roig-Vila & Moreno-Isac, 2020). Third, although deep learning has attracted considerable attention as an educational framework that promotes meaningful understanding and reflective thinking, few studies have examined its application in Islamic educational settings (Pegram et al., 2023). As a result, the literature lacks a comprehensive model for integrating coding activities, deep learning principles, and Islamic values to support children's pedagogical development. This gap is particularly significant because contemporary learners require educational experiences that simultaneously cultivate technological competence, critical thinking, ethical awareness, and spiritual maturity. Addressing this gap is essential for developing educational practices that are relevant to the realities of the digital era while preserving the core objectives of Islamic education.

The novelty of this research lies in the development of an Islamic techno-pedagogical framework that integrates deep learning and coding into Islamic Religious Education at the elementary school level. Unlike previous studies that position technology merely as an instructional tool, this research conceptualizes technology as a medium for reflective, ethical, and spiritual learning. Within this framework, coding is not understood solely as a technical skill but as a form of computational reasoning that enables students to explore Islamic values through creative problem-solving and knowledge construction. Likewise, deep learning is interpreted not only as a pedagogical strategy but also as a process of cultivating meaningful understanding, self-awareness, and spiritual reflection. By combining these perspectives, the study introduces a new approach in which religious learning becomes an interactive dialogue between faith, technology, and lived experience. This state-of-the-art perspective contributes to contemporary discussions on educational innovation by offering a model that aligns technological advancement with the moral and spiritual objectives of Islamic education.

Based on these considerations, this study seeks to answer the following research question: How does the integration of deep learning and coding contribute to children's pedagogical development in Islamic Religious Education at elementary schools? This research argues that integrating deep learning and coding can transform Islamic Religious Education from a predominantly transmission-based model into a dialogical, reflective, and experiential learning process. Such integration is expected to foster critical thinking, computational reasoning, creativity, and spiritual awareness simultaneously. Furthermore, the study proposes that technology and religion should not be viewed as opposing domains but rather as complementary dimensions that can enrich children's learning experiences. Theoretically, this research contributes to the development of Islamic techno-pedagogy as a new conceptual framework for understanding the relationship between digital learning and religious education. In practice, it provides educators and policymakers with innovative strategies for designing future-ready Islamic Religious Education that remains faithful to its spiritual mission while effectively responding to the demands of the digital age.

## **RESEARCH METHODS**

This research employed a Research and Development (R&D) approach, aiming to produce and test the effectiveness of an educational product, an Islamic Techno-Pedagogy learning model based on Deep Learning and Coding, in Islamic Religious Education (PAI) in elementary schools. The R&D method was chosen based on the research objective, which was not only to describe the phenomenon but also to develop an innovative learning model that meets the demands of 21st-century education and strengthens students' Islamic character.

The model was developed using a Design-Based Research (DBR) approach, which included needs analysis, model design, prototype development, expert validation, product revision, limited implementation, and model refinement. After the model was declared feasible, an effectiveness test was conducted using a Pretest-Posttest Control Group design to determine the effect of the model's implementation on student learning outcomes in the cognitive, affective, and psychomotor domains.

The research was conducted at an elementary school that had implemented digital technology-based learning and had adequate learning resources for implementing the Islamic Techno-Pedagogy model. The selection of the elementary school as the research location was based on several considerations. First, elementary school is a fundamental phase in character development, digital literacy, and religious understanding in students. Second, the implementation of technology-based learning at the elementary school level still requires a model integrated with Islamic values, thus necessitating pedagogical innovations appropriate to student development. Third, schools must have the necessary human resources, technological infrastructure, and institutional support to optimally conduct developmental research.

Research data was collected using various complementary techniques to obtain comprehensive information regarding the development and implementation of the Islamic Techno-Pedagogy model. Observation techniques were used to observe the learning process, teacher and student activities, and the implementation of the developed model. Interviews were conducted with school principals, Islamic Education teachers, and students to explore learning needs, responses to the model, and supporting and inhibiting factors for its implementation. Furthermore, questionnaires were used to obtain expert validation data, teacher responses, and student responses regarding the quality, practicality, and usefulness of the learning model. Learning outcomes were measured using pretests and posttests to assess improvements in students' cognitive abilities following the model's implementation. Furthermore, documentation was used as supporting data, including learning materials, school archives, activity photos, student work, and various other documents relevant to the research.

To ensure the credibility and validity of the data, this study employed several validation techniques, including source triangulation, which compared information obtained from the principal, teachers, and students, and technical triangulation, which compared the results of observations, interviews, questionnaires, tests, and documentation. Furthermore, member checking was conducted by confirming the interview results and the data interpretation with informants to ensure the intended meaning was accurate. Data validity was also strengthened through peer debriefing, a discussion with fellow researchers or education experts to obtain input on the analysis results, and an audit trail, which documented the entire research process, from field notes and research instruments to data analysis results for further analysis. Through these procedures, the developed Islamic Techno-Pedagogy model is expected to meet the criteria of validity, practicality, and effectiveness in improving the quality of Islamic Religious Education learning in elementary schools.

## RESULTS AND DISCUSSION

### Results

This research began with a shift in elementary school learning spaces, which have experienced epistemological tension between the sacredness of Islamic values and the rationality of technology, shaping children's thinking. Through the model *Design-Based Research (DBR)*, so that in this research process it does not stop at description, but rather goes through several cycles: 1) needs analysis, integrative model design, *deep learning*, and *coding*, 2) limited implementation, 3) continuous evaluation and revision. The results of the study showed that *first cycle*, Islamic Religious Education learning is still teacher-centered with an active student participation rate of 42% and an average score of 62/100 for understanding Islamic concepts. Then, after revisions were made to

add components of spiritual reflection, on the *second cycle*. There was an increase in participation to 78% and in conceptual understanding to 84%, accompanied by changes in student learning behavior toward greater collaboration and reflection. *In the third cycle, the validation results for teachers and principals strengthen the position of the model Islamic Techno-pedagogy as a new approach that integrates digital rationality with Islamic spiritual values. More specific details can be seen in the following table;*

**Table 1. Development of Active Participation and Islamic Understanding**

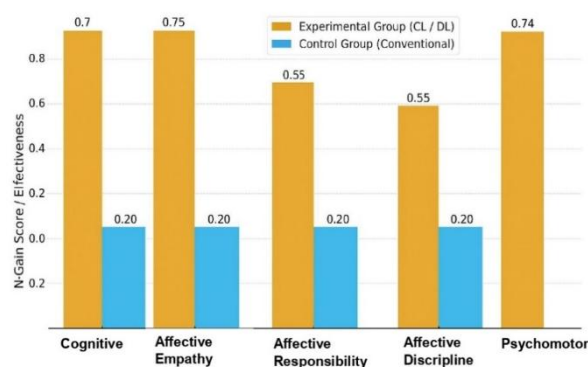
Cycle	Quantitative Indicators	Active Participation Percentage	Concept Understanding Score (0–100)	Main Qualitative Description
Cycle I	Initial observations, memorization patterns, dominant lectures	42%	62	Passive students, high teacher dominance, limited interaction
Cycle II	Revised model with components of <i>spiritual reflection</i>	78%	84	Students began actively discussing, able to reflect Islamic values in their coding.
Cycle III	Final implementation and validation of the model	85%	88	Teachers and principals assess the effectiveness of the model for integrating Islamic values and technology.

Table 1 shows that the implementation of the Islamic Techno-Pedagogy model gradually increased students' active participation and understanding of Islamic concepts over the three research cycles. In Cycle I, learning was still dominated by lecture and memorization methods, resulting in only 42% active student participation, a conceptual understanding score of 62, and low interaction and high teacher dominance. After revising the model by adding a spiritual reflection component in Cycle II, student participation increased significantly to 78%, and the understanding score reached 84, indicating that students began to discuss and connect Islamic values with coding activities actively. This increase continued in Cycle III, where active participation reached 85% and the conceptual understanding score increased to 88. Qualitatively, teachers and the principal assessed the developed model as effective in integrating Islamic values with digital technology. These findings indicate that implementing Islamic Techno-Pedagogy not only increases student engagement in the learning process but also strengthens their understanding of Islamic concepts in a more contextual and meaningful way.

**Table 2. Model Validation Results *Islamic Techno-pedagogy***

Rated aspect	Average value	Category
Conformity with PAI Objectives	4.7	Very good
Integration of Spiritual Values	4.8	Very good
Relevance to the Digital Age	4.6	Very good
Implementation in elementary school	4.5	Good
<b>Rate-rate Total</b>	<b>4.65</b>	<b>Very Worthy</b>

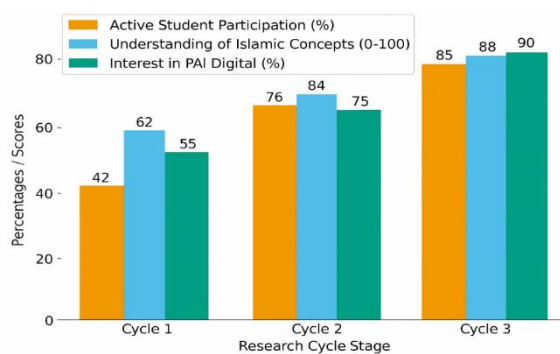
Table 2 shows that the Islamic Techno-Pedagogy model achieved a very high level of feasibility based on expert validation results. The suitability aspect with the objectives of Islamic Religious Education (PAI) received an average score of 4.7, categorized as very good, indicating that the developed model aligns with the learning outcomes and objectives of Islamic education. The aspect of integrating spiritual values received the highest score, namely 4.8 (very good), indicating that the model effectively internalizes Islamic values in the technology-based learning process. Furthermore, the relevance to the demands of the digital era received a score of 4.6 (very good), indicating that the model aligns with the needs of 21st-century learning. Meanwhile, the implementation aspect at the elementary school level received a score of 4.5, categorized as good, indicating that the model can be practically applied to the characteristics of elementary school students. Overall, the average validation score was 4.65, indicating very high feasibility, so the Islamic Techno-Pedagogy model is considered to meet the feasibility standards for use as a learning innovation that integrates Islamic values, digital technology, and the holistic development of student competencies.



**Figure 1: Comparison of Development Cycle Results *Islamic Techno-pedagogy***

Figure 1 shows a significant increase in three main indicators, namely active student participation, understanding of Islamic concepts, and interest in digital-based Islamic Religious Education (PAI) learning during three cycles of Design-Based Research (DBR) research. From the initial condition which was still dominated by a teacher-centered approach with a participation rate of 42%, understanding of 62%, and learning interest of 55%, the implementation of the Islamic Techno-Pedagogy model that integrates Deep Learning, Computational

Thinking, and spiritual reflection successfully increased the achievement to 85% participation, 88% understanding, and 90% learning interest in the third cycle. This finding indicates that the developed model can simultaneously strengthen students' cognitive, affective, and spiritual dimensions. The results of the effectiveness test using the Pretest–Posttest Control Group Design also strengthen these findings, as the Independent-Samples t-Test showed a very significant difference ( $p < 0.01$ ) between the experimental and control groups across all ability domains. The N-Gain Score analysis showed that the experimental group achieved an average increase of 0.75 in the cognitive domain (high category), much higher than the control group, which achieved only 0.20 (low category). Improvements in affective character were also observed in indicators of empathy (0.75), responsibility (0.68), and discipline (0.55), while in the psychomotor domain of coding skills, students achieved an effectiveness level of 74.3%, which falls within the high category. These results confirm that the Islamic Techno-Pedagogy model is effective in holistically improving student learning outcomes, encompassing knowledge, attitudes, and skills.



**Figure 2. Comparison of the Effectiveness of Islamic Education Learning**

Figure 2 shows consistent improvement in three key indicators across the three research cycles: active student participation, understanding of Islamic concepts, and interest in Digital Islamic Religious Education (PAI). In Cycle 1, active student participation remained at 42%, understanding of Islamic concepts reached 62, and interest in Digital Islamic Religious Education (PAI) reached 55%. After instructional improvements in Cycle 2, all three indicators increased to 76%, 84%, and 75%, respectively. This improvement continued in Cycle 3, with even more optimal results: active student participation reached 85%, understanding of Islamic concepts reached 88%, and interest in Digital Islamic Religious Education (PAI) reached 90%. These findings indicate that implementing Digital Islamic Religious Education (PAI) is effective in increasing student engagement, deepening understanding of Islamic material, and fostering greater interest in learning, thereby maximizing achievement of learning objectives from one cycle to the next.

The results of this study demonstrate a strong and linear relationship between the reflective process in the Design-Based Research (DBR) cycle and the empirical results obtained through experimental testing. The process of

reflection, evaluation, and refinement of the model in each DBR cycle resulted in the development of an Islamic Techno-Pedagogy model that is increasingly effective and directly impacts student learning outcomes. These findings demonstrate that integrating Deep Learning and Computational Thinking approaches into Islamic Religious Education learning not only improves students' cognitive abilities and digital skills but also contributes significantly to the formation of Islamic character, as measured empirically. Through interactive, critical, reflective, and problem-solving-based learning, students are no longer simply memorizing religious material; they can understand, internalize, and apply Islamic teachings in context in their daily lives. Thus, the developed model successfully integrates spiritual strengthening, technological mastery, and the development of 21st-century competencies in a balanced manner in Islamic Religious Education learning in elementary schools.

## **Discussion**

The research results show that the Islamic Techno-Pedagogy model, developed through a Design-Based Research (DBR) approach, significantly increased student active participation, understanding of Islamic concepts, and interest in learning digital-based Islamic Religious Education (Dohn, 2026; Pegram et al., 2023). This finding aligns with various studies on Deep Learning, which confirm that student-centered, reflective, and problem-solving-based learning can increase learning engagement and deeper conceptual understanding compared to conventional memorization-oriented approaches (Sahoo et al., 2025). The increase in participation from 42% in the first cycle to 85% in the third cycle indicates that integrating digital technology with spiritual reflection activities can create a more interactive and meaningful learning environment. This finding also supports constructivist theory, which positions students as active subjects in constructing knowledge through authentic and contextual learning experiences (Istiqlal et al., 2024; Tonbuloglu, 2025).

In addition to increasing learning engagement, this study found that integrating Computational Thinking and Coding into Islamic Religious Education can strengthen understanding of Islamic concepts while developing 21st-century skills (Alirahman et al., 2023; Azman, Hamzah, & Abd Razak, 2025). These results expand on previous research, which generally views coding and computational thinking as relevant competencies for science and technology. In this study, both approaches were proven to be adaptable to religious learning, enabling students not only to understand Islamic teachings textually but also to analyze, reflect on, and connect Islamic values to various life issues logically and systematically (Amirudin et al., 2025; Cahyadi et al., 2025; Widodo, 2025). This finding contrasts with some literature that still separates religious education from digital literacy development, as the research results demonstrate that the two can be harmoniously integrated without diminishing the substance of the spiritual values taught.

The expert validation results, which obtained an average score of 4.65, categorized as very appropriate, and the effectiveness test results showing high N-Gain values in the cognitive, affective, and psychomotor aspects, provide important theoretical implications for the development of contemporary Islamic pedagogy (Murhayati et al., 2025; Sahib et al., 2026; Siregar et al., 2025). Theoretically, this study offers a new learning model that connects the paradigms of Deep Learning, Computational Thinking, and Islamic character education within a unified conceptual framework. This model enriches the study of Islamic Education Technology by demonstrating that digital transformation in Islamic education should not be understood as a process of secularization of learning, but rather as a means to strengthen the internalization of Islamic values through a more adaptive approach to current developments (Alirahman et al., 2023; Arim et al., 2024; Wedi & Mardiana, 2025). Thus, this research contributes to the development of Islamic learning theory that is responsive to the challenges of the Industrial Revolution 4.0 and Society 5.0.

From a practical perspective, this research provides a tangible contribution to teachers, schools, and educational policymakers in designing Islamic Religious Education (ISE) learning that is more relevant to the characteristics of the digital generation (Cahyadi et al., 2025; Murhayati et al., 2025; Rokhimawan et al., 2025). The Islamic Techno-Pedagogy model can be used as an alternative learning innovation to improve the quality of Islamic Religious Education (ISE) learning in elementary schools through the integration of digital technology, spiritual reflection, and higher-order thinking activities (Arim et al., 2024; Sahib et al., 2026; Siregar et al., 2025). The success of this model in improving Islamic understanding, student character, and coding skills demonstrates that Islamic education serves not only as a means of knowledge transfer but also as a medium for character formation and the simultaneous development of future competencies. Therefore, this research provides a practical contribution in the form of a valid, effective, and implementable learning model to strengthen character education and improve students' digital literacy at the elementary school level.

## CONCLUSION

This research concludes that integrating Deep Learning and Coding into Islamic Religious Education through the Islamic Techno-Pedagogy model significantly increases participation in learning, understanding of Islamic concepts, and digital skills, while strengthening the spiritual character of elementary school students. The most important findings from this research show that technology need not be positioned as a threat to religious values, but can be an effective means of deepening understanding, reflection, and the internalization of Islamic teachings in a more contextual, critical, and meaningful way. From a scientific perspective, this research provides a conceptual contribution in the form of developing an Islamic pedagogical model that

integrates Deep Learning, Computational Thinking, and spiritual values in a learning framework that is adaptive to the demands of the digital era, as well as enriching the study of learning innovations in Islamic Religious Education at the elementary school level. However, this research still has limitations because it was conducted in a school setting and the number of subjects was limited. Hence, the generalizability of the research results needs careful consideration. Therefore, further research is recommended to test the Islamic Techno-Pedagogy model across a broader range of educational levels, regions, and student characteristics, as well as to explore the use of artificial intelligence, learning analytics, and more sophisticated digital learning platforms to strengthen the effectiveness of Islamic Religious Education learning in the future.

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