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RESEARCH ARTICLE

Digital transformation in madrasah education: A conceptual framework for integrating higher-order thinking skills and internet of things in teaching

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Abstract: The rapid digital transformation in education has compelled Islamic schools (madrasahs) to adapt pedagogical approaches toward technology-based learning. However, a significant gap remains between technological potential and teachers' pedagogical readiness. This study explores how *Digital-Based Learning* (DBL) integrated with *Higher Order Thinking Skills* (HOTS) and the *Internet of Things* (IoT) enhances teachers' reflective practices and learning effectiveness in madrasahs. Employing a qualitative descriptive phenomenological design, data were collected through in-depth structured interviews with four Islamic education teachers at SMP IT Cendekia Multazam Pantai Raja and Multazam Boarding School in Kampar, Indonesia. Data were analysed using the Miles, Huberman & Saldaña (2018) interactive model: data reduction, display, and verification. Findings reveal that HOTS enables teachers to analyse, evaluate, and creatively design digital lessons grounded in Islamic ethical values, while IoT facilitates learning efficiency, real-time monitoring, and collaborative engagement. The integration of HOTS and IoT within DBL creates a *Reflective Islamic Digital Pedagogy* that balances cognitive development with spiritual awareness. This study contributes a theoretical model linking reflective thinking, digital innovation, and Islamic pedagogy, and recommends continuous professional training for madrasah teachers in ethical and data-driven digital instruction.

Keywords: Digital-based learning, higher order thinking skills, internet of things, active pedagogy.

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1. Introduction

The development of digital technology in the era of the Industrial Revolution 4.0 has transformed the learning paradigm from conventional models to digital-based learning. The world of education is required to adapt to the rapid advancement of information technology so that the learning process remains relevant and effective. In the context of Islamic education, particularly in madrasahs, digitalization not only serves as a technical tool but

also as a means to expand access to knowledge and enhance students' thinking abilities (Bakar & Zain, 2023; Firdaus et al., 2025). Madrasah teachers are now challenged not only to act as knowledge transmitters but also as creative, adaptive, and reflective learning facilitators in response to technological developments. The implementation of Digital-Based Learning (DBL) has become one of the strategies to address these challenges, enabling two-way learning interactions between teachers and students through the use of digital technologies such as Learning Management Systems, smart devices, and interactive media (Muhajir et al., 2025; Rasyidi et al., 2025). However, field findings show that not all madrasah teachers are ready to face this change. Interviews with madrasah teachers reveal that some still have limited abilities in utilizing digital media for interactive learning and in fostering critical thinking skills (Dini & Putri, 2025). This phenomenon illustrates a gap between the global demands for digital learning and the readiness of madrasah teachers to implement it.

Previous studies have shown that the effectiveness of digital learning largely depends on the cognitive and reflective quality of teachers in managing the teaching and learning process (Mukhlis et al., 2024; Alsolami, 2026). Therefore, mastering Higher Order Thinking Skills (HOTS) is an essential aspect for madrasah teachers to adapt to technological developments and create meaningful learning innovations. HOTS encompasses analytical, evaluative, and creative abilities (Anderson & Krathwohl, 2001), which serve as the main foundation of digital-based learning. However, the study by Anggoro et al. (2025) revealed that most madrasah teachers still operate at a lower level of thinking (Lower Order Thinking Skills), where the learning process is more focused on memorization rather than analysis and synthesis of knowledge. Based on interview findings, a Fiqh teacher stated that before using problem-based and digital learning approaches, students tended to memorize legal rulings without understanding their context. After implementing digital media and analytical approaches, students became more active and were able to draw conclusions from real cases, such as differences among schools of thought in ablution laws (Esmaeili & Karimi, 2024; Sukenti et al., 2025; Tambak, & Sukenti, 2024). This fact indicates that the application of HOTS through digital learning has great potential to enhance students' critical and reflective thinking skills in madrasahs.

In addition to the cognitive aspect, the integration of the Internet of Things (IoT) in learning also presents a great opportunity for madrasah teachers to enhance teaching effectiveness. IoT enables the interconnection of various digital devices such as smartboards, smart projectors, tablets, and digital attendance systems within an efficient learning network (Gubbi et al., 2013; Susanto & Raharjo, 2025). IoT serves not only a technical efficiency function but also acts as a medium for building collaborative and contextual learning. In interviews, an Al-Qur'an Hadith teacher stated that IoT facilitated the teaching process since they could prepare digital materials at home and connect them directly to classroom devices. Students were also able to access learning materials and evaluation results through an integrated digital system. A Tauhid teacher added that the use of IoT helped them understand the relationships among digital devices, allowing for faster and more systematic evaluation of learning media effectiveness. Thus, IoT not only provides technological convenience but also fosters reflective and problem-solving skills—hallmarks of 21st-century learning. However, research by Rahman & Lubis (2024) emphasizes that the implementation of IoT in madrasahs is often hindered by infrastructure limitations, lack of teacher training, and insufficient integration between technology and pedagogical strategies.

Based on literature analysis and interview results, it can be concluded that there is a gap between the potential of digital technology and the pedagogical capacity of madrasah teachers in utilizing it. Most previous studies (Judijanto & Wahyuni, 2024; Alsolami, 2026; Sukenti et al., 2025) have primarily emphasized the technological aspect without considering the teachers' cognitive dimension, which serves as the foundation for implementing digital learning. Meanwhile, this study highlights that effective Digital-Based Learning must involve the strengthening of Higher Order Thinking Skills (HOTS) as a reflective thinking framework, as well as the utilization of the Internet of Things (IoT) as an innovative instrument that facilitates student collaboration and creativity. Interview findings also reveal that madrasah teachers with higher analytical and evaluative abilities tend to be more adaptive to digital learning (Tambak, & Sukenti, 2025). For instance, an Islamic Cultural History (SKI) teacher encouraged students to create digital posters about the *Wali Songo*'s da'wah strategies to compare Islamic historical values with modern social conditions. Such activities demonstrate that HOTS- and IoT-based learning not only enhances technological skills but also instills spiritual and social values that are relevant to students' life contexts.

Considering these various findings, this study aims to conduct an in-depth analysis of the impact of implementing Digital-Based Learning (DBL) that incorporates Higher Order Thinking Skills (HOTS) and the Internet of Things (IoT) in the learning process at madrasahs. This research seeks to address several key questions: (1) How do madrasah teachers' higher-order thinking skills play a role in understanding, planning, and evaluating digital learning? (2) How does the utilization of IoT support the effectiveness of digital learning strategies in madrasahs? and (3) How does the combination of HOTS and IoT contribute to developing 21st-century competencies among teachers and students? The purpose of this study is to explore the significance and influence of HOTS- and IoT-based DBL implementation on enhancing the professional competence of madrasah teachers in responding to the challenges of digital education. Theoretically, the results of this study are expected to strengthen conceptual discussions on the integration of HOTS and IoT within the context of Islamic education. Practically, this study is expected to provide recommendations for developing policies and training programs for madrasah teachers so that they can effectively, adaptively, and characteristically implement digital learning that aligns with Islamic values.

2. Literature review

2.1. Higher order thinking skills in Islamic education

The concept of higher order thinking skills (HOTS) is rooted in the revised Bloom's Taxonomy by Anderson & Krathwohl (2001), which classifies higher-level thinking skills as analysis, evaluation, and creation. In the context of Islamic education, HOTS is not merely a cognitive ability but also represents *spiritual cognition*—a form of reflective thinking that integrates the values of *tauhid* (monotheism) and *akhlaq* (morality) (Asnawi & Mas'ad, 2025). Muslim's (2024) research found that the implementation of HOTS-based digital learning media effectively enhances students' analytical and evaluative abilities in Islamic Religious Education. This finding is supported by Fatimah & Wakifah (2023), who assert that strengthening HOTS in Islamic education plays a crucial role in preparing students to face Society 5.0—a society that integrates technology with humanity.

In madrasah education, HOTS is implemented through project-based learning activities, analysis of religious texts, and digital simulations of social issues. Research by Sivakumar & Boon (2026) shows that Islamic Religious Education (IRE) learning that integrates HOTS within Problem-Based Learning (PBL) enhances students' digital literacy, ethics, and digital culture. Conceptually, this aligns with Bruner's (2019) constructivist learning theory, which emphasizes that meaningful learning occurs when students construct understanding through reflective experiences. International research also supports this view. Ambya et al. (2025) state that modern Islamic educational institutions in Indonesia that implement HOTS-based learning demonstrate higher adaptability to digital technology compared to traditional *salaf pesantren*. Thus, the strengthening of HOTS serves as an essential conceptual foundation for integrating Digital-Based Learning (DBL) and the Internet of Things (IoT) in madrasah education.

2.2. Internet of things in digital learning within madrasahs

The internet of things (IoT) refers to a network of interconnected devices that function to collect, transmit, and analyze data within a system (Gubbi et al., 2013; Bashir, & Nasir, 2024). In the context of Islamic education, IoT serves not only as a form of technology but also as a medium for fostering contextual and collaborative learning (Santosa & Jazuli, 2022; Suresman et al., 2025). Research by Yusuf, Pamungkas & Kustini (2026) shows that integrating IoT into the management of Islamic Religious Education (IRE) enhances administrative efficiency, personalizes learning materials, and actively engages students through interactive digital systems. Muslim's (2024) study also emphasizes that the implementation of IoT in madrasahs has the potential to strengthen teachers' skills in pedagogical reflection and data-driven teaching. By utilizing automated attendance systems, classroom sensors, and smart projectors, teachers can adjust the pace of learning according to students' needs. Meanwhile, Frimayanti et al. (2024) found that the use of IoT-based smart classrooms helps madrasah students better understand religious concepts through more contextual digital visual and audio simulations.

IoT also encourages the emergence of the concept of *Islamic Cyber Pedagogy* (Mawardi & Setiawan, 2024), in which technology is not merely used as a supporting tool but is integrated with Islamic values such as honesty, trustworthiness (*amanah*), and responsibility. In global research, Tsipianitis et al. (2025) explain that IoT can support Islamic character education by creating a disciplined, efficient, and transparent learning environment through digital systems that can be openly audited. In theoretical terms, the implementation of IoT aligns with Connectivism Theory (Mukhlis et al., 2024), which asserts that learning in the digital era occurs through networks connecting human and technological entities. IoT serves as a medium for teachers to bridge traditional Islamic knowledge with modern technological innovation. The integration of IoT with Digital-Based Learning (DBL) provides students with opportunities to experience data-driven learning processes, thereby strengthening their reflective and analytical abilities as emphasized in the concept of Higher

2.3. The interaction of digital-based learning, HOTS, and IoT toward 21st-century competencies

Digital-based learning (DBL) is an approach that utilizes technology to strengthen collaboration, communication, creativity, and critical thinking—the four core competencies of the 21st century (OECD, 2019). In Islamic education, DBL plays an essential role in fostering ethical and spiritually grounded digital literacy (Maskin et al., 2025). Research by Ladiqi & Nasaruddin (2023) concluded that integrating DBL into Islamic Religious Education enhances the effectiveness of Islamic value transmission through the use of reflection-based e-learning platforms. Similar findings were reported by Sharma et al. (2025), who emphasized that DBL can reinforce a culture of critical and collaborative thinking when accompanied by Islamic character development. Furthermore, Rifdillah (2025) found that the implementation of DBL combined with HOTS and IoT creates a creative, measurable, and student-centered learning environment tailored to the real needs of madrasah students.

HOTS, IoT, and DBL represent an integrated educational paradigm of the 21st century that forms an “Islamic digital learning ecosystem” (Imelda & Azhar, 2024). This system enables madrasah teachers to integrate technology with spiritual approaches to cultivate reflective lifelong learners. In global research, Suyitno et al. (2025) emphasize that digital learning strategies aligned with Islamic principles enhance Islamic digital literacy and foster ethical thinking skills among students. In addition, Asnawi & Mas'ad (2025) highlight the importance of madrasah human resources being prepared to understand new pedagogical theories such as digital constructivism and Islamic critical pedagogy. HOTS-based DBL and IoT can be applied through project-based learning (PjBL), flipped classroom, or learning analytics models.

3. Method

3.1. Research Desain

This study utilised a descriptive qualitative approach with a phenomenological design. This approach was chosen because the study aimed to explore the meaning of madrasah teachers' experiences in implementing digital-based learning integrated with Higher Order Thinking Skills (HOTS) and the Internet of Things (IoT). Phenomenology allows researchers to understand phenomena as directly experienced by research subjects (Creswell & Poth, 2018). Through in-depth interviews, researchers sought to uncover teachers' interpretations of digital pedagogical changes in madrasah environments oriented towards Islamic values. A descriptive qualitative design was used because this study focused on narrative and interpretive descriptions without variable manipulation (Miles, Huberman, & Saldaña, 2018). The aim was not to test hypotheses but to understand teachers' experiences in a naturalistic manner. This approach is highly appropriate for the madrasah context, where learning practices cannot be separated from spiritual and social values. Thus, the research results are expected to describe the reflective dynamics of madrasah teachers in adapting HOTS and IoT-based digital learning contextually.

3.2. Research Informant

The research informants were determined using a purposive sampling technique, which involves the deliberate selection of participants based on specific criteria (Sugiyono, 2021). The criteria for selecting informants include; madrasah teachers who have been using digital technology in their teaching for at least one year; actively utilizing IoT-based devices such as smart projectors, smartboards, or e-learning platforms; having reflective experience in integrating HOTS into their teaching practices; and willing to participate in in-depth structured interviews. Based on these criteria, four primary informants were selected from two Islamic educational institutions in Kampar Regency, Riau Province, namely SMP IT Cendekia Multazam Pantai Raja and Pondok Pesantren Multazam Boarding School.

Table 1. Research informants

No.	Name of Informant	Subject	Teaching Experience	Role of Digital Technology in Learning
1	Teacher 1	Fiqh	7 years	Utilizes video media and digital discussions to analyze *fiqh* laws.
2	Teacher 2	Islamic Cultural History	5 years	Develops HOTS-based digital projects on the history of *Wali Songo's* da'wah.
3	Teacher 3	Tauhid	2 years	Applies text-based critical analysis through Google Classroom.
4	Teacher 4	Al-Qur'an and Hadith	1 year	Uses IoT to display interactive *tafsir* and conduct online evaluations.

The four informants were selected because they represent variations in age, areas of expertise, and levels of technological adaptation, thereby providing a holistic understanding of the implementation of Digital-Based Learning (DBL) in madrasahs. This selection also aligns with the principle of maximum variation sampling (Patton, 2015), which aims to capture rich and in-depth data by including participants with diverse backgrounds and experiences.

3.3. Data collection techniques

Data were collected through structured in-depth interviews, a technique that allows the researcher to obtain systematic yet in-depth information regarding teachers' perceptions, understanding, and practices in digital learning. The interview guidelines were developed based on the conceptual framework of the study, encompassing three main aspects; teachers' understanding of HOTS in digital learning; teachers' experiences in utilizing IoT as a learning medium; the impact of DBL–HOTS–IoT implementation on students' 21st-century competencies. Examples of questions posed to the informants include: *"How do you integrate analytical and evaluative skills into digital-based learning?" "To what extent do IoT devices support the effectiveness of your teaching?" "How does digital learning influence students' critical and creative thinking?"*

The interviews were conducted face-to-face, each lasting 45–60 minutes per informant, and were audio-recorded before being transcribed verbatim. Field data were verified through the member checking technique, in which participants were asked to review and confirm the accuracy of their transcribed responses to ensure that the interpretations truly reflected their intended meanings (Lincoln & Guba, 1985). In addition to the main interviews, field notes were taken to record non-verbal expressions, contextual details, and situational nuances observed during the interview sessions.

3.4. Data analysis

Data analysis using the Miles, Huberman, & Saldaña (2018) model, which comprises three main stages: *Data reduction*. This stage involves sorting, simplifying, and focusing data based on its relevance to the research objectives. The interview data was coded into thematic categories, such as the role of HOTS in teacher reflection, the use of IoT in teaching effectiveness, and the impact of DBL on 21st-century competencies. For example,

Ustadz Rizqi's answer: 'IoT makes it easier for me to display visual interpretations of the Qur'an so that students can better understand the meaning of the verses' is categorised as cognitive reinforcement through IoT. *Data display.* The reduced data were then presented in the form of matrices and thematic narratives to facilitate the identification of patterns and relationships among categories. The presentation was conducted using thematic quotation tables that highlighted the meaning of each teacher's experience, such as the relationship between HOTS and the effectiveness of DBL. Verification and conclusion drawing. The final stage involved interpreting the meaning of the data through cross-verification among informants and source triangulation. The researcher re-examined the consistency between the collected data, the theoretical framework presented in the literature review, and the field context. Conclusions were considered valid if they had undergone member checking and peer debriefing processes.

3.5. Research Ethics

Research ethics constituted an essential aspect of ensuring scientific integrity and protecting participants' rights. All research procedures adhered to the Code of Ethics for Islamic Education Research issued by the Ministry of Religious Affairs of Indonesia (Kemenag, 2022). Prior to conducting the interviews, the researcher provided participants with an informed consent form explaining the research objectives, interview procedures, potential risks, and the informants' right to withdraw at any time without any consequences. The confidentiality of informants' identities was maintained by using initials (for example, "Teacher F" for Fiqh and "Teacher T" for Tauhid). All data were stored in encrypted form and used solely for academic purposes. In addition, the researchers have maintained neutrality throughout the interview process by refraining from judging or intervening in the informants' viewpoints. Within the context of Islamic education, this study also upheld ethical values rooted in Islamic law, such as honesty (*ṣidq*), trustworthiness (*amānah*), and respect for human dignity. This principle is consistent with Abdullah, Rahman & Ismail (2022) perspective that knowledge in Islam should be directed toward the attainment of adab and the promotion of public welfare (*maṣlaḥah*).

4. Result

4.1. Higher HOTS in madrasah teachers' digital-based learning

The results of the study indicate that Higher Order Thinking Skills (HOTS) play a crucial role in shaping madrasah teachers' reflective thinking patterns in the planning, implementation, and evaluation of Digital-Based Learning (DBL). Based on interviews with four informants, it was found that teachers with higher levels of analytical and evaluative skills were better able to select and utilize digital media effectively, as well as to adapt pedagogical approaches to students' characteristics.

The Fiqh teacher explained that prior to implementing digital learning, the instructional methods used tended to be one-directional and focused primarily on memorization of legal rulings. However, after integrating DBL with HOTS principles, he began encouraging students to analyse and evaluate legal contexts in everyday life. He stated:

> "Before using digital media, students only memorized fiqh rulings. After HOTS-based digital learning was implemented, they were able to analyse cases such as tayammum or performing wudu with injuries, and then search for the relevant evidence through valid digital sources." (Informant 1).

These findings demonstrate a shift from a reproductive learning paradigm toward a reflective and analytical learning approach. HOTS enables teachers not only to use technology as an instructional tool but also as a means to train students to think critically and creatively about religious issues. Similarly, the Islamic Cultural History teacher emphasized that the application of HOTS encouraged her to design project-based learning through digital media. Students were assigned to create digital posters or videos reflecting the da'wah strategies of Wali Songo in modern social contexts. She explained:

> "I asked students to create digital projects that present the *da'wah* strategies of Wali Songo and connect them with contemporary *da'wah* media. Students learn to analyse historical values and apply them to today's digital life." (Informant 2).

This process illustrates that higher-order thinking skills guide teachers in creating more creative learning environments, where students act as knowledge creators rather than merely recipients of information. Meanwhile, the Tauhid teacher revealed that HOTS plays a significant role in managing digital learning materials, particularly in selecting content that aligns with Islamic values. He stated:

> "Analytical skills help me determine which applications and sources are appropriate according to Islamic values. I can assess which content is educational and which is merely entertainment." (Informant 3).

From these interview findings, it can be concluded that madrasah teachers employ HOTS not only as a cognitive approach but also as an ethical filter in the digital environment. HOTS makes teachers more selective and reflective in choosing digital learning resources. The following table 2 presents the patterns of findings related to the integration of HOTS in madrasah teachers' digital learning.

Table 2. Analysis interview informants

HOTS Aspect	Form of Implementation	Practical Example	Impact on Students
Analysis	Teachers guide students to identify contextual religious cases.	Analysing *fiqh* rulings through digital learning videos.	Students are able to connect theoretical concepts with real-life practices.
Evaluation	Teachers assess the validity of digital sources and guide students in evaluating content.	Examining differences in Qur'anic interpretations from various online sources.	Students develop critical and ethical thinking in using technology.
Creation	Teachers encourage reflective digital projects based on Islamic values.	Creating digital *da'wah* posters and vlogs.	Students become creative and communicative in an Islamic manner.

These findings reinforce the theory of Anderson & Krathwohl (2001) and the research of Muslim (2024), both of which affirm that HOTS-based learning can enhance reflective and creative thinking skills among teachers and students. Thus, the integration of Higher Order Thinking Skills (HOTS) serves as a fundamental conceptual foundation for developing Digital-Based Learning (DBL) in madrasahs that focuses on the cultivation of Islamic character and digital ethics.

4.2. The Implementation of the IoT in digital-based learning at madrasahs

The second finding indicates that the utilization of the Internet of Things (IoT) makes a significant contribution to improving the effectiveness, flexibility, and efficiency of the digital learning process in madrasahs. All teacher informants reported using IoT-based devices such as smart projectors, digital attendance systems, and Google Classroom to manage teaching and learning activities. The Qur'an Hadith teacher explained that IoT is highly beneficial in preparing and presenting learning materials. He stated:

> "IoT makes it easier for me to prepare lessons at home and present them directly in class through a smart projector. Students can also access their learning outcomes instantly." (Informant 4)

This statement illustrates how IoT facilitates connectivity among devices (teacher–student–content), making the learning process more interactive and efficient. IoT allows learning to extend beyond the classroom, continuing within students' digital environments, thereby fostering continuous engagement and accessibility in the learning process. The Tauhid teacher added that the use of IoT accelerates the reflection process on learning outcomes, as students' grades and activity data can be accessed in real time. He stated:

> "I can see who is active and who has not completed their assignments. This makes the process of reflection and mentoring much faster." (Informant 2).

Meanwhile, the Islamic Cultural History teacher stated that IoT encourages cross-class student collaboration in digital projects. She explained:

> "We use a collaborative platform that allows students from different classes to contribute to a digital history project. This enhances cooperation and communication among students." (Informant 3).

The data indicate that IoT impacts not only the technical aspects of learning but also strengthens its social dimension, particularly in fostering collaboration and communication — two key components of 21st-century competencies (OECD, 2019). The following table 3 summarizes the findings related to the utilization of IoT in madrasah learning:

Table 3. Analysis interview informants

Aspect of IoT Utilization	Example of Implementation	Impact on Teachers and Students
Teaching Efficiency	Teachers prepare materials at home and access them in class through smart projectors.	Preparation time is reduced; the learning process becomes more focused and systematic.
Monitoring & Evaluation	Use of digital systems to monitor student participation.	Teachers can provide quick feedback, and students are motivated to be more active.
Digital Collaboration	Use of collaborative platforms for Islamic history projects.	Enhances teamwork and improves students' digital communication skills.

The utilization of IoT in madrasahs also strengthens teachers' ability to apply the principles of data-driven education, in which instructional decisions are made based on the results of digital observation and analysis. This finding is consistent with the studies of Frimayanti et al. (2024) and Almardiah & Muis (2025), which state that the implementation of IoT in madrasahs enhances interactivity and enables teachers to adapt learning processes according to students' real-time data. However, all informants also acknowledged the existence of challenges, particularly concerning infrastructure and network readiness. The Fiqh teacher noted that limited internet access in rural madrasahs remains a major obstacle, highlighting the need for hybrid learning strategies that combine both online (daring) and offline (luring) methods. This indicates that the success of IoT integration in madrasahs depends not only on technological capability but also on institutional policy support and the digital literacy capacity of teachers. Therefore, a sustainable IoT-based learning ecosystem requires not just adequate technology, but also pedagogical readiness, ethical awareness, and institutional collaboration to ensure that technological advancement aligns with the holistic goals of Islamic education.

In general, the findings of this study confirm that the utilization of IoT within Digital-Based Learning (DBL) in madrasahs functions as an enabler for the realization of reflective, collaborative, and adaptive learning. IoT enhances teachers' ability to apply Higher Order Thinking Skills (HOTS) while simultaneously developing students' digital competencies grounded in Islamic values. Thus, the synergy between HOTS and IoT through DBL can serve as a 21st-century Islamic pedagogical model that is both relevant and sustainable.

5. Discussion

The results of this study reveal that the implementation of Digital-Based Learning (DBL) integrating Higher Order Thinking Skills (HOTS) and the Internet of Things (IoT) has transformed the teaching paradigm of madrasah teachers from a conventional approach to one that is reflective, collaborative, and data-driven (Sani, & Farhana, 2023). This finding aligns with Constructivist Learning Theory (Arputharaj, & Karunanithy, 2026; D'Elia et al., 2025; Bruner, 2019), which posits that knowledge is constructed through active interaction between experience and reflection. Madrasah teachers who applied HOTS demonstrated the ability to connect religious content with modern social realities. For instance, the Fiqh teacher trained students to analyse cases of worship law using digital sources, thereby encouraging learners to interpret Islamic legal concepts in a contextual and analytical manner (Bakri, & Mukhtar, 2023; Che, & Nor, 2023; Bashar, & Salim, 2024).

These findings reinforce the framework of the Taxonomy of Educational Objectives proposed by Anderson & Krathwohl (2001), which emphasizes that learning involving analysis, evaluation, and creation leads to a deeper conceptual understanding. The integration of HOTS within DBL transforms teachers from mere users of technology into critical designers of digital learning experiences. Meanwhile, the utilization of IoT in learning demonstrates the practical application of Connectivism Theory (Mukhlis et al., 2024), which posits that learning occurs through networks that connect devices and human interactions with intelligent systems. IoT enables continuous connectivity among teachers, students, and learning resources through digital platforms such as Google Classroom and smart projectors, fostering an interactive and data-driven educational environment (Szilágyi et al., 2025; Ilgun Dibek, Sahin Kursad, & Erdogan, 2025; Abdullah et al., 2025). Thus, the findings of this study reveal two significant theoretical relationships: first, HOTS serves as a reflective thinking framework for madrasah teachers in utilizing technology; and second, IoT functions as a connective instrument that enhances the effectiveness and efficiency of the learning process. The synergy between HOTS and IoT forms a 21st-century Islamic learning model that is deeply rooted in spiritual values yet remains highly relevant to the digital era.

The results of this study strongly align with the findings of several recent studies. Muslim (2024) reported that the integration of HOTS in Islamic Religious Education (IRE) learning improves students' analytical and evaluation skills regarding social phenomena based on Islamic values. This finding is consistent with the findings of this study, where madrasah teachers considered HOTS key in transforming students from mere memorizers to reflective thinkers (Kamal, & Fitri, 2024; Tambak et al., 2022). Furthermore, a study by Fatmiyati, Juandi, & Fatimah (2026) confirmed that digital-based learning integrated with HOTS has the potential to strengthen critical religious literacy—the ability to think critically in understanding religious teachings contextually. This is reflected in the practice of ISE teachers who encourage students to reinterpret the values of the Wali Songo's da'wah in the context of modern social media (Che, & Nor, 2023; Goswami, Iqbal, & Choi, 2026).

Another consistent finding is that of Almardiah & Muis (2025), who found that the use of IoT in madrasahs improves classroom management efficiency and student participation. In this study, Qur'an and Hadith teachers also confirmed that IoT facilitates material preparation and displays learning outcomes in real time, increasing student engagement in digital activities. However, this study adds value by combining the three components—DBL, HOTS, and IoT—within a single conceptual framework. Most previous research has addressed these issues separately (Du et al., 2025; Arita et al., 2025; Latif, & Huda, 2024; Kurniawan, & Lubis, 2024; Chapakiya et al., 2025). This study's original contribution is demonstrating that the synergistic relationship between these three components creates a reflective and technology-based Islamic learning system (Reflective-Islamic Digital Pedagogy).

Theoretically, the results of this study strengthen the modern cognitive learning model in the context of Islamic education. First, this study confirms the relevance of HOTS theory (Anderson & Krathwohl, 2001) in the spiritual realm of education. HOTS functions not only as a cognitive development tool but also as an epistemological approach to understanding Islamic teachings critically and contextually. Second, this study expands the application of connectivism theory (Mukhlis et al., 2024) by linking it to Islamic values. In madrasah learning, digital connectivity mediated by IoT is not merely mechanistic but also ethical and spiritual (Bansal, 2026; Che, & Nor, 2023; Ridwan, & Fauzi, 2023; Rui, & Jin, 2026). Connections between teachers, students, and digital resources must be built on the basis of honesty (*sidq*) and trustworthiness. Third, this study offers a new theoretical model, the "HOTS–IoT–Reflective Digital Model," which illustrates the relationship between higher-order thinking skills (HOTS), connective technology (IoT), and Islamic reflection. This model illustrates that the effectiveness of digital learning depends on the balance between teachers' analytical skills and moral sensitivity in managing technology (Bashir & Nasir, 2024; Yusuf & Abdullah, 2025; Hakim, & Syam, 2024; Tambak, Sukenti, & Firdaus, 2024). Thus, this research contributes to the development of a new paradigm in digital Islamic education, namely spiritual digital pedagogy — technology-based learning grounded in spirituality and scientific ethics.

The results of this study provide several practical implications for the development of digital learning in madrasas. First, systematic training is needed for madrasa teachers to improve their HOTS skills, particularly in analysing, evaluating, and creating digital media. These skills are crucial for teachers to become not only

technology users but also innovators in Islamic values-based learning. Second, madrasas need to develop IoT-based learning systems gradually, taking into account infrastructure readiness (Gong et al., 2026; Ismail, & Noor, 2022; Yusuf, & Abdullah, 2025; Guevara et al., 2026). The implementation of network-based smart classrooms can improve administrative efficiency and monitor student learning outcomes. Third, Islamic educational institutions need to develop a Learning Management System (LMS) specifically designed for religious learning, with features that support collaboration, reflection, and Islamic academic integrity (Arita et al., 2025; Suresman et al., 2025; Tambak et al., 2025). The LMS should include elements that remind students of digital ethics, such as media etiquette, the use of authentic content, and a prohibition on plagiarism. Fourth, the government and the Ministry of Religious Affairs need to strengthen madrasah digitalization policies by emphasizing the spiritual and ethical dimensions, not just the technical ones. ICT training programs for madrasa teachers should include HOTS components, digital ethics, and Islamic values-based IoT applications. With these steps, madrasas can become pioneers of digital education that are not only technologically savvy, but also spiritually dignified (Rosa-Bilbao et al., 2025; Kandil et al., 2025; Halim, & Yusuf, 2023; Yasin et al., 2025).

Overall, this study demonstrates that the integration of HOTS and IoT in DBL can improve the quality of learning in madrasas, both cognitively and spiritually. HOTS forms the basis for teachers' reflective and critical thinking, while IoT strengthens the dimensions of efficiency, interactivity, and collaboration in learning (Kania, & Kusumah, 2025; Bashir & Nasir, 2024; Du et al., 2025). The combination of the two creates a learning model that aligns with the demands of the 21st century: creative, collaborative, communicative, and Islamic in character. The findings of this study also emphasize that the success of madrasah digitalization lies not solely in technological sophistication, but rather in the readiness of teachers as reflective actors and lifelong learners. By combining HOTS and IoT, madrasah teachers can create a learning ecosystem that not only educates intellectually but also fosters students' spiritual and moral awareness. Thus, HOTS- and IoT-based Digital-Based Learning can serve as a model for future Islamic pedagogy—a bridge between modern science and divine values—keeping madrasas relevant and superior in the era of digital transformation.

6. Conclusion

Higher-order thinking skills (HOTS) play a fundamental role in shaping how madrasah teachers plan, implement, and evaluate digital learning. Teachers with strong analytical and evaluative skills tend to be more reflective and innovative in utilizing technology. HOTS helps teachers assess the effectiveness of digital media, select credible learning resources, and foster students' critical thinking regarding religious and social phenomena. As expressed by a Fiqh teacher, HOTS transforms learning from mere memorization to a process of analyzing fiqh laws related to the realities of life. Thus, HOTS functions not only as a cognitive strategy but also as an ethical framework for Islamic thinking that guides teachers and students to process information critically, logically, and morally. The use of the Internet of Things (IoT) has a significant impact on the effectiveness and efficiency of digital learning in madrasahs. IoT enables teachers to integrate various digital devices such as smart projectors, Google Classroom, and automated attendance systems to enhance the connection between teachers, students, and materials. A Qur'an and Hadith teacher, for example, utilizes IoT to display interpretation materials and student learning outcomes in real time, making learning interactions more dynamic and participatory. Thus, IoT not only improves technical efficiency but also promotes digital collaboration and students' independent learning. The integration of HOTS and IoT within the DBL framework constructs a 21st-century Islamic learning model that is reflective, collaborative, and data-driven. HOTS functions as the intellectual core that fosters teachers' analytical and evaluative abilities, while IoT acts as a technological enabler that enhances learning effectiveness. The combination of both produces a Reflective Islamic Digital Pedagogy — a learning model that integrates technology with Islamic values such as honesty (*sidq*), responsibility (*amanah*), and cooperation (*ta'awun*).

The research findings also confirm that the success of DBL implementation in madrasas is determined not only by technological capabilities, but also by the teachers' pedagogical and spiritual preparedness. Teachers with reflective awareness and strong Islamic values are better able to maintain digital ethics, avoid plagiarism, and teach the wise use of technology. This demonstrates that digital transformation in madrasas must remain grounded in the principles of Islamic education—namely, the balance between reason, knowledge, and faith.

Therefore, this study concludes that the implementation of HOTS and IoT-based Digital-Based Learning is not merely a technological innovation, but an epistemological transformation leading to the formation of an intelligent, creative, and dignified Islamic learning ecosystem. Madrasas with this model will be able to produce a generation of digital *ulul albab*—a generation with high knowledge, noble character, and global competitiveness.

Author Contribution Statement

Contributions of the authors in this article: Achmad Baihaqi contributed as concepts and drafters of the article; Nurhasanah & Afdillah Nur Rahman contributed as data analysers and interpreters; Fariza Rahma Jenery as the drafter of the manuscript; Sali Husnaini Fitri contributed in collecting data and critically revising the article. All authors agree to take responsibility for all aspects of this work.

Disclosure of Interests

We have no conflict of interest to declare.

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