International Journal of Learning, Teaching and Educational Research
Vol. 24, No. 8, pp. 842-863, August 2025
https://doi.org/10.26803/ijlter.24.8.37
Received Jul 8, 2025; Revised Aug 7, 2025; Accepted Aug 11, 2025

Digital Transformation Model of Islamic Religious Education in the AI Era: A Case Study of Madrasah Aliyah in East Java, Indonesia

Agus Wedi
Universitas Negeri Malang
East Java, Indonesia

Dina Mardiana* **and Umiarso**
Universitas Muhammadiyah Malang
East Java, Indonesia

Abstract. Islamic Religious Education (*Pendidikan Agama Islam*, PAI) at the madrasah level in Indonesia currently faces significant challenges in the Artificial Intelligence (AI) era, particularly in integrating digital technology while preserving core Islamic values. Therefore, the digital transformation of PAI learning is essential as a concrete step toward establishing a responsive and sustainable modern education model. This study explores the digital transformation model of PAI at three Madrasah Aliyah in East Java (MAJB, MANR, MAJE) in the AI era. Employing a qualitative aapproach through a multi-site case study design, data were collected through non-participant observation, in-depth interviews, and document analysis. Data analysis followed Rogers' Diffusion of Innovations Theory and the interactive model proposed by Miles, Huberman, and Saldaña. The results reveal that the digital transformation model in MAJB, MANR, and MAJE is manifested in two key aspects. *First* is the institutional strategy, which encompasses the development of digital infrastructure and stakeholder collaboration. *Second* is the pedagogical and instructional system, which involves integrating Learning Management Systems (LMS) and implementing the flipped classroom model. This study highlights how madrasahs balance digital transformation with Islamic values by implementing ethical content filtering, teacher training grounded in Islamic principles, and value-based learning design. These strategies integrate technology in madrasahs while preserving core Islamic values, enhancing educational quality. This research contributes by: 1) Expanding Rogers' Diffusion of Innovations Theory in Islamic education; 2) Offering practical models for digital transformation; 3) Developing contextually relevant digital education models.

*Corresponding author: Dina Mardiana; *dinamardiana@umm.ac.id*

Keywords: digital transformation; Islamic religious education; AI era; learning technology; diffusion of innovations theory

1. Introduction

The phenomenon of digital transformation in education, particularly in Islamic Education, has become a prominent topic of discussion among scholars. This transformation is evident in Indonesia's educational system, where madrasahs, as key institutions of Islamic education, encounter unique challenges in adapting to digitalization. Several key factors driving the necessity of digital transformation in the field of Islamic Education include globalization and technological advancement (Samala et al., 2024), institutional readiness and infrastructure (Hamdani, 2023; Siregar et al., 2025), as well as the opportunities and challenges posed by the realities of modernity (Ahmad et al., 2025; S. Khamis, 2024). This challenges teachers to integrate digital learning models that are responsive to local contexts, such as Madrasah Aliyah in East Java.

Digital transformation involves integrating modern digital technologies, including AI, to enhance and innovate educational processes. This approach focuses not only on digitizing materials but also on reconfiguring teaching and learning strategies. Within the contemporary educational landscape, this digital transformation has had a significant impact in redefining the learning paradigm, particularly in the context of Islamic Religious Education (PAI) (Selwyn, 2019). As a compulsory subject in the national curriculum in Indonesia, PAI is not immune to the impacts of digital transformation, which has ushered in a new era characterized by enhanced connectivity and the integration of advanced technologies (Arim et al., 2024), especially Artificial Intelligence (AI).

AI has been demonstrated to hold significant potential in improving adaptive learning by personalizing instruction to the individual needs of each student. Studies indicate that AI can serve as a "bridge" in the customization of instructional content, tailoring it to students' abilities, interests, and preferences (Ferk Savec & Jedrinović, 2025). At the academic level, this motivates students and engages them more actively through adaptive learning processes. Furthermore, augmented by AI, the contemporary learning paradigm is a promising solution for guiding students in problem-solving activities and improving their cognitive competencies within academic settings. AI also plays a vital role in supporting inclusive education by addressing diverse learner needs and accommodating various learning styles, including those of students with special needs (Gyonyoru et al., 2024).

The impact of AI on learning is an important research topic due to its potential to transform the educational paradigm and improve learning outcomes. Understanding the implications, benefits, and challenges of integrating AI into educational contexts is essential for supporting teachers, policymakers, and researchers in making informed decisions and improving future educational practices (Raja et al., 2024). In this context, the integration of AI into the Islamic Education system -read: Islamic Religious Education (*Pendidikan Agama Islam*, PAI)- has the potential to offer personalized learning experiences, support

adaptive learning pathways, and improve intelligent tutoring systems, particularly in the acquisition of religious knowledge, while still upholding core Islamic values (Jailani & Huda, 2024). This argument is reinforced by Radif (2024) that have examined the transformative impacts of AI on contemporary education, with particular emphasis on its effect on learning environments and student engagement. It is this integration of technology that opens the door to digital transformation at the institutional level.

Madrasah Aliyah (MA) -an educational level equivalent to Senior High School (SMA)-also faces the challenge of adopting and integrating digital technology into its learning processes. This effort aims to increase the effectiveness and relevance of Islamic Education in the digital age, as a result of Nugroho & Astutik (2024) research. Notably, the technological demands of the AI era have been met with a positive response by Madrasah Aliyah institutions in Indonesia (Mahsusi et al., 2024), particularly in East Java. Madrasah Aliyah in Jombang (hereinafter referred to as MAJB), Madrasah Aliyah Negeri in Gresik (hereinafter referred to as MANR), and Madrasah Aliyah in Jember (hereinafter referred to as MAJE) are three institutions that have increasingly adopted digital transformation-based learning models.

This is reflected in their achievements, such as effective school website management (Agung, 2023; Mubarikh, 2025), student accomplishments in digital literacy (Aqobah, 2023), recognition as innovative schools, and the global engagement of their alumni. These developments highlight the adaptive and responsive capabilities of Madrasah Aliyah institutions in meeting the demands of modernity, particularly in the academic and instructional domains.

Undoubtedly, digital transformation introduces significant changes to learning patterns at the Madrasah Aliyah level through the education systems being implemented. Although this transformation holds great potential to improve the quality of Islamic Religious Education (PAI), several challenges must still be addressed. Research by Radjak et al., (2024) indicates that access to modern technology remains limited for most Madrasah Aliyah institutions in Indonesia.

Furthermore, there is currently no established model of digital transformation in PAI learning that effectively reflects the foundational objectives of Islamic Education. As a result, the adoption of technology across these institutions remains uneven. Alarmingly, PAI teachers who come from Islamic Educational backgrounds -read: *pesantren* (Islamic boarding schools)- are often reported to have a less optimal understanding of emerging technologies when compared to their counterparts from general educational backgrounds (Ritonga et al., 2025).

Despite extensive research on digital transformation in education, there remains an empirical gap in understanding how Islamic Religious Education at the madrasah level, particularly in East Java, constructs and implements digital transformation models that are appropriate for the AI era. Operationally, 'digital transformation' in this study refers to the systemic integration of digital technologies, including AI-driven learning systems, to improve educational

quality. Therefore, this study aims to address that gap by comprehensively exploring, understanding, and analyzing the model, processes, and barriers of digital transformation in Islamic Religious Education learning at three Madrasah Aliyah institutions in East Java, Indonesia, through the central research question: "What is the digital transformation model of Islamic Religious Education learning at Madrasah Aliyah Jombang (MAJB), Madrasah Aliyah Negeri Gresik (MANR), and Madrasah Aliyah Jember (MAJE)?". By addressing this research question, the study contributes to filling an existing research gap by offering new empirical insights into the readiness of Madrasah Aliyah to face the AI era through the optimization of digital transformation in PAI learning. The findings are expected to inform curriculum developers and policymakers, contributing to the enhancement of educational quality and digital readiness of madrasahs.

2. Literature Review

This section reviews empirical studies and theoretical perspectives relevant to the digital transformation of Islamic Religious Education (PAI) in the AI era. 'Digital transformation' in this study is operationally defined as the systematic integration of digital technologies, including AI, into instructional systems to enhance the quality and relevance of Islamic Religious Education (PAI). The review is organized into three subsections: (1) empirical evidence from previous studies, (2) methodological approaches and key findings, and (3) theoretical framework.

2.1 Empirical Evidence from Previous Studies

Prior research highlights that digital transformation has reshaped the landscape of education, including Islamic education contexts. According to Kasman & Madjid (2024), the utilization of AI in education encompasses various aspects, ranging from adaptive learning and AI-based learning management systems to modern technologies such as social media during the learning process (Susanti et al., 2024).

Samala et al. (2024) found that AI-driven learning technologies enhance engagement and support personalized learning. In Islamic educational settings, Ahmad et al. (2025) emphasized the potential of mobile and online platforms to strengthen students' access to religious content, while Siregar et al. (2025) demonstrated that teacher readiness and infrastructure significantly influence technology adoption. Despite these advancements, studies by Radjak et al. (2024) and Ritonga et al. (2025) revealed persistent challenges such as digital literacy gaps among teachers and unequal access to infrastructure.

2.2 Methodological Approaches and Key Findings

Research in digital transformation of education typically adopts qualitative, case-study, or mixed-method designs. For example, Mahsusi et al. (2024) used institutional case studies to analyze how school leadership shapes digital transformation readiness, whereas Nugroho and Astutik (2024) investigated the integration of digital technologies in *pesantren*-based education. Besides, the other impact is that an adaptive learning system (Gyonyoru et al., 2024; Yan et al., 2023), empowers learners in navigating the digital landscape (Hamdanah et al., 2024; Milicevic et al., 2024) and improves the quality of interactions between teachers

and students (Kumar & Sharma, 2025; Li et al., 2025). Additionally, the Indonesian government's regulations have supported the goal of enhancing the quality of education by facilitating the procurement of IT-based facilities and infrastructure that aid the learning process in schools (Operational Instructions for Regular Physical Special Allocation Funds in the Education Sector for the 2021 Fiscal Year, 2021). These studies collectively demonstrate that effective digital transformation requires not only technological investment but also pedagogical innovation and stakeholder collaboration (Krishnan et al., 2023).

2.3 Theoretical Framework

This study applies Rogers' Diffusion of Innovations Theory (Rogers, 2003) and further discussed by Greenhalgh et al., (2004), which conceptualizes how innovations are adopted within social systems. The theory outlines five stages of innovation adoption -knowledge, persuasion, decision, implementation, and confirmation- and highlights factors influencing adoption, such as relative advantage, compatibility, complexity, trialability, and observability. Besides, Rogers' theory outlines five characteristics that influence society's adoption of emerging innovations: compatibility, relative advantage, complexity, observability, and trial (Mbatha, 2024). This theory applies directly to Islamic education, where the adoption of innovation interacts with cultural and religious values.

At the conceptual level, the research's findings (Andoniou, 2024; Huang et al., 2024; Stylianidis et al., 2024) show diverse models of digital transformation, offering lessons on successful strategies and common pitfalls that can inform local practices in Indonesia's madrasahs. Furthermore, innovation through digital culture (Navarro-Newball & Adolfo, 2023; Proietti, 2025), and support from policymakers (Solberg & Tømte, 2023) requires not only digitization but also a systemic shift in instructional strategies, supported by clear theoretical frameworks. Meanwhile, the implementation of digital transformation through internal creativity strategies (Mañero & Escaño, 2024) and *Project-based teaching* (Wang et al., 2023), AI-based classroom space and teaching (Ting & Hong, 2024), digital teaching competence enhancement (Zheng & Yang, 2025), are seen as practical ways.

Several studies have found that the main challenge of digital transformation in the fields of education lies in the institutional leaders (Tømte, 2024), the readiness of educational institutions (Hamdani, 2023), limitations of technological infrastructure (Espina-Romero et al., 2024), and formal policies that have not fully accommodated these changes (Samuelsson, 2024). These studies highlight barriers, including limited infrastructure, teacher readiness, cultural constraints, and policy gaps, which hinder the effective integration of technology in educational institutions, especially in Islamic contexts.

In the context of Islamic education, this theoretical lens is particularly relevant because innovation adoption interacts with cultural and religious values (Hornik, 2023). By using this framework, the study interprets how Madrasah Aliyah

institutions adopt AI-supported learning technologies while preserving core Islamic values.

3. Research Methodology

Based on the description above, this study employed a multi-site qualitative approach with a comparative case study design to critically examine adaptive digital transformation in learning, particularly the integration of Learning Management Systems (LMS) and the use of modern technology across three madrasah institutions in East Java, Indonesia: Madrasah Aliyah Jombang (MAJB), Madrasah Aliyah Negeri Gresik (MANR), and Madrasah Aliyah Jember (MAJE).

3.1 Research Sites and Participants

The three madrasahs were purposefully selected based on their documented initiatives in digital transformation and recognition for educational innovation. The design facilitated a comparative analysis of institutional strategies, processes, and barriers to digital transformation. The participants included six PAI teachers, three vice principals for curriculum, and three principals. These individuals were selected purposively because of their roles in policy formulation and practical implementation of digital transformation strategies.

3.2 Data Collection Techniques

Data were collected through three main techniques:

3.2.1 Non-participant observation, focusing on digital classrooms, LMS usage, and IT infrastructure. Observations were recorded using a structured checklist that captured classroom technology integration, teacher-student interaction patterns, and infrastructure availability. To ensure systematic and consistent data collection, two primary research instruments were used: (1) a non-participant observation checklist and (2) a document analysis checklist. These instruments were designed based on the objectives of the study and adapted from relevant prior research.

3.2.1.1 Non-Participant Observation Checklist

The observation checklist was developed to capture critical aspects of digital transformation in teaching and learning. It focused on infrastructure readiness, technology integration, and teacher-student engagement. Table 1 presents the key indicators observed.

Table 1. Non-Participant Observation Checklist (Creswell, 2007)

Observation Focus	Indicators
Infrastructure Readiness	Availability of stable internet connectivity; number of digital devices available in classrooms.
LMS Integration	Frequency of LMS use in lesson delivery; type of digital content uploaded by teachers.
Teacher and Student Engagement	Teacher competency in using digital tools; student participation in online or blended learning activities

3.2.1.2 Document Analysis Checklist

The document analysis checklist focused on institutional policies and curriculum content relevant to digital transformation. It was applied to school policy documents, digital strategy plans, and curriculum guides. Table 2 provides an excerpt of the indicators used.

Table 2. Document Analysis Checklist (Miles et al., 2014)

Document Type	Indicators
Digital Strategy Plan	Inclusion of digital infrastructure investment plans, teacher training programs for digital literacy
School Policy Documents	Policies supporting online learning and remote teaching readiness
Curriculum Documents	Integration of AI-based learning modules; alignment with national digital education standards

3.2.2 In-depth semi-structured interviews with principals, vice principals, and teachers, which explored perceptions, challenges, and strategies in implementing digital transformation. Interviews were conducted face-to-face and audio-recorded for accuracy.

3.2.3 Document analysis, which utilized a checklist to examine school policy documents, digital strategy plans, and curriculum documents to assess institutional readiness and policy alignment with digital transformation goals. Table 3 illustrates the diversity of participant roles, ranging from principals to teachers and curriculum leaders. This diversity supports data triangulation, ensuring that findings reflect multiple perspectives on digital transformation implementation.

Table 3. Research informant

No.	Initials	Status	Sex	Role in Schools' Digital Transformation
1.	SA	Principals of MAJB	Female	Policy Maker
2.	NH	Vice Principals for the curriculum of MAJB	Female	Person in charge of the curriculum
3.	IL	PAI teacher of MAJB	Female	Subject of digital transformation
4.	SM	PAI teacher of MAJB	Male	Subject of digital transformation
5.	M	Principals of MANR	Male	Policy Maker
6.	AS	Vice Principals for the curriculum of MANR	Female	Person in charge of the curriculum
7.	YM	PAI teacher of MANR	Female	Subject of digital transformation
8.	RW	PAI teacher of MANR	Male	Subject of digital transformation
9.	A	Principals of MAJE	Male	Policy Maker
10.	IS	Vice principals for curriculum of MAJE	Male	Person in charge of the curriculum
11.	NA	PAI teacher of MAJE	Female	Subject of digital transformation
12.	KH	PAI teacher of MAJE	Male	Subject of digital transformation

3.3 Data Analysis Procedures

Data analysis followed the interactive model proposed by Miles, Huberman, and Saldaña, which includes data condensation, data display, and conclusion drawing. Each step was carried out iteratively to ensure validity and reliability. Credibility was ensured through triangulation of sources and methods, member checking, and maintaining an audit trail of all analytic decisions. The interactive relationship of the four stages is presented in Figure 1, about the interactive model data analysis.

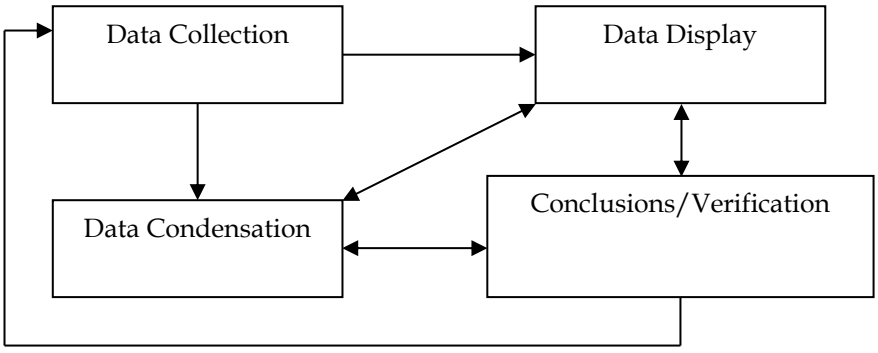

Figure 1. Interactive Model Data Analysis

3.4 Ethical Considerations

The study adhered to strict ethical standards to ensure the protection and dignity of all participants. Formal ethical clearance was obtained from the researchers'

affiliated institution before the study commenced. Additionally, official permission to conduct the research was secured from the relevant educational authorities at Universitas Muhammadiyah Malang. All participants were provided with detailed information about the purpose, procedures, and potential implications of the study. Informed consent was obtained from each participant, ensuring that their involvement was entirely voluntary and based on a clear understanding of their rights.

Participants were assured that their responses would remain confidential and that all identifying information would be anonymized using pseudonyms. Furthermore, they were informed of their right to withdraw from the study at any time without facing any negative consequences. These ethical safeguards were implemented to create a respectful and trustworthy research environment.

4. Results and Discussion

4.1 Theme 1: Digital Transformation Model of PAI at MAJB, MANR, and MAJE

At the level of practical implementation within educational institutions, digital transformation encompasses the processes applied in the education system through the integration of digital technology into the activities of human resources within the institution. This process fundamentally recontextualizes the methodology of Islamic Education by introducing new perspectives and values that are constructive and forward-looking. This dynamic is evident in the cases of MAJB, MANR, and MAJE.

Observational data indicated that MAJB had implemented digital transformation through a Learning Management System (LMS) platform called "Siunggul." This application served as a computer-based management information system developed and operated independently by the school's internal team. Its core function was to facilitate administrative processes and improve accessibility to learning resources within MAJB. In addition, interview responses (SA, Principal of MAJB) highlighted: "*Our school has a feature called 'Siunggul'. We created this feature to facilitate the institution's administration system….*" The combined findings from observation and interviews demonstrated the school's commitment to regular digital literacy training for teachers.

The information from the interview results is based on the content of the "Siunggul" application owned by MAJB, which the researcher visualizes through the following Figure 2 about the "Siunggul" application display on MAJB.

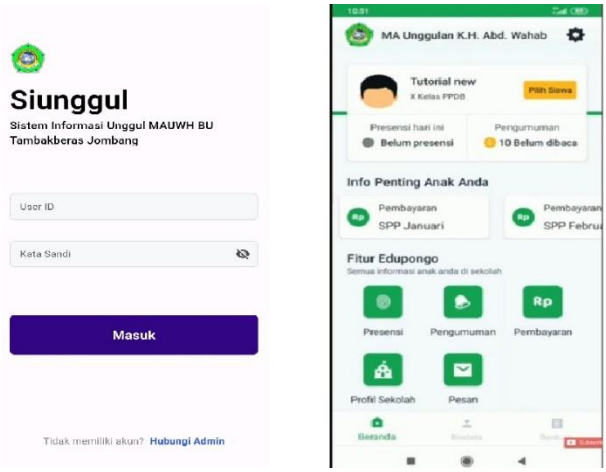

Figure 2. "Siunggul" application display on MAJB

Document analysis of internal manuals and observational data confirmed that the "Siunggul" application -as shown in Figure 2- supported student-teacher administrative processes and acted as a digital communication medium between the school and parents. Interview responses from school staff emphasized the existence of seven main features in the application -student attendance, student tasks, announcements, parents' forum, payment information from parents, and student learning outcome reports, and an additional reporting feature- highlighting comprehensive administrative digitalization.

Observational data showed that MAJB utilized digital platforms to optimize learning space and resources, as evidenced by the presence of an electronic library (E-library) providing various learning references for the entire academic community. Interview responses (NH, Vice Principal for Curriculum) confirmed that the E-library had been active for over a decade and supported learning resources for MAJB students. Furthermore, the curriculum required teachers to upload scientific work and learning references, highlighting teacher involvement in the activation of the E-library.

The results highlight critical factors contributing to success and obstacles in digital transformation at MAJB. Successes include the effective development and utilization of the "Siunggul" information system and the sustained operation of its E-library for over a decade. However, obstacles identified were limited digital literacy among senior staff and occasional infrastructure disruptions. These were addressed through internal training initiatives and gradual technology upgrades.

The research findings at MAJB are not much different from the field findings of researchers at MANR. This educational institution also carries out digital transformation based on the learning management system in its school, one of which is through online learning resources packaged in an internal web link titled "Ruang Pintar." This website contains various books and digital learning resources that can supply learning reference needs for students and teachers, as shown in Figure 3, about view of the "Ruang Pintar" e-library at MANR.

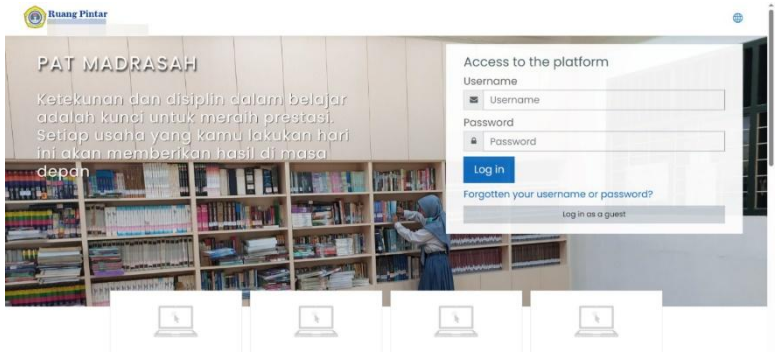

Figure 3. View of the "Ruang Pintar" e-library at MANR

The data collected by researchers from the "Ruang Pintar" platform identifies five main features. First, there is a search and browsing feature that allows "Ruang Pintar" visitors to find information accurately through metadata provided by the Online Public Access Catalog (OPAC), based on the available categories. Second, the platform offers an online borrowing and returning feature. Third, there is a digital content management feature that enables users to access various digital collections through the "E-book Reader". This feature also supports automated reading with "Text-To-Speech" and helps users compile an automatic bibliography in a standardized writing style.

Fourth, the community and user management feature allow users to register as members of "Ruang Pintar" without needing to visit in person. Users can access their borrowing history, return records, and other settings through their "User Profile". Finally, the fifth feature includes additional services such as news and article searches, announcements, and integration of "Ruang Pintar" with other academic systems at MANR.

The principal of MANR, AS, confirms the features of the "Ruang Pintar," which, in reality, is an essential resource for implementing the learning process in the classroom. In contrast to the results of the researcher's interview with AS, the vice principal for curriculum at MANR explained the other side of the feature, the "Ruang Pintar," namely, the database used in the digital management system.

> *"So, in the web of 'Ruang Pintar,' we utilize low-level settings modifications in the Windows operating system database known as the registry configuration. Through this database, we accommodate the needs of our students' learning resources so that they no longer need to carry heavy books to school. In addition, the "Ruang Pintar" also proves our commitment to innovation through e-libraries."*

Findings from interviews with teachers and parents indicated that the integration of digital-based learning at MANR was supported by using Google Classroom, one of the digital learning platforms widely adopted by teachers. Notably, parents were actively involved in monitoring their children's learning activities at home. This parental monitoring process was described during interviews and corroborated by teacher-completed parental involvement checklists, demonstrating a collaborative academic environment that connected schools, students, and families. Parental monitoring activities were observed through

structured teacher-completed parental involvement checklists and follow-up interviews with selected parents to understand home-based learning dynamics.

The enthusiasm for implementing digital transformation is what ultimately led MANR to earn the title of a "Research Madrasah." This title was awarded in recognition of the institution's consistent commitment to technology-based innovation in madrasah education, particularly through digital transformation synergized with academic processes. Observational data documented the presence of digital classrooms actively used by students in grades X, XI, and XII.

These facilities demonstrated how MANR integrated digital technology across all educational levels. This integration improved student engagement and facilitated a more flexible learning experience. Moreover, IT-based infrastructure also supported both academic and administrative activities at MANR, including the availability of free Wi-Fi study zones and IT-driven administrative services, further underscoring the existence and implementation of digital transformation within the institution.

Document analysis and interview data confirmed several key successes at MANR, including the adoption of the "Ruang Pintar" digital platform, active parental involvement in digital learning monitoring, and recognition as a "Research Madrasah". Conversely, resistance to change among some staff and uneven digital competence emerged as obstacles to digital transformation. These challenges were mitigated through targeted workshops and peer mentoring, as reported by school leaders.

In contrast, the approach to digital transformation implemented at MAJE differs significantly. This school has developed a " MOSAIC " program as part of its curriculum framework. MOSAIC is a website owned and managed by MAJE that serves as a promotional platform for the school by organizing various student competitions targeting participants from public (general) and Islamic junior high schools at the national level. These competitions span various academic and Islamic religious disciplines and are held annually. Notably, during these events, teachers act only as facilitators and advisors. The design, execution, and evaluation of the competitions are entirely handled by MAJE students, who independently manage the MOSAIC website.

Specifically, KH, a PAI teacher at MAJE, explained that the uniqueness of the MOSAIC program lies in its integration with the school's Learning Management System (LMS). In fact, student parents and external community stakeholders are also involved in the event's organization. Document analysis of promotional materials and observational data captured the design and function of the "MOSAIC" website, as shown in Figure 4, which display the appearance of the platform and its role in digital competition management.

Figure 4. The appearance of the "MOSAIC" website in MAJE

Another uniqueness that researchers obtained from MAJE is the digital transformation process carried out at the school. As an Islamic educational institution, MAJE systematically transforms the technology-based education system in all aspects of its learning, not only focusing on religious lessons. In fact, the digital transformation in science materials is more apparent at this school through the "Research Program," which is one of MAJE's mainstays. MAJE's contribution to digital transformation includes the pioneering use of self-developed management systems that enhanced administrative efficiency and access to learning resources, setting a model for similar institutions in the region.

Document analysis focused on official school policy documents, digital strategy plans, and curriculum guidelines from MAJB, MANR, and MAJE. These documents were selected because they represent the institutional framework guiding digital transformation efforts. Analysis was conducted using a structured checklist that assessed policy priorities, infrastructure planning, teacher training, and curriculum alignment with digital learning and AI integration. The findings revealed several consistent themes:

1. Commitment to Digital Infrastructure Development: All three madrasahs documented explicit budget allocations for ICT infrastructure, including internet connectivity upgrades, procurement of digital devices, and LMS deployment.
2. Teacher Digital Literacy Programs: Each institution had formal training programs for teachers to improve digital competencies, ranging from basic digital literacy workshops to advanced training on LMS and AI-based learning tools.
3. Curriculum Integration of Digital Learning: Curriculum documents from the three schools emphasized blended and flipped learning approaches, integration of digital content repositories, and the inclusion of AI-supported learning modules.
4. Stakeholder Engagement: Policies highlighted collaboration with parents and community stakeholders in supporting students' digital learning, aligning with interview findings on parental involvement in monitoring student activities at home.

Clearly, these document analyses revealed that all three madrasahs had formal policy documents emphasizing digital literacy development, explicit budget allocations for ICT infrastructure, and curriculum guidelines integrating AI-based

learning tools. These documents reinforced interview findings regarding strategic institutional support for digital transformation. Based on the presentation of the study results, it is evident that digital transformation has systemic implications for improving the capacity to construct new learning models within educational institutions such as MAJB, MANR, and MAJE. Although gender was not a primary variable in this study, digital transformation initiatives in all three madrasahs involved both male and female teachers equally in training programs, ensuring equitable access to technological capacity building. In this context, the digital transformation model functions as an essential entity that must be considered to improve the quality of learning, including in Islamic Religious Education itself.

Consequently, empirical studies on digital transformation are often associated with the renewal or innovation of learning within educational institutions (Pingali et al., 2021). In other words, digital transformation possesses the potential to generate innovative elements in the development of Islamic Religious Education learning frameworks, particularly within madrasah settings. It acts as a normative-prescriptive catalyst influencing the substantial components of learning -read, Islamic Religious Education.

The virtual applications introduced through the “Siunggul” Management Information System in MAJB, “Ruang Pintar” in MANR, and “MOSAIC” in MAJE demonstrate the implementation of digital transformation as a strategic "bridge" for improving the quality of madrasah management. This, in turn, contributes to achieving institutional effectiveness and positions these institutions as pioneers in fostering dynamic, visionary, and up-to-date learning processes.

Reasonably, such processes give rise to new, innovative educational products that serve as a magnet for public attention -drawing on Rogers' concept of the diffusion of innovation (Rogers, 2003). This educational design model situates institutions within a visionary-didactic framework, where the learning system is directed toward digital integration. Indeed, such an approach creates a conducive environment for the development and improvement of human resource competencies -read: students- in the field of technology, as the Radif (2024) study has revealed.

All data obtained from the observations were carefully analyzed. The findings were organized by each madrasah to reflect each institution's specific contributions, challenges, and innovations, to ensure a comprehensive coverage of the research findings. In all three madrasahs studied (MAJB, MANR, MAJE), maintaining Islamic values during the digital transformation process was a clear institutional priority. Interview responses and document analysis revealed that specific strategies were employed to ensure the ethical alignment of digital integration. First, teacher training programs were developed with a focus on Islamic pedagogy, guiding teachers on how to incorporate religious values into online teaching. Second, digital learning materials uploaded to LMS platforms were reviewed to ensure alignment with Islamic ethical standards. This content filtering process was particularly emphasized in MAJE, where student-produced

content on the MOSAIC platform was supervised by teachers and aligned with religious themes. Third, the design of the flipped classroom and blended learning modules integrated Quranic values, character education, and moral reflection activities. These strategies collectively illustrate how digital transformation was implemented without compromising the foundational spiritual and moral identity of Islamic Religious Education (PAI). Based on this description, researchers examined the implementation of digital transformation in these three institutions through two key dimensions.

First, digital transformation through institutional strategy. The school management strategies used by MAJB, MANR, and MAJE are inseparable from the role of digital technology. The integration of digital technology across educational domains is evident in the development of infrastructure that fundamentally transforms these institutions by introducing new, constructive perspectives and values. In other words, MAJB, MANR, and MAJE adopt innovative digital technologies to construct operational transformations that are adaptable to ongoing advancements in modern technology.

In this study, Rogers' Diffusion of Innovations Theory guided both data analysis and interpretation. The adoption process in each madrasah reflected the five stages of innovation -knowledge, persuasion, decision, implementation, and confirmation. Findings also mapped to Rogers' innovation attributes: relative advantage (improved learning outcomes), compatibility (alignment with Islamic values), complexity (training needs), observability (visible improvements in student engagement), and trialability (pilot projects before full implementation). These theoretical lenses explained variations in teacher behaviours and institutional change patterns during digital adoption.

In addition to infrastructure development, researchers found that the school management strategies involving digital transformation at the three institutions cannot be separated from the collaboration among stakeholders that each institution fosters. External stakeholders -in this case, parents of students- are actively involved in optimizing school programs. Indirectly, through the use of digital technology at MAJB, MANR, and MAJE, the mindset of society -read: parents of students- as stakeholders has also experienced a positive shift. Their perception suggests that schools that involve them as partners are perceived to have high educational quality. This, in turn, contributes to the emergence of new entities that significantly influence the substantial dimensions of academic institutions (Uygun, 2024), especially in improving institutional quality, as Pingali et al., (2021) study has revealed.

Second, digital transformation through the educational and instructional system. MANR has been empirically proven to implement a Learning Management System (LMS) model actively used by its academic community. Indirectly, the application of LMS technology fosters students' technological literacy -read: assimilative sensitivity- in alignment with the rapid developments of the modern era. It is not surprising that, from a technical-didactic perspective, digital transformation through this LMS platform holds strong potential for realizing

effective learning. This is due to the LMS's capability to facilitate interactive communication between teachers and students, serve as a medium for delivering instructional materials, learning videos, and academic documents from teachers to students (Dabbagh & Bannan-Ritland, 2005). Reasonably, digital transformation through LMS-based learning technology is regarded as a means to foster student independence and improve the effectiveness of the learning process (Khan & Ali, 2023).

The data findings at MANR also led researchers to identify the implementation of flipped classrooms as an integral component of the school's learning model. The flexibility granted to students to access learning materials outside the classroom enables them to study from anywhere, thereby increasing their level of understanding (Merino-Campos, 2025). Flipped classrooms are part of an educational approach that facilitates the personalization of learning experiences by aligning educational content with the needs, preferences, and competencies of each learner. In its theoretical context, this personalization allows the development of adaptive learning pathways and provides timely feedback, thereby increasing student engagement and academic performance. This supports study results regarding the positive impact of flipped classrooms on improving the academic capabilities of both students and teachers (Alkandari & Alabdulhadi, 2023).

Based on this narrative, it is evident that digital transformation significantly affects the foundational structure of education. This implies that the rapid advancement of technology offers a new perspective on the importance of aligning education, including Islamic Education, with the realities of the "open world" through meaningful integration. This integration is reflected in crucial aspects of education, including the system (Hamdanah et al., 2024), and stakeholder involvement (Krishnan et al., 2023).

Notably, MAJB, MANR, and MAJE have demonstrated both optimism and responsiveness in embracing the "open world" through a strategic shift towards a technology-based educational system. In this context, they have effectively challenged the previously held assumption of teachers' incapacity to confront the demands of modernity in the AI era, a belief that has been contradicted by empirical results revealed by Selwyn (2019). Researchers visualize the digital transformation model of Islamic Religious Education learning through the following figure 5 about "Digital Transformation Model in Madrasah".

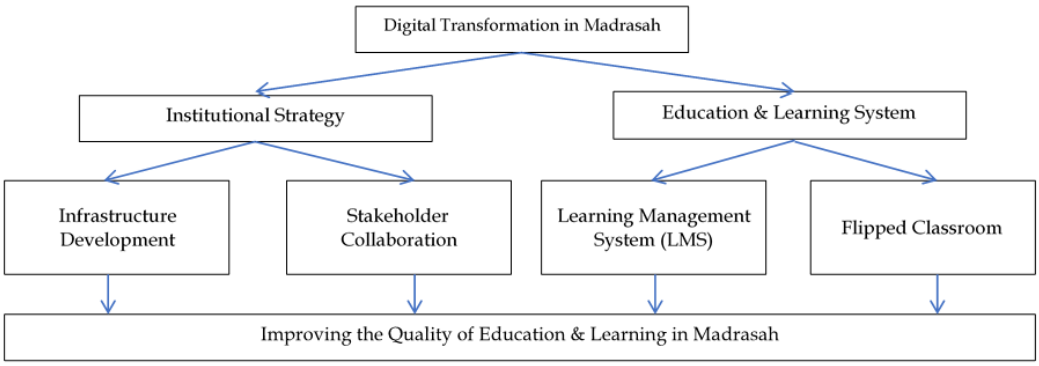

Figure 5. Digital Transformation Model in Madrasah

The section on research results provides a coherent description of the digital transformation model in madrasas. Furthermore, the analysis is structured by transformation model aspect: (a) Infrastructure: MAJB excelled in administrative digitalization; (b) Pedagogy: MANR advanced flipped classrooms and interactive LMS use; (c) Stakeholder Participation: MAJE led student-driven initiatives. Figure 5 represents an abstraction of the digital transformation model synthesized from these empirical findings and prior studies. The findings are linked to Rogers' Diffusion of Innovations Theory (Rogers, 2003), as well as recent study (Ajani, 2024). The digital transformation model through institutional strategy provides a new landscape regarding the synergy of internal institutional development - read: infrastructure development - and solid stakeholder collaboration.

These support that the stages of knowledge, persuasion, decision, implementation, and confirmation occurred distinctly at each madrasah, while efficiency was seen in reduced administrative workloads (at MAJB) and improved feedback cycles (at MANR). Impact indicators included increased digital literacy and collaborative engagement that strengthened the research (Phuong et al., 2023). Likewise, the education and learning system through LMS and flipped classrooms in madrasas can lead to improvements in the quality of education, which, in this context, confirms the findings of El-Hamamsy et al., (2024) research.

Undoubtedly, the technological innovation and digital transformation implemented at MAJB, MANR, and MAJE, through both institutional strategy and educational and instructional system, can generate new approaches in developing high-quality education. These transformations can catalyze significant shifts in educational paradigms and instructional practice models, as supported by the research's results of (Wang et al., 2023).

5. Conclusion

This study concludes that MAJB, MANR, and MAJE have successfully developed and implemented digital transformation models aligned with the demands of the AI era. These models integrated infrastructure development, pedagogical innovation, and stakeholder collaboration, reflecting adaptive and responsive strategies in navigating modern educational challenges. Importantly, the findings emphasize that the digital transformation of Islamic Religious Education (PAI) in the AI Era is achievable through well-coordinated institutional strategies, the

adoption of Learning Management Systems (LMS), the implementation of flipped classroom models, and active parental involvement. These efforts collectively enhance the quality and relevance of PAI learning, ensuring that Islamic values remain central while embracing technological advancements. From a theoretical perspective, this research extends Rogers' Diffusion of Innovations Theory by illustrating how innovation adoption interacts with cultural and religious values in Islamic education contexts.

Practically, the study provides actionable insights and models for madrasahs seeking to integrate digital learning while preserving their unique educational missions. Furthermore, the proposed digital transformation model can be adapted for other religious educational institutions by contextualizing value-preservation strategies, stakeholder engagement, and infrastructure planning to local cultural and religious contexts.

Recommendations of this research include prioritizing capacity building by educational authorities, integrating adaptive learning technologies by curriculum developers, encouraging teachers to adopt reflective digital practices, and motivating students to engage actively with digital platforms. Despite the study's contributions, this study has limitations, including potential constraints on transferability due to unique regional contexts, differences in technology access among schools, and contextual biases.

Additionally, there are challenges in validating the instruments used in this research. Future research should explore broader and more diverse educational settings to enhance generalizability. These results underscore the importance of sustained capacity building, investment in adaptive learning technologies, and strong stakeholder engagement to ensure that Islamic Religious Education remains adaptive and future-ready in the rapidly evolving digital era.

7. References

Agung, M. W. (2023). *Congratulations! MA Best Award Winner in Website Management*. Mauwh.Sch.Id. https://mauwh.sch.id/post/selamat-peraih-penghargaan-ma-terbaik-dalam-pengelolaan-website

Ahmad, K. A., Asni, F., Hasbulah, M. H., Hashom, H., Mustafa, W. A., Noor, A. M., Tambak, S., & Nasir, K. (2025). Mobile Learning of Islamic Studies: A Comprehensive Review. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *48*(2), 211–224. https://doi.org/10.37934/araset.48.2.211224

Ajani, O. A. (2024). Exploring digital transformation and future trends in higher education development across African nations. *Journal of Pedagogical Sociology and Psychology*, *6*(3), 34–48. https://doi.org/10.33902/jpsp.202427374

Alkandari, K., & Alabdulhadi, M. (2023). Promoting Self-Regulation Skills Among Pre-Service Islamic Studies Teachers Through Project-Based Learning Utilizing a Flipped Learning Strategy. *International Journal of Learning, Teaching and Educational Research*, *22*(5), 74–100. https://doi.org/10.26803/ijlter.22.5.4

Andoniou, C. (2024). Technology Integration and Digital Transformation in Post-COVID-19 Hybrid Education. In R. Khamis Hamdan, A. Hamdan, B. Alareeni, & R. E. Khoury (Eds.), *Information and Communication Technology in Technical and Vocational Education and Training for Sustainable and Equal Opportunity* (pp. 303–

315). Springer. https://doi.org/https://doi.org/10.1007/978-981-99-6909-8_27

Aqobah, F. (2023). *Main Female Student Ambassador of Gresik Regency*. Man1gresik.Sch.Id. https://man1gresik.sch.id/2025/03/28/fildina-aqobah-siswa-kelas-xi-10-dinobatkan-sebagai-duta-siswa-utama-putri-kabupaten-gresik/

Arim, S. N., Ajmain, M. T., Razak, K. A., Salleh, M. N. M., Yusof, A. S., & Noor, S. S. M. (2024). Navigating Educational Turbulence: A Systematic Literature Review on Challenges Faced by Islamic Education Amid the Pandemic. In *Studies in Systems, Decision and Control* (pp. 663–680). Springer Nature. https://doi.org/https://doi.org/10.1007/978-3-031-62106-2_50

Creswell, J. W. (2007). *Qualitative Inquiry & Research Design: Choosing Among Five Approaches*. SAGE Publications.

Dabbagh, N., & Bannan-Ritland, B. (2005). *Online Learning: Concepts, Strategies, and Application*. Prentice-Hall.

El-Hamamsy, L., Monnier, E. C., Avry, S., Chessel-Lazzarotto, F., Liégeois, G., Bruno, B., Zufferey, J. D., & Mondada, F. (2024). An Adapted Cascade Model to Scale Primary School Digital Education Curricular Reforms and Teacher Professional Development Programs. *Education and Information Technologies*, *29*(9), 10391–10436. https://doi.org/10.1007/s10639-023-12043-6

Espina-Romero, L., Ríos Parra, D., Noroño-Sánchez, J. G., Rojas-Cangahuala, G., Cervera Cajo, L. E., & Velásquez-Tapullima, P. A. (2024). Navigating Digital Transformation: Current Trends in Digital Competencies for Open Innovation in Organizations. *Sustainability (Switzerland)*, *16*(5), 1–19. https://doi.org/10.3390/su16052119

Ferk Savec, V., & Jedrinović, S. (2025). The Role of AI Implementation in Higher Education in Achieving the Sustainable Development Goals: A Case Study from Slovenia. *Sustainability (Switzerland)*, *17*(1), 1–22. https://doi.org/10.3390/su17010183

Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., & Kyriakidou, O. (2004). Diffusion of Innovations in Service Organizations: Systematic Review and Recommendations. *Milbank Quarterly*, *82*(4), 581–629. https://doi.org/10.1111/j.0887-378X.2004.00325.x

Gyonyoru, K., Ida, K., & Katona, J. (2024). Student Perceptions of AI-Enhanced Adaptive Learning Systems: A Pilot Survey. *7th International Conference and Workshop Obuda on Electrical and Power Engineering*, 93–98. https://doi.org/10.1109/CANDO-EPE65072.2024.10772884

Hamdanah, Rusmaniah, Rajiani, I., & Muslimah. (2024). Continuance intention of digital education in traditional Indonesian higher education: Policy implication forward. *Journal of Infrastructure, Policy and Development*, *8*(5), 1–16. https://doi.org/10.24294/jipd.v8i5.3596

Hamdani, N. A. (2023). Scrutinizing Islamic Higher Education Institutions in Indonesia. *Jurnal Pendidikan Islam*, *9*(1), 93–106. https://doi.org/10.15575/jpi.v0i0.24478

Hornik, R. (2023). Some Reflections on Diffusion Theory and the Role of Everett Rogers. In *Zitteliana* (Vol. 19, Issue 8). https://doi.org/https://doi.org/10.1080/1081070490271610

Huang, R., Liu, D., Kanwar, A. S., Zhan, T., Yang, J., Zhuang, R., Liu, M., Li, Z., & Adarkwah, M. A. (2024). Global Understanding of Smart Education in the Context of Digital Transformation. *Open Praxis*, *16*(4), 663–676. https://doi.org/10.55982/openpraxis.16.4.761

Jailani, M., & Huda, M. (2024). Artificial Intelligence (AI): An Opportunity and Challenge for Achieving Success in Islamic Education in the Era of Digital Transformation. *Suhuf: International Journal of Islamic Studies*, *36*(2), 200–215. https://doi.org/https://doi.org/10.23917/suhuf.v36i2.6273

Kasman, R., & Madjid, A. (2024). Opportunities and Challenges of Artificial Intelligence and Their Implications in Islamic Education. *Intiqad: Jurnal Agama Dan Pendidikan*

Islam, *16*(1), 1–13. https://doi.org/10.30596/19308

Khamis, S. (2024). The Paradoxes of Modern Islamic Discourses and Socio-Religious Transformation in the Digital Age. *Religions*, *15*(207), 1–9. https://doi.org/10.3390/rel15020207

Khan, R. A., & Ali, A. (2023). Students' Perceptions of EvalTools LMS: A Case Study. *The International Journal of Technologies in Learning*, *30*(1), 91–105. https://doi.org/https://doi.org/10.18848/2327-0144/CGP/v30i01/91-105

Krishnan, C., Babbar, M., & Singh, G. (2023). *Digital Transformation in Education: Emerging Markets and Opportunities*. Bentham Books.

Kumar, R., & Sharma, S. (2025). Secondary school teachers' perspectives on GenAI proliferation: generating advanced insights. *International Journal for Educational Integrity*, *21*(1), 1–17. https://doi.org/10.1007/s40979-025-00180-z

Li, W., Coelen, R., & Otten, S. (2025). Enhancing interaction quality in interdisciplinary group work: The impact of student motivation and teacher-initiated diversity climate. *Social Psychology of Education*, *28*(1), 1–21. https://doi.org/10.1007/s11218-024-10004-6

Mahsusi, Hudaa, S., Fahmi, M., Kusen, Haryanti, N. D., & Wajdi, M. B. N. (2024). Achieving excellence: the role of digital transformation in madrasah management and Islamic culture. *Cogent Arts and Humanities*, *11*(1), 2304407. https://doi.org/10.1080/23311983.2024.2304407

Operational Instructions for Regular Physical Special Allocation Funds in the Education Sector for the 2021 Fiscal Year, Pub. L. No. 5/2021, 1 (2021). https://jdih.kemdikbud.go.id/

Mañero, J., & Escaño, C. (2024). A systematic review approach to the understanding of intercreativity as an educational resource. *Interactive Learning Environments*, *32*(1), 273–285. https://doi.org/https://doi.org/10.1080/10494820.2022.2086573

Mbatha, B. (2024). Diffusion of Innovations: How Adoption of New Technology Spreads in Society. In D. Ocholla, O. B. Onyancha, & A. O. Adesina (Eds.), *Information, Knowledge, and Technology for Teaching and Research in Africa* (pp. 1–18). Springer, Cham. https://doi.org/https://doi.org/10.1007/978-3-031-60267-2_1

Merino-Campos, C. (2025). The Impact of Artificial Intelligence on Personalized Learning in Higher Education: A Systematic Review. *Trends in Higher Education*, *4*(17), 1–15. https://doi.org/https:// doi.org/10.3390/higheredu4020017

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative Data Analysis A Methods Sourcebook* (3rd ed.). SAGE Publications.

Milicevic, N., Kalas, B., Djokic, N., Malcic, B., & Djokic, I. (2024). Students' Intention toward Artificial Intelligence in the Context of Digital Transformation. *Sustainability (Switzerland)* , *16*(9), 1–15. https://doi.org/10.3390/su16093554

Mubarikh, S. (2025). *Facilities and infrastructure at MAN Gresik*. Man1gresik.Sch.Id. https://man1gresik.sch.id/sarana-prasarana/

Navarro-Newball, & Adolfo, A. (2023). Smart expanded realities for innovation in digital culture. *Periferica Internacional*, *24*, 129–141. https://doi.org/10.25267/Periferica.2023.i25.12

Nugroho, A., & Astutik, A. P. (2024). Digital Transformation of Islamic Boarding School Education. *Indonesian Journal of Law and Economics Review*, *12*(2), 1–9. https://doi.org/https://doi.org/10.21070/ijis.v12i2.1723

Phuong, T. T. T., Nguyen, T. T., Danh, N. N., Van, D. N., Luong, H. D., Nguyen, L. V. A., & Tran, T. (2023). Digital transformation in education: a bibliometric analysis using Scopus. *European Science Editing*, *49*, 1–14. https://doi.org/10.3897/ese.2023.e107138

Pingali, S. R., Prakash, S., & Korem, J. R. (2021). *Digital Transformation Strategies: Theory and Practice*. SAGE Publication.

Proietti, E. (2025). Third Mission and Digital Transformation: An Opportunity to Take

Advantage. *European Journal of Education Research, Development and Policy*, *60*(1), e70035. https://doi.org/https://doi.org/10.1111/ejed.70035

Radif, M. (2024). Artificial Intelligence in Education: Transforming Learning Environments and Enhancing Student Engagement. *Educational Sciences: Theory and Practice*, *24*(1), 93–103. https://doi.org/10.12738/jestp.2024.1.008

Radjak, D. S., Jusuf, S., & Bongkan, A. D. (2024). The Urgency of Digitizing Learning for Madrasah Aliyah Islamic Boarding School Students in The Era Of Society 5.0. *Journal of Learning and Technology*, *3*(1), 1–9. https://doi.org/10.33830/jlt.v3i1.7896

Raja, S., Jebadurai, D. J., Ivan, L., Mykola, R. V., Ruslan, K., & Nadiia, P. R. (2024). Impact of Artificial Intelligence in Students' Learning Life. In R. Khamis & A. Buallay (Eds.), *Studies in Systems, Decision and Control* (pp. 3–17). Springer, Cham. https://doi.org/10.1007/978-3-031-49544-1_1

Ritonga, M., Ritonga, S., Mudinillah, A., Julhadi, & Putra, I. E. (2025). The Role of Future Technology in the Preparation of Prospective Teachers. In W. M. Yafooz & Y. Al-Gumaei (Eds.), *Studies in Computational Intelligence*. Springer. https://doi.org/https://doi.org/10.1007/978-3-031-80334-5_16

Rogers, E. M. (2003). *Diffusion of Innovations Fifth Edition* (5th Ed.). Free Press.

Samala, A. D., Rawas, S., Criollo-C, S., Bojic, L., Prasetya, F., Ranuharja, F., & Marta, R. (2024). Emerging Technologies for Global Education: A Comprehensive Exploration of Trends, Innovations, Challenges, and Future Horizons. *SN Computer Science*, *5*(8), 1175. https://doi.org/10.1007/s42979-024-03538-1

Samuelsson, R. (2024). Computational transformations of early childhood education: Pathways toward child-centred computing in two educational change projects. *British Journal of Educational Technology*, *April*, 1–20. https://doi.org/10.1111/bjet.13536

Selwyn, N. (2019). *Should robots replace teachers? AI and the Future of Education* (1st ed.). Polity Press.

Siregar, H. S., Nurhamzah, Munir, M., & Fikri, M. (2025). Enhancing Islamic Education Through Technology Integration: a Study of Teaching Practices in Indonesia. *Jurnal Ilmiah Peuradeun*, *13*(2), 959–986. https://doi.org/10.26811/peuradeun.v13i2.1875

Solberg, E., & Tømte, C. E. (2023). Moving beyond policy on digital transformation: Perceptions of digital transformation of teaching by academic staff and students. In *The Impact of Covid-19 on the Institutional Fabric of Higher Education: Old Patterns, New Dynamics, and Changing Rules?* (pp. 345–363). Springer International Publishing. https://doi.org/10.1007/978-3-031-26393-4_14

Stylianidis, E., Chrysovergis, V., & Toka, E. (2024). From classroom to marketplace: the impact of digital transformation on academic entrepreneurship. In F. Spigarelli, L. Kempton, & L. Compagnucci (Eds.), *Entrepreneurship and Digital Humanities* (pp. 209–226). Elgaronline. https://doi.org/https://doi.org/10.4337/9781035331864.00025

Susanti, S. S., Nursafitri, L., Hamzah, I., Zunarti, R., Darmanto, Fitriyah, Asy'arie, B. F., & Sa'ad, M. S. (2024). Innovative Digital Media in Islamic Religious Education Learning. *Jurnal Pendidikan Agama Islam*, *21*(1), 40–59. https://doi.org/10.14421/jpai.v21i1.7553

Ting, G., & Hong, Y. (2024). An Inquiry Into AI-Supported Classroom Transformation. *2024 6th International Conference on Computer Science and Technologies in Education (CSTE)*, 114–118. https://doi.org/10.1109/CSTE62025.2024.00028

Tømte, C. E. (2024). Conceptualisation of professional digital competence for school leaders in schools with 1:1 coverage of digital devices. *Computers and Education*, *222*(May), 1–11. https://doi.org/10.1016/j.compedu.2024.105151

Uygun, D. (2024). Teachers' perspectives on artificial intelligence in education. *Advances*

in Mobile Learning Educational Research, *4*(1), 931–939. https://doi.org/10.25082/amler.2024.01.005

Wang, X., Lee, C.-F., Li, Y., & Zhu, X. (2023). Digital Transformation of Education: Design of a "Project-Based Teaching" Service Platform to Promote the Integration of Production and Education. *Sustainability*, *15*, 1–24. https://doi.org/10.3390/su151612658

Wang, Y., Hong, D., & Huang, J. (2023). A Diffusion of Innovation Perspective for Digital Transformation on Education. *Procedia Computer Science*, *225*, 2439–2448. https://doi.org/10.1016/j.procs.2023.10.235

Yan, L., Sha, L., Zhao, L., Li, Y., Martinez-Maldonado, R., Chen, G., Li, X., Jin, Y., & Gašević, D. (2023). Practical and ethical challenges of large language models in education: A systematic scoping review. *British Journal of Educational Technology*, *55*(1), 90–112. https://doi.org/10.1111/bjet.13370

Zheng, Y., & Yang, Y. (2025). Investigation and Enhancement Strategies for the Cultivation of Pre-service Teachers' Digital Teaching Competence. *ICETM '24: Proceedings of the 2024 7th International Conference on Educational Technology Management*, 492–497. https://doi.org/https://doi.org/10.1145/3711403.3711483