Artificial Intelligence in the Development of Islamic Education Learning at Pondok Pesantren: A Literature Review Analysis

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Abstract

The rapid advancement of Artificial Intelligence (AI) technology has opened up transformative opportunities across various sectors, including education. However, the adoption of AI in traditional educational institutions such as Islamic boarding schools (pesantren) remains limited. This study aims to explore how AI can be integrated into the pesantren ecosystem to support educational innovation and institutional sustainability. Employing a literature review approach, the research investigates the potential applications of AI in learning systems, administrative management, and decision-making processes within pesantren. The findings reveal that AI can enhance value-based education, accelerate digital transformation, and strengthen the self-reliance of pesantren in the digital era. Furthermore, this study proposes a conceptual framework for AI transformation aligned with the values and specific needs of pesantren. These insights contribute to the development of sustainable, technology-based Islamic education strategies.

Keywords: Artificial Intelligence, Pesantren, Digital Transformation, Personalized Learning, Institutional Sustainability

Abstrak

Perkembangan pesat teknologi Kecerdasan Buatan (AI) telah membuka peluang transformasi dalam berbagai sektor, termasuk pendidikan. Namun, pemanfaatan AI di lembaga pendidikan tradisional seperti pesantren masih sangat terbatas. Penelitian ini bertujuan untuk mengeksplorasi bagaimana AI dapat diterapkan dalam konteks pesantren guna mendukung inovasi pendidikan dan keberlanjutan kelembagaan. Dengan menggunakan pendekatan review penelitian literatur, studi ini mengkaji potensi integrasi AI ke dalam sistem pembelajaran, manajemen, dan pengambilan keputusan di pesantren. Hasil penelitian menunjukkan bahwa AI dapat memperkuat efektivitas pendidikan berbasis nilai, mempercepat digitalisasi administrasi, serta mendukung kemandirian pesantren di era digital. Studi ini juga merumuskan kerangka konseptual transformasi AI yang sesuai dengan nilai-nilai dan kebutuhan khas pesantren. Temuan ini memberikan kontribusi penting dalam pengembangan strategi pendidikan Islam berbasis teknologi yang berkelanjutan.

Kata kunci: Kecerdasan Buatan, Pesantren, Transformasi Digital, Pembelajaran yang Dipersonalisasi, Keberlanjutan Pesantren

Duna Izfanna, Dini Oktarina Dwi Handayani, Tutik Lestari |

Artificial Intelligence in the Development of Islamic Education Learning at Pondok Pesantren: A Literature Review Analysis

Introduction

In recent years, the rapid advancement of Artificial Intelligence (AI) has transformed various sectors, including education. AI technologies have been increasingly adopted to enhance learning experiences, personalize instruction, automate administrative tasks, and optimize institutional management. While these developments are widely observed in formal education systems, the integration of AI in traditional and religious educational institutions, such as pesantren, remains relatively limited.

Pesantren, as Indonesia's indigenous Islamic boarding schools, play a vital role in shaping the character, knowledge, and moral foundation of millions of students. Rooted in religious tradition and community-based learning, pesantren have historically relied on face-to-face interactions and classical teaching methods. However, the evolving educational landscape and the demands of the digital era necessitate the incorporation of innovative approaches, including the use of digital tools and AI, to ensure the relevance and sustainability of pesantren education.

This study aims to explore the transformative potential of AI in supporting educational innovation and institutional sustainability in the pesantren context. It investigates how AI technologies can be aligned with the values and pedagogical frameworks of pesantren, and how they can contribute to enhancing the quality of learning, decision-making, and institutional governance. By adopting a qualitative approach and drawing insights from experts and practitioners, the research seeks to provide a conceptual model for AI-driven transformation that is contextually appropriate for pesantren.

Literature Review
The Role of AI in Pesantren

AI is revolutionizing education by offering personalized learning experiences, intelligent tutoring systems, and administrative automation (Tilepbergenovna, 2024). AI enhances student engagement, tailors lessons to individual needs, and improves communication between teachers and students (Chhatwal et al., 2023). It provides round-the-clock access to educational resources and offers personalized feedback on assignments and quizzes (Murgai et al., 2024). AI applications in education, known as AIED, facilitate teaching, learning, and decision-making processes (Karya Bakti et al., 2023). While AI streamlines routine tasks and enables a more thorough assessment of teachers and students (Chhatwal et al., 2023), it is not a replacement for human educators. Teachers remain crucial as facilitators and supporters of learning in AI implementation (Karya Bakti et al., 2023). Despite its benefits, integrating AI into education raises concerns about equity and ethics (Tilepbergenovna, 2024).

AI has been widely adopted in modern education to enhance learning experiences through personalized instruction, automated assessments, and intelligent tutoring systems. AI applications in education include machine learning algorithms, natural language processing, and data analytics, which help tailor educational content to individual student needs.

AI is revolutionizing Islamic education by enhancing learning experiences and outcomes (Zaharah et al., 2024). AI technologies offer personalized learning, improved accessibility, and adaptive instruction in Islamic studies (Rozaanah, 2024). They assist in accelerating student development, making teaching more satisfying, and helping teachers improve their practices (Hakim & Anggraini, 2023). AI implementation in Islamic education has shown significant impacts, including increased student understanding, stimulated creativity, and improved management efficiency (Syafitri et al., 2024). However, ethical considerations, data privacy concerns, and preserving traditional values

must be addressed (Hakim & Anggraini, 2023; Rozaanah, 2024). While AI is transforming educational paradigms and methods, it is viewed as a complement to, rather than a replacement for, human educators (Zaharah et al., 2024). A balanced approach integrating AI with traditional teaching methods is crucial to maintaining essential aspects of character formation in Islamic education (Rozaanah, 2024).

Table 1. References Journals

Title	Author(s)	Year	Problem	Solution
The Role of AI in Education	Tilepbergenovna	2024	Ethical concerns, equity issues in AI integration	Personalized learning, intelligent tutoring, admin automation, teacher support
AI in Islamic Education	Zaharah et al.	2024	Adapting AI to religious values and pedagogy	Enhanced learning outcomes, AI as a complement to traditional methods
Management and Creativity through AI	Syafitri et al.	2024	Inefficient management, lack of innovation	Improved educational management, and creativity stimulation through AI
AI Feedback and Access to Resources	Murgai et al.	2024	Lack of timely feedback and access	24/7 educational access, personalized feedback systems
AI in Teaching and Decision Making	Karya Bakti et al.	2023	Overdependence concerns on AI	AI to assist teaching/assessment, not replace educators
AI Enhancing Student Engagement	Chhatwal et al.	2023	Limited engagement, routine task overload	Tailored lessons, improved communication, deeper teacher-student interaction
AI for Teacher Satisfaction and Practice	Hakim & Anggraini	2023	Teaching challenges, teacher workload	AI to support teaching efficiency and instructional development

The application of AI in Pesantren is still emerging but holds great potential. AI-based tools have been developed to assist in Quranic studies, Hadith interpretation, and Arabic language learning. Virtual learning platforms enable remote access to Islamic education, breaking geographical barriers and providing inclusive learning opportunities.

Benefits of AI in Pesantren

AI offers significant benefits for pesantren, enhancing personalized learning, improving student engagement, and increasing understanding of Islamic teachings (Bastomi et al., 2024; Syafitri et al., 2024; Zaharah et al., 2024). AI technologies, including Virtual and Augmented Reality, create interactive learning experiences that stimulate creativity and motivation among students (Syafitri et al., 2024). In Qur'an and Hadith studies, AI facilitates the exploration of complex verses and optimizes teaching methods (Afif & Nawawi, 2024; Syafitri et al., 2024). While AI shows promise in improving educational outcomes and administrative efficiency, challenges such as ethical concerns, privacy issues, and technological infrastructure limitations persist (Bastomi et al., 2024; Syafitri et al., 2024). Importantly, AI is viewed as a complement to, not a replacement for, human educators, whose role remains crucial in guiding and contextualizing learning (Zaharah et al., 2024). Successful integration of AI in pesantren requires collaboration between stakeholders and alignment with Islamic values (Afif & Nawawi, 2024; Bastomi et al., 2024).

a. **Personalized Learning:** AI enables individualized instruction, catering to students' different learning paces and styles.
b. **Curriculum Development:** AI can analyze large datasets to suggest improvements in Islamic studies curricula.

Duna Izfanna, Dini Oktarina Dwi Handayani, Tutik Lestari |

Artificial Intelligence in the Development of Islamic Education Learning at Pondok Pesantren: A Literature Review Analysis

c. **Administrative Efficiency:** AI automates tasks such as grading, attendance tracking, and student progress monitoring, allowing educators to focus more on teaching.

d. **Accessibility:** AI-driven platforms make pesantren more accessible to diverse learners, including those with disabilities.

Challenges and Ethical Considerations

The development and implementation of AI in various domains, particularly healthcare and program development, present significant ethical and regulatory challenges. These include safety, reliability, accountability, and transparency (Sedat Sonko et al., 2024). Researchers face difficulties defining ethical practices for digital and social media data collection and analysis, highlighting the need for improved guidance and resources (Shilton & Sayles, 2016). Best practices in data management for U.S. program development involve robust procedures for informed consent, privacy protection, and regulation compliance (Arenike Patricia Adekugbe & Chidera Victoria Ibeh, 2024). The healthcare sector specifically grapples with ethical concerns surrounding AI-powered decision support systems, emphasizing the necessity for a comprehensive governance framework to ensure successful implementation (Mennella et al., 2024). Addressing these challenges requires interdisciplinary collaboration, inclusive dialogue, and the establishment of ethical frameworks that prioritize stakeholder interests and risk assessment (Arenike Patricia Adekugbe & Chidera Victoria Ibeh, 2024; Sedat Sonko et al., 2024).

a. **Theological Concerns:** The use of AI in Pesantren education must align with Pesantren principles, raising questions about the role of machine-generated knowledge.

b. **Bias and accuracy:** AI models must be carefully trained to avoid bias in religious interpretations and ensure accurate educational content.

c. **Privacy and Data Security:** AI-powered platforms must uphold ethical standards in handling student data and maintaining privacy.

d. **Teacher-Student Interaction:** While AI enhances learning, it cannot replace the human elements of mentorship and moral guidance provided by educators.

Digital Transformation of Traditional Education

Digital transformation revolutionises traditional education by integrating technology into learning processes and management systems (Soedjono, 2022). This shift enhances pedagogy, offering interactive classrooms and new learning experiences (Zain, 2021). It provides flexibility for students with diverse needs, allowing them to study independently (Zain, 2021). Emerging trends like gamification, augmented reality, and the Internet of Things are reshaping the educational landscape (Zain, 2021). Digital education has made knowledge more accessible than traditional methods, enabling rapid information dissemination globally (Yarychev & Mentsiev, 2020). It supports various learning styles and improves instructional approaches, particularly in higher education (Atamuratov & Xushvaqtov, 2025; Soedjono, 2022). The digital transformation of education is considered a key factor in ensuring quality learning experiences (Atamuratov & Xushvaqtov, 2025). As education evolves, digital tools are becoming increasingly crucial in supporting teachers and learners in creating innovative learning methods (Atamuratov & Xushvaqtov, 2025). The digital transformation of traditional education refers to the application of digital technologies to change how education is delivered and experienced. This includes adopting online learning platforms, AI-powered educational applications, and edtech. This transformation aims to improve the accessibility,

efficiency, and effectiveness of education while making learning more engaging and individualized for students.

Methods

The methods in this paper aim to provide employemploys a literature review approach, analyzing academic papers, reports, and case studies on AI in pesantren, with a particular focus on its implementation in Pesantren.

Table 2. Research Methods

Component	Description
Type of Research	Literature research with a case study approach
Research Subject	Pondok Pesantren Darunnajah, South Jakarta
Data Collection Methods	Observation of a literature review approach, in-depth interviews, and document analysis
Data Analysis Technique	Interactive analysis model by mix methods: data reduction, data display, and conclusion /verification
Research Instruments	Interview guidelines, observation sheets, and documentation
Research Objective	To explore and analyze the digitalization and automation processes implemented in the pesantren to achieve independence and sustainability

The review synthesizes findings from peer-reviewed journals, conference proceedings, and online educational resources.

The Role of AI in Pesantren Education

Artificial Intelligence (AI) opens new opportunities in the field of education, including in pesantren. Some benefits of AI in the pesantren learning system include:

a. **Personalized Learning**
   AI can tailor learning materials based on each student's abilities and needs, allowing them to learn more effectively.
b. **Automation of Evaluation and Exams**
   AI-based systems can automatically grade exams, provide instant feedback, and recommend additional materials based on students' weaknesses.
c. **Automatic Translation and Interpretation**
   AI can assist in translating classical Islamic texts (*kitab kuning*) and provide interactive interpretations that are easier for students to understand.
d. **Chatbot as a Learning Assistant**
   AI-powered chatbots can directly answer students' questions about lesson materials, helping them grasp concepts more quickly.

Concept and Implementation of AI in Education

AI in education encompasses various applications such as chatbots for tutoring, AI-based learning management systems, and curriculum personalization tailored to students' needs. In several modern educational institutions, AI has been implemented to enhance learning effectiveness, analyze student performance, and develop adaptive learning materials. Pesantren can adopt AI in various aspects, including:

a. **AI-Based E-Learning:** Online learning platforms that can adjust materials according to students' abilities.
b. **Pesantren Chatbot:** A system that provides automated guidance on Pesantren studies.
c. **Learning Analytics:** Data-driven monitoring of students' academic progress.
d. **AI Adaptation Strategies in Pesantren Education**

Duna Izfanna, Dini Oktarina Dwi Handayani, Tutik Lestari |

Artificial Intelligence in the Development of Islamic Education Learning at Pondok Pesantren: A Literature Review Analysis

e. To implement AI effectively in pesantren, several strategies can be applied, including:

f. **Gradual Technology Integration**
Pesantren can start with simple technologies like e-learning before transitioning to more complex AI systems.

g. **Collaboration with External Parties**
Cooperation with educational institutions, government bodies, and tech companies can assist pesantren in developing infrastructure and training human resources.

h. **AI-Based Curriculum Development**
Adapting the curriculum to integrate AI to make learning more effective while preserving the traditional values of pesantren.

i. **Development of AI-Based Islamic Applications**
Creating applications that can help students understand classical Islamic texts (kitab kuning), memorize the Quran, and deepen their religious knowledge more interactivelyin a more interactive way.
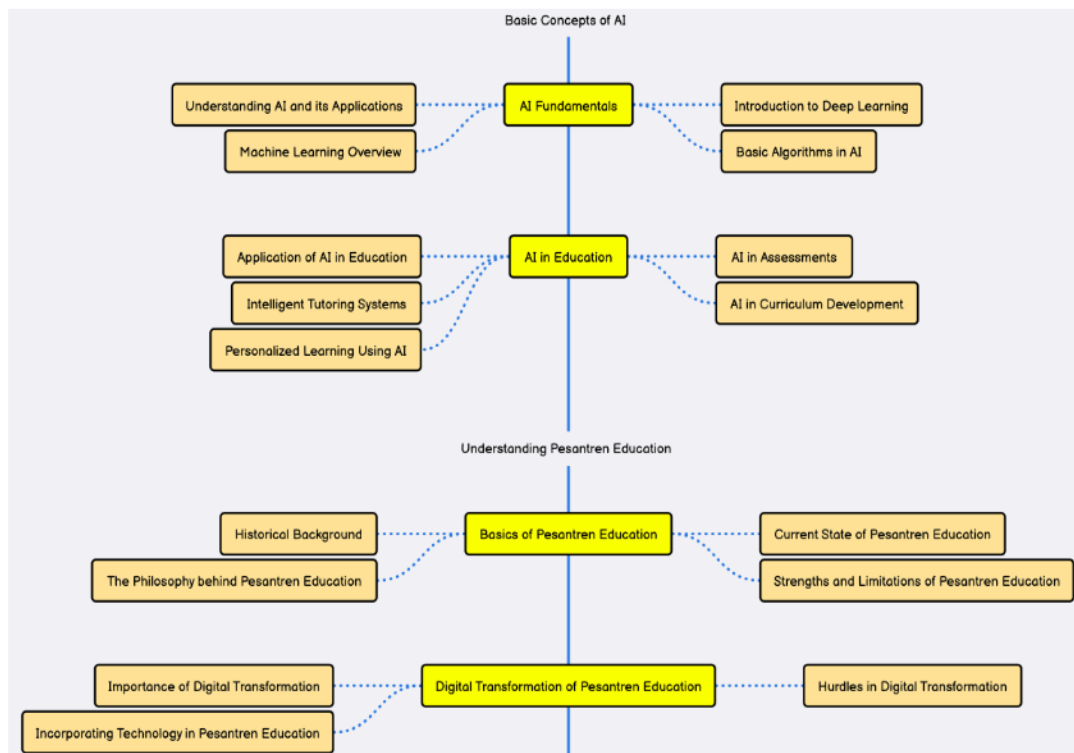

Figure 1. Understanding Pesantren Education

Incorporating Technology in Pesantren Education

Incorporating technology in Pesantren education involves the integration of technological tools and applications in Pondok Pesantren to enhance teaching and learning practices. This may include using learning management systems, online learning platforms, and digital literacy programs, with a focus on adopting and adapting Artificial Intelligence innovation for a technology-based learning environment.

Findings and Discussion

The literature review highlights that AI is revolutionizing Pesantren by enabling digital learning solutions that enhance accessibility and engagement. However, the integration

of AI in this domain must be done cautiously, ensuring that technological advancements align with pesantren's philosophies. The findings suggest a need for collaboration between AI experts, Islamic scholars, and educators to develop AI-driven learning solutions that uphold ethical standards and educational integrity.

Results

Despite the numerous benefits that artificial intelligence (AI) can bring to education, its implementation in pesantren faces several key challenges. One of the primary obstacles is the limited technological infrastructure, as many pesantren still lack stable internet access and sufficient digital devices to support AI-based learning. Additionally, there is a notable gap in digital literacy among educators, including teachers and ustadz, who often require targeted training to effectively use AI technologies. Moreover, the integration of AI must be approached with careful consideration of ethical aspects and the preservation of pesantren values, ensuring that technological advancements do not compromise the spiritual and cultural foundations of pesantren education.

Discussion

Issues in Technological Innovation

a. Principles and Data Security

The growing use of technologies, such as artificial intelligence, big data analytics, and smart sensors, raises ethical questions about the collection, use, and protection of individuals' ~~personal~~ data. The need to ensure that data use is carried out ethically and that individual privacy is respected.

As technology advances, cyber security threats also grow. Cyberattacks can damage information systems, steal sensitive data, or even cause physical damage through attacks on critical infrastructure. The need to protect information systems and technology infrastructure from potentially damaging cyber attacks.

b. Mental and Social Health

Technology use, especially social media and video games, has been linked to mental health problems such as stress, depression and addiction. Apart from that, technology can also influence social dynamics and human interactions, both positively and negatively. There is a need to understand the mental and social health impacts of technology and find ways to manage and minimize the associated risks.

c. Environmental Impact

The development and use of technology can have a significant impact on the environment, either through high energy consumption, pollution, or excessive use of natural resources. There is a need to consider how technology can be developed and implemented taking into account its impact on the environment and promoting sustainable practices.

Value-Based Approach in Technological Innovation

1. *The Importance of Human Values*
   a. Respect for Human Rights: Technological innovation must consider its impact on human rights, such as the right to privacy, freedom of expression and social justice. It is necessary to ensure that technology is not used to violate human rights or reinforce inequalities.
   b. Transparency and Accountability: Companies and technology developers must be transparent about how their products and services work, as well as their impact on users and society. The need to ensure that technology-related decisions and actions can be accounted for and can be understood by the public.
   c. Fairness and Inclusivity: Technological innovation must be directed at creating equal opportunities for all people, without reinforcing social inequalities or

Duna Izfanna, Dini Oktarina Dwi Handayani, Tutik Lestari |

Artificial Intelligence in the Development of Islamic Education Learning at Pondok Pesantren: A Literature Review Analysis

discrimination. It is important to ensure that technology can be easily accessed and used by various groups in society, including those who are vulnerable or marginalized.

d. Sustainable and Environmentally Friendly: Technology must be developed taking into account its impact on the environment and encouraging sustainable practices. This includes reducing energy consumption, reducing e-waste, and integrating technology solutions to support sustainable development goals.

e. Prioritizing Human Welfare: Technological innovation must aim to improve overall human welfare, both physically, mentally and socially. It is necessary to ensure that technology not only provides economic benefits, but also improves the quality of life and happiness of individuals and society in general.

2. *Influence of Culture and Environment*

It is important to pay attention to local culture and values in the technology development environment. This includes understanding the needs and preferences of local communities and ensuring that technology does not conflict with cultural or religious values held by the community.

A value-based approach to technological innovation emphasizes the importance of prioritizing human interests and societal welfare in the development and implementation of new technologies. This requires active engagement from a wide range of stakeholders, including technology companies, governments, academia, and civil society, to ensure that technology continues to provide positive benefits for humans while strengthening the values that society at large deems important.

3. *Stakeholder Involvement*

Stakeholder involvement in technological innovation is very important to ensure that the technology developed and implemented meets the needs and expectations of the various parties involved. Following are some of the key stakeholders typically involved in technological innovation:

a. **The Role of Scientists and Technology Developers**

Educational and research institutions have a role in producing the knowledge and skills needed to support technological innovation. They can also be partners for technology companies in the development of new products and innovative solutions.

b. **Technology Companies and Developers**

Technology companies are key stakeholders in technological innovation. They are responsible for developing new products and services and ensuring that the technology they develop meets high standards of quality and safety.

c. **The Role of Government**

The government plays an important role in regulating and supervising technological innovation to ensure that the technology developed complies with applicable regulations and does not violate the law. They can also provide financial and policy support to encourage sustainable and inclusive technological innovation.

d. **The Role of Society**

Civil society and advocacy groups are often the voice for the general public's interests in technological innovation. They can raise concerns about the social, environmental or ethical impacts of new technologies, and encourage companies and governments to act responsibly.

e. **Consumers and End Users**

Consumers and end users are the stakeholders most directly affected by technological innovation. Their opinions and experiences in using new technologies can provide valuable insights for developers to refine and improve their products and services.

f. **Investors and Financiers**

Investors and financiers play an important role in supporting technological innovation by providing funding for research, development, and scale-up of new products and services. They can also influence the direction of technological innovation by prioritizing investment in certain sectors.
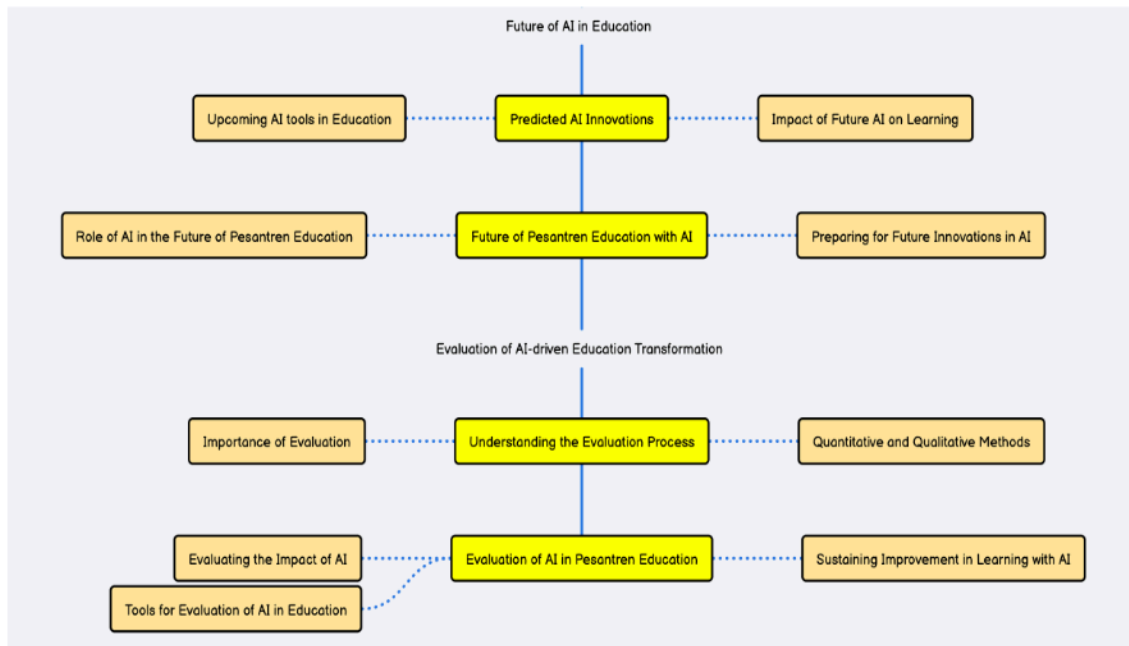

Figure 2. Evaluation of AI – Driven Education Transformation

This mind map displays the relationships between key topics related to ethics in technological innovation, as well as the stakeholders involved and relevant value-based approaches. Mind maps can help in visualizing the structure and key concepts related to the topic.

Conclusion and Recommendations

AI presents significant opportunities for improving Islamic education and learning in the digital age. While AI-driven tools enhance personalized learning, curriculum development, and administrative processes, challenges such as ethical concerns, data security, and maintaining traditional teacher-student interactions must be addressed. Future research should explore the development of AI-based educational models specifically designed for Pesantren, ensuring they align with Pesantren and pedagogy. Policymakers and educators should work together to create guidelines for the responsible and effective use of AI in Pesantren.

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Duna Izfanna, Dini Oktarina Dwi Handayani, Tutik Lestari |

Artificial Intelligence in the Development of Islamic Education Learning at Pondok Pesantren: A Literature Review Analysis

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Duna Izfanna, Dini Oktarina Dwi Handayani, Tutik Lestari |

Artificial Intelligence in the Development of Islamic Education Learning at Pondok Pesantren: A Literature Review Analysis

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