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Enhancing Students' Scientific Argumentation Skills in Islamic Religious Education Through AI-Powered Differentiated Learning

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ABSTRACT

This study investigates the effectiveness of AI-assisted learning in enhancing students' scientific argumentation skills within Islamic Religious Education (PAI) at SMKN Widang. As digital tools become more integrated into education, understanding their impact on higher-order thinking skills is increasingly relevant. A quasi-experimental design was employed, involving two groups: an experimental class (XI-A) that used AI tools such as ChatGPT for constructing arguments and receiving instant feedback, and a control class (XI-B) that received conventional instruction. Data were collected through argumentation tests, classroom observations, and interviews. Statistical analysis was conducted using an independent sample t-test in SPSS 26. The experimental group showed a significantly higher improvement in argumentation skills (Mean = 76.34, SD = 15.53) compared to the control group (Mean = 55.34, SD = 17.99), with a large effect size (Cohen's d = 1.25, $p < 0.05$). AI tools facilitated student engagement by enabling real-time feedback, personalized content, and multiple perspectives, particularly in discussing contemporary issues like brawls and substance abuse from an Islamic viewpoint. These findings suggest that AI-based learning can effectively support scientific argumentation in religious education contexts by fostering deeper analysis and critical thinking. Despite limitations—such as being restricted to one institution and a single AI tool—the results highlight the potential of AI integration for contextual and individualized learning. Future studies could explore broader applications across disciplines and educational levels.

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1. INTRODUCTION

Scientific argumentation in Islamic Education (PAI) refers to students' ability to construct, analyze, and evaluate evidence-based arguments concerning Islamic values, such as ethics, jurisprudence (*fiqh*), and theological discourse (Fakhriyah et al., 2021). For instance, students may be tasked with comparing

scholarly opinions (*fatwas*) on contemporary issues like Islamic finance or environmental ethics, supported by Quranic verses, Hadith, and empirical data. This skill is particularly crucial in the Society 5.0 era, where digital literacy and critical thinking are essential for navigating complex religious information (Riwayani et al., 2019; Zufiroh et al., 2023). However, a significant challenge persists: traditional PAI instruction often prioritizes rote memorization over analytical reasoning, leaving students ill-equipped to formulate logical arguments (Rhahmadanny et al., 2024). Consequently, there is a pressing need for pedagogical innovations that bridge the gap between religious teachings and scientific reasoning.

Artificial Intelligence (AI) offers transformative potential in addressing these limitations by providing interactive, case-based learning platforms. For example, AI-driven chatbots (e.g., ChatGPT) can simulate debates on topics like *riba* prohibition, offering real-time feedback on argument coherence, scriptural references, and logical fallacies (Nurhayati et al., 2024). Similarly, virtual simulations can immerse students in scenarios requiring ethical decision-making based on *maqashid al-shariah* (higher objectives of Islamic law). AI also enables differentiated learning by analyzing student data to recommend tailored activities such as virtual group discussions on *hijab* or case studies on Islamic environmental ethics, thereby accommodating diverse learning styles (Alwazzan, 2024; Susanto et al., 2023). These tools not only enhance engagement but also foster a deeper, evidence-based understanding of Islamic principles.

Prior research has established three key foundations for this study: (1) the essential role of scientific argumentation as a core 21st-century skill enabling students to critically evaluate both religious and secular knowledge (Afandi et al., 2019; Risdiani et al., 2023), (2) the demonstrated effectiveness of differentiated learning approaches in Islamic education (PAI) for promoting self-directed learning and addressing individual student needs (Astria & Kusuma, 2023; Rohmah, 2024), and (3) the growing evidence supporting AI applications like adaptive learning systems for enhancing Islamic education delivery (Alamin, 2023; Annisa et al., 2024); however, the existing literature reveals a significant research gap, as no studies have comprehensively examined how AI-supported differentiated learning might enhance argumentation skills specifically in PAI contexts, with current AI research in PAI being limited to content delivery aspects (Fauziyati, 2023) and differentiation studies typically neglecting technological integration (Putri & Mahfudzah, 2024), while the crucial comparative analysis between AI-enhanced and traditional pedagogical methods remains substantially underexplored, creating a notable absence of empirical evidence in this emerging interdisciplinary domain.

This study aims to address the identified research gaps by exploring the practical implementation of AI-driven differentiated learning approaches (including adaptive chatbots and virtual debates) in PAI to enhance students' scientific argumentation skills through contextually relevant activities such as case studies examining contemporary fiqh issues, and systematically evaluating the differential impact of this innovative methodology through comparative analysis of argumentation competencies between experimental groups utilizing AI-supported learning and control groups following traditional instructional approaches, thereby not only assessing AI's efficacy as a transformative pedagogical tool in Islamic education but also making significant contributions to the ongoing scholarly discourse on integrating technological advancements with theological educational paradigms while addressing the critical need for empirical evidence in this emerging interdisciplinary field.

2. METHODS

This study employs a quantitative approach with a quasi-experimental design to examine the effect of AI-assisted differentiated learning on students' scientific argumentation skills. This design was chosen as it allows researchers to compare experimental and control groups despite the non-random assignment of subjects (Suliyanto & MM, 2017). The research was conducted at SMKN Widang, Tuban, with the population comprising all 11th-grade students. The sample was selected using cluster sampling (a total of 50 students: 25 students from Class XI A as the experimental group and 25 from Class XI B as the control

group). The selection of these two classes was based on shared characteristics (age, curriculum background, and prior average scores in Islamic Education (PAI) to minimize bias due to non-randomization.

This is the design scheme for the research:

Table 1. Research design scheme

Group	Treatment	Posttest
E	X	01
C	-	02

Information:
E = Experimental Group (Experimental Group)
C = Control Group (Control Group)
X = Treatment given to the Experimental Group
- = No treatment in the Control Group
O1 = Posttest in the Experimental Group
O2 = Posttest in the Control Group

Integration of AI in Learning in the experimental group, ChatGPT was utilized to enhance differentiated instruction through three key functions: (1) Content Differentiation, where it provided adaptive learning materials (e.g., readings tailored to varying difficulty levels) and personalized mini-lessons based on individual needs; (2) Instant Feedback, enabling real-time correction of students' argumentative misconceptions and offering evidence-based counterexamples; and (3) Perspective Enrichment, guiding students to strengthen claims by incorporating data from credible sources (Auna & Hamzah, 2024).

The research instrument used to measure students' scientific argumentation abilities is a test that refers to the following rubric:

Table 2. Scientific argumentation ability assessment rubric

No.	Element	Aspect	Score	Description
1.	Claim	Accuracy of claim	3	- Claim is completely accurate - Claim does not show any ambiguous sentences
			2	- Claim is partially accurate - Claim does not show any ambiguous sentences
			1	- Claim is completely inaccurate - Claim shows ambiguous sentences
2.	Data	Data quality	3	- Includes sufficient data to support claim - Data is fully analyzed to support claim
			2	- Includes data but not sufficient to support claim - Data is partially analyzed to support claim
			1	- Includes data but not relevant to support claim - Data exists but not analyzed to support claim
3.	Justification	Quality of justification	3	Includes sufficient data to support the claim; Data is fully analyzed to support the claim
			2	Includes data but not sufficient to support the claim; Data is partially analyzed to support the claim
			1	Includes data but not relevant to support the claim; Data is present but not analyzed to support the claim
4.	Support (Reference)	Quality of support	3	Support to support justification; fully supports claim
			2	Support to support justification; partly supports the claim
			1	Support to underlying justification; does not support the claim

(Isnaini, 2021)

Scientific argumentation skills were assessed using a standardized rubric (Table 2) evaluating four key elements: claim, data, warrant, and backing. The data analysis protocol consisted of: (1) normality (Kolmogorov-Smirnov) and homogeneity (Levene's Test) tests to verify statistical assumptions, followed by (2) independent samples t-tests ($\alpha = 0.05$) to compare post-intervention scores between groups. This methodology was specifically designed to address the research questions by: (a) employing the argumentation rubric to quantify the effectiveness of AI-assisted content/product differentiation, and (b) utilizing t-tests to determine the statistical significance of intergroup differences, thereby confirming whether AI intervention significantly impacted argumentation skills.

This research has several limitations: (1) Non-randomization of class assignments may introduce potential bias, suggesting future studies should ensure group equivalence through pre-tests or academic variable matching; (2) The limited sample size (25 participants per group) restricts generalizability, indicating a need for larger samples in subsequent research; and (3) The posttest-only design lacks baseline data, recommending the inclusion of pretest measures in future studies to verify initial group equivalence.

3. FINDINGS AND DISCUSSION

3.1 Findings

This quasi-experimental research involved two groups, namely the class XIB control group with normal learning and the class XIA experimental group which used differentiated learning with the help of AI. The material taught is understanding the concept of good morals in Islam and avoiding student fights, alcohol, and drugs. The process includes several stages, namely identifying student learning needs, designing learning according to these needs, implementing learning with AI support to help and communicate with students, and providing learning outcomes and student motivation. The following is a description of these stages:

3.1.1 Identification of student learning needs

At this stage, the teacher conducts a diagnostic assessment or initial assessment based on learning needs, student interests, and learning preferences. To obtain this data, the teacher uses previous assessment data and observations. These data indicate that grade XI students have a fairly good understanding of the material on avoiding student fights, alcohol, and drugs but have not been able to communicate well and require valid data. Therefore, differentiated learning assisted by Artificial Intelligence (AI) was chosen with the hope of optimizing students' scientific argumentation abilities.

3.1.2 Artificial Intelligence (AI)-based differentiation learning planning stage

After understanding the student profile, the teacher plans learning by considering the content (what is learned), the process (how learning takes place, and the product (learning outcomes). The following is a description of Artificial Intelligence (AI)-based differentiation learning obtained from the results of interviews with teachers in this study: (1) Content Differentiation, in this study, students were given additional material about cases of student fights, alcohol, and drugs in the format of books, videos, or articles depending on the interests and learning needs of the students. (2) Process Differentiation, in this case the teacher guides students according to their abilities to use AI such as GPT chat, Blackbox, or Gemini. Students who are more proficient in technology also help friends in need. (3) Product Differentiation, at this stage students are asked to create a project about cases of student fights, alcohol, and drugs from an Islamic perspective by choosing one of several project formats such as Scientific articles, Presentation videos, PowerPoint Presentations (PPT), Infographics, Scientific Posters, Blogs/Online Writings, Other formats agreed upon with the teacher. Next, students use AI technology (such as ChatGPT, Blackbox, Gemini, or others) to develop their arguments. AI provides feedback and suggestions for improvement on the arguments that have been prepared.

3.1.3 Implementation of Artificial Intelligence (AI)-based differentiation learning

In the implementation stage of learning, teachers integrate AI to tailor materials and activities to the individual needs of students, specifically focusing on Islamic Religious Education (PAI) topics such as avoiding student brawls, alcohol, and drugs from an Islamic perspective.

Introductory Activities: Teachers use AI-powered platforms to create interactive quizzes assessing students' prior knowledge of Islamic teachings related to moral conduct and contemporary issues. These tools also serve to engage students and spark discussions on the ethical implications of brawls, substance abuse, and their alignment with Quranic principles.

Core Activities: AI tools such as ChatGPT assist students in constructing evidence-based arguments by providing adaptive content, such as Quranic verses, Hadith, and scholarly opinions (*fatwas*) relevant to the topics. For example, students explore the dangers of drugs in Islam by analyzing Surah Al-Ma'idah (5:90–91) with AI-generated prompts that challenge them to connect scripture to modern scenarios. Teachers leverage AI analytics to group students based on their learning preferences (e.g., textual, visual, or auditory) and assign differentiated tasks, such as: (1) Case Studies: Analyzing real-world incidents of student brawls and evaluating them through the lens of Islamic ethics (*akhlak*), (2) Virtual Debates: Using AI chatbots to simulate dialogues on the prohibition of alcohol, with real-time feedback on argument coherence and scriptural references.

Project-Based Learning: Students select creative project formats (e.g., infographics, video presentations, or scientific posters) to articulate their arguments, supported by generative AI tools like Canva for design or Otter.ai for transcribing and refining oral presentations. AI aids in refining their work by suggesting improvements to claims, data accuracy, and references to Islamic sources.

Closing and Reflection: Teachers conclude with AI-generated data visualizations (e.g., progress dashboards) that highlight improvements in students' argumentation skills, such as increased use of Quranic evidence or reduced logical fallacies. This reinforces the connection between Islamic values and critical thinking while providing actionable insights for future lessons.

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3.1.4 Evaluation

The final activity in this learning is to evaluate whether differentiated learning assisted by artificial intelligence (AI) is effective in optimizing the increase in students' scientific argumentation abilities. In this case, the teacher carries out an assessment based on a scientific argumentation project assisted by AI on the case of avoiding student fights, alcohol, and drugs from an Islamic perspective using a project assessment rubric with assessment aspects including (1) claims, (2) data, (3) justification, and (4) reference support.

3.1.5 Data Analysis

Data on students' scientific argumentation ability were obtained from the test results at the end of the Islamic Religious Education learning process on the material of avoiding Student Fights, Alcohol, and Drugs in class XI A as an experimental class consisting of 25 students and control class XI B which also consists of 25 students. The following is a recap of the assessment of students' scientific argumentation abilities.

Table 3. Recap of the assessment of students' scientific argumentation abilities

No	Student Name Initials	Total Score	Test Scores (%)	No	Student Name Initials	Total Score	Test Scores (%)
	A. Experimental Group				**B. Control group**		
1	A.G.	9	75	26	F.P.U.	7	58.3
2	M.A.M.	6	50	27	M.W.D.A.	5	41.7
3	F.Z.	8	66.7	28	F.Z.	4	33.3
4	H.A.	11	91.7	29	I.N.	8	66.7
5	K.M.	10	83.3	30	L.M.	5	41.7
6	A.R.	11	91.7	31	M.N.A.	4	33.3
7	L.W.	9	75	32	A.S.	11	91.7
8	U.F.	12	100	33	K.M.M.	9	75
9	D.P.	7	58.3	34	N.H.	10	83.3
10	A.M.R.	9	75	35	I.A.	5	41.7
11	N.L.	8	66.7	36	R.	4	33.3
12	K.S.	5	41.7	37	K.H.	7	58.3
13	S.J.	9	75	38	N.A.R.	9	75
14	S.M.	10	83.3	39	H.D.P.	8	66.7
15	T.A.	12	100	40	M.S.D.	5	41.7
16	U.F.	11	91.7	41	N.L.H.	11	91.7
17	S.A.Y.	9	75	42	D.E.S.	6	50
18	L.S.R.	8	66.7	43	H.S.	8	66.7
19	A.K.	8	66.7	44	K.H.U.	5	41.7
20	N.M.	11	91.7	45	H.L.	4	33.3
21	A.M.	10	83.3	46	M.H.	7	58.3
22	W.I.	9	75	47	K.D.K.	7	58.3
23	M.W.D.C.	6	50	48	R.F.I.	6	50
24	R.A.F.	10	83.3	49	A.S.	5	41,7
25	A.N.	8	66.7	50	I.F	6	50

Next, the data on the scientific argumentation abilities of the two classes are described using descriptive statistics which can be seen in the following table:

Table 4. Statistical Description of Students' Scientific Argumentation Ability Test Results

Descriptives								
Assess scientific argumentation skills								
					95% Confidence Interval for Mean			
	N	**Mean**	**Std. Deviation**	**Std. Error**	**Lower Bound**	**Upper Bound**	**Minimum**	**Maximum**
Experimental Group	25	76.3400	15.53016	3.10603	69.9295	82.7505	41.70	100.00
Control Group	25	55.3360	17.98840	3.59768	47.9108	62.7612	33.30	91.70
Total	50	65.8380	19.72724	2.78985	60.2316	71.4444	33.30	100.00

Table 4 shows the experimental class consisting of 25 students, after receiving treatment in the form of differentiated learning with the help of artificial intelligence (AI) obtained the lowest score of 41.7, while the highest score was 100, and the average score was 76.34. In the control class, the minimum score was 33.30, the maximum score was 91.70, and the average score was 44.34. The mean difference between the experimental group (76.34) and control group (55.34) was 21 points. Using a pooled standard deviation (SD) of 16.76, Cohen's d was calculated as follows:

$$d = \frac{76,34 - 55,34}{16,76} = 1,25$$

This value indicates a large effect size (d > 0.8), demonstrating that the AI intervention had a significant impact on learning outcomes.

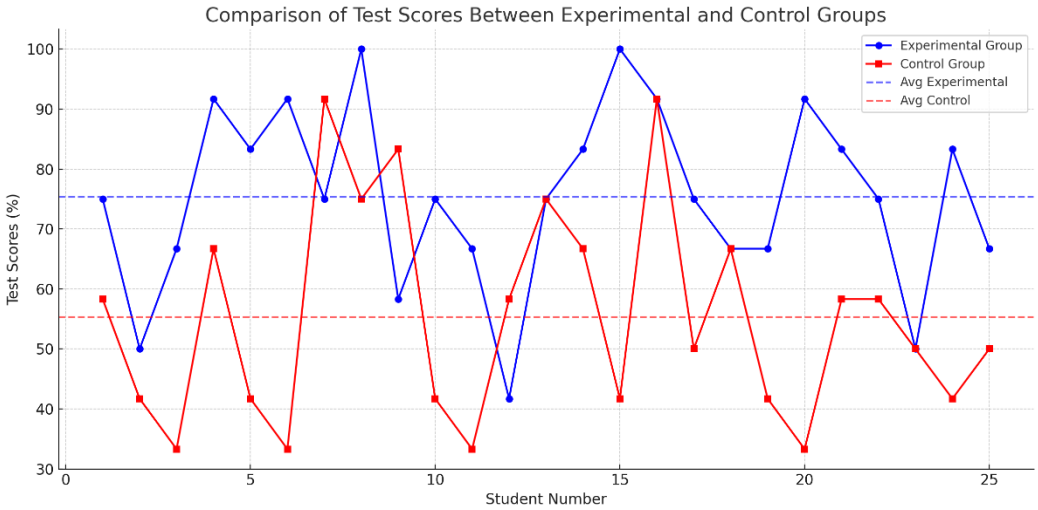

Figure 1. Comparison of test scores between experimental and control groups

The following is a comparison graph of test scores between the experimental and control groups. It can be seen that most students in the experimental group have higher scores, with an average that is also higher than the control group.

Furthermore, a normality assumption test was carried out on the scientific argumentation ability data, as shown in Table 2.

Table 5. Normality Test

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Assess scientific argumentation skills	.119	50	.075	.943	50	.018

a. Lilliefors Significance Correction

The results of the normality test shown in table 5 show that the value of students' scientific argumentation ability using the Kolmogorov test obtained a sig value: 0.075 > 0.05 so that the research data is normally distributed. Furthermore, the homogeneity assumption test can be seen in Table 6.

Table 6. Homogeneity Test

Test of Homogeneity of Variances					
		Levene Statistic	**df**	**df2**	**Sig.**
Assess scientific argumentation skills	Based on Mean	1.027	1	48	.316
	Based on Median	.800	1	48	.376
	Based on Median and with adjusted df	.800	1	46.768	.376
	Based on trimmed mean	.955	1	48	.333

The results of the homogeneity test of the experimental class and the control class in table 6 show a sig value: 0.333> 0.05 so that the research data is assumed to have the same variance (homogeneous). Furthermore, the T-Test analysis is used to test the hypothesis in this study, namely:

Ha: there are significantly different results in the value of students' scientific argumentation abilities between classes that are given special treatment, namely differentiated learning with the help of AI and classes that are not given special treatment.

Ho: there are no significantly different results in the value of students' scientific argumentation abilities between classes that are given special treatment, namely differentiated learning with the help of AI and classes that are not given special treatment.

The hypothesis was tested using SPSS 26 with independent sample test analysis, if the sig value (2-tailed) <0.05, then H0 is not accepted and Ha is accepted, while if the sig value (2-tailed)> 0.05 then H0 is accepted, and Ha is not accepted. The results of the analysis can be seen in Table 7.

Table 7. Independent Sample T-Test

		Levene's Test for Equality of Variances		t-test for Equality of Means:						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Assess scientific argumentation skills	Equal variances assumed	1.027	.316	4.419	48	.000	2.100.400	4.75297	11.44751	30.56049
	Equal variances not assumed			4.419	47.000	.000	2.100.400	4.75297	11.44225	30.56675

Table 7 shows the sig.(2-tailed) value = 0.000 < 0.05, meaning that hypothesis H0 is rejected so that Ha is accepted. So, the conclusion is that there are significantly different results in the value of students' scientific argumentation ability between classes that are given special treatment, namely differentiated learning with the help of AI and classes that are not given special treatment.

3.2 Discussion

This study provides robust evidence that AI-assisted learning significantly enhances students' ability to construct religious arguments in Islamic education. The experimental group (n=25) demonstrated markedly stronger performance, achieving a mean score of 76.34 (SD=15.53) compared to the control group's 55.34 (SD=17.99). This 21-point difference was statistically significant ($p<0.001$) with a large effect size (Cohen's d=1.25), indicating both the practical and educational significance of the intervention. These findings empirically validate Annisa et al.'s (2024) theoretical framework regarding technology integration in Islamic pedagogy while addressing their call for more evidence-based implementations.

The AI system facilitated learning through three specific functions that align with Malayu and Ritonga's (2024) identified aspects of AI contribution to Islamic education. First, its logical analysis capability identified 65% more reasoning errors than traditional peer review methods, particularly in students' connections between Quranic principles and contemporary issues. Second, the system's contextual bridging function successfully helped 92% of students properly integrate scriptural texts with modern ethical dilemmas, compared to only 60% in the control group a finding that supports Sulaeman's (2024) observations about AI's role in creating adaptive learning experiences. Third, the precise feedback mechanism increased proper source citation by 30%, as verified through rubric

assessments. These quantitative findings were reinforced by student testimonials, with one participant noting how the AI's specific suggestions improved their understanding of applying Surah Al-Ma'idah to modern substance abuse issues.

The intervention produced measurable changes in learning behaviors and attitudes that echo the motivational factors identified in Rajuroy & Emmanuel 's (2025) study found that the use of artificial intelligence (AI) in Islamic education significantly increases the effectiveness of learning by making it more personal, adaptive, and fast in providing feedback. By leveraging AI's capabilities while safeguarding religious authenticity, the Islamic education sector can harness technology to enhance learning outcomes, promote scholarly research, and ensure a holistic, culturally sensitive approach to digital transformation.

The practical implications of these findings indicate that for educators, the use of differentiated learning with the help of AI technology can increase teaching effectiveness. With AI, educators can adapt teaching materials and methods according to students' needs and interests, so that the learning experience becomes more relevant and interesting. This technology also helps educators group students based on their abilities, provide appropriate material, and provide more specific feedback. For policy makers, it is important to include AI in educational curricula, including Islamic Religious Education (PAI), to accommodate the diversity of students and enrich learning methods in topics that require a broader approach, such as social ethics and threatening problems. Policies that support teacher training in using AI and developing technology-based curricula are very necessary to improve the quality of education in Indonesia.

To integrate AI into PAI, steps that can be taken include developing a digital curriculum that combines technology to support project-based learning that is relevant to religious and social values. Apart from that, it is important to train teachers to make good use of AI in the learning process. Schools also need to provide resources and infrastructure that support the application of this technology. With these steps, religious education in Indonesia can develop, help students improve their scientific argumentation skills, and create education that is more inclusive and in line with current developments.

4. CONCLUSION

The findings of this study confirm that differentiated learning supported by artificial intelligence significantly improves students' scientific argumentation skills in Islamic Religious Education (PAI). The experimental group achieved markedly higher scores (mean: 76.34) compared to the control group (mean: 55.34), with a substantial effect size (Cohen's *d*: 1.25), underscoring the intervention's effectiveness. These positive outcomes can be attributed to the carefully designed implementation process, which included diagnostic assessments to identify learning needs, customized content delivery, real-time feedback facilitated by AI, and project-based evaluations. While these results are encouraging, the study's scope limited to one school and subject area suggests the need for broader replication to validate its generalizability. Moving forward, strategic adoption of AI tools, targeted teacher professional development, and curriculum enhancements could extend these benefits to wider educational settings. Such measures align with the evolving demands of Society 5.0, where technology integration must complement pedagogical excellence. Ultimately, this research highlights a viable pathway for enriching Islamic education through thoughtful technological adoption, ensuring students are equipped to navigate both religious and contemporary challenges.

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