

The Effects of Turats Learning, AI, Digital Literacy, Spiritual Leadership, and Collaboration on Santri Achievement through Engagement

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Keywords:

Turats Learning;
Artificial Intelligence;
Digital Literacy;
Student Engagement;
Santri Achievement.

Abstract

The development of digital technology has transformed learning systems in Islamic boarding schools. Santri no longer rely solely on traditional kitab-based learning but also utilize digital technology and artificial intelligence in daily academic activities. This study aims to analyze the effects of Turats Learning, AI Assisted Learning, digital literacy, spiritual leadership, and collaborative learning on santri academic achievement through student engagement. The research employed a quantitative approach using a survey method involving 250 santri from several modern Islamic boarding schools in East Java, Indonesia. Data were collected through questionnaires distributed using purposive sampling techniques. Data analysis was conducted using Partial Least Square Structural Equation Modeling (SEM-PLS). The hypotheses examined both direct and indirect relationships among the variables. The findings reveal that Turats Learning and digital literacy have strong effects on student engagement and santri academic achievement. AI-assisted learning and collaborative learning also significantly improve student participation in the learning process. This study contributes to the development of an adaptive Islamic boarding school education model that integrates digital transformation while maintaining spiritual values and traditional Islamic learning culture. The findings highlight the importance of balancing modern technology with pesantren academic traditions to improve the quality of santri education.

Abstrak

Perkembangan teknologi digital telah membawa perubahan pada sistem pembelajaran di lingkungan pesantren. Santri tidak lagi hanya belajar melalui metode tradisional berbasis kitab, tetapi mulai memanfaatkan teknologi digital dan kecerdasan buatan dalam aktivitas akademik sehari-hari. Penelitian ini bertujuan menganalisis pengaruh Turats Learning, AI Assisted Learning, literasi digital, kepemimpinan spiritual, dan collaborative learning terhadap prestasi akademik santri melalui student engagement. Penelitian menggunakan pendekatan kuantitatif dengan metode survei pada 250 santri di beberapa pesantren modern di Jawa Timur. Pengumpulan data dilakukan melalui penyebaran kuesioner menggunakan teknik purposive sampling. Analisis data menggunakan Structural Equation Modeling berbasis Partial Least Square (SEM-PLS). Hipotesis penelitian menguji pengaruh langsung dan tidak langsung antarvariabel penelitian. Hasil penelitian menunjukkan bahwa Turats Learning dan literasi digital memiliki pengaruh kuat terhadap student engagement dan prestasi akademik santri. Penggunaan AI dan proses pembelajaran kolaboratif juga terbukti meningkatkan keterlibatan santri dalam proses pembelajaran. Penelitian ini memberikan kontribusi pada pengembangan model pendidikan pesantren yang adaptif terhadap transformasi digital tanpa menghilangkan nilai spiritual dan tradisi pembelajaran Islam. Temuan penelitian menegaskan pentingnya keseimbangan antara teknologi modern dan budaya akademik pesantren dalam meningkatkan kualitas pendidikan santri

Kata kunci:

Pembelajaran Turats;
Kecerdasan Buatan;
Literasi Digital;
Keterlibatan Siswa;
Prestasi Santri.

Article history:

Received: 29-05-2026

Revised 12-07-2026

Accepted 28-07-2026

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INTRODUCTION

The rapid advancement of digital technology has significantly transformed educational practices across various learning environments, including Islamic boarding schools (*pesantren*) (Baihaqi et al., 2023; Kardi et al., 2023; Mursidah & Nadhir, 2025). The integration of Artificial Intelligence (AI), digital learning platforms, and online collaborative tools has created new opportunities for improving learning effectiveness and accessibility (Dwivedi et al., 2023; Kasneci et al., 2023) (Indasari, 2026; Sutrisno et al., 2025). Within the *pesantren* context, however, educational objectives extend beyond academic achievement. *Pesantren* are also responsible for cultivating moral values, religious understanding, and intellectual traditions through the study of classical Islamic texts (*turats*). This dual responsibility creates a unique challenge (Amalia, 2026; Mustikamah et al., 2025). On one hand, *pesantren* are expected to adapt to technological developments; on the other hand, they must preserve their educational identity rooted in Islamic scholarship and character formation. Understanding how traditional learning approaches and modern educational technologies interact has therefore become an important issue for both educational theory and the future development of Islamic education institutions.

Recent studies have demonstrated that AI-assisted learning, digital literacy, spiritual leadership, and collaborative learning positively influence student engagement and academic achievement in various educational settings (Bond et al., 2021; Getenet et al., 2024; Du et al., 2026). Research has also confirmed that engagement serves as a key predictor of learning success because engaged students tend to demonstrate higher motivation, participation, and academic performance (Alajmi, 2021). Nevertheless, most previous studies have been conducted in general education contexts and have focused on technology adoption, digital competencies, or learning outcomes separately. Limited attention has been given to how these factors operate simultaneously within the *pesantren* environment, where religious values, traditional learning systems, and spiritual leadership remain central components of education (Achruah et al., 2024). Furthermore, empirical evidence regarding the role of student engagement as a mediating mechanism connecting *Turats Learning*, *AI-Assisted Learning*, *Digital Literacy*, *Spiritual Leadership*, and *Collaborative Learning* to *Santri Academic Achievement* remains scarce.

This gap is particularly important because preliminary observations conducted in several modern *pesantren* in East Java indicate a growing dependence on digital technologies among students. A preliminary survey involving 60 students found that 68% used AI-based tools almost every day to support academic activities, while only 41% reported maintaining strong engagement in intensive *Turats* learning. Interviews with several *ustadz* further revealed concerns regarding declining learning concentration, uneven digital literacy skills, and the increasing challenge of ensuring that technology use remains aligned with *pesantren* values. These findings suggest that technological adoption alone may not guarantee improved academic achievement. Instead, student engagement may function as a crucial mechanism through which traditional learning, technological competencies, leadership practices, and collaborative learning influence educational outcomes.

Based on these conditions, this study seeks to address an important theoretical and practical gap in the literature. Theoretically, this research extends student engagement theory by integrating traditional Islamic learning (*Turats Learning*) with contemporary educational factors, including *AI-Assisted Learning*, *Digital Literacy*, *Spiritual Leadership*, and *Collaborative Learning* within a single empirical framework.

Practically, the study provides evidence that may assist pesantren leaders, educators, and policymakers in designing learning systems that effectively combine technological innovation with the preservation of Islamic educational values. The novelty of this study lies in examining the simultaneous influence of these five antecedent variables on Santri Academic Achievement through Student Engagement, an approach that remains relatively underexplored in pesantren-based educational research.

Hypothesis Development

Student engagement reflects students' cognitive, emotional, and behavioral involvement in learning activities. Previous studies suggest that students who actively participate in the learning process tend to achieve better academic outcomes (Bond et al., 2021). In the pesantren context, engagement is expected to be influenced by both traditional and modern learning factors.

Turats Learning encourages deep intellectual involvement through intensive study of classical Islamic texts and is expected to strengthen student engagement and academic achievement. Similarly, AI-Assisted Learning provides personalized learning support and broader access to educational resources, potentially increasing both engagement and learning outcomes (Kasneci et al., 2023). Digital Literacy enables students to effectively evaluate and utilize information, thereby supporting meaningful participation in learning activities. Spiritual Leadership contributes to creating a supportive learning environment through role modeling, value transmission, and motivation (Nurabadi et al., 2021). Collaborative Learning facilitates active interaction, discussion, and knowledge sharing among students, which may further enhance engagement and achievement (Zhang & Zou, 2022).

Accordingly, the following hypotheses are proposed:

- H1: Turats Learning positively affects Student Engagement.
- H2: Turats Learning positively affects Santri Academic Achievement.
- H3: AI-Assisted Learning positively affects Student Engagement.
- H4: AI-Assisted Learning positively affects Santri Academic Achievement.
- H5: Digital Literacy positively affects Student Engagement.
- H6: Digital Literacy positively affects Santri Academic Achievement.
- H7: Spiritual Leadership positively affects Student Engagement.
- H8: Spiritual Leadership positively affects Santri Academic Achievement.
- H9: Collaborative Learning positively affects Student Engagement.
- H10: Collaborative Learning positively affects Santri Academic Achievement.

This study also proposes that Student Engagement mediates the relationships between Turats Learning, AI-Assisted Learning, Digital Literacy, Spiritual Leadership, Collaborative Learning, and Santri Academic Achievement. The following is a diagram of the conceptual framework:

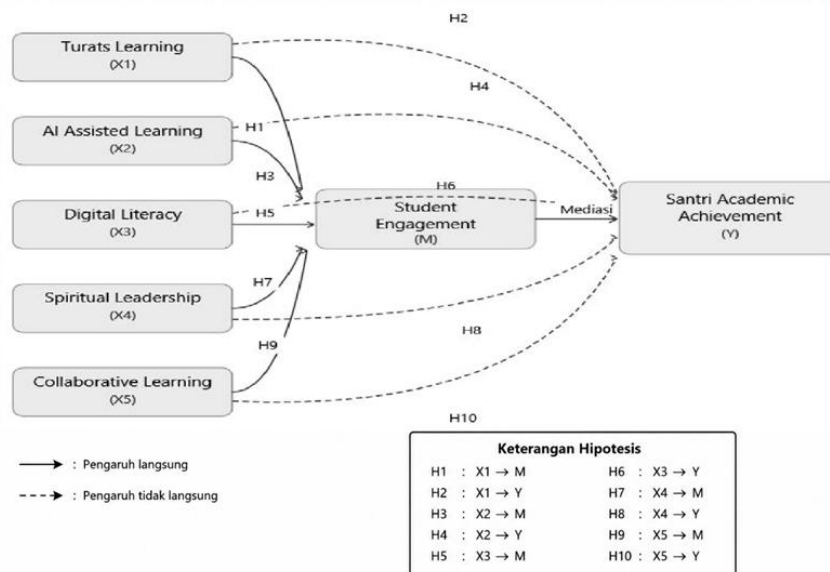


Figure 1 *Conceptual Framework*
 Sumber: data processed by the author, 2026

RESEARCH METHOD

This study employs a quantitative approach with an explanatory research design to test the relationships among variables within the research model. The research focuses on the influence of Turats Learning, Artificial Intelligence (AI), Digital Literacy, Spiritual Leadership, and Collaboration on Santri Achievement through Engagement as a mediating variable. The research was conducted at several modern and semi-modern Islamic boarding schools in East Java that have utilized digitalbased learning in their academic activities. The selection of research locations was based on the consideration that these boarding schools have begun integrating digital technology with the Turats learning system.

The population in this study consists of all active senior high school-level santri and pesantren students involved in both formal and non-formal digital-based learning. The sampling technique employed purposive sampling, with criteria including santri who actively participate in Turats learning, use digital media in their studies, and have experience using AI technology in academic activities. The sample size comprised 250 respondents. This number was deemed sufficient for Structural Equation Modeling–Partial Least Squares (SEM-PLS) analysis, as it adequately represents the relationships among constructs in the research model. Data collection was conducted through the distribution of questionnaires both in person and online using a five-point Likert scale, ranging from a score of 1 (strongly disagree) to a score of 5 (strongly agree).

The independent variables in the study consist of Turats Learning (X1), AI (X2), Digital Literacy (X3), Spiritual Leadership (X4), and Collaboration (X5). The mediating variable is Engagement (M), while the dependent variable is Santri Achievement (Y). The Turats Learning indicator is measured through understanding of classical texts, depth of study, and consistency in studying Turats. The AI variable is measured through the intensity of AI use in learning, ease of access to information, and the effectiveness of technology use in understanding the material. Digital Literacy is measured through the ability to understand, evaluate, and utilize digital information wisely. Spiritual

Leadership is measured through exemplary behavior, spiritual values, motivation, and leadership approaches within the pesantren environment. Collaboration is measured through the ability to work together, group discussions, and participation in collective learning. Meanwhile, Engagement is measured through students' emotional, cognitive, and behavioral involvement in the learning process. Student Achievement is measured through academic performance, understanding of the material, and consistency in academic achievement.

The research instruments were tested for validity and reliability before being used in the main analysis phase. Data processing was conducted using the SEM-PLS method with the assistance of SmartPLS software. The analysis stage included evaluations of the outer model and inner model. The outer model evaluation was performed through convergent validity testing using outer loadings and Average Variance Extracted (AVE), discriminant validity using the Fornell-Larcker Criterion and HTMT, as well as composite reliability and Cronbach's alpha to assess construct reliability. Furthermore, the inner model evaluation was conducted through tests of path coefficients, t-statistics, p-values, R-squared, effect size (f^2), predictive relevance (Q^2), and Standardized Root Mean Square Residual (SRMR). Hypothesis testing was performed using bootstrapping with a significance level of 5% or a t-statistic value > 1.96 . Through these stages, this study is expected to provide an empirical description of the relationships between variables in improving students' academic achievement in the era of digital learning.

RESULTS AND DISCUSSION

RESULTS

Descriptive Statistics of Respondents

This study involved 250 student respondents from several modern and semi-modern Islamic boarding schools in East Java. Respondent characteristics indicate that the majority of respondents are aged 17–23 years and are actively engaged in boarding school learning activities and the use of digital technology. Based on the questionnaire results, the majority of students have used digital media and Artificial Intelligence (AI) in the learning process, particularly for reference searches, book translation, and online academic discussions.

Table 1
Characteristics of Research Respondents

Characteristics	Category	Total	Percentage
Gender	Male	138	55,2%
	Female	112	44,8%
Age	17–19 Years	96	38,4%
	20–23 Years	154	61,6%
Length of Boarding School	< 3 Years	73	29,2%
	≥ 3 Years	177	70,8%
Use of AI in Learning	Frequently	168	67,2%
	Rarely	82	32,8%

Source: Processed primary data, 2026.

The descriptive results indicate that students are becoming accustomed to using digital technology in their daily learning. However, traditional learning remains a central component of the pesantren education system. This demonstrates an ongoing process of adaptation between traditional learning systems and modern technological advancements within the pesantren environment.

Outer Model Evaluation

An outer model evaluation was conducted to ensure that all research indicators met the criteria for validity and reliability. The first test was conducted using outer loading values. The test results showed that all indicators had outer loading values above 0.70, thus meeting the criteria for convergent validity. These values indicate that the indicators are able to explain the latent construct well

Table 2
Convergent Validity Test Results

Variable	Outer Loading	Description
Turats Learning	0,722 – 0,786	Valid
AI	0,735 – 0,785	Valid
Digital Literacy	0,716 – 0,792	Valid
Spiritual Leadership	0,727 – 0,801	Valid
Collaboration	0,711 – 0,772	Valid
Engagement	0,773 – 0,796	Valid
Santri Achievement	0,809 – 0,829	Valid

Source: SmartPLS Output, 2026.

Next, reliability testing was conducted using Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE). The test results showed that all constructs had Cronbach's Alpha and Composite Reliability values greater than 0.70 and AVE values above 0.50. Thus, all variables were deemed reliable and capable of explaining the variance of the indicators well.

Table 3
Results of Reliability and AVE Tests

Variabel	Cronbach's Alpha	Composite Reliability	AVE
Turats Learning	0,932	0,941	0,572
AI	0,934	0,943	0,580
Digital Literacy	0,933	0,942	0,574
Spiritual Leadership	0,935	0,943	0,581
Collaboration	0,930	0,940	0,565
Engagement	0,792	0,865	0,616
Santri Achievement	0,755	0,859	0,671

Source: SmartPLS Output, 2026

Additionally, testing of discriminant validity using the Fornell-Larcker Criterion and HTMT indicates that each construct exhibits good empirical distinction from the others. All HTMT values are below 0.90, so the model meets the criteria for discriminant validity

Inner Model Evaluation

Inner model evaluation was conducted to examine the relationships among variables within the research model. The multicollinearity test showed that all Variance Inflation Factor (VIF) values were below 5. This indicates that the research model is free from multicollinearity issues.

Furthermore, the results of the path coefficient test show that all independent variables have a positive and significant effect on engagement and santri achievement

Table 4
Results of the Direct Effect Hypothesis Test

Relationships Between Variables	Path Coeffisient	T-Statistics	P-Values	Description
AI → Engagement	0,498	9,707	0,000	Significant
Turats Learning → Engagement	0,538	8,783	0,000	Significant
Collaboration → Engagement	0,429	8,164	0,000	Significant
Spiritual Leadership → Engagement	0,501	8,421	0,000	Significant
Digital Literacy → Engagement	0,462	8,936	0,000	Significant
Engagement → Santri Achievement	0,244	2,329	0,020	Significant

Source: SmartPLS Output, 2026

These results indicate that Turats Learning has the greatest influence on student engagement compared to other variables. This finding demonstrates that the study of classical texts remains the primary foundation capable of enhancing student engagement despite the ongoing development of digital technology.

In addition to direct effects, this study also examined indirect effects through the mediating variable of engagement

Table 5
Indirect Effect Test Results

Mediation Relationship	Path Coeffisient	T-Statistics	P-Values	Description
AI → Engagement → Achievement	0,122	2,339	0,019	Significant
Turats Learning → Engagement → Achievement	0,131	2,310	0,021	Significant
Collaboration → Engagement → Achievement	0,105	2,263	0,024	Significant
Spiritual Leadership → Engagement → Achievement	0,122	2,303	0,021	Significant
Digital Literacy → Engagement → Achievement	0,113	2,308	0,021	Significant

Source: SmartPLS Output, 2026

These results indicate that engagement serves as a significant mediator in the relationship between all independent variables and student achievement. In other words, students' active engagement acts as a crucial factor that amplifies the influence of learning, technology, spiritual leadership, and collaboration on students' academic achievement.

Furthermore, the R-Square value indicates that engagement is explained by independent variables by 70.9%, while student achievement is explained by independent variables by 42.7%. These values indicate that the research model possesses a fairly strong predictive capability

Table 6
R-Square Value

Endogenous Variables	R-Square	Adjusted R-Square
Engagement	0,709	0,703
Santri Achievement	0,427	0,413

Source: SmartPLS Output, 2026

Furthermore, the predictive relevance (Q^2) result shows a value above zero and an SRMR value of 0.050, which is below the 0.08 threshold. Thus, the research model is deemed to have a good goodness of fit and is suitable for use in testing the research hypotheses

DISCUSSION

Turats Learning and Student Engagement

The findings demonstrate that Turats Learning positively influences Student Engagement. From a theoretical perspective, this result can be explained through the Social Constructivist Learning Theory, which emphasizes that knowledge is developed through meaningful interaction, reflection, and participation in a learning community. The study of classical Islamic texts requires students to engage in intensive reading, interpretation, discussion, and consultation with teachers, creating a learning environment that naturally promotes cognitive and emotional engagement. Unlike many contemporary learning approaches that emphasize rapid information acquisition, Turats Learning encourages deep processing of knowledge and sustained intellectual involvement.

These findings extend previous studies that primarily viewed Turats Learning as a mechanism for transmitting religious knowledge and preserving Islamic traditions (Indra & Alim, 2024). The present study demonstrates that Turats Learning also functions as a significant driver of student engagement in technology-supported learning environments. This finding challenges the common assumption that traditional learning methods become less relevant as educational technology advances. Instead, the results suggest that traditional Islamic learning can coexist with digital innovation and may even provide the intellectual and moral foundation necessary for meaningful engagement in modern educational settings.

From a practical perspective, pesantren administrators should not regard digital transformation as a replacement for traditional learning systems. Rather, technology integration should strengthen the pedagogical values embedded in Turats Learning. This finding contributes to the emerging discourse on hybrid Islamic education by showing that educational modernization and preservation of traditional scholarship are not mutually exclusive.

Artificial Intelligence, Engagement, and Academic Achievement

The positive effect of AI-Assisted Learning on both Student Engagement and Academic Achievement supports recent arguments derived from Technology Acceptance Theory and Self-Determination Theory. AI technologies provide immediate feedback, personalized learning support, and rapid access to information, all of which can enhance learners' perceptions of competence and autonomy. These psychological conditions are known to stimulate higher levels of engagement and academic performance.

While previous studies have consistently reported the educational benefits of AI (Xu, 2024; Kasneci et al., 2023), the present findings reveal an important contextual nuance. AI does not directly improve learning outcomes independently. Its effectiveness largely depends on students' active involvement in the learning process. Students who critically evaluate AI-generated information, engage in discussion, and integrate AI outputs into deeper learning activities achieve significantly better outcomes than students who use AI merely for obtaining quick answers.

This finding contributes to the growing debate regarding the role of AI in education. Rather than viewing AI as a substitute for learning, this study supports the perspective that AI should function as a cognitive partner that enhances students' intellectual engagement. Therefore, the educational value of AI depends not only on technological capability but also on learners' willingness to engage actively with knowledge construction processes.

Digital Literacy and Learning Outcomes

Digital Literacy emerged as a significant predictor of both Student Engagement and Academic Achievement. This finding can be interpreted through Information Processing Theory, which argues that individuals' ability to evaluate, organize, and utilize information influences the effectiveness of learning activities. Students with stronger digital literacy skills are more capable of identifying credible information, integrating multiple sources of knowledge, and participating actively in digital learning environments.

The findings support earlier research emphasizing the importance of digital literacy in contemporary education (Safitri, 2020; Getenet et al., 2024). However, this study extends the literature by demonstrating that digital literacy within pesantren settings involves dimensions that are not commonly emphasized in mainstream educational research. Beyond technical competence, students are expected to exercise ethical judgment, digital etiquette, and moral responsibility when engaging with online information.

This distinctive characteristic highlights the importance of integrating digital literacy with Islamic ethical values. Consequently, the study contributes a context-specific perspective to digital literacy research by demonstrating that effective digital competence in religious educational institutions requires both technological proficiency and moral accountability.

Spiritual Leadership and Student Engagement

The positive relationship between Spiritual Leadership and Student Engagement reinforces the assumptions of Spiritual Leadership Theory, which suggests that values-based leadership creates meaningful learning experiences and strengthens organizational commitment. In pesantren, spiritual leadership is embodied by kiai and ustaz who function simultaneously as educators, mentors, and moral exemplars.

Consistent with previous findings (Afkarina et al., 2025), the results confirm that spiritual leadership contributes to creating a supportive academic culture. However, the current study provides a deeper explanation by demonstrating that spiritual leadership becomes particularly important during periods of educational transformation. As pesantren increasingly adopt digital technologies, students may experience uncertainty regarding the appropriate use of technology within Islamic educational contexts.

The findings suggest that spiritual leadership acts as a stabilizing mechanism that aligns technological innovation with institutional values. This role goes beyond motivation and discipline; it helps preserve the cultural identity of pesantren while facilitating adaptation to changing educational demands. Therefore, spiritual leadership should be viewed as a strategic resource for sustainable educational transformation in Islamic institutions.

Collaboration and Academic Achievement

The positive influence of Collaborative Learning on Student Engagement and Academic Achievement is consistent with Social Interdependence Theory, which argues that learning outcomes improve when individuals work together toward shared goals. Collaborative learning enables students to exchange ideas, solve problems collectively, and construct knowledge through social interaction.

Although previous studies have established the academic benefits of collaborative learning (Musfirah et al., 2020), this study reveals that collaboration within pesantren environments possesses unique characteristics. Collaboration is deeply embedded in the traditions of musyawarah, collective learning, and mutual support that have long characterized Islamic boarding school culture.

This cultural dimension differentiates collaboration in pesantren from conventional group-based learning models. Students engage not only for academic purposes but also to strengthen social bonds, develop solidarity, and cultivate collective responsibility. These additional dimensions explain why collaborative learning demonstrates a particularly strong relationship with engagement in the pesantren context.

The Mediating Role of Student Engagement

Perhaps the most important finding of this study is the significant mediating role of Student Engagement. The results indicate that engagement serves as the primary mechanism through which Turats Learning, AI-Assisted Learning, Digital Literacy, Spiritual Leadership, and Collaborative Learning influence Academic Achievement.

This finding is consistent with Student Engagement Theory, which positions engagement as a central determinant of learning success (Bond et al., 2021). However, the present study extends the theory by demonstrating that engagement in pesantren education is not driven by a single factor. Instead, it emerges from the interaction of traditional learning practices, technological competence, spiritual values, and collaborative learning experiences.

The theoretical contribution of this study lies in proposing an integrated engagement model for Islamic boarding schools. The findings suggest that successful educational transformation in pesantren cannot rely solely on technological adoption. Sustainable improvement in student achievement requires balancing innovation with spiritual values, traditional scholarship, and active student participation. This integrated perspective offers a new framework for understanding how Islamic educational institutions can remain relevant in the digital era while preserving their distinctive educational identity.

CONCLUSION

This study reveals that student engagement is the primary mechanism through which Turats Learning, Artificial Intelligence (AI), Digital Literacy, Spiritual Leadership, and Collaboration influence Santri Academic Achievement. The most important and unexpected finding is that Turats Learning emerged as the strongest predictor of student engagement, exceeding the influence of more contemporary factors such as AI-Assisted Learning and Digital Literacy. This finding is particularly noteworthy because it challenges the common assumption that technological innovation is the dominant driver of educational success in the digital era. The results indicate that the traditional intellectual practices embedded in classical Islamic text studies continue to play a crucial role in sustaining students' cognitive, emotional, and behavioral involvement in

learning. Another significant finding is that AI does not automatically improve academic achievement. Its positive impact becomes meaningful only when students demonstrate strong engagement in the learning process. These findings suggest that technology functions as an enabling tool rather than a direct determinant of educational success within the pesantren context.

This study contributes to the literature in several ways. First, it confirms previous findings regarding the positive roles of Digital Literacy, Spiritual Leadership, Collaborative Learning, and Student Engagement in improving educational outcomes. Second, it extends existing research by demonstrating that these factors operate differently within the pesantren environment, where religious traditions, spiritual values, and communal learning cultures remain central to educational practices. Third, the study offers a new perspective by integrating Turats Learning, AI-Assisted Learning, Digital Literacy, Spiritual Leadership, and Collaborative Learning into a single empirical framework with Student Engagement serving as the mediating mechanism. This integrated model contributes to the development of student engagement theory by showing that engagement in Islamic boarding schools is shaped not only by technological and pedagogical factors but also by traditional religious learning and spiritual leadership. Consequently, this research challenges the assumption that educational modernization requires the replacement of traditional learning systems and instead demonstrates that tradition and technology can coexist and reinforce one another in promoting student achievement.

Despite its contributions, this study has several limitations. The research was conducted exclusively in modern and semi-modern pesantren located in East Java, limiting the generalizability of the findings to other pesantren contexts, particularly traditional salaf pesantren that may exhibit different educational characteristics and technological adoption patterns. The sample was restricted to 250 respondents from a specific educational level and age group, which may not fully capture the diversity of student experiences across Indonesia. Furthermore, the study employed a cross-sectional quantitative design, preventing a deeper exploration of how students experience AI integration, digital transformation, and engagement in their daily learning activities. Future studies should therefore expand the geographical scope, include larger and more diverse samples, and examine different types of pesantren across various regions. The use of mixed-methods or qualitative approaches is also recommended to provide richer insights into the interaction between traditional learning values and emerging educational technologies. Such efforts will contribute to a more comprehensive understanding of digital transformation in Islamic education and provide stronger evidence for the formulation of educational policies that are both technologically adaptive and culturally responsive.

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