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STRENGTHENING RELIGIOUS MODERATION THROUGH DEEP-LEARNING-ASSISTED LOCAL-WISDOM LEARNING MATERIALS IN ISLAMIC BOARDING SCHOOLS

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ABSTRACT

The rapid development of artificial intelligence (AI) offers new opportunities for educational, however, its role in value-oriented Islamic education remains insufficiently understood, particularly in relation to culturally grounded learning and religious moderation. This study examines how deep-learning-assisted local-wisdom learning materials contribute to strengthening religious moderation in Islamic boarding schools (*pesantren*) while preserving cultural authenticity and teacher mediation. A sequential exploratory mixed-methods design was employed across seven *pesantren* in South Sumatra, Indonesia. Qualitative data were collected through interviews, observations, and document analysis involving 30 teachers and 12 *pesantren* leaders and were thematically analyzed using NVivo 12 Plus. The quantitative phase involved a questionnaire administered to 250 students to examine moderation-related responses. The findings reveal a complementary relationship among technology, culture, pedagogy, and social experience. Deep-learning-assisted technology primarily supported the organization, contextualization, and enrichment of learning materials and facilitated conceptual understanding, while local wisdom provided cultural authenticity and contextual relevance. Teachers played a critical role in ensuring the cultural, religious, and pedagogical appropriateness of technology-assisted materials. Most importantly, direct social experiences, including group discussions, cooperation, communal religious practices, and everyday interactions, emerged as the primary context for internalizing moderation values. Quantitative responses showed positive patterns in tolerance understanding, discipline, and cooperation. The study concludes that religious moderation is strengthened not through technological intervention alone but through the integration of technological support, culturally grounded knowledge, teacher mediation, and lived social experience. These findings offer a human-centered and culturally responsive framework for integrating AI-assisted learning into *pesantren* education.

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kecerdasan buatan; <i>deep learning</i> ; kearifan lokal; moderasi beragama; pondok pesantren	Perkembangan kecerdasan buatan (<i>Artificial Intelligence/AI</i>) membuka peluang baru bagi inovasi pembelajaran, tetapi perannya dalam pendidikan Islam yang berorientasi pada pembentukan nilai masih belum sepenuhnya dipahami, khususnya dalam kaitannya dengan kearifan lokal dan moderasi beragama. Penelitian ini bertujuan menganalisis bagaimana bahan ajar berbasis kearifan lokal dengan <i>deep learning</i> berkontribusi terhadap penguatan moderasi beragama di pondok pesantren dengan tetap mempertahankan autentisitas budaya. Penelitian menggunakan desain <i>sequential exploratory mixed methods</i> pada tujuh pondok pesantren di Sumatera Selatan. Data kualitatif diperoleh melalui wawancara, observasi, dan analisis dokumen yang melibatkan 30 ustaz/ustazah dan 12 pimpinan pesantren, kemudian dianalisis secara tematik berbantuan NVivo 12 Plus. Tahap kuantitatif melibatkan 250 santri melalui penyebaran kuesioner untuk mengidentifikasi respons terkait dimensi moderasi beragama. Hasil penelitian menunjukkan hubungan yang saling melengkapi antara teknologi, kearifan lokal, pendidik, dan pengalaman sosial. Teknologi berbantuan <i>deep learning</i> terutama mendukung pengorganisasian, kontekstualisasi, dan pengayaan bahan ajar serta membantu pemahaman konseptual santri. Kearifan lokal memberikan autentisitas budaya dan relevansi kontekstual, sedangkan pendidik berperan penting dalam memastikan kesesuaian budaya, keagamaan, dan pedagogis materi berbantuan teknologi. Temuan utama menunjukkan bahwa pengalaman sosial langsung melalui diskusi, kerja sama, praktik keagamaan komunal, dan interaksi sehari-hari menjadi konteks utama internalisasi nilai moderasi beragama. Respons kuantitatif juga menunjukkan pola positif pada pemahaman toleransi, disiplin, dan kerja sama. Penelitian ini menyimpulkan bahwa penguatan moderasi beragama tidak dihasilkan oleh teknologi semata, melainkan melalui integrasi dukungan teknologi, kearifan lokal, pendidik, dan pengalaman sosial yang nyata.

A. INTRODUCTION

Religious moderation has become an increasingly important educational concern in culturally and religiously diverse societies. In Indonesia, religious diversity intersects with ethnic, linguistic, and cultural plurality, requiring educational institutions to develop not only students' religious knowledge but also their capacity for tolerance, justice, social responsibility, respect for diversity, and peaceful coexistence. These competencies are particularly important amid continuing concerns about exclusivist religious attitudes, identity-based polarization, stereotyping, and intolerance among younger generations. Religious education, therefore, needs to move beyond the transmission of doctrinal knowledge toward learning processes that enable students to understand, experience, and practice religious values within their social and cultural realities.

Within this context, Islamic boarding schools (*pesantren*) occupy a strategic position. Pesantren are not merely institutions for transmitting Islamic knowledge but also socio-cultural environments in which students' religious identities, moral dispositions, and patterns of social interaction are continuously formed. Religious learning in pesantren takes place through formal instruction as well as through interactions with *kyai*, *ustadz/ustadzah*, peers, institutional traditions, communal religious practices, and surrounding communities. Religious moderation in this context is closely associated with Islamic principles such as *tawassuṭ* (moderation), *tawāzun* (balance), *i'tidāl* (justice), *tasāmuḥ* (tolerance), and *ukhuwwah*

(brotherhood). These principles are not merely cognitive concepts to be learned but values that need to be internalized and manifested in students' attitudes and everyday social behavior. Consequently, strengthening religious moderation in pesantren requires pedagogical approaches that connect normative Islamic teachings with students' lived cultural and social experiences.

Local wisdom provides an important pedagogical resource for establishing this connection. It encompasses culturally inherited knowledge, traditions, ethical principles, language, narratives, social practices, and collective values transmitted across generations. Previous research has demonstrated that culturally grounded education can contribute to character development, cultural identity, social cohesion, tolerance, and appreciation of diversity. In Islamic educational settings, recent studies have further demonstrated the relevance of local wisdom to religious moderation. Zahrah and Amaliyah (2024), for instance, show that local traditions, educational culture, teacher exemplification, and everyday educational practices can contribute to the cultivation of religious moderation. Sugianto et al. (2024) similarly emphasize culturally embedded values as an important foundation for constructing moderation-oriented religious education, while Syarif et al. (2025) demonstrate that local-wisdom-based religious education in pesantren operates through a broader social ecology involving *kyai*, students, alumni, institutional traditions, and community networks. These studies suggest that religious moderation becomes more meaningful when Islamic values are connected to culturally recognizable practices rather than presented merely as abstract normative principles.

This cultural dimension is particularly relevant in South Sumatra, where pesantren operate within diverse Palembang Malay, Ogan, Komerling, Basemah, and Musi cultural environments. These communities maintain traditions associated with mutual cooperation, deliberation, respect for elders, communal responsibility, social harmony, and culturally embedded forms of religious communication. Such values correspond closely with Islamic principles such as *ta'āwun* (cooperation), *shūrā* (deliberation), *adab* (ethical conduct), *ukhuwwah* (brotherhood), and *tasāmuḥ* (tolerance). Local wisdom can therefore function not merely as supplementary cultural content but as an ethnopedagogical resource through which abstract principles of religious moderation are translated into culturally meaningful learning experiences.

Despite this potential, transforming local wisdom into contemporary learning materials presents substantial challenges. Local cultural knowledge is often transmitted orally, experientially, and communally rather than systematically documented in formal instructional resources. Teachers may possess rich knowledge of local traditions but have limited resources for organizing cultural narratives, adapting them to instructional objectives, developing contextual illustrations, or transforming them into interactive learning materials. At the same time, students increasingly encounter digital information environments in which religious and cultural information may be fragmented, decontextualized, stereotypical, or culturally insensitive. This situation creates a pedagogical need for learning materials capable of connecting cultural authenticity with the characteristics of contemporary digital learning.

Developments in artificial intelligence (AI) offer new possibilities for responding to this challenge. AI has increasingly been employed in education to support content generation, personalization, adaptive learning, intelligent tutoring, automated assessment, learning analytics, and instructional decision-making. Wang et

al. (2024) demonstrate the growing application of AI across educational contexts and its potential to support instructional processes and personalized learning. The development of generative AI and large language models has further expanded opportunities for educators to generate, organize, adapt, summarize, and enrich instructional content (Kasneci et al., 2023). Such developments create possibilities for transforming culturally embedded knowledge into learning resources that are more accessible, contextualized, and responsive to students' learning needs.

Within this broader AI ecosystem, deep-learning-based technologies provide computational capabilities for processing complex patterns in textual and contextual information. In the present study, AI and deep learning are therefore positioned hierarchically rather than treated as interchangeable concepts. AI constitutes the broader technological framework, whereas deep-learning-assisted processes refer to technological capabilities within this framework that can support the analysis, organization, adaptation, enrichment, and contextualization of local-wisdom learning materials. Deep learning is consequently not conceptualized as an autonomous educational intervention that directly produces religious moderation. Rather, it functions as a technological support mechanism embedded within a broader pedagogical process involving cultural knowledge, teacher mediation, and social experience.

In practice, deep-learning-assisted technologies can support educators in organizing cultural information, analyzing textual materials, adapting explanations, developing contextual learning scenarios, enriching instructional content, and presenting local narratives in forms that are more accessible to learners. In the pesantren context, such capabilities potentially enable local traditions, historical narratives, community practices, and culturally embedded Islamic values to be transformed into contemporary learning materials without removing them from their socio-cultural foundations. This technological potential is particularly relevant when educators need to bridge orally transmitted cultural knowledge and the increasingly digital learning experiences of younger generations.

Nevertheless, technological sophistication does not automatically ensure pedagogical, religious, or cultural appropriateness. AI-supported systems may generate inaccurate, generalized, biased, or decontextualized information. Kasneci et al. (2023) identify significant educational opportunities associated with large language models but also emphasize risks related to misinformation, bias, reliability, and overdependence on automated systems. Tlili et al. (2023) similarly highlight concerns surrounding truthfulness, privacy, manipulation, and responsible adoption, while Akgun and Greenhow (2022) draw attention to fairness, privacy, human agency, and ethical responsibility in educational AI. These concerns become particularly significant when technological systems are used to process religious and culturally embedded knowledge because a linguistically plausible output may not necessarily be culturally authentic or religiously appropriate.

For this reason, teacher mediation remains indispensable. Local wisdom cannot be reduced to textual information because its meanings are historically situated, socially transmitted, and interpreted through community experience. Teachers and pesantren leaders therefore retain responsibility for selecting culturally meaningful knowledge, evaluating technology-assisted outputs, ensuring religious appropriateness, preserving cultural authenticity, and determining the pedagogical relevance of the resulting learning materials. Deep-learning-assisted technology can

enrich the development of materials, but it cannot independently determine the religious and cultural validity of the knowledge being represented. This human-mediated relationship is particularly important in pesantren, where educational authority, exemplary behavior, interpersonal relationships, and communal practices remain central to learning.

Existing scholarship, however, has not sufficiently explained this relationship. Previous studies have largely developed along separate lines. Research on local-wisdom-based and culturally responsive education has demonstrated the contribution of cultural values to identity formation, character development, tolerance, and social cohesion. Studies of religious moderation in pesantren have emphasized curriculum, habituation, exemplary leadership, multicultural education, communal religious practices, and social interaction. Meanwhile, research on AI-supported education has predominantly focused on personalization, content generation, adaptive learning, automated assessment, learning analytics, and instructional efficiency. Although these strands provide important theoretical and empirical foundations, the pedagogical intersection among technology, local cultural knowledge, teacher mediation, and religious moderation remains underdeveloped.

More specifically, previous research has not sufficiently explained how deep-learning-assisted local-wisdom learning materials can be developed, culturally validated, and pedagogically integrated within pesantren while preserving cultural authenticity and strengthening students' religious moderation. Local-wisdom studies generally emphasize cultural values and character formation but provide limited explanation of how culturally embedded knowledge can be transformed into technologically assisted instructional materials. Conversely, AI-in-education research emphasizes technological affordances and learning efficiency but gives comparatively less attention to cultural authenticity, local knowledge systems, teacher mediation, and the internalization of religious values within culturally embedded Islamic educational environments. Similarly, studies of religious moderation in pesantren have primarily examined curriculum, habituation, social interaction, and direct educational practices rather than the pedagogical role of deep-learning-assisted culturally grounded materials.

This fragmentation reveals three interconnected gaps. The first is a development gap concerning how local narratives, traditions, ethical values, and community practices can be identified, organized, culturally validated, and transformed into deep-learning-assisted learning materials without decontextualizing their meanings. Technological processing may facilitate the organization and presentation of cultural information, but cultural authenticity ultimately depends on contextual interpretation and recognition by those who understand the cultural environment from which the knowledge originates.

The second is a pedagogical integration gap concerning how teachers and *ustadz/ustadzah* mediate deep-learning-assisted materials within pesantren pedagogy. Integrating technology involves more than introducing digital tools into instruction. It requires decisions regarding which cultural values should be represented, how technology-generated content should be evaluated, how inappropriate or inaccurate information should be corrected, and how technologically enriched materials should be connected with established pesantren learning traditions. Teacher mediation therefore functions as a critical mechanism linking technological affordances with religious authority, cultural authenticity, and pedagogical objectives.

The third is a mechanism gap concerning the respective roles of deep-learning-assisted materials, local wisdom, teacher mediation, and direct social experience in strengthening religious moderation. Previous research has not adequately clarified whether technology itself contributes to the internalization of moderation values or whether its principal contribution lies in facilitating conceptual understanding and enriching learning materials, while value internalization occurs primarily through teacher guidance, interpersonal relationships, habituation, communal activities, and lived social experiences. This distinction is crucial because understanding the concept of tolerance does not automatically produce tolerant behavior, just as understanding cultural diversity does not necessarily lead to acceptance of differences.

In *pesantren*, the internalization of religious and moral values has historically occurred through *uswah* (exemplary behavior), habituation, collective worship, mutual cooperation, teacher–student relationships, peer interaction, community service, and everyday social practices. Technology may enrich students’ conceptual understanding and provide new forms of engagement with culturally grounded content, but direct social experience provides the context in which those concepts are negotiated, practiced, and transformed into dispositions and behavior. Attributing religious moderation directly to technological intervention would therefore risk technological determinism and overlook the human, cultural, and social processes central to value formation.

Against this background, the present study conceptualizes the relationship among technology, culture, pedagogy, and social experience as complementary rather than substitutive. AI provides the broader technological ecosystem; deep-learning-assisted capabilities support the analysis, adaptation, contextualization, and enrichment of learning materials; local wisdom provides cultural authenticity and contextual relevance; teacher mediation ensures pedagogical, religious, and cultural validation; and direct social interaction provides the experiential context for value internalization. Within this framework, technological assistance is expected to strengthen access to and conceptual understanding of culturally contextualized religious values, while teacher mediation and lived social experiences remain central to translating those values into attitudes and everyday practices.

Accordingly, the novelty of this study does not lie merely in combining AI, deep learning, local wisdom, and religious moderation. Rather, it lies in explaining their differentiated and complementary pedagogical functions within the socio-cultural ecosystem of *pesantren*. The study moves beyond the question of whether advanced technologies can be used in Islamic boarding schools and instead examines how deep-learning-assisted local-wisdom learning materials can be developed and pedagogically mediated while preserving cultural authenticity and supporting the internalization of religious moderation values. This positioning also recognizes teacher agency as an essential component of educational technology integration rather than treating technology as an autonomous driver of religious and moral development.

Empirically, the study examines seven Islamic boarding schools in South Sumatra, where culturally distinctive Palembang Malay, Ogan, Komering, Basemah, and Musi traditions provide contextual resources for religious moderation education. The study therefore offers an opportunity to investigate how culturally situated knowledge can interact with advanced technological support without weakening the social and cultural characteristics that constitute the pedagogical identity of *pesantren*. Such a perspective is particularly relevant to the development of culturally

responsive educational technology in contexts where religious knowledge, cultural authority, and social experience are deeply interconnected.

Based on these considerations, this study aims to examine how deep-learning-assisted local-wisdom learning materials can contribute to strengthening religious moderation in Islamic boarding schools within a broader AI-supported pedagogical ecosystem. Specifically, it investigates the challenges involved in developing local-wisdom-based learning materials, examines how AI and deep-learning-assisted capabilities support their development and pedagogical integration, and analyzes the complementary roles of technologically assisted materials, teacher mediation, local wisdom, and direct social experience in strengthening religious moderation and mitigating intolerant attitudes. The study is expected to contribute theoretically by connecting previously fragmented discussions of religious moderation, ethnopedagogy, AI-supported education, and deep-learning-assisted learning; pedagogically by proposing a human-mediated and culturally responsive model of technological integration; and contextually by providing evidence from South Sumatran *pesantren* on how advanced educational technologies can support rather than replace the cultural and interpersonal processes central to religious moderation education.

B. METHOD

This study employed a sequential exploratory mixed-methods design, in which qualitative exploration preceded quantitative analysis. The design was selected to obtain an in-depth understanding of how local wisdom was identified and transformed into learning materials, how artificial intelligence (AI) and deep-learning-assisted technologies supported this process, and how these materials were pedagogically integrated into Islamic boarding school (*pesantren*) education to strengthen religious moderation. The quantitative phase subsequently complemented the qualitative findings by examining students' responses to constructs emerging from the theoretical framework and qualitative exploration.

The study proceeded through four interconnected stages. First, qualitative data were collected through semi-structured interviews, observations, and document analysis to explore local cultural values, challenges in developing culturally grounded learning materials, the use of AI and deep-learning-assisted technologies, teacher mediation, and social practices related to religious moderation. Second, the qualitative data were analyzed thematically using NVivo 12 Plus. Third, quantitative data were collected through a structured questionnaire administered to 250 students (*santri*). Finally, the qualitative and quantitative findings were integrated to identify convergence, complementarity, and divergence between the two strands of evidence.

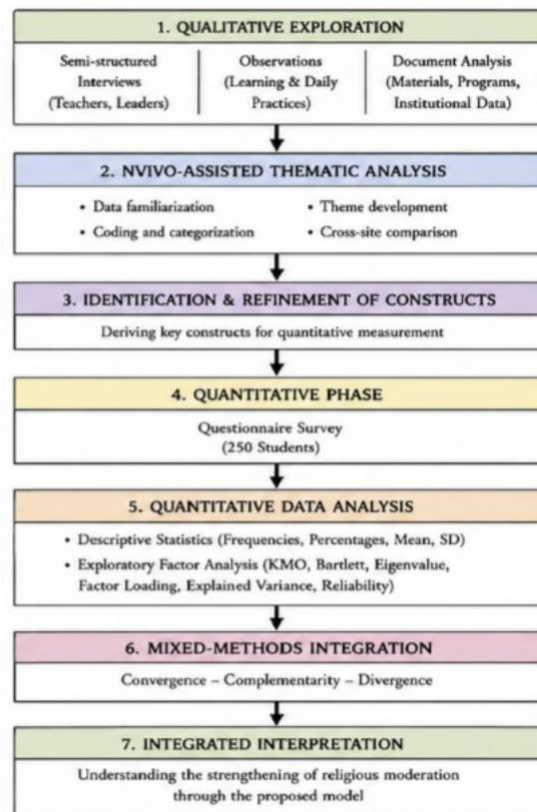


Figure 1. Sequential Exploratory Mixed-Methods Research Procedure

The study was conducted at seven Islamic boarding schools in South Sumatra, Indonesia: Darussa'adah in Muara Enim, Darul Huda in South OKU, An-Nur and Darussalam in Ogan Komering Ilir, Darul Barokah in Musi Rawas, Ittifaqiyah in Ogan Ilir, and Syifaun Hinayyah in Musi Banyuasin. The sites were purposively selected to represent variations in geographical location, socio-cultural context, institutional characteristics, and technological readiness. The cultural environments represented Palembang Malay, Ogan, Komering, Basemah, and Musi traditions, providing diverse forms of local wisdom relevant to the development of culturally contextualized religious-moderation learning materials. The broader population consisted of approximately 2,370 students, 215 teachers, and 25 pesantren leaders. Participants were selected purposively according to their roles in the respective research phases. The quantitative sample consisted of 250 students, all of whom participated in the questionnaire phase. Meanwhile, 30 teachers (*ustadz/ustadzah*) and 12 pesantren leaders served primarily as qualitative informants through interviews, observations, and institutional documentation. Teachers and leaders were therefore not included in the quantitative student sample.

Qualitative data were collected through semi-structured interviews, non-participant observations, and document analysis. Semi-structured interviews with teachers and pesantren leaders explored five major areas: local cultural values relevant to religious moderation; challenges in developing local-wisdom-based learning materials; the use and pedagogical functions of AI and deep-learning-assisted technologies; processes of cultural and religious validation; and educational practices through which tolerance and religious moderation were cultivated. Observations were conducted in both formal learning settings and everyday pesantren activities. Particular attention was given to congregational worship, group discussions, mutual

cooperation, community activities, teacher–student interaction, peer interaction, and other communal practices through which tolerance, empathy, cooperation, respect for others, and acceptance of differences were manifested. Document analysis was used to complement interview and observational evidence by examining learning materials, institutional programs, cultural documentation, and other relevant educational records. The use of multiple data sources enabled methodological and source triangulation. Evidence obtained from interviews was compared with observational and documentary data to reduce reliance on self-reported perceptions and to obtain a more contextualized understanding of religious moderation within the pesantren environment. Qualitative data were analyzed using thematic analysis assisted by NVivo 12 Plus. The analysis involved data familiarization, initial coding, categorization, theme development, and interpretation. Interview transcripts, observational notes, and documentary materials were organized systematically before coding. Codes sharing conceptual similarities were grouped into broader categories and subsequently developed into themes. Analytical attention was directed particularly toward local wisdom, cultural authenticity, technological readiness, AI/deep-learning assistance, teacher mediation, social interaction, tolerance, and religious moderation. Cross-site comparisons were also undertaken to identify recurring patterns and contextual differences among the seven pesantren. The analysis did not treat technology as an isolated determinant of religious moderation. Instead, it examined how technological assistance interacted with local cultural knowledge, teachers' pedagogical decisions, institutional contexts, and students' lived social experiences.

Within this study, AI was positioned as the broader technological framework, while deep-learning-assisted capabilities referred to technological functions within this framework that supported the processing, organization, adaptation, contextualization, and enrichment of culturally grounded learning materials. Deep-learning-assisted technology was therefore used as a pedagogical support mechanism rather than as an autonomous instructional intervention. The material-development process began with the identification of local narratives, traditions, ethical principles, community practices, and culturally embedded values considered relevant to religious moderation. These cultural resources constituted the contextual foundation of the learning materials. AI and deep-learning-assisted functions subsequently supported the organization of textual information, adaptation of explanations, contextualization of learning content, development of learning scenarios, and enrichment of instructional presentation. Technology-assisted outputs were not automatically regarded as culturally or religiously valid. Teachers and pesantren representatives functioned as human mediators and validators, reviewing the resulting materials in terms of cultural authenticity, contextual accuracy, religious appropriateness, linguistic suitability, and pedagogical relevance. Content considered inaccurate, culturally inappropriate, or inconsistent with pesantren educational values was revised or excluded before instructional use. The development procedure can therefore be represented as follows:

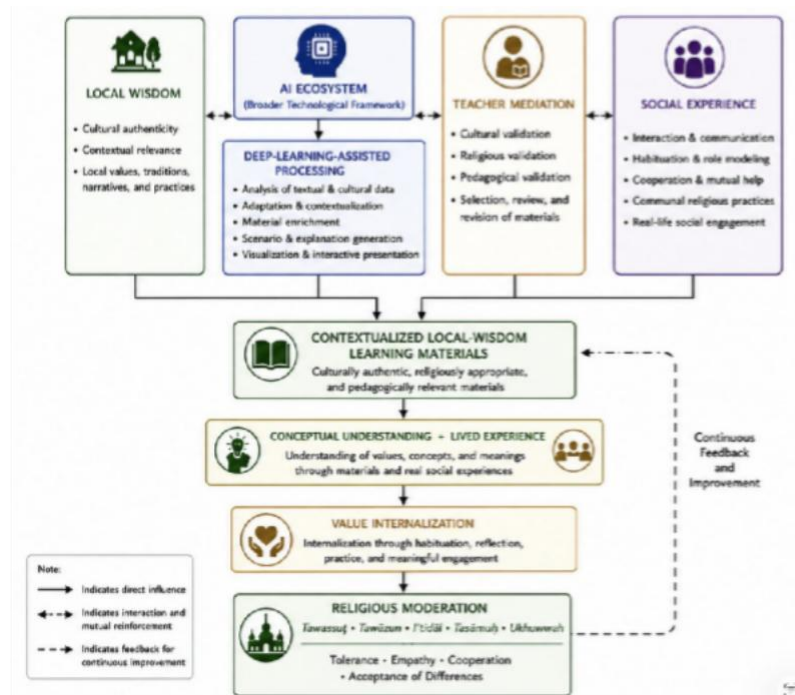


Figure 2. Deep-Learning-Assisted Local-Wisdom Learning

Quantitative data were collected using a structured questionnaire administered to 250 students. The questionnaire employed a five-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The instrument was designed to measure constructs emerging from the theoretical framework and qualitative exploration, particularly religious moderation, understanding of local wisdom, social empathy, collaboration, and acceptance of differences.

Construct	Dimension	Main Indicator
Religious moderation	Tolerance	Respect for and acceptance of differences
	Acceptance of diversity	Openness to social and cultural diversity
Local wisdom	Cultural understanding	Recognition and understanding of local values
	Cultural relevance	Relating cultural values to religious and social life
Social empathy	Perspective-taking	Understanding others' perspectives
	Respect for others	Respectful responses to social differences
Collaboration	Cooperation	Participation and mutual assistance
Acceptance of differences	Openness to disagreement	Constructive responses to different opinions

Instrument Validity and Reliability

The questionnaire was evaluated for validity and reliability before substantive interpretation. Content validity focused on the relevance, clarity, representativeness, cultural appropriateness, and correspondence of questionnaire items with their intended constructs. Where expert judgment was employed, items were reviewed for conceptual relevance, linguistic clarity, and suitability for the pesantren context. Internal consistency was evaluated using Cronbach's alpha (α). A coefficient of $\alpha \geq .70$ was adopted as the conventional criterion for acceptable reliability. The final manuscript should report the actual alpha coefficient for each construct or subscale.

Where pilot testing and empirical item-validity procedures were conducted, the number of pilot participants, item-validation procedure, criteria, and results should also be explicitly reported.

Quantitative Data Analysis

Quantitative data obtained from the 250 students were analyzed using descriptive and, where appropriate, factor-based statistical procedures. Descriptive statistics included frequencies, percentages, means, and standard deviations, providing an empirical profile of students' responses concerning local wisdom, tolerance, empathy, collaboration, diversity, and acceptance of differences. The term "V-Factor Analysis/V-Vaktor" used in the earlier version of the manuscript was replaced with standard statistical terminology. If the purpose of the original analysis was to identify the latent dimensional structure underlying the questionnaire, the appropriate procedure is Exploratory Factor Analysis (EFA). Prior to factor extraction, sampling adequacy should be examined using the Kaiser–Meyer–Olkin (KMO) measure, while the factorability of the correlation matrix should be assessed using Bartlett's Test of Sphericity. A KMO value of at least .60 indicates adequate sampling suitability, while a statistically significant Bartlett's test ($p < .05$) indicates that the correlations among items are sufficient for factor analysis. The EFA should report the extraction method, factor-retention criterion, eigenvalues, percentage of explained variance, rotation method, factor loadings, and reliability coefficients of the retained factors. These statistics must be based on the actual dataset. Factor loadings represent the strength of association between observed items and latent factors and should not be interpreted as percentage increases, intervention effects, or evidence of causality. Accordingly, quantitative findings were interpreted as patterns of student responses and relationships among measured constructs rather than as evidence that technological intervention independently caused changes in religious moderation.

C. RESULTS AND DISCUSSION

The findings revealed that the strengthening of religious moderation through deep-learning-assisted local-wisdom learning materials in Islamic boarding schools was shaped by the interaction of four major components: **local wisdom, technological support, teacher mediation, and direct social experience**. The qualitative findings further showed that these components performed different but complementary pedagogical functions. Local wisdom provided cultural and contextual relevance; AI and deep-learning-assisted technologies supported the development and enrichment of learning materials; teachers ensured cultural, religious, and pedagogical appropriateness; and direct social experiences provided the primary context for the internalization of religious moderation values.

The qualitative data showed that local cultural values were already embedded in the daily life and educational practices of the participating pesantren. Values associated with mutual cooperation, deliberation, respect for elders, communal responsibility, social harmony, and respect for differences were repeatedly identified in interviews and observations.

These values were particularly relevant because the seven participating pesantren were situated within diverse cultural environments influenced by Palembang Malay, Ogan, Komering, Basemah, and Musi traditions. Rather than being treated merely as

cultural heritage, these values functioned as contextual resources for connecting students' everyday experiences with Islamic educational principles. Mutual cooperation, for example, could be pedagogically associated with *ta'āwun*; deliberation with *shūrā*; respect for elders with *adab*; and cultural diversity with *ukhuwwah* and *tasāmuḥ*. The findings therefore indicate that local wisdom provided an experiential and culturally recognizable context for explaining religious moderation.

Table 3. Qualitative Themes and Supporting Evidence

Main Theme	Empirical Finding	Pedagogical Meaning
Local wisdom	Mutual cooperation, deliberation, respect for elders, social responsibility, and cultural diversity were embedded in pesantren life	Provides cultural and contextual relevance
AI/deep-learning assistance	Technology supported organization, adaptation, visualization, and enrichment of learning materials	Supports conceptual understanding and material development
Teacher mediation	Teachers selected, interpreted, reviewed, and contextualized technology-assisted materials	Ensures cultural, religious, and pedagogical validity
Technical barriers	Device limitations, internet access, and differences in digital literacy affected implementation	Conditions the accessibility and effectiveness of technological support
Social experience	Group discussion, communal worship, cooperation, community activities, and daily interaction were central to value formation	Provides the primary context for value internalization

The findings further demonstrated that local cultural values could be transformed into more explicit moderation-oriented learning materials when connected with Islamic educational principles and contemporary learning activities. Deep-learning-assisted technology supported this transformation by helping organize cultural information, provide alternative representations and explanations, develop contextual scenarios, and enrich learning materials. However, the cultural meaning of the materials remained dependent on teachers' contextual knowledge. The relationship between local wisdom and the resulting learning materials is illustrated in Table 4.

Table 4. Transformation of Local Wisdom into Moderation-Oriented Learning Materials

Local Wisdom	Islamic Educational Value	Learning Focus	Technology-Assisted Function	Moderation Competency
Deliberation	<i>Shūrā</i>	Differences of opinion and conflict resolution	Contextual scenario development	Respect for differences
Mutual cooperation	<i>Ta'āwun</i>	Collective responsibility	Material enrichment and contextual activities	Cooperation
Respect for elders	<i>Adab</i>	Social ethics and respectful communication	Contextual explanation and case presentation	Respectful interaction
Cultural	<i>Ukhuwwah</i> and	Intercultural	Comparative and	Tolerance and

Local Wisdom	Islamic Educational Value	Learning Focus	Technology-Assisted Function	Moderation Competency
diversity	<i>tasāmuḥ</i>	relationships	contextual content	acceptance of diversity
Communal responsibility	<i>Tawāzun</i> and <i>i'tidāl</i>	Individual and collective responsibility	Contextual learning scenarios	Balance, justice, and responsibility

These findings indicate that the technological component did not replace local cultural knowledge. Instead, it supported the transformation of culturally embedded values into more structured and accessible learning materials.

The qualitative analysis identified AI and deep-learning-assisted technology primarily as pedagogical support mechanisms. Teachers reported that technology helped them develop learning materials, search for cultural references, organize content, provide visual representations, and explain abstract concepts related to tolerance and local cultural values. NVivo-assisted analysis also identified themes related to adaptive learning and the visualization of abstract material. The original qualitative findings indicate that students appeared more engaged when culturally grounded materials were presented through digital media. Teachers observed greater enthusiasm, questioning, and participation in discussions following the use of such materials. The findings therefore suggest that the principal contribution of AI and deep-learning-assisted technology occurred at the conceptual and representational levels. Technology facilitated students' access to abstract concepts and enriched the presentation of local-wisdom-based materials, but the evidence does not support interpreting technology itself as the direct mechanism responsible for the internalization of religious moderation.

Teacher mediation emerged as another major finding. Teachers did not simply transmit technology-generated content to students. Instead, they played an active role in selecting local cultural values, determining their educational relevance, reviewing technology-assisted materials, adapting explanations, and connecting materials with Islamic and pesantren values. This role was especially important because cultural authenticity could not be determined solely by technological output. Teachers' knowledge of the local social context remained necessary to assess whether culturally based content was appropriate, accurate, and meaningful for students. The findings therefore position teachers as **cultural, religious, and pedagogical mediators** between deep-learning-assisted technology, local wisdom, and the educational objectives of religious moderation.

The most consistent qualitative finding concerned the role of direct social experience. Students and teachers indicated that group discussions, cooperation, community activities, congregational worship, and daily interaction within pesantren provided particularly meaningful contexts for developing tolerance, discipline, empathy, and cooperation. The NVivo analysis similarly identified the theme of **“internalizing values through real-world practice.”** The source data indicate that social activities such as group discussions, community service, and congregational prayer were perceived as more influential in fostering tolerance and discipline than digital learning alone. The findings therefore show a functional distinction between conceptual learning and value internalization. AI and deep-learning-assisted materials supported students' understanding of concepts, whereas direct social interaction provided opportunities to experience and practice those concepts. The empirical

findings revealed a complementary pattern among technological, cultural, pedagogical, and social dimensions. Deep-learning-assisted technology primarily supported the enrichment of learning materials and facilitated students' conceptual understanding, while local wisdom provided cultural and contextual relevance to the learning content. Teacher mediation played an essential role in ensuring the cultural, religious, and pedagogical appropriateness of technology-assisted materials. In contrast, direct social interaction provided the primary context in which students practiced and internalized moderation-related values. Taken together, these findings indicate that religious moderation was supported not by technology alone, but through the interaction of technology-assisted learning, culturally grounded knowledge, teacher mediation, and lived social experience.

Technological and Pedagogical Barriers

Despite its potential, the use of AI and deep-learning-assisted technology was constrained by variations in infrastructure and digital competence. Interviews and observations identified limitations in device availability, internet connectivity, and digital literacy among teachers and students. These differences affected the extent to which technology-assisted materials could be implemented across the research sites. In some contexts, limited technological infrastructure restricted access to digital materials, while variations in teachers' digital literacy affected their ability to integrate technological resources pedagogically. Importantly, social and communal practices continued even where technological access was limited. This finding reinforces the interpretation that technology functioned as an enrichment mechanism rather than as a replacement for the traditional social learning processes of pesantren.

Quantitative Findings

The quantitative phase involved **250 student respondents**. The questionnaire examined students' responses related to local wisdom, tolerance, discipline, cooperation, acceptance of differences, and other dimensions associated with religious moderation.

The original manuscript reported values of **82% for understanding of tolerance, 75% for discipline, and 88% for cooperation**. Because the study did not employ a documented pre-test-post-test design, these figures are presented descriptively rather than interpreted as percentage increases.

Table 5. Descriptive Quantitative Findings

Dimension	Reported Percentage	Descriptive Interpretation
Understanding of tolerance	82%	High positive response
Discipline	75%	Positive response
Cooperation	88%	High positive response

These results indicate that positive student responses were particularly evident in cooperation and tolerance understanding, while discipline also showed a predominantly positive pattern. The percentages describe the distribution of student responses and should not be interpreted as causal effects of AI or deep-learning-assisted technology.

Integration of Qualitative and Quantitative Findings

The mixed-methods integration revealed considerable complementarity between the qualitative and quantitative findings. Positive quantitative patterns in tolerance, discipline, and cooperation were consistent with qualitative evidence concerning students' participation in culturally grounded and socially embedded pesantren practices. However, the qualitative findings provide an important clarification: these positive patterns should not be attributed exclusively to technology. Deep-learning-assisted materials contributed primarily to conceptual understanding and material enrichment, whereas local wisdom provided contextual meaning, teachers mediated the learning process, and direct social experiences provided the context in which moderation values were practiced and internalized.

Table 6. Integration of Qualitative and Quantitative Findings

Dimension	Quantitative Finding	Qualitative Finding	Integrated Interpretation
Tolerance	82% positive/high response	Discussions and interaction exposed students to differences	Cultural materials support understanding; interaction supports practice
Discipline	75% positive/high response	Habituation and communal activities were prominent	Discipline is reinforced through repeated social practice
Cooperation	88% positive/high response	Mutual assistance and collective activities were frequently observed	Local wisdom and lived experience reinforce cooperative behavior
Conceptual understanding	Supported qualitatively	Technology enriched explanation and visualization	AI/deep learning primarily supports cognitive learning
Value internalization	Supported qualitatively	Social interaction and direct experience were dominant	Value formation primarily occurs through lived experience

Overall, the results indicate that strengthening religious moderation within pesantren emerged from the complementarity between technology, local culture, teacher mediation, and social experience, rather than from the independent influence of technological intervention.

DISCUSSION

The central finding of this study is that deep-learning-assisted technology supports religious moderation indirectly rather than functioning as its primary mechanism. Technology primarily enriched culturally grounded learning materials and facilitated conceptual understanding, whereas the internalization of moderation values depended more strongly on teacher mediation and students' direct social experiences. This distinction provides a more theoretically coherent explanation of the relationship between technological innovation and value-oriented education in pesantren. This finding is important because contemporary educational technology discourse often emphasizes the capacity of AI to personalize learning, generate content, provide adaptive explanations, and facilitate access to complex knowledge. Kasneci et al. (2023) demonstrate that large language models can support educational content generation, personalization, and instructional interaction, while Wang et al. (2024) identify personalization, instructional support, and learning analytics among the major applications of AI in education. The present findings are broadly consistent with these technological affordances: teachers perceived technology as useful for organizing materials, developing alternative explanations, visualizing abstract content, and

enriching learning resources.

However, this study extends the AI-in-education literature by showing that these technological affordances should not be equated with the internalization of religious or moral values. Understanding tolerance conceptually is different from demonstrating tolerance in actual social relationships. Similarly, understanding the meaning of cooperation does not automatically produce cooperative behavior. This distinction is particularly important in pesantren, where character formation has historically depended on a combination of religious knowledge, exemplary behavior, habituation, interpersonal relationships, communal worship, and collective social practices.

The findings therefore suggest that the pedagogical contribution of deep-learning-assisted technology is located primarily at the level of conceptual accessibility and material enrichment. Technology can help students encounter local cultural narratives in more structured, visual, interactive, and contextually adapted forms. Yet the transformation of these concepts into attitudes and behavioral dispositions requires interaction with teachers, peers, and the wider pesantren community.

Local wisdom constitutes a second important element in this process. The findings demonstrate that culturally embedded values such as deliberation, mutual cooperation, respect for elders, communal responsibility, and appreciation of cultural diversity provide concrete contexts for teaching religious moderation. This supports previous studies showing that local wisdom can function as an important educational resource for constructing religious moderation and tolerance in pesantren contexts (Zahrah S Amaliyah, 2024; Sugianto et al., 2024; Syarif et al., 2025). The contribution of local wisdom is not simply that it makes learning more culturally attractive. More fundamentally, it provides a contextual bridge between normative Islamic values and students' lived experiences. Deliberation makes *shūrā* observable in everyday decision-making; mutual cooperation provides an experiential representation of *ta'āwun*; respect for elders contextualizes *adab*; while interactions across cultural differences provide concrete contexts for *tasāmuḥ* and *ukhuwwah*. In this respect, local wisdom transforms religious moderation from an abstract normative discourse into a culturally recognizable educational experience.

The incorporation of deep-learning-assisted technology adds another dimension to this process. Cultural knowledge that has traditionally been transmitted orally or through direct social participation can be organized and represented in more structured instructional forms. Technology can support contextual scenario development, adaptation of explanations, visualization, comparative content, and other forms of pedagogical enrichment. Nevertheless, the findings suggest that technological transformation must be accompanied by cultural validation. Without such validation, technologically generated content may simplify, misrepresent, or remove cultural knowledge from the context in which its meaning was originally formed.

This necessity explains the central role of teacher mediation found in the study. Teachers functioned not merely as users of technology but as cultural, religious, and pedagogical mediators. They determined which local values were educationally relevant, assessed the appropriateness of technology-assisted content, adjusted explanations to students' contexts, and ensured alignment between learning materials and pesantren values.

This finding resonates with broader concerns regarding human agency in educational AI. Akgun and Greenhow (2022) emphasize ethical issues surrounding bias, fairness, privacy, and human responsibility in educational AI, while Kasneci et al. (2023) and Tlili et al. (2023) stress the need for human oversight because generative systems can produce inaccurate, biased, or contextually inappropriate content. In culturally and religiously sensitive settings, such oversight becomes even more important because factual plausibility alone does not guarantee religious or cultural appropriateness. Teacher mediation should therefore be understood as a form of epistemic, cultural, and pedagogical validation. The teacher does not simply correct technological errors; the teacher determines whether technological output makes sense within the local cultural context, corresponds with Islamic educational values, and serves the intended learning objectives. Consequently, AI and deep-learning-assisted technology should be understood as tools operating under human educational authority rather than as autonomous producers of culturally grounded knowledge.

The strongest contribution of the study nevertheless concerns social experience as the primary context for value internalization. Group discussion, mutual assistance, community activity, congregational worship, teacher–student interaction, and peer relationships emerged as particularly important for cultivating religious moderation. This finding explains why technological materials, although useful for conceptual learning, cannot replace the experiential dimension of pesantren education. From the perspective of Islamic education, religious moderation involves more than tolerance as a general social attitude. It can be understood through interconnected principles such as *tawassuṭ*, *tawāzun*, *i’tidāl*, *tasāmuḥ*, and *ukhuwwah*. Each principle requires observable social expression. *Tawassuṭ* is manifested in avoiding extreme positions; *tawāzun* involves balancing individual and collective responsibilities; *i’tidāl* requires justice and proportionality; *tasāmuḥ* is expressed through respect for differences; and *ukhuwwah* becomes visible through solidarity, cooperation, and social empathy. These values cannot be internalized solely through informational exposure. They require repeated practice and meaningful interaction. Students learn tolerance not only by reading about diversity but also by negotiating differences in actual discussions. Cooperation becomes meaningful when students participate in collective activities. Respect is formed through recurring interactions with teachers, peers, and community members. In this sense, pesantren's communal character provides a pedagogical advantage that technologically mediated education alone cannot reproduce. The findings thus point to a distinction between conceptual understanding and value internalization. Deep-learning-assisted learning materials can strengthen the former by making abstract concepts more accessible and culturally contextualized. Social experience strengthens the latter by enabling students to enact and repeatedly practice those concepts. This relationship should therefore be understood as complementary rather than competitive.

The quantitative findings should be interpreted within this framework. The reported positive responses concerning tolerance understanding (82%), discipline (75%), and cooperation (88%) indicate favorable student dispositions, but they do not by themselves demonstrate that technology caused those dispositions. The absence of a documented pre-test–post-test experimental design prevents these percentages from being interpreted as causal increases. Instead, the qualitative component explains how these positive patterns are embedded within a broader educational ecosystem involving local cultural values, teacher mediation, technological support, and repeated

social practice.

This interpretation strengthens the mixed-methods contribution of the study. The quantitative findings describe the distribution of students' moderation-related responses, whereas the qualitative findings clarify the pedagogical mechanisms through which those orientations may be supported. Thus, the value of integrating the two strands lies not in using one to prove causality in the other but in constructing a more complete explanation of religious moderation education within pesantren. Another important finding concerns technological inequality. Differences in internet access, device availability, and digital literacy affected the implementation of AI-supported learning. These challenges indicate that the educational usefulness of deep-learning-assisted technologies cannot be evaluated independently of institutional readiness. Technological infrastructure, teacher competence, access to devices, and the capacity to critically evaluate AI-generated content all influence whether technological innovation can be implemented effectively.

At the same time, the continued functioning of social and cultural learning practices despite technological constraints provides an important insight. Pesantren did not depend on AI to cultivate religious moderation; rather, technology enriched educational processes that were already embedded in cultural and communal practices. This reverses a technology-centered interpretation of innovation. Instead of asking how pesantren can adapt themselves to AI, the findings suggest that AI should be adapted to the pedagogical, religious, and cultural ecosystem of pesantren.

The findings can therefore be synthesized into a theoretical model in which technological, cultural, pedagogical, and experiential components perform distinct but complementary functions in strengthening religious moderation. The AI ecosystem provides the broader technological infrastructure, while deep-learning-assisted processing supports the organization, adaptation, contextualization, and enrichment of learning materials. Local wisdom provides cultural authenticity and contextual relevance, ensuring that religious-moderation concepts are connected to students' socio-cultural realities. Teacher mediation integrates these components by providing cultural, religious, ethical, and pedagogical validation, whereas social experience enables students to encounter, practice, and internalize moderation values through habituation, interaction, cooperation, and lived experience. Through this complementary process, the principles of *tawassuṭ* (moderation), *tawāzun* (balance), *i'tidāl* (justice), *tasāmuḥ* (tolerance), and *ukhuwwah* (brotherhood) are translated into observable competencies such as tolerance, empathy, cooperation, justice, and acceptance of differences. It provides a more theoretically defensible explanation than the proposition that AI directly produces religious moderation. It identifies the specific function and limits of technology: AI and deep-learning-assisted processes primarily support cognitive and instructional dimensions, whereas cultural authenticity is grounded in local wisdom, integration is mediated by teachers, and value internalization is strengthened through social experience.

Accordingly, the contribution of the present study lies not merely in demonstrating that AI, deep learning, and local wisdom can coexist in pesantren education. Its more important contribution is explaining how these components perform differentiated yet complementary pedagogical functions. Technology enriches the material, culture gives it meaning, teachers validate and integrate it, and social experience transforms it into lived values. This human-mediated and culturally grounded model offers an alternative to technologically deterministic approaches to

educational AI. It suggests that advanced technologies are most educationally meaningful when they strengthen rather than replace existing human, cultural, and social learning processes. In the pesantren context, the future of AI-assisted religious education should therefore be understood not as a transition from traditional to technological pedagogy, but as a process of integrating technological affordances into a learning ecosystem in which culture, religious authority, teacher agency, and lived social experience remain central.

CONCLUSION

This study demonstrates that strengthening religious moderation through deep-learning-assisted local-wisdom learning materials in Islamic boarding schools is a human-mediated, culturally grounded, and socially embedded process, rather than a direct consequence of technological intervention. Deep-learning-assisted technology primarily supports the organization, contextualization, and enrichment of learning materials and facilitates students' conceptual understanding. Local wisdom provides cultural authenticity and contextual relevance, while teachers play a crucial role in validating and integrating technological content within Islamic and pesantren educational values. Most importantly, direct social experiences—including discussion, cooperation, communal religious practices, and everyday interaction—remain central to the internalization of religious moderation values. These findings suggest a complementary pedagogical relationship in which deep-learning-assisted technology supports conceptual understanding, local wisdom provides contextual meaning, teacher mediation ensures cultural and religious validity, and social interaction facilitates value internalization. Together, these elements contribute to the cultivation of *tawassuṭ*, *tawāzun*, *i'tidāl*, *tasāmuḥ*, and *ukhuwwah*, manifested through tolerance, empathy, cooperation, justice, and acceptance of differences. The principal contribution of this study therefore lies in positioning AI not as a substitute for teachers or lived social experience, but as a pedagogical support mechanism within the socio-cultural ecology of pesantren. Practically, the findings imply that AI-supported innovation in pesantren should be accompanied by teacher digital competence, culturally validated learning materials, adequate technological infrastructure, and sustained opportunities for direct social learning. Since the quantitative component of this study was descriptive and the research was limited to seven pesantren in South Sumatra, the findings should not be interpreted as evidence of a causal effect of AI on religious moderation. Future studies should employ longitudinal or quasi-experimental designs and validated multidimensional measures to examine more precisely how deep-learning-assisted culturally grounded education contributes to religious moderation across diverse pesantren contexts.

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