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INTEGRATING SCIENCE AND ISLAMIC VALUES THROUGH EXCELLENCE PROGRAMS IN PESANTREN EDUCATION

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Abstract

This study addresses the limited empirical explanation of how Islamic educational institutions operationalize the integration of science and Islamic values in practice. It aims to examine how excellence programs in pesantren education facilitate this integration within daily learning processes. A qualitative case study was conducted at Pesantren Nurul Islam Jember, Indonesia. Data were collected through in-depth interviews with key stakeholders (pesantren leader, madrasah head, program coordinator, teachers, mentors, and students), classroom and laboratory observations, and analysis of institutional documents. Data were analyzed using an interactive model consisting of data condensation, data display, and conclusion verification. The findings reveal that the science excellence program functions as an integrative platform through four key components: institutional commitment, reflective pedagogy, collaborative learning, and experiential activities (e.g., robotics and competition-based mentoring). These components not only improve students' scientific competencies and academic achievements but also foster discipline, ethical awareness, and leadership within a pesantren-based learning culture. This study concludes that excellence programs provide a practical and context-specific model for integrating science and Islamic values in Islamic education. The study contributes empirically by demonstrating how institutional programs translate integrative educational ideals into everyday practices.

Keywords: *Science–Islam Integration; Pesantren; Excellence Program; Qualitative Case Study; Islamic Education; Experiential Learning.*

Abstrak

Penelitian ini dilatarbelakangi oleh masih terbatasnya penjelasan empiris mengenai bagaimana lembaga pendidikan Islam mengoperasionalkan integrasi sains dan nilai-nilai Islam dalam praktik pendidikan. Penelitian ini bertujuan untuk menganalisis

bagaimana program unggulan di pesantren memfasilitasi integrasi tersebut dalam proses pembelajaran sehari-hari. Penelitian menggunakan pendekatan kualitatif dengan desain studi kasus di Pesantren Nurul Islam Jember. Data dikumpulkan melalui wawancara mendalam dengan pemangku kepentingan utama (kyai, kepala madrasah, koordinator program, guru, pembimbing, dan santri), observasi pembelajaran dan laboratorium, serta analisis dokumen kelembagaan. Analisis data dilakukan secara interaktif melalui reduksi data, penyajian data, dan verifikasi kesimpulan. Hasil penelitian menunjukkan bahwa program unggulan sains berfungsi sebagai platform integratif melalui empat komponen utama: komitmen kelembagaan, pedagogi reflektif, pembelajaran kolaboratif, dan pembelajaran eksperiensial (seperti robotika dan pembinaan berbasis kompetisi). Komponen tersebut tidak hanya meningkatkan kompetensi sains dan prestasi akademik santri, tetapi juga membentuk kedisiplinan, kesadaran etis, dan kepemimpinan dalam budaya belajar pesantren. Penelitian ini menyimpulkan bahwa program unggulan merupakan model praktis dan kontekstual dalam mengintegrasikan sains dan nilai-nilai Islam. Studi ini berkontribusi secara empiris dengan menunjukkan bagaimana program kelembagaan menerjemahkan gagasan integrasi ke dalam praktik pendidikan sehari-hari.

Kata Kunci: *Integrasi Sains-Islam; Pesantren; Program Unggulan; Studi Kasus Kualitatif; Pendidikan Islam; Pembelajaran Eksperiensial.*

INTRODUCTION

Islamic educational institutions are increasingly challenged to respond to rapid scientific and technological developments while maintaining their foundational religious values. In the context of globalization and knowledge-based societies, education is expected to produce individuals who are not only scientifically literate and innovative but also ethically and spiritually grounded. This condition has intensified the need to overcome the long-standing dichotomy between religious knowledge and modern science. In Islamic epistemology, knowledge is inherently unified, where scientific inquiry and religious values function as complementary rather than contradictory domains (Al-Attas, 1978; Al-Faruqi, 1982; Riwanda, 2023; Fouz Mohamed Zacky & Moniruzzaman, 2024). Consequently, the integration of science and Islamic values has become a central issue in contemporary Islamic education reform.

Historically, Islamic civilization exemplified an integrative tradition in which scientific development was embedded within a religious worldview. Scholars such as Al-Farabi, Ibn Sina, and Al-Biruni advanced scientific knowledge within a framework grounded in Islamic theology and philosophy (Siddiqui, 2025; Suleimenov et al., 2025; Ainusyamsi et al., 2025). However, the legacy of colonial

education systems introduced a structural separation between religious and secular sciences, resulting in dualistic educational models. Contemporary scholarship highlights that this dichotomy constrains the development of holistic education, calling for integrative approaches that reconnect science with ethical and spiritual values (Marshall, 2025; Ribeiro & Vasconcelos, 2025; Tan, 2011; Halstead, 2004).

Within the Indonesian context, pesantren represent a distinctive form of Islamic education that combines religious learning, moral formation, and community-based values. Traditionally, pesantren focused on classical Islamic texts and character education, but they have increasingly adapted to modernization by incorporating formal curricula, including scientific subjects (Jubba et al., 2022; Rofiah et al., 2025; Nurazizah et al., 2025; Hanif et al., 2024; Muhajir, 2022). This transformation reflects a broader effort to produce graduates who are both intellectually competent and spiritually grounded.

One important innovation in this transformation is the emergence of science-oriented excellence programs in pesantren. These programs aim to strengthen students' competencies in science and technology while embedding Islamic ethical values within the learning process. Integrative approaches of this kind are aligned with twenty-first-century educational demands, particularly in fostering critical thinking, creativity, collaboration, and communication (Putri & Ilahiyah, 2025; González-Pérez & Ramírez-Montoya, 2022; Nahon Crystal et al., 2024). In practice, such programs involve laboratory experiments, scientific research, and participation in competitions, combined with religious learning activities that reinforce moral and spiritual development (Irham & Wahyudi, 2023; Atikah et al., 2025).

Pesantren Nurul Islam Jember represents a notable case of this innovation through its structured science excellence program integrated into the formal senior secondary curriculum. The program includes intensive instruction in mathematics, physics, chemistry, biology, and robotics, supported by laboratory practice, research activities, and competition-based mentoring. This model represents a systematic effort to integrate scientific knowledge with Islamic values within a pesantren environment. At the same time, it aligns with national education policies that emphasize the integration of intellectual development and character formation (Law No. 20 of 2003; Regulation of the Minister of Religious Affairs No. 23 of 2022).

Although previous studies have extensively discussed the integration of science and Islam, most of them remain at the level of philosophical discourse or curriculum design. Empirical studies that explain how integration is operationalized in everyday educational practices, particularly through institutional programs in pesantren, are still limited. Moreover, research on excellence programs in pesantren

tends to focus on management, curriculum innovation, or student achievement, rather than examining how such programs function as concrete mechanisms for integrating scientific knowledge with Islamic values.

This study addresses this gap by investigating how an institutional excellence program operationalizes the integration of science and Islamic values in daily educational practices within a pesantren context. Understanding this process is crucial because pesantren provide a unique environment where religious traditions, community life, and modern academic knowledge interact dynamically.

Therefore, this study aims to examine how excellence programs in pesantren education facilitate the integration of scientific knowledge and Islamic values. Specifically, it explores how the program contributes to students' scientific competencies, character formation, and twenty-first-century learning skills. By focusing on Pesantren Nurul Islam Jember, this study offers an empirical and context-specific model of integrative Islamic education that bridges science and religion in practice.

RESEARCH METHODS

This study employed a qualitative approach to investigate how excellence programs in pesantren education facilitate the integration of scientific knowledge and Islamic values. Qualitative inquiry is particularly suitable for examining complex educational phenomena, as it enables the exploration of participants' experiences, meanings, and social interactions within their natural contexts (Creswell & Poth, 2018). Through this approach, the study seeks to generate an in-depth and contextual understanding of how integrative educational practices are implemented within the socio-cultural environment of pesantren education.

This research adopted a qualitative case study design. Case study research is appropriate for examining contemporary phenomena within real-life contexts, particularly when the boundaries between the phenomenon and its context are not clearly evident (Yin, 2018). This design allows the researcher to explore the implementation of a science excellence program holistically through multiple sources of evidence, including interviews, observations, and institutional documents. Previous studies also highlight the relevance of qualitative case studies for investigating educational innovation and institutional transformation in specific contexts (Mtisi, 2022).

The study was conducted at Pesantren Nurul Islam (NURIS) Jember, located in Antirogo, Sumbersari District, Jember Regency, East Java, Indonesia. The research was carried out over a four-month period, from January to April 2025. This site was selected purposively because it represents an Islamic educational institution that

actively develops a structured science excellence program integrated into the formal senior secondary curriculum. The program includes intensive instruction in mathematics, physics, chemistry, biology, and robotics, supported by laboratory-based learning, scientific research activities, and participation in academic competitions. Such initiatives reflect broader efforts within Islamic education to integrate scientific knowledge with Islamic values in order to produce intellectually competent and morally grounded graduates (Budiyono et al., 2024; Saputro et al., 2025).

Participants were selected using purposive sampling, focusing on individuals who were directly involved in the planning, implementation, and participation in the science excellence program (Patton, 2015). A total of 12 participants were involved in this study, consisting of one pesantren leader (kyai), one madrasah head, one program coordinator, four science teachers, two robotics mentors, and three students participating in the program. These participants were selected based on their roles, experience, and relevance to the research focus, ensuring that the data reflected multiple perspectives within the institutional context.

In qualitative research, the researcher serves as the primary instrument responsible for data collection and interpretation (Creswell & Poth, 2018). The researcher was directly involved in the field through prolonged engagement, enabling a deeper understanding of the research context and the development of trust with participants. Reflexivity was maintained throughout the research process by continuously reflecting on potential biases and ensuring that interpretations remained grounded in participants' perspectives.

The study utilized two main categories of data: primary and secondary data. Primary data were obtained through in-depth interviews and observations involving key participants. Secondary data were collected from institutional documents, including curriculum guidelines, program reports, student achievement records, and documentation of scientific competitions. These documents provided additional contextual evidence and supported the interpretation of findings (Bowen, 2009).

Data collection employed three techniques: observation, in-depth interviews, and document analysis. Observations were conducted to examine directly how the science excellence program operates in daily educational practices, including classroom instruction, laboratory experiments, mentoring sessions, and competition training. In-depth interviews were conducted using semi-structured protocols to explore participants' perspectives regarding program implementation, the integration of Islamic values into science learning, and its impact on students' development. Each interview lasted approximately 45–90 minutes and was

conducted during the research period (January–April 2025). Document analysis was carried out to complement and triangulate the findings obtained from interviews and observations.

Data analysis followed the interactive model proposed by Miles, Huberman, and Saldaña (2014), which consists of data condensation, data display, and conclusion drawing and verification. Data condensation involved coding and organizing interview transcripts, observation notes, and documents to identify key themes related to science–Islam integration. Data display was conducted through thematic matrices and narrative descriptions to facilitate pattern recognition. Conclusions were drawn iteratively and continuously verified through comparisons across multiple data sources to ensure analytical rigor.

To ensure the trustworthiness of the findings, several strategies were employed, including triangulation, member checking, prolonged engagement, and peer debriefing. Triangulation was conducted by comparing data obtained from interviews, observations, and documents to confirm consistency. Member checking was carried out by sharing interview summaries and preliminary interpretations with participants to validate accuracy. Prolonged engagement enabled a deeper contextual understanding, while peer debriefing with academic colleagues helped refine interpretations. These strategies align with the criteria of credibility, transferability, dependability, and confirmability in qualitative research (Ahmed, 2024).

Ethical considerations were carefully addressed throughout the research process. Participants were informed about the purpose of the study and their voluntary participation prior to data collection. Informed consent was obtained from all participants, and confidentiality was maintained by anonymizing identities using pseudonyms. These procedures ensured respect for participants' rights and upheld the integrity of the research process.

RESULTS AND DISCUSSION

Results

Integrating Science and Islamic Values through Institutional Excellence Programs

The findings demonstrate that the science excellence program at Pesantren Nurul Islam Jember functions as a structured institutional mechanism for integrating scientific knowledge with Islamic values. Rather than operating as a supplementary or extracurricular activity, the program is embedded within the pesantren's institutional vision and academic system.

Interview data collected between January and April 2025 indicate that the program was intentionally designed to challenge the dichotomy between religious and scientific knowledge. The pesantren leader stated:

> "*We want to demonstrate that pesantren can produce students who not only master religious knowledge but are also able to compete in the fields of science and technology. Therefore, we developed the science program seriously so that students possess strong academic competencies while maintaining solid Islamic character*." (Interview with Pesantren Leader, February 2025).

This perspective is reinforced by the madrasah head, who emphasized:

> "*This program reflects our institutional commitment to integrating science and Islamic values. We do not separate them; instead, we position science as part of religious understanding*." (Interview with Madrasah Head, March 2025).

These findings indicate that integration is institutionally constructed rather than incidental. Field observations further confirm that this vision is operationalized through structured mentoring systems, additional science classes, and systematic preparation for competitions. Institutional documents also reveal the presence of a coordinated academic structure involving teachers, mentors, and peer tutors, which supports the sustainability of the program.

Taken together, these findings suggest that institutional commitment plays a central role in shaping the integration of science and Islamic values within the pesantren context.

Table 1. Institutional Integration Mechanisms

Theme / Mechanism	Interview Evidence	Observation Evidence	Document Evidence	Analytical Interpretation
Institutional Commitment to Integration	Pesantren leader emphasized integrating science and religion as a core vision; madrasah head highlighted science as part of religious understanding	School activities reflect alignment between religious routines and science program implementation	Institutional vision and program design documents show integration as a formal objective	Integration is structurally embedded at the institutional level, not incidental
Structured Excellence Program Design	Program coordinator explained systematic mentoring from	Regular mentoring sessions, additional classes, and competition training observed	Program guidelines and schedules indicate structured	The program functions as an organized academic system supporting integration

	basic concepts to olympiad level		academic pathways	
Leadership-Driven Educational Policy	Leadership actively promotes science excellence within pesantren values	Leaders involved in monitoring and supporting program activities	Policy alignment with national education and madrasah standards	Leadership plays a central role in legitimizing and sustaining integration
Collaborative Academic Ecosystem	Teachers and mentors highlighted teamwork and peer tutoring	Students engaged in group learning and peer mentoring activities	Documentation shows involvement of teachers, mentors, and senior students	Integration is supported through a collaborative learning culture
Integration of Religious and Scientific Orientation	Teachers and leaders emphasized linking science to Islamic values	Religious activities coexist with science learning in daily routines	Curriculum documents reflect integration of academic and religious learning	Integration operates through alignment of epistemological and practical dimensions

Integrating Scientific Learning with Islamic Educational Values

The findings indicate that the integration of scientific knowledge and Islamic values is primarily enacted through reflective pedagogical practices. Observations of classroom and laboratory activities show that teachers consistently connect scientific concepts with ethical and spiritual reflections.

For instance, during a biology lesson observed in March 2025, students were encouraged to reflect on the harmony and complexity of biological systems as manifestations of divine creation. This approach was articulated by a science teacher:

> "*We do not only teach scientific concepts in a technical way. We also encourage students to understand that knowledge is a means to appreciate the greatness of God's creation. In this way, they learn science while simultaneously developing moral awareness*." (Interview with Science Teacher, March 2025).

Another teacher emphasized the ethical dimension of scientific inquiry:

> "*Students are guided to think about how science should be used responsibly, not just mastered academically*." (Interview with Science Teacher, April 2025).

In addition to reflective teaching, collaborative learning practices further reinforce this integration. Observations reveal that students frequently work in small groups to discuss and solve scientific problems. One student explained:

> "*Usually we study in small groups. When we encounter difficult problems, we discuss them together until we find the solution*." (Interview with Student, February 2025).

These findings suggest that the integration of science and Islamic values occurs through continuous pedagogical interactions, where scientific understanding is embedded within ethical reflection and social collaboration.

Table 2. Pedagogical Integration Patterns

Theme / Pattern	Interview Evidence	Observation Evidence	Document Evidence	Analytical Interpretation
Reflective Integration of Science and Islamic Values	Teachers emphasized linking scientific concepts with appreciation of God's creation and moral awareness	Classroom interactions show teachers connecting scientific topics with ethical and spiritual reflection (e.g., biology lessons)	Lesson plans and teaching notes indicate integration of values within science instruction	Integration occurs through reflective pedagogy that embeds ethical meaning into scientific knowledge
Ethical Framing of Scientific Knowledge	Teachers highlighted the importance of responsible use of science	Students encouraged to consider responsibility, stewardship, and ethical implications of scientific knowledge	Curriculum documents emphasize character education alongside academic learning	Science learning is framed within an ethical perspective rooted in Islamic values
Collaborative Learning Practices	Students described group discussions as essential for understanding scientific concepts	Frequent use of small-group discussions and peer problem-solving observed	Program design includes peer tutoring and collaborative assignments	Collaboration supports both cognitive development and social interaction aligned with pesantren values
Dialogic and Inquiry-Based Learning	Teachers encourage students to ask questions and explain reasoning	Students actively participate in discussions and present their problem-solving processes	Teaching strategies reflect inquiry-based and student-centered learning approaches	Integration is strengthened through active learning that promotes critical thinking
Continuous Value Reinforcement in Learning Process	Teachers consistently integrate moral messages during instruction	Ethical reflections embedded in both formal lessons and informal interactions	Institutional learning guidelines emphasize integration of	Integration is not episodic but continuously reinforced across learning activities

	knowledge and character

Strengthening Scientific Competence through Excellence Programs

The results show that the science excellence program significantly contributes to the development of students' scientific competencies. Institutional documents indicate that students participating in the program have achieved consistent success in regional and national science competitions.

Interviews with program coordinators reveal that these achievements are supported by a structured and intensive mentoring system:

> "*This program is designed to nurture students who have strong interests in science. We provide intensive mentoring, from strengthening basic concepts to practicing olympiad-level problems*." (Interview with Program Coordinator, March 2025).

Observations conducted during mentoring sessions between February and April 2025 demonstrate that students are required not only to solve problems but also to articulate their reasoning processes. Teachers provide continuous feedback, encouraging analytical thinking and conceptual understanding.

A student confirmed this experience:

> "*We are trained not only to answer questions, but also to explain the reasoning behind them*." (Interview with Student, April 2025).

These findings indicate that the program promotes higher-order thinking skills, including critical reasoning, problem-solving, and scientific communication.

Table 3. Scientific Competency Development Evidence

Theme / Competency	Interview Evidence	Observation Evidence	Document Evidence	Analytical Interpretation
Conceptual Understanding in Science	Program coordinator emphasized strengthening basic concepts before advancing to olympiad-level problems	Students demonstrate the ability to explain concepts during mentoring sessions	Program curriculum outlines staged conceptual learning	The program builds strong foundational knowledge as a basis for advanced scientific learning
Critical Thinking and Problem-Solving Skills	Teachers and coordinators highlighted training in analytical reasoning and systematic thinking	Students required to explain reasoning and solve complex problems during mentoring	Training modules include higher-order thinking exercises	The program enhances higher-order cognitive skills essential for scientific competence

Scientific Communication Skills	Students reported being trained to present and explain their reasoning	Students actively present solutions and engage in discussions during mentoring sessions	Program activities include presentations and academic discussions	Communication skills are developed through structured academic interaction
Academic Achievement and Competition Performance	Coordinators reported consistent student success in science competitions	Preparation sessions for competitions observed regularly	Achievement records show participation and awards in regional and national competitions	The program translates learning outcomes into measurable academic achievements
Learning Motivation and Academic Engagement	Teachers observed increased student interest and enthusiasm for science	Students actively engage in discussions both inside and outside the classroom	Program participation records indicate sustained student involvement	The program fosters intrinsic motivation and sustained engagement in scientific learning

Experiential Learning through Robotics Innovation

Experiential learning represents a key component of the science excellence program, particularly through robotics activities that enable students to apply scientific knowledge in practical contexts.

Figure 1. Robotics Activities in the Science Excellence Program at Pesantren Nurul Islam Jember

The figure illustrates students participating in robotics training sessions, where they collaborate in small groups to assemble robotic systems, install sensors, and test movement mechanisms. Observations conducted in March and April 2025

show that students actively engage in designing, testing, and refining robotic prototypes.

A robotics mentor explained:

> "*In robotics activities, students learn directly through practice. They design robots, conduct experiments, and then improve any errors that occur. Through this process, they learn to think systematically and creatively*." (Interview with Robotics Mentor, March 2025).

Importantly, the findings indicate that robotics activities are also linked to Islamic values. Mentors emphasize the ethical use of technology, responsibility, and discipline. One mentor stated:

> "*We remind students that technology should be used for beneficial purposes (maslahah), not for harm. This is part of their moral responsibility*." (Interview with Robotics Mentor, April 2025).

Observations further reveal that students develop persistence, teamwork, and responsibility during iterative experimentation processes. These qualities are interpreted within the pesantren context as part of character formation grounded in Islamic values.

Thus, robotics serves as an experiential learning platform that integrates scientific knowledge, technological skills, and ethical awareness.

Holistic Development of Students in the Pesantren Learning Environment

Beyond academic outcomes, the findings indicate that the science excellence program contributes to students' holistic development by integrating scientific learning with the religious life of the pesantren.

Students are required to balance intensive academic training with daily religious practices, including prayer, Qur'anic recitation, and religious study. One student explained:

> "*This program is quite challenging because we have to divide our time between studying science and participating in pesantren activities. However, through this experience, we learn discipline and responsibility*." (Interview with Student, February 2025).

Teachers also observed broader developmental impacts:

> "*Students in the program tend to show stronger leadership and initiative. Many of them become role models and help guide other students*." (Interview with Science Teacher, March 2025).

Field observations confirm the emergence of an academic culture within the pesantren. Students frequently engage in informal discussions about scientific topics outside formal classroom settings, particularly after evening prayers.

These findings suggest that the program fosters not only scientific competence but also discipline, leadership, collaboration, and intellectual curiosity within a religious learning environment.

Discussion

The findings of this study demonstrate that the science excellence program implemented at *Pesantren* Nurul Islam Jember provides a context-specific and practice-oriented model for integrating scientific knowledge with Islamic values. Unlike many previous studies that conceptualize integration at the philosophical or curricular level, this study shows how integration is operationalized through institutional structures, pedagogical practices, and daily learning interactions. The results indicate that integration is realized through the interplay of institutional commitment, reflective pedagogy, experiential learning, and the emergence of a scientific culture within the *pesantren* environment.

These findings reinforce the broader argument that Islamic educational institutions are increasingly developing integrative models to overcome the historical dichotomy between religious and scientific knowledge (Muhajir, 2022; Atika et al., 2025; Tuna, 2024; Asman et al., 2025). However, this study extends the existing literature by demonstrating that integration is not merely a conceptual or curricular construct but a socially and institutionally embedded practice. In the *pesantren* context, integration is sustained through leadership vision, program design, and everyday educational routines, rather than through isolated instructional strategies.

The role of institutional commitment identified in this study highlights a distinctive feature of *pesantren*-based integration. Unlike formal schooling systems, where curriculum reform often drives integration, the findings suggest that in *pesantren*, leadership and institutional culture play a more central role in shaping educational transformation. The science excellence program reflects how *pesantren* institutions adapt to contemporary educational demands while preserving their religious identity. This finding aligns with previous studies indicating that integrative models enhance students' academic motivation and ethical awareness (Tabassum et al., 2024; Rohmatulloh et al., 2023), while also revealing that such integration depends heavily on institutional coherence and leadership-driven vision.

At the pedagogical level, this study demonstrates that integration is enacted through reflective teaching practices that embed ethical and spiritual meaning within scientific learning. Teachers do not present science as value-neutral knowledge; rather, they frame it within a moral and theological perspective. This finding supports previous research emphasizing the importance of integrating religious values into science education to cultivate ethical awareness (Amirudin et al., 2025; Zul et al., 2026; Imamah, 2025). However, the present study offers a more nuanced understanding by showing that integration occurs through continuous micro-level interactions in classroom practices, rather than through formal curricular insertion alone.

Collaborative learning practices further strengthen this integration by fostering both cognitive and social dimensions of learning. Consistent with research on integrative STEM and STEAM education (AlAli, 2024; Al-Mutawah et al., 2022), the findings show that collaborative environments enhance students' engagement and critical thinking. In the *pesantren* context, however, collaboration carries additional meaning, as it is closely linked to values of solidarity, mutual support, and collective responsibility embedded in *pesantren* culture. This highlights a context-specific dimension of integrative learning that is often overlooked in general STEM education literature.

The findings also underscore the importance of experiential learning, particularly through robotics and laboratory activities, in strengthening students' scientific competencies. Consistent with previous studies (Winarni et al., 2024; Hsu et al., 2023; Pepilina, 2024; Rochmat, 2024), hands-on learning enables students to develop problem-solving skills, creativity, and analytical reasoning. However, this study reveals an additional dimension: experiential learning in *pesantren* is not only oriented toward technical competence but is also framed within ethical considerations, such as responsibility (*amanah*) and the use of technology for societal benefit (*maslahah*). This integration of technical and ethical dimensions represents a distinctive contribution to the literature on STEAM and Islamic education.

Another important finding is the emergence of a scientific culture within the *pesantren* environment. Students actively engage in academic discussions beyond formal classroom settings, indicating that learning extends into the broader social life of the *pesantren*. This supports previous research suggesting that *pesantren* institutions are increasingly incorporating modern knowledge systems into their educational frameworks while maintaining their traditional religious identity (Sahil et al., 2024; Halimah et al., 2024; Hadi, 2022). However, this study further demonstrates that such transformation is not without challenges.

A critical insight emerging from this study concerns the tension between intensive scientific training and the demands of religious routines within *pesantren* life. Students are required to balance rigorous academic activities with structured religious obligations, which can create time management challenges and cognitive pressure. While this tension can foster discipline and resilience, it also indicates the need for careful program design to ensure sustainability. This aspect is rarely addressed in previous studies, which tend to emphasize the success of integration without critically examining its practical constraints.

From a theoretical perspective, this study contributes to the development of integrative education theory in Islamic education by shifting the focus from abstract conceptualization to empirical operationalization. The findings suggest that effective integration requires the interaction of multiple components: institutional commitment, reflective pedagogy, experiential learning, collaborative culture, and a supportive religious environment. Rather than viewing integration as a static outcome, this study conceptualizes it as a dynamic educational ecosystem in which scientific and religious knowledge continuously interact and reinforce one another.

Furthermore, this study proposes a practical model of integrative excellence programs in Islamic education. This model highlights that integration is most effective when it is institutionally embedded, pedagogically enacted, and culturally sustained. This contribution extends existing literature by providing a framework that can be adapted by other Islamic educational institutions seeking to integrate scientific knowledge with religious values in a holistic and context-sensitive manner.

The implications of this study extend beyond the *pesantren* context. In an era characterized by rapid scientific and technological advancement, educational systems are increasingly required to produce graduates who are not only technically competent but also ethically grounded. The findings suggest that integrative excellence programs offer a viable approach for achieving this balance. However, successful implementation requires alignment between institutional vision, pedagogical practice, and cultural context.

CONCLUSION

This study demonstrates that the implementation of science excellence programs in *pesantren* education provides an effective and context-specific mechanism for integrating scientific knowledge with Islamic values. The findings show that integration is not merely conceptual but is operationalized through institutional commitment, reflective pedagogical practices, collaborative learning, and experiential activities. These elements collectively contribute to the

development of students' scientific competencies while simultaneously fostering ethical awareness, discipline, and holistic character formation.

This study contributes to the literature on integrative Islamic education by offering empirical evidence of how integration is enacted in everyday educational practices within a *pesantren* context. Unlike previous studies that primarily focus on philosophical or curricular perspectives, this research proposes a practice-based model of integrative excellence programs, in which institutional structures, learning processes, and cultural environments interact to form a dynamic educational ecosystem. This model demonstrates that scientific learning and Islamic values can function as mutually reinforcing dimensions rather than as separate domains.

The findings also carry important practical implications. They suggest that Islamic educational institutions can enhance both academic excellence and character development by designing structured programs that integrate scientific learning with value-based education. However, the study also indicates the need for careful program management to balance intensive academic training with the religious routines characteristic of *pesantren* life.

Despite its contributions, this study has several limitations. It is based on a single case study within one *pesantren*, which limits the generalizability of the findings. In addition, the relatively small number of participants reflects a specific institutional context. Future research is therefore needed to examine integrative science programs across multiple *pesantren* settings, as well as to explore their long-term impact on students' academic trajectories, professional development, and contributions to science and technology. Expanding research in this area will further strengthen both the theoretical and practical understanding of integrative education models in Islamic educational contexts.

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