

Implementation of the STEAM Approach in Islamic Science Teaching in Integrated Islamic Primary Schools

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ABSTRACT

This study addresses the challenge of integrating science and Islam in learning practices at Integrated Islamic Elementary Schools (SDITs), which seek to bridge general and religious knowledge. This study provides empirical evidence that an integrative STEAM approach grounded in Qur'anic values (ayat kauniyah), tauhid-oriented experimentation, and the khalifah principle positively impacts primary students' scientific inquiry skills, creativity, and value integration. Students taught using this model demonstrated higher engagement and deeper conceptual understanding than those in conventional classrooms. These findings confirm the effectiveness of STEAM as an integrative pedagogical framework for embedding Islamic values within primary science education. Employing a qualitative case study design, data were collected from two SDITs in Surabaya and Malang through participatory classroom observations, interviews with science and Islamic education teachers, and analysis of instructional documents and student projects. The findings reveal three models of STEAM-based Islamic science learning: project-based activities inspired by Qur'anic verses of nature, tauhid-oriented scientific experiments, and contextual problem-solving grounded in the khalifah principle. These models demonstrate that STEAM supports integrative, student-centered learning, enhances higher-order thinking skills, and positions science as a meaningful religious practice within primary Islamic education.

Keywords: Elementary Science Learning, Integrated Islamic, Primary Islamic Education, STEAM Approach, Teaching Implementation

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INTRODUCTION

Islamic education in Indonesia, particularly in Integrated Islamic Elementary Schools (SDIT), adopts an integrated curriculum grounded in *Tauhid* that rejects the dichotomy between religious and general knowledge, positioning science learning not merely as the study of natural laws but as a means of recognizing the greatness of the Creator through *ayat kauniyah*, thereby aligning scientific inquiry with spiritual values and strengthening students' faith (Siti Rohmah Kurniasih et al., 2023). In parallel, the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach has been globally recognized as an interdisciplinary, project-based framework for fostering 21st-century skills such as creativity, critical thinking, collaboration, and digital literacy (Quigley & Herro, 2019). The holistic orientation of STEAM resonates with the vision of Islamic education (*tarbiyah syumuliyah*), making its integration within SDIT a relevant pedagogical strategy; however, current practices remain limited and fragmented, often confined to isolated projects or extracurricular activities, underscoring the need for more systematic and sustained integration in science learning.

In practice, several Islamic educational institutions have begun to incorporate elements of STEM/STEAM, albeit in a limited and fragmented manner, often confined to extracurricular activities or thematic projects. These initiatives reflect attempts to respond to contemporary educational demands while maintaining Islamic identity. The following table provides a comprehensive overview of the common ground between Islamic education principles, STEAM objectives, and practices in SDIT.

Table 1. Convergence of Islamic Education Principles, STEAM Approach, and Practices in SDIT

Islamic Education Principles (Naqliyah)	STEAM Philosophy & Objectives	Potential Manifestations at SDIT	Reference Sources
Integration of Knowledge (Tawhid): Uniting divine and empirical knowledge.	Interdisciplinary: Connecting science, technology, art, and mathematics for holistic solutions.	Thematic learning that links scientific concepts (physics, biology) with verses from the Qur'an and Hadith.	(Al Zeera, 2019; Chanifidin & Nuriyati, 2020)
Contextual Learning (Iqra' bil 'Alam): Reading the verses of creation in the universe.	Problem-Based/Project-Based Learning (PjBL): Learning through exploration and solving real-world problems.	Projects to create simple technologies (water purifiers, planting systems) inspired by natural processes in the Qur'an.	(Gusmaniarti et al., 2024)
Character and Moral Development (Akhlaq al-	Strengthening the 4Cs (Creativity, Critical Thinking, Collaboration,	Collaboration on projects emphasizes trustworthiness, cooperation, and	(Anas & Iswantir, 2024)

Islamic Education Principles (Naqliyah)	STEAM Philosophy & Objectives	Potential Manifestations at SDIT	Reference Sources
Karimah): The ultimate goal of education.	Communication): Essential non-technical skills.	respectful communication.	
Khalifah fil Ardh: Humans as responsible stewards of the earth.	Engineering Design Process: Designing solutions for human and environmental needs and problems.	Designing waste recycling or energy-saving solutions based on the concepts of <i>ishlah</i> (improvement) and prohibition of <i>israf</i> (excessiveness).	(Zaman et al., 2025)
Beauty and Balance (Mizan): Appreciating the beauty of Allah's creation.	Integration of Arts: Adding aesthetic, creative, and design dimensions.	Designing project reports with calligraphy or creating aesthetically pleasing science models.	(Sopiah, 2021)

Table 1 shows a strong conceptual convergence between Islamic science principles and the interdisciplinary orientation of STEAM. In SDIT contexts, science learning is designed to integrate Islamic values so that natural phenomena are understood as manifestations of Allah's signs (*ayat kauniyah*), fostering integrated ways of thinking rather than symbolic verse recitation (Chanifudin & Nuriyati, 2020). Core Islamic principles such as *iqra'* and *khalifah* encourage inquiry and discovery-based learning, which aligns with STEAM pedagogies particularly project-based learning and engineering design in promoting higher-order thinking and real-world problem solving (Gusmanianti et al., 2024). While Islamic education emphasizes character and spiritual formation, STEAM contributes essential 21st-century skills, with the arts component enabling aesthetic and reflective expression that deepens monotheistic understanding (Guyotte, 2020).

Despite this potential, empirical realities reveal persistent challenges. Teachers often struggle with authentic epistemological integration, resulting in superficial practices such as decorative verse insertion without deep conceptual linkage (Tamphu et al., 2024). These difficulties are compounded by limited teacher capacity, rigid curricula, inadequate infrastructure, and demanding assessment systems, causing STEAM implementation to remain incidental rather than embedded in everyday culture of learning practices (Dewi Regina et al., 2022; Izzah et al., 2025). Existing studies remain fragmented: conceptual works highlight philosophical compatibility without SDIT based empirical validation, while empirical studies focus on partial STEM implementation, vocational settings, or symbolic integration lacking epistemological depth (Amelia et al., 2024; Kurniawan et al., 2024; Rahmawati & Musa, 2022). Scholars have also warned of the risk of religious reductionism and secular epistemological dominance when integration lacks critical awareness (Al Zeera, 2019).

Consequently, research on STEAM integration in Islamic education remains at an early and inconclusive stage, with no comprehensive study examining

holistic STEAM implementation—particularly the arts component—alongside epistemological depth and contextual success factors in SDIT science learning. Addressing this gap, the present study employs a multi-site qualitative case study to investigate how STEAM is pedagogically enacted and epistemologically grounded in Islamic values. This study contributes by (1) foregrounding the arts as a creative epistemological medium, (2) distinguishing authentic integration from patchwork practices through analysis of lesson planning, classroom interaction, and student work, and (3) identifying contextual patterns across diverse SDIT settings. Guided by these aims, the study examines how STEAM is implemented, how Islamic epistemological principles are embedded beyond symbolic practices, and what pedagogical, institutional, and learner-related factors influence the depth and sustainability of holistic Islamic-STEAM integration.

METHOD

This research employed a qualitative multiple-case study design to examine how the STEAM approach is implemented in Islamic elementary science classrooms. This design was selected to address the interdisciplinary and context-sensitive nature of STEAM pedagogy, particularly when integrated with religious values, which cannot be adequately captured through experimental approaches. A qualitative case study enables in-depth examination of how inquiry processes, engineering design, and value integration are negotiated in authentic classroom practices, including instructional strategies, learning activities, and teacher mediation. The inclusion of multiple cases allows for comparative analysis across schools, highlighting variations in instructional design and the enactment of STEAM components, while providing rich empirical insight into how scientific inquiry, engineering practices, and ethical considerations are coherently aligned within Islamic science education.

The research was conducted in two Integrated Islamic Elementary Schools (Sekolah Dasar Islam Terpadu / SDIT) located in Surabaya and Malang, Indonesia. Data collection took place between January and June 2025, allowing sufficient time for repeated classroom observations, in-depth interviews, and document analysis. The cases were purposively selected based on three criteria: institutional recognition as best-practice Islamic schools, documented adoption of STEAM-oriented curriculum frameworks, and willingness to provide sustained research access. A literal replication logic guided case selection, as both schools operate within comparable socio-religious, curricular, and organizational contexts characteristic of integrated Islamic education (Nurhikmah, 2024). This approach enabled examination of pattern consistency across cases and strengthened analytical robustness through systematic cross-case comparison.

The unit of analysis focused on the process of STEAM integration in Islamic science instruction, including lesson design, classroom enactment, teacher-student interaction, and the incorporation of Islamic values. The study involved 20 key informants, consisting of Grade 4 and Grade 5 classroom teachers, Islamic Education teachers, and school leaders responsible for curriculum implementation. In addition, 100 Grade 4 and Grade 5 students served as

observation subjects, selected due to their developmental readiness for inquiry-based, interdisciplinary, and value-oriented learning.

Data were collected through methodological triangulation comprising non-participant classroom observations conducted across eight integrated thematic learning sessions (approximately 90 minutes each), semi-structured interviews with key informants, and document analysis of lesson plans, instructional materials, student artifacts, and curriculum policy documents.

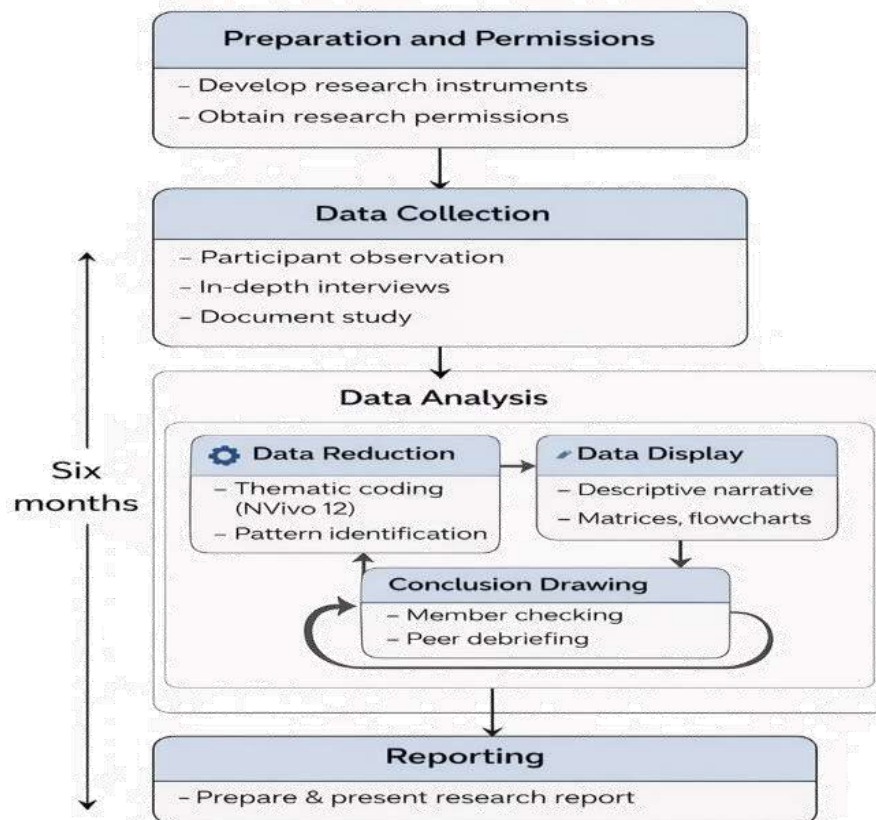


Figure 1. Research Design and Analytical Procedures

Data analysis followed the interactive model of Miles, Huberman, and Saldaña (2014), involving data reduction, data display, and conclusion drawing and verification. The coding process employed a two-cycle qualitative coding strategy. In the first cycle, descriptive coding was used to summarize observed instructional activities and pedagogical practices, while in vivo coding captured participants' emic expressions related to STEAM implementation and Islamic values. In the second cycle, pattern coding was applied to identify recurring themes, relationships, and cross-case regularities. NVivo 12 supported systematic coding, analytical matrices, and visual displays. During classroom observations, the researchers assumed the role of non-participant observers, documenting classroom practices and interactions without instructional involvement. Trustworthiness was ensured through triangulation, prolonged engagement, audit trails, member checking, and peer debriefing, with strict adherence to ethical principles. Although limited to two SDITs in Java and upper elementary grades,

the study offers contextually grounded insights transferable to comparable Islamic elementary education settings.

RESULTS AND DISCUSSION

RESULT

STEAM Implementation Models in Islamic Science Learning

This study identifies four distinct STEAM implementation models in Islamic science learning at SDITs, each systematically integrating science, technology, engineering, arts, and mathematics (STEAM) with Qur'anic verses and Islamic values. These models transform conventional science lessons into contextual, student-centered experiences that foster higher-order thinking skills (HOTS) while reinforcing tawhid, khalifah, and tafakkur principles. Table 4 presents the models, project examples, STEAM components, Islamic integrations, and implementation levels across both research sites.

Table 2. Identified Steam Implementation Models in Islamic Science

Model	Project Examples	STEAM Components	Integration of Islamic Values	Level of Implementation
Projects Based on Natural Laws	Designing an automatic plant watering system	S: Plant capillarity T: Simple humidity sensor E: Design an irrigation system A: Design an aesthetically pleasing container M: Measuring water volume and flow rate	Q.S. Al-Hijr: 22 on the process of water absorption; the concept of <i>Khalifah</i> in water management	High (85% implementation in both schools)
Integrated experiment with the value of Tawhid	Water cycle and rainfall	S: Evaporation & condensation T: Time-lapse video E: Creating a water cycle model A: Calligraphy of verses in the report M: Measuring temperature & volume	Q.S. Al-Mu'minun: 18; Tawhid as the regulator of nature; Gratitude for the blessing of water	Very High (92% implementation)

Model	Project Examples	STEAM Components	Integration of Islamic Values	Level of Implementation
Contextual Problem Solving for the Community	Designing school waste solutions	S: Material decomposition T: Waste audit application E: Designing separate waste bins A: Recycling crafts M: Daily waste statistics	Concept of <i>Ishlah</i> (improvement); prohibition against causing damage (Q.S. Al-A'raf: 56)	In progress (78% implementation)
Exploration of Biodiversity	Herbarium & plant identification	S: Morphology & classification T: Digital Microscope E: Specimen preservation techniques A: Photography & herbarium layout M: Measurement & Comparison	Q.S. Al-An'am: 99; Verses on diversity; Concept of <i>Tafakkur</i>	High (88% implementation)

Source: processed data (2025)

Based on observations, four main models of STEAM implementation were identified. The "Ayat Kauniyah-Based Project" model was the most widely implemented (85%), for example, an automatic plant watering project that integrated the principle of capillarity with a verse from the Qur'an about water absorption. The "Integrated Experiments with Tauhid Values" model achieved the highest implementation rate (92%), including learning about the water cycle in relation to Allah's power. The "Contextual Problem Solving for the Community" model (78% implementation) is evident in school waste management projects grounded in the concept of *ishlah* (improvement). Meanwhile, the "Exploration of Biodiversity" model (88% implementation) is realized in the creation of herbaria linked to verses about the diversity of creatures.

Transformation of Lesson Plans and Learning Processes

This section analyzes lesson plan evolution (Table 5: cognitive-to-5E STEAM models), classroom observations (Table 6: avg. 4.25/5 effectiveness), and teacher perceptions (Table 7: challenges/recommendations) post-STEAM integration in SDIT Islamic science learning.

Table 3. Analysis of Lesson Plan Documents

Analysis Components	Pre-Implementation	Post-Implementation STEAM	Significant Changes
Learning Objectives	Cognitively Dominant	Cognitive, psychomotor, and affective integrated	Addition of spiritual attitude objectives and design/engineering skills
Core Activities	Lectures, question and answer sessions, and simple experiments	5 Stages: <i>Engage</i> (verse), <i>Explore</i> (experiment), <i>Explain</i> (Islamic science), <i>Elaborate</i> (STEAM project), <i>Evaluate</i> (presentation)	Shift to inquiry-based learning and project-based learning
Learning Resources	Textbooks, worksheets	Qur'anic verses, experimental tools, project kits, digital applications, and school environment	Addition of digital resources and engineering kits
Assessment	Written tests (70%), attitude (30%)	Authentic: Project products (40%), presentations (30%), concept tests (20%), spiritual attitude (10%)	Assessment of products and processes becomes dominant

Source: processed data (2025)

Analysis of 22 lesson plans shows a significant transformation in learning planning. Before STEAM implementation, learning objectives were still dominated by cognitive aspects using lecture and simple experiment methods. After implementation, there was a shift toward integrative objectives encompassing cognitive, psychomotor, and affective-spiritual domains. The activity structure changed to the 5E model (*Engage*, *Explore*, *Explain*, *Elaborate*, *Evaluate*) with verses from the Qur'an as triggers (*engage*). Learning resources evolved from textbooks to include project kits, digital applications, and the environment. The assessment system also shifted from a dominance of written tests (70%) to an emphasis on authentic assessment, with project products (40%) and presentations (30%).

Table 4. Observation Results of the Learning Process (Scale 1-5)

Indicator	SDIT Surabaya Raya Average	SDIT Malang Raya Average	Description
Student Engagement	4.6	4.5	Students actively ask questions and express ideas
Collaboration Skills	4.2	4.0	Group work is more structured with role division
Integration of Science and Islam	4.5	4.3	Teachers can connect each stage with Islamic verses/values
Application of the 5 STEAM Components	4.0	3.8	The arts component still needs strengthening
Critical Thinking	4.3	4.2	Students can analyze prototype failures and revise them
Product Creativity	4.4	4.1	The variety of solutions produced is diverse and innovative
Spiritual Reflection	4.5	4.3	Students connect scientific findings with God's power

Source: processed data (2025)

Observations of 8 learning sessions showed very positive results. Student engagement scored an average of 4.55 (out of 5), indicating enthusiasm and active participation. Students' collaborative skills also developed well (score of 4.1), with more structured role-sharing within groups. The integration of science and Islam was effective (score of 4.4), with teachers consistently connecting each stage of scientific exploration with Islamic values or verses. The implementation of the five STEAM components was exemplary, although the arts component still needed strengthening (score of 3.9). The aspects of critical thinking (score of 4.25), product creativity (score of 4.25), and spiritual reflection (score of 4.4) also showed encouraging progress.

Table 5. Results of Interviews with Teachers (Thematic)

Theme	Initial Perception	Implementation Experience	Challenges	Recommendations
Understanding STEAM	"Similar to regular practical learning"	"More holistic, involving design and aesthetics"	Difficulty integrating arts (art) in a meaningful way	Learning design training in contextual STEAM
Integration of Islamic Values	"By reading verses before practical learning"	"Verses as an introduction, ethical foundation, and reflection"	Finding relevant verses for each scientific concept	Development of a thematic "Ayat Kauniyah" database
Infrastructure readiness	"The laboratory is sufficient"	"Project materials, engineering kits, and art supplies are needed"	Limited budget for project materials	Collaboration with parents and the community

Impact on students	"Students prefer practical work"	"Students see science as worship and exploration of God's verses"	Individual differences in ability within the group	More equitable division of roles within the group
Evaluation	"It is difficult to assess engineering and artistic aspects"	"Using product rubrics and process observation"	Subjectivity in aesthetic assessment	Development of standardized rubrics for all aspects of STEAM

Source: Processed data (2025)

In-depth interviews with seven teachers revealed the evolution of their understanding and experiences. Initially, some teachers considered STEAM to be the same as regular practical work, but after implementation, they realized that this approach was more holistic because it involved design and aesthetics. The main challenges were integrating the arts component meaningfully and finding relevant verses for each scientific concept. In terms of integrating Islamic values, there was a shift from simply reading verses at the beginning of the lesson to using verses as a basis for ethics and spiritual reflection throughout the process. Teachers also acknowledged that although the laboratory infrastructure was adequate, they needed more project materials and engineering kits. Consistently, teachers reported that students now view science as a form of worship and an exploration of the signs of Allah's power.

Student Impact and Product Analysis

This section quantifies STEAM's effects on student outcomes through pre/post comparisons (Table 8) and analyzes 100 project portfolios (Table 9). Results demonstrate significant gains in science understanding (+12.8 points), science-Islam connections (+43%), HOTS/creativity (+1.4-1.6 points), and motivation (92% high). Product quality shows 42% excellent prototypes and 38% highly creative posters, confirming STEAM's transformative impact on Islamic science learning.

Table 6. Impact on Students (Quantitative & Qualitative Data)

Impact Aspect	Pre-Implementation	Post-Implementation	Improvement
Science Concept Understanding	Average score: 72.5	Average score: 85.3	+12.8 points
Ability to Connect Science and Islam	45% of students are able	88% of students are able	+43
Critical Thinking Skills	Average rubric score: 2.8/5	Average rubric score: 4.2/5	+1.4 points
Creativity (Based on Product)	Average score: 2.5/5	Average score: 4.1/5	+1.6 points
Motivation to Study Science	65% high	92% high	+27
Perception of Islamic Science	"Lessons in memorizing verses"	"Exploration of the signs of Allah's power"	Paradigm shift
21st Century Skills	Limited collaboration	Collaboration, communication, and	Significant

problem-solving skills
are being developed.

Source: processed data (2025)

The implementation of the STEAM approach has had a measurable positive impact on students. Understanding of scientific concepts has increased significantly from an average score of 72.5 to 85.3 (an increase of 12.8 points). The ability to connect science with Islamic values has jumped from 45% to 88% of students. Critical thinking skills increased from a score of 2.8 to 4.2 (on a scale of 5), while creativity, as measured through products, rose from a score of 2.5 to 4.1. Motivation to learn science also increased, with 65% of students showing high motivation rising to 92%. Qualitatively, there has been a paradigm shift where students no longer view Islamic science as a subject for memorizing verses, but as an active exploration of the signs of Allah's power. 21st-century skills such as collaboration, communication, and problem-solving have also developed rapidly.

Table 7. Analysis of Student Products and Portfolios

Type of Product	Evaluation Criteria	Performance Category	Percentage
Automatic Watering Prototype	Functionality, aesthetics, scientific principles, process documentation	Excellent (meets all criteria)	42
		Satisfactory (functional, minimal documentation)	48
		Needs guidance (does not function optimally)	10%
Water Cycle Poster with Calligraphy	Scientific accuracy, integration of verses, aesthetics, and creativity	Highly Creative (unique layout, original illustrations)	38
		Adequate (accurate information, standard presentation)	52
		Minimal (meets only the minimum requirements)	10
Recycling Project Report	Data analysis, innovative solutions, Islamic principles, presentation	In-depth analysis	35
		Descriptive	55
		Fundamentals	10

Source: processed data (2025)

Analysis of 100 project portfolios shows variation in the quality of student products. In the automatic sprinkler prototype project, 42% were classified as excellent (meeting all criteria for function, aesthetics, and documentation), 48% were adequate (functional with minimal documentation), and 10% still required guidance. For the water cycle posters with calligraphy, 38% were rated highly creative, with unique layouts and original illustrations; 52% were adequate, with accurate information but a standard appearance; and 10% were minimal. The

recycling project reports showed that 35% of students produced in-depth analyses, 55% produced descriptive analyses, and 10% were still at a basic level. This data indicates that the majority of students are capable of producing adequate to creative products, although there is still room for improvement.

Recommendations Framework

This section presents tiered recommendations (Table 10) derived from research findings, targeting teachers (STEAM training/rubrics), schools (STEAM Corners/festivals), and policymakers (curriculum integration/university partnerships). Each includes measurable success indicators to ensure sustainable Islamic STEAM implementation across SDITs.

Table 8. Recommendations Based on Findings

Level	Strategic Recommendations	Success Indicators
Teachers	1. Training in integrated STEAM project design incorporating Islamic values 2. Development of authentic assessment rubrics 3. Practitioner community for sharing modules	1. 90% of teachers can create STEAM lesson plans independently 2. Use of uniform rubrics in all classes 3. Formation of a professional learning community
School	1. Provision of a STEAM Corner with recycled materials 2. Allocation of block time for projects (3-4 hours/week) 3. Annual Islamic science festival	1. Availability of project materials for 10 different themes 2. Flexible learning schedule 3. 80% student participation in the festival
Policy	1. Integration of Islamic STEAM models into Islamic school curricula 2. Partnerships with universities for mentoring 3. Development of national Islamic science modules based on STEAM	1. Official guidelines from the Ministry of Religious Affairs 2. Establishment of cooperation with at least three state universities 3. Availability of modules for all levels of primary/elementary schools

Source: processed data (2025)

Based on the research findings, tiered recommendations were formulated. At the teacher level, training in STEAM project design integrated with Islamic values, the development of authentic assessment rubrics, and the formation of a community of practitioners to share modules are required. At the school level, it is recommended to provide a STEAM Corner with recycled materials, allocate block time for projects (3-4 hours per week), and hold an annual Islamic science festival. At the policy level, it is necessary to integrate the Islamic STEAM model into the Islamic school curriculum, establish partnerships with universities for ongoing mentoring, and develop national Islamic STEAM modules that various levels of Islamic education in Indonesia can adopt.

DISCUSSION

The findings indicate that the integration of Islamic values within the STEAM approach in this study operates at a paradigmatic rather than instrumental level. Unlike earlier implementations that primarily employ Qur'anic verses as motivational or symbolic entry points, the observed practices reveal a coherent epistemological and ethical framework in which Islamic concepts actively shape inquiry, design, and reflection. For instance, the use of Q.S. Al-Hijr:22 in learning about capillarity was not limited to textual citation but functioned as a conceptual lens through which students framed technological problem-solving as an expression of human responsibility as khalifah. This contrasts with several empirical studies of STEAM in religious contexts that report superficial alignment between scientific content and religious references, where integration remains largely additive (e.g., inserting verses without pedagogical transformation). In this regard, the present findings extend the arguments of Adyaksa and Sudirman (2024) and Saleh et al. (2025) by demonstrating how Islamic concepts can operate as generative principles that reorganize the entire learning process, rather than merely legitimizing scientific topics.

When situated against dominant secular STEAM frameworks, which tend to prioritize innovation outputs, efficiency, and measurable performance gains, the Islamic STEAM model foregrounds ethical intentionality (niyyah) and moral accountability as central learning orientations. This distinction is analytically significant because it challenges the conflict or dichotomy model between science and religion identified by Harahap et al. (2025). Instead of positioning Islamic values as constraints on scientific inquiry, the findings suggest a tauhidic curriculum logic in which scientific exploration becomes a form of ethical and spiritual meaning-making. This contributes to the broader discourse on integrated curricula by offering empirical evidence that value-based epistemologies can coexist with, and even enrich, inquiry-driven pedagogies.

Within this epistemological framing, STEAM functions not merely as a set of interdisciplinary techniques but as an operational pedagogy aligned with the holistic aims of Islamic education. While previous studies often emphasize improvements in higher-order thinking or engagement as standalone outcomes, the present findings point to a qualitatively different form of learning significance. Students' interpretations of scientific phenomena as signs of divine order indicate a convergence between analytical reasoning and spiritual consciousness. This finding nuances earlier empirical work by Pasca Emilidha & Waluya (2024); Warsah et al. (2024) ; and Nur Hadi (2025), which document affective and moral gains but do not sufficiently theorize how these gains emerge from epistemic integration. The current study therefore advances a deeper understanding of how STEAM-based inquiry can simultaneously cultivate cognitive complexity and value internalization.

The role of teachers emerges as a critical mediating factor in sustaining this form of integration. Rather than technical proficiency in STEAM components, the findings highlight teachers' capacity to redesign learning environments and adopt facilitative pedagogical roles as the primary determinant of coherence. This observation contrasts with policy-oriented studies that frame implementation

challenges mainly in terms of resource limitations or curriculum overload. While difficulties in integrating the arts dimension and identifying relevant Qur'anic references echo systemic issues in teacher preparation reported by the Ma'arif NU Education Institute (2023), the successful use of structured inquiry models – such as the 5E framework enriched with Islamic texts – demonstrates that pedagogical design can partially compensate for structural constraints. This supports and extends the work of Yulias Anggraeni et al. (2025) and Nipyrakis et al. (2025) by showing that collaborative lesson design not only enhances pedagogical reasoning but also enables teachers to align disciplinary integration with value-based educational goals.

From the learner perspective, Islamic STEAM fosters collaborative problem-solving that is explicitly framed within ethical and communal responsibility. Unlike secular models that often conceptualize collaboration as a workforce-oriented competency, students in this study interpreted teamwork as collective *amal* directed toward addressing socially relevant issues, such as environmental management. This finding offers an important contrast to dominant 21st-century skills discourse, suggesting that competencies acquire deeper meaning when embedded within culturally and morally grounded frameworks. Consistent with Zaman et al. (2025), the value of STEAM lies not only in skill acquisition but also in its capacity to situate those skills within shared ethical commitments.

Despite these contributions, the findings also reveal persistent structural constraints, particularly in infrastructure availability and the assessment of creative and artistic outcomes. These limitations resonate with national-level is by the Indonesian Ministry of Religious Affairs (2023), indicating that pedagogical innovation alone is insufficient without systemic support. Although this study is situated within two SDITs, its analytical transferability lies in the shared curricular orientations and value commitments of comparable Islamic education settings. Policy initiatives such as nationally developed Islamic STEAM modules and university-school partnerships aligned with the Merdeka Belajar agenda could therefore play a pivotal role in scaling these practices. A clearly articulated implementation roadmap is essential to ensure that Islamic STEAM evolves from context-specific innovation into a sustainable model that contributes simultaneously to scientific advancement and character formation within Indonesian Islamic education.

CONCLUSION

This study demonstrates that the STEAM approach in Islamic science learning functions as a meaningful integrative pedagogy that connects scientific concepts with Islamic values within a coherent epistemological framework. Its primary theoretical contribution lies in showing that STEAM can facilitate a shift from text-centred instruction toward inquiry-based learning that integrates logical reasoning, creativity, and spiritual reflection, thereby reinforcing an Islamic epistemology of science rather than merely enhancing performance outcomes.

Practically, the findings indicate that STEAM supports holistic student development by promoting higher-order thinking, technological literacy, collaboration, and ethical awareness in alignment with the aims of Islamic

education. Effective implementation, however, depends on structured, context-sensitive instructional design and sustained teacher professional development, particularly in integrating the arts component and inquiry-based strategies. Policy support in terms of infrastructure provision and curriculum alignment is therefore essential for ensuring the sustainability and scalability of Islamic STEAM practices.

This study is limited by its qualitative focus on a small number of Islamic schools and a relatively short implementation period, which restricts generalizability and prevents conclusions about long-term effects. Variations in teacher readiness and technological competence also influenced the consistency of implementation. Future research should directly address these limitations by employing mixed-methods or longitudinal designs across diverse educational levels and institutional contexts, with particular attention to examining the long-term impact of STEAM on value internalization, character formation, and competency development in Islamic education.

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