Volume 7 Nomor 2 (2026) Pages 377–393
Hadlonah: Jurnal Pendidikan dan Pengasuhan Anak
Email Journal:jurnalhadlonahuibbc@gmail.com
Web Journal: http://journal.bungabangsacirebon.ac.id/index.php/hadlonah

Preparing Pre-service Teachers for STEAM with Islamic Values: A Multi-site Qualitative Study of Indonesian Early Childhood Teacher-Education Programmes

Dzikri Rahmat Romadhon[1], Ratna Faeruz[2]✉, Rahmatullah Rahmatullah[3]

[1]Pendidikan Fisika, Fakultas Ilmu Tarbiyah dan Keguruan, UIN Syarif Hidayatullah Jakarta
[2]✉Pendidikan Islam Anak Usia Dini, Fakultas Ilmu Tarbiyah dan Keguruan, UIN Syarif Hidayatullah Jakarta
[3]Pendidikan Agama Islam, Fakultas Ilmu Tarbiyah dan Keguruan, UIN Syarif Hidayatullah Jakarta

Email: dzikri@uinjkt.ac.id[1], ratnaf@uinjkt.ac.id[2], rahmatullah@uinjkt.ac.id[3]

Received: 2026-04-26; Accepted: 2026-11-13; Published: 2026-11-19

Abstract

This study aimed to explore how Indonesian early childhood teacher-education programmes prepare pre-service teachers to teach STEAM (science, technology, engineering, arts and mathematics) and whether and how Islamic values are integrated into that preparation. A multi-site qualitative design was used. Ten informants (six lecturers, one also a programme head; two further programme heads; one final-year student; and one recent graduate) were purposively selected from six programmes: two in Islamic higher-education institutions and four in general universities. Data were collected in May–June 2022 through online interviews and written or spoken responses to a common protocol, and were analysed using codebook thematic analysis with a cross-site case-by-theme matrix. Four themes were developed. First, staff perceived pre-service teachers' conceptual understanding of STEAM as stronger than their ability to enact it, a gap linked to STEAM being taught in separate courses with few opportunities for supervised enactment; engineering was the least visible component. Second, constraints cut across programme types: lecturer expertise, a narrow digital-only conception of technology, pandemic disruption and, at three programmes, placement teachers who did not model integrated STEAM. Third, proposed improvements were largely stated intentions. Fourth, expectations for values integration formed a gradient, from institution-wide mandates in the two Islamic institutions, through faculty-level expectations in one programme housed in a general university, to none in the other three general programmes; reported practices were mostly additive rather than embedded in STEAM pedagogy. The study offers a 2022 baseline and points to coherent, sequenced STEAM coursework and pluralism-sensitive approaches to values integration.

Keywords: STEAM Education; Early Childhood Teacher Education; Pre-service Teachers; Islamic Values.

Copyright © 2026 Authors

INTRODUCTION

Integrating science, technology, engineering, arts and mathematics (STEAM) in early childhood education is widely promoted as a way of developing young children's problem-solving, collaboration and creativity through play-based inquiry (Rafiq-uz-Zaman, 2025). The early years are often regarded as well suited to integration because subject boundaries are not yet fixed (Evagorou, 2024), although engineering remains under-represented relative to the other strands (Cohrssen et al., 2025). Whether this potential is realised depends largely on teachers. Structured methods coursework and guided design experiences can strengthen pre-service teachers' confidence and pedagogical content knowledge for STEAM (Brusic et al., 2023; Evagorou, 2024) and their attitudes towards integrating it (Stepić, 2025). Nevertheless, many pre-service early childhood teachers hold fragmented, discipline-siloed conceptions of STEAM (Angelone, 2020), and practicum studies show that their pedagogical content knowledge does not always develop into classroom practice (Machmud et al., 2025).

In Indonesia, these international concerns meet a distinctive institutional landscape. Early childhood teachers are prepared in two broad types of undergraduate programme. Islamic Early Childhood Education programmes (Pendidikan Islam Anak Usia Dini, PIAUD) are offered mainly by Islamic higher-education institutions under the Ministry of Religious Affairs, whereas Early Childhood Teacher Education programmes (Pendidikan Guru Pendidikan Anak Usia Dini, PGPAUD) are offered mainly by general universities under the education ministry. The two types operate under different expectations regarding religion. Islamic higher-education institutions are expected to integrate religious and general knowledge under a national guideline (Direktorat Jenderal Pendidikan Islam, 2019) that reflects an integrative–interconnective paradigm rejecting the separation of religious and scientific knowledge (Abdullah, 2014). General universities have no equivalent requirement, although the national early childhood curriculum treats religious and moral values as one of three learning-outcome elements, alongside identity and the foundations of literacy, mathematics, science, technology, engineering and arts (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi [Kemendikbudristek], 2024).

This landscape has changed since the data for this study were collected in May–June 2022. At that time, the Merdeka Curriculum (Kurikulum Merdeka) was one of three curricula that early childhood settings and schools could choose (Kemendikbudristek, 2022). It became the national curriculum in 2024 (Kemendikbudristek, 2024) and was amended in 2025 to incorporate a deep-learning approach (Kementerian Pendidikan Dasar dan Menengah, 2025). The education ministry was also restructured in late 2024: early childhood, primary and secondary education now fall under the Ministry of Primary and Secondary Education, and higher education, including teacher-education programmes in general universities, under the Ministry of Higher Education, Science, and Technology (Presiden Republik Indonesia, 2024a, 2024b). Implementation studies describe STEAM approaches being adopted in early childhood settings under the Merdeka Curriculum (Kay et al., 2025; Pasiningsih et al., 2025), while also reporting variation in teachers' beliefs, confidence and resources (Drupadi & Zain, 2025; Kay et al., 2025). Because the national curriculum now applies to all settings, preparing teachers to teach its STEAM-related outcomes has become more pressing, although the 2022 data cannot show whether programmes have changed since.

Against this background, existing research leaves three gaps. First, Indonesian studies of Islamic–STEAM integration have focused on kindergarten classrooms and in-service teachers,

documenting strategies such as thematic integration of Islamic content and reference to the Qur'an and Hadith in science-related activities (Nadlifah & Latif, 2024; Nurhayati et al., 2025; Rahmatullah et al., 2022; Rahmawati et al., 2023; Yuniarti & Suyadi, 2025), rather than on how teacher-education programmes prepare pre-service teachers for such integration. Second, Indonesian research on STEM teacher education has grown substantially, but studies in early childhood contexts and studies of religious or cultural values within pre-service preparation remain a small subset of it (Nugraha et al., 2023). Third, although Islamic and general programmes operate under different policy expectations, there is little comparative evidence on whether these expectations translate into different preparation practices, or whether similar constraints cut across both programme types.

These gaps matter for both programme types. For PIAUD programmes, a policy commitment to integrating knowledge has limited value if graduates are not taught how to enact it in STEAM activities; studies of Islamic early childhood settings report that integration is constrained by limited resources and the need for further teacher training (Nadlifah & Latif, 2024). For PGPAUD programmes, which prepare teachers for religiously diverse settings, the question is how the religious and moral values required by the national curriculum can be addressed without privileging a single faith. Without attention to how programmes prepare teachers for these tasks, values integration risks remaining a matter of institutional identity rather than of pedagogy.

Conceptual Framing

Three concepts guide the interpretation of the findings. They were not part of the 2022 interview design and are used as interpretive lenses rather than as a pre-specified framework. First, *STEAM integration* is understood as a continuum from disciplinary teaching, in which components are taught separately, through multidisciplinary and interdisciplinary approaches to transdisciplinary teaching organised around real-world problems (English, 2016); definitions of STEAM, including the role of the arts, vary considerably (Perignat & Katz-Buonincontro, 2019). Second, *readiness* is approached through pedagogical content knowledge (PCK), the knowledge that enables teachers to transform content into forms that learners can grasp (Shulman, 1986). Because PCK develops through enactment, readiness is treated as including both conceptual understanding and opportunities to teach integrated STEAM; because the data come mainly from staff, the study examines perceived rather than measured readiness. Third, *Islamic values* are understood as beliefs, dispositions and knowledge grounded in the Qur'an and Hadith, such as recognition of God as Creator, gratitude and good conduct. Their *integration* may be additive, when religious elements such as prayers, verses or memorisation are attached to otherwise unchanged content, or epistemic, when inquiry itself is framed as understanding creation and religious and scientific knowledge are treated as interconnected, as the integrative–interconnective paradigm proposes (Abdullah, 2014).

This study therefore aimed to explore how six Indonesian early childhood teacher-education programmes, two in Islamic higher-education institutions and four in general universities, prepared pre-service teachers for STEAM in 2022, and whether and how Islamic values were integrated into that preparation. Four research questions guided the study: (1) How do staff and pre-service teachers describe pre-service teachers' readiness and preparation to teach STEAM? (2) What constraints and facilitators shape this preparation? (3) What improvements do participants propose? (4) How is the integration of Islamic values approached

in STEAM preparation, and how does this differ across programmes? The study's novelty lies in examining teacher-education programmes rather than kindergarten classrooms, in comparing Islamic and general programmes within one design, and in distinguishing additive from epistemic forms of values integration. Its theoretical contribution is to show where, in the structure of teacher preparation, the gap between STEAM policy and practice arises; its practical contribution is a set of programme-level actions grounded in that analysis.

METHODS

Research Design

A multi-site qualitative design was used (Miles et al., 2020). The unit of comparison was the early childhood teacher-education programme, and the data were the accounts of informants associated with each programme. Because each programme was represented by one to three informants and no programme documents were analysed, the study does not offer within-case analyses of programmes. Instead, it compares patterns across sites, treating each programme's accounts as a bounded body of evidence about that programme in 2022.

Sites and Programme Classification

Six programmes in Java were selected purposively to include both programme types (Patton, 2015). Selection was based on programme type and on access through the research team's professional networks, and was therefore partly convenience-based. Programmes were classified by the type of host institution. Two were PIAUD programmes in Islamic higher-education institutions, coded I1 (a state Islamic university) and I2 (a private Islamic higher-education institute). Four were in general universities, coded G1 (a private university) and G2–G4 (public universities). G1–G3 were PGPAUD programmes. G4 was a boundary case: a programme housed in a Faculty of Islamic Studies within a general public university and referred to by its informants as a PIAUD programme. G4 was retained in the general group because classification was by host institution, but its intermediate position is analysed explicitly in the findings. Real institution names are withheld (Table 1).

Participants

Ten informants took part: six lecturers, one of whom also headed her programme; two further heads of study programme; one final-year student; and one recent graduate. Inclusion criteria were teaching STEAM-related courses, heading a study programme, or being a final-year student or recent graduate with STEAM coursework and field experience. All informants were women; no claim is made about the gender composition of the wider workforce. Because the student and the graduate provide the only pre-service perspectives, claims about pre-service teachers' readiness are reported as staff-perceived readiness unless otherwise indicated. Informants are identified by role (L = lecturer; HP = head of study programme; LHP = lecturer and head of study programme; ST = final-year student; GR = recent graduate) and programme code.

Table 1. Programmes, informants and data sources

Programme	Host institution and programme type	Informants	Data mode	Recording and duration
I1	State Islamic university; PIAUD	L, HP, ST	Written responses to the protocol (no probing)	Not applicable
I2	Private Islamic higher-education institute; PIAUD (newer programme)	LHP	Online interview with follow-up probes	Recorded; at least 81 minutes (transcript timestamps)
G1	Private general university; PGPAUD	L	Online interview with follow-up probes	Recording indicated; duration not documented
G2	Public general university; PGPAUD	L, GR	Joint online interview with follow-up probes	Recording indicated; duration not documented
G3	Public general university; PGPAUD	L	Extended spoken response to the protocol, transcribed; no interviewer turns	Duration not documented
G4	Public general university; programme designated PIAUD, housed in a Faculty of Islamic Studies	HP, L	Joint online interview with follow-up probes	Recording indicated; duration not documented

Note. All data were in Indonesian. Recording is reported only where the transcripts indicate it. Programme founding years, accreditation status and locations are not reported to reduce the risk of identification.

Data Collection

Data were collected in May and June 2022, about two years into the COVID-19 pandemic and during the transition to the Merdeka Curriculum and the Merdeka Belajar Kampus Merdeka (MBKM, 'Freedom to Learn, Independent Campus') higher-education policy. A semi-structured protocol covered four domains corresponding to the research questions: readiness and preparation; constraints and facilitators; improvement plans; and the integration of Islamic values. The protocol, which also served as the written instrument, contained 15 questions in the staff version and 11 in the student version (Supplementary Material S1).

Collection modes varied (Table 1). Six informants from four programmes took part in online interviews conducted by members of the research team, two of them as joint sessions with two informants; the three I1 informants returned written responses to the protocol; and the G3 informant gave an extended spoken response to the protocol questions, which was transcribed. The mode of each quotation is indicated in the text. Quoted extracts were translated from Indonesian into English by the authors and re-checked against the Indonesian source during revision; the original-language extracts are provided in Supplementary Material S2.

Data Analysis

Data were analysed using codebook thematic analysis (Braun & Clarke, 2021), which retains a qualitative orientation but uses a structured code list, partly developed in advance, and charts data into matrices; this suited a cross-site comparison organised around predetermined research questions. The phases described by Braun and Clarke (2006) were used as a sequence of steps, without adopting the reflexive approach now associated with that paper. The study takes a broadly realist stance: informants' accounts are treated as reports of programme practices in 2022, while recognising that they are perspectival and shaped by informants' positions and the interview context. Coding was carried out manually by the research team using word-processing and spreadsheet files; no qualitative-analysis software was used. A code list combined deductive codes derived from the four protocol domains (for example, 'practical skill deficit', 'engineering absence' and 'Islamic integration mandate') with inductive codes for unanticipated patterns (for example, 'technology conflated with digital devices' and 'student–staff perception gap'). The initial analysis produced summaries organised by protocol domain. During revision, these summaries were developed into four analytic themes, each with a central organising idea, and every finding was re-checked against the Indonesian source transcripts. A case-by-theme matrix (Table 2) records which programmes and roles support each finding (Miles et al., 2020). Counts refer to programmes unless informants are specified. They show how widely a finding was reported across the six sites, not its prevalence beyond them or its importance (Miles et al., 2020), and the accounts of the single student and single graduate are treated as illustrative rather than representative.

Trustworthiness and Reflexivity

Credibility was supported by comparing accounts across roles where a programme had more than one informant (I1, G2 and G4), by re-checking every reported finding and quotation against the source transcripts, and by reporting discrepant and boundary cases: the I1 student's account of values integration, the intermediate position of G4 and the G3 informant's view that values integration did not apply to her institution. Member checking and peer debriefing were not undertaken, and the coding records and analytic memos from the original analysis were not retained, which limits dependability; the revision-stage verification is documented in a private evidence matrix held by the authors. Transferability is supported by the programme descriptions in Table 1 and in the findings, within the limits set by anonymity, and confirmability by the case-by-theme matrix and original-language extracts, which allow readers to trace claims to evidence (Lincoln & Guba, 1985).

The authors are affiliated with the institution that hosts programme I1, and the interviews were conducted by members of the research team. No author taught or assessed the student or graduate informants, and relationships with the other five programmes were professional. Two features of this position may have shaped the data. First, I1 informants were responding to colleagues from their own institution, which may have encouraged favourable accounts of the institutional mandate. Second, in some interviews the interviewer described the integration expectations at the authors' institution and offered examples of Islamic–STEAM integration before inviting informants' views. Expressions of personal support for values integration may therefore partly reflect this framing, and heads of programme, who also spoke for their institutions, may have presented their programmes favourably. These possibilities are taken into account in interpreting the fourth theme.

Participant Protection and Data Handling

No application for prospective ethical clearance was made before the May–June 2022 data collection, and no Ethical Clearance reference number exists for this study. The responsible institution cannot issue ethical clearance retrospectively; this is a limitation of the original study design, which the authors disclose transparently. Informants agreed voluntarily to take part at

the time of data collection, but this agreement was given informally and was not documented in writing. During manuscript revision, all ten informants were re-contacted and gave affirmative, publication-specific re-consent for the continued use of their data, anonymised reporting of their roles and programme categories, and the use of transcript-verified, anonymised quotations. Re-consent was documented through written messages, voice notes or signed forms. These records, the private coding key and the transcripts are held securely by the authors and are not included in the manuscript or supplementary materials. Institution and participant names were replaced with codes, and potentially identifying details were removed or generalised.

Methodological Limitations and Their Implications for Credibility

Five limitations bear directly on how the findings should be read. First, the mix of collection modes means that the depth of data varied: interview accounts could be probed, whereas written and monologic responses could not. The modes are therefore not treated as equivalent, and findings that rest mainly on written data, notably the I1 accounts of the institutional mandate and the student's account, are identified as such. Second, pre-service perspectives come from one student and one graduate, so readiness is reported as perceived by staff. Third, the data are self-reports that were not verified against curriculum documents or observation, and no data were collected from supervising teachers in placement settings; statements that a course or practice was absent mean that no informant described it, not that its absence was verified. Fourth, the data were collected in 2022 during pandemic disruption and curriculum transition. The findings describe the programmes at that time and cannot establish current conditions, although the features they concern, namely course structure, placement design, staffing and institutional mandates, are not altered in themselves by the school-curriculum and ministerial changes noted above. Fifth, all six programmes were in Java and selection was partly convenience-based, which limits transferability. With the absence of prospective ethical review, these limitations mean that the findings are a context-specific account rather than evidence of sector-wide patterns.

RESULTS AND DISCUSSION

The findings are presented as four analytic themes, one for each research question (RQ), followed by a discussion. Table 2 shows which programmes and informant roles support each finding.

Table 2. Analytic themes, central organising ideas and supporting programmes and roles

Theme and finding	I1	I2	G1	G2	G3	G4
Theme 1 (RQ1). Knowing STEAM but not yet enacting it. *Pre-service teachers were perceived to understand what STEAM is better than how to teach it, a gap informants linked to separate courses and limited opportunities for supervised enactment.*						
Conceptual understanding perceived as ahead of enactment	L, ST	–	L	L (c)	L	–
STEAM components taught in separate courses; no integrated STEAM course described	L	–	L	L	L	HP
Limited opportunities for supervised enactment within coursework (peer teaching, microteaching, practice hours)	L, ST	LHP	–	–	L	–

No dedicated engineering course: named as a gap (I1) or described as embedded in other courses (G2, G4)	L	–	–	L	–	HP
Arts and mathematics described as established, course-based components	–	–	–	L	L	HP
Methods and media varied; no shared instructional model	L, HP	LHP	–	L, GR	–	L
Theme 2 (RQ2). Constraints lie in people, placements and paradigms. *Constraints were located less in institutional type than in lecturer expertise, placement settings and a narrow conception of technology.*						
Lecturer backgrounds mismatched with early childhood or Islamic studies	–	LHP	–	–	–	L, HP
No shared understanding of STEAM among lecturers, or no STEAM-specific training	L	–	L	L	–	–
Placement teachers not modelling integrated STEAM	–	–	L	GR	L	–
Technology narrowly equated with digital devices	–	–	L	L, GR	–	–
Laboratory-school access as facilitator (I2, G3) or constraint (G4)	–	LHP	–	–	L	L
Pandemic disruption to learning, observation, microteaching or motivation	–	LHP	–	–	L	L
Formal partnership agreements under-used	–	LHP	L	–	–	–
Theme 3 (RQ3). Improvement as stated intention. *Priorities converged on curriculum coherence, structured practicum and lecturer development, but in 2022 these were intentions rather than completed reforms.*						
Curriculum review or revision planned or under way	L	LHP	–	–	L	HP, L
More and better-structured practicum (hours, verified sites, microteaching, mentoring)	L, ST	–	L	–	L	–
Lecturer development (training, visits, shared understanding)	L	–	–	L	–	HP
Advanced digital-technology curriculum component planned	–	–	–	–	–	HP, L
Theme 4 (RQ4). A gradient of values integration. *Formal expectations ranged from institution-wide mandates to none, but integration was mostly additive and rarely embedded in STEAM pedagogy.*						
Institution-wide mandate to integrate Islamic values across courses, including STEAM	L, HP	LHP	–	–	–	–
Faculty- or programme-level Islamic mission; integration in some courses but not yet in STEAM	–	–	–	–	–	HP, L

No institutional mandate; religion taught separately or through a multi-faith values course	–	–	L	L, GR	L	–
Reported practices mainly additive (openings, prayers, memorisation, added sessions)	–	LHP	–	–	–	HP, L
Personal support for integrating values into STEAM	L, HP	LHP	L	L, GR	–	L
Religious diversity of classrooms requires non-denominational framing	–	–	–	L, GR	–	–
Integration not experienced concretely in STEAM coursework (discrepant account)	ST	–	–	–	–	–

Note. Cells show the roles of the informants whose accounts support each finding: L = lecturer; HP = head of study programme; LHP = lecturer and head of study programme; ST = final-year student; GR = recent graduate; (c) = contrasting account. A dash means that no informant at that programme described the finding; it does not indicate that the feature was verified as absent.

Theme 1: Knowing STEAM but Not Yet Enacting It (RQ1)

In three programmes (I1, G1 and G3), staff described pre-service teachers' conceptual understanding of STEAM as adequate but their ability to enact it as weak. The G1 lecturer, who supervised field practice, observed: "What I feel when students are in the field is that the essential practice of the STEAM approach is lacking … students must know how, not only the what … So don't let the approach, pardon me, still be teacher-directed or teacher-centred" (L, G1; interview). The G3 lecturer linked the gap to practice time: "theoretically they are capable, [but] they must still be prepared with additional hours of teaching experience, because, after all, this approach will be applied well when they have good teaching experience" (L, G3; spoken response). The I1 student described her own preparation as "mostly just theory … not yet reaching the implementation stage" (ST, I1; written). The G2 lecturer gave a contrasting account, describing students as prepared because STEAM had recently been strengthened in the programme's curriculum and in its teacher-certification programme (Pendidikan Profesi Guru, PPG).

Informants linked the gap to how preparation was organised. No informant described a dedicated, integrated STEAM course. At I1, G2, G3 and G4, STEAM components were described as spread across separate courses such as science, mathematics, arts and media development; the G2 lecturer summarised that the components were taught but had not yet been brought together into one course, and the G1 lecturer questioned how students could master STEAM when its components were taught in separate courses. Opportunities to enact integrated STEAM within coursework were also limited: practice took the form of peer teaching rather than teaching children (I2), STEAM-based microteaching needed more encouragement (I1), and additional teaching hours were requested (G3). Engineering was the least visible component, and no programme described a dedicated engineering course. The I1 lecturer named this as a gap: "There is not yet a course related to engineering for early childhood. As a result, students are not yet accustomed to creating activities related to engineering for young children and integrating them within one learning theme" (L, I1; written). At G2 and G4, engineering was described as embedded in other courses, such as media development or motor development.

By contrast, informants at G2, G3 and G4 described arts and mathematics as established components with their own courses. The analysis therefore concentrates on technology and engineering, the components in which informants located difficulty.

Teaching methods and media varied without a shared model, from project-based, problem-based and discovery learning (I1) to low-cost natural materials (I1), augmented-reality storybooks (G2) and video documentation of students' media (G4). The most structured sequence was at G2: students learned a concept in one course, designed a related resource in a media course and implemented it in a play-and-games course.

Theme 2: Constraints Lie in People, Placements and Paradigms (RQ2)

At I2 and G4, informants described a mismatch between lecturers' backgrounds and the combined demands of early childhood education and Islamic studies. The I2 head reported that few lecturers had an early childhood background, many coming from Islamic religious education (Pendidikan Agama Islam, PAI), and that the programme's first curriculum had been weighted towards PAI content until it was reviewed. The G4 lecturer described the challenge as reciprocal: "The challenge of PIAUD is … integrating Islamic values with PAUD [early childhood education]; the PAI people must learn the PAUD discipline, the PAUD people must learn about Islamic knowledge, and that's where we need to sit together and discuss" (L, G4; interview). Elsewhere, the issue was shared understanding rather than background: the I1 and G2 lecturers reported that colleagues teaching STEAM-related courses did not yet share a common understanding of STEAM, and the G1 lecturer reported that none of her six colleagues had received STEAM-specific training, although professional-development funds were available for other purposes.

A second constraint lay in placement settings. At G1, G2 and G3, informants reported that teachers in partner settings did not consistently model integrated STEAM. The G1 lecturer said that many partner schools claimed to implement STEAM but, when students practised there, the components were still taught separately, and the G3 lecturer noted that not all placement schools used the approach. These accounts come from three informants; supervising teachers were not interviewed. A related constraint, reported at G1 and G2, was a narrow understanding of technology. The G2 graduate described a lesson she had tried with young children: "For technology, it is very, very, very difficult to make some teachers who teach in PAUD understand … For the technology [component], we taught [the children] to make orange juice using a blender. Well, they assumed that this was not technology" (GR, G2; interview). She added that some fellow students equated technology with laptops and tablets, a tendency also described by the G1 and G2 lecturers.

Laboratory-school access was described as a facilitator at I2 and G3 and as a constraint at G4. At I2, a newer programme, pre-service teachers themselves staffed the affiliated laboratory school ("all the teachers are students"; LHP, I2; interview), although its use as an observation site had been limited during online learning. G3 had its own day-care centre and kindergartens and partnerships with alumni-run non-formal settings, whereas G4 had no laboratory school and relied on visits to partner sites. At I2, G3 and G4, the pandemic had disrupted preparation through what the I2 head called "loss learning" and "loss teaching" during online classes (LHP, I2; interview), restricted classroom observation and microteaching (G3) and reduced student motivation (G4). Formal partnership agreements existed but were

described as under-used at I2 and G1, whereas support from programme leadership, such as reassigning lecturers or arranging enrichment sessions, was described as a facilitator at G1.

Theme 3: Improvement as Stated Intention (RQ3)

Curriculum review was planned or under way at I1, I2, G3 and G4, often prompted by national policy. The I2 head described it as obligatory: "curriculum review has become a mandatory agenda … One obstacle is that we need many MoUs [memoranda of understanding] and to listen more to aspirations from the field" (LHP, I2; interview). The I1 lecturer proposed an integrated STEAM course and a course on engineering for early childhood, and G4 was preparing to add a university-wide digital-technology component covering artificial intelligence, blockchain, cloud computing and data analysis.

Practicum proposals were concrete. The G3 lecturer proposed more teaching hours; the G1 lecturer proposed designating as placement sites only schools that already applied integrated STEAM; and the I1 lecturer and student called for more STEAM-based microteaching and for direct training and mentoring in real classrooms. Plans for lecturer development were largely aspirational: thematic workshops and visits to STEAM-implementing institutions (I1), a shared understanding of STEAM and richer references (G2), and use of an existing monthly programme forum to align staff perceptions (G4). Plans for facilities and media, such as a practical handbook of low-cost media at G4, likewise depended on future investment. In 2022, these were intentions rather than completed reforms.

Theme 4: A Gradient of Values Integration (RQ4)

Informants described three levels of formal expectation. At I1 and I2, integrating Islamic values across all courses, including STEAM-related courses, was an institutional requirement. The I1 head wrote that her institution "explicitly and implicitly requires the integration of Islamic values in all courses", recorded in semester learning plans (Rencana Pembelajaran Semester, RPS) and monitored by internal quality-assurance and curriculum teams (HP, I1; written), and the I2 head described a Qur'anic and Hadith foundation at the start of every syllabus. G4 occupied an intermediate position. Its informants reported no university-level instruction but described Islamic elements in the faculty's and programme's mission statements, Islamic-studies courses, a requirement to memorise the thirtieth part (juz) of the Qur'an before graduation, and Islamic perspectives added to the first sessions of some courses after a curriculum revision; STEAM-related courses, however, had not yet been integrated. At G1, G2 and G3, informants reported no institutional mandate. Religion was taught as a separate course at G1; at G2, values were addressed through a course on religious and moral development covering several religions; and the G3 lecturer considered the question not applicable "because we are not from a university based on Islam" (L, G3; spoken response).

The practices informants described were mostly additive: opening prayers and memorisation of short Hadith linked to a lesson's topic in the I2 laboratory school, and Islamic-perspective sessions and Qur'an memorisation at G4. The I1 lecturer reported presenting science content from an Islamic perspective. Statements framing science itself as a way of understanding creation were rarer. The I1 head wrote that Islamic values "help students see science not only as worldly knowledge, but as a means to understand the majesty of God's creation" (HP, I1; written), and a G4 informant gave the example of linking the study of fresh and wilted plants in science to gratitude.

Personal support for integrating values into STEAM was expressed at five programmes (I1, I2, G1, G2 and G4) but not at G3. General-programme informants qualified this support in two ways. The G2 lecturer distinguished her own view from her institution's position: "Personally, not representing the institution as a particular group, I would certainly be very happy … However, if I speak in terms of the institution, it depends on needs … in general kindergartens, knowledge of other religions must also be present" (L, G2; interview). The G2 graduate described adapting to a religiously diverse placement kindergarten by teaching only that "we are created by God" (GR, G2; interview) and by having children pray according to their own beliefs. At G1, support was expressed after the interviewer had offered examples of integration (see Trustworthiness and Reflexivity).

The only student account diverged from staff accounts at the same programme. Despite the I1 mandate, the student wrote: "So far I haven't felt the integration. There are some courses that discuss Islamic values, but they haven't really explained how to integrate them into STEAM material concretely …" (ST, I1; written). She added that whether integration happened seemed to depend on individual lecturers. Because this is a single written account, it is reported as a discrepant case rather than as evidence of a general pattern.

Discussion

Why the Theory–Practice Gap Persists

The first theme suggests that the theory–practice gap arises mainly from the structure of coursework. Where STEAM components are taught in separate courses, students experience STEAM at the disciplinary or, at best, multidisciplinary end of the integration continuum (English, 2016), which helps to explain why staff saw students applying components separately once in classrooms; the I1 and G1 lecturers made this link explicitly. Because PCK develops when knowledge is transformed through teaching (Shulman, 1986), the scarcity of supervised enactment within coursework matters as much as course content. Placement settings, reported at three programmes, are better seen as a compounding constraint than as the source of the gap: teachers there did not consistently model integrated STEAM or recognise simple tools as technology. This rests on three informants' accounts, without data from supervising teachers, but is consistent with research showing that early childhood pre-service teachers tend to equate technology with screen-based devices and that practicum settings shape these perceptions (Dong & Mertala, 2021), whereas technology education research treats technology more broadly, as artefacts, creation processes and human practice (Eliasson et al., 2023).

These findings are consistent with evidence that structured coursework and field experience support pre-service teachers' STEAM confidence (Brusic et al., 2023; Evagorou, 2024), that engineering is under-represented in early childhood teacher education and that children's exposure to it is mostly incidental (Cohrssen et al., 2025; Ramanathan et al., 2024), and that STEAM-specific training can improve early childhood teachers' pedagogical competence (Fatwikiningsih & Ismaeil, 2025), which makes the absence of such training for lecturers notable. They extend this literature in one respect. Studies of pre-service preparation often evaluate a specific course or design experience (e.g., Evagorou, 2024), whereas informants here described STEAM content that was present but distributed across courses without an integrating sequence. The issue in these programmes was therefore less the absence

of STEAM content than its coherence across the programme, which the G2 sequence of concept, resource design and implementation illustrates on a small scale.

What Is Distinctive about the Indonesian Programmes

Two features of the Indonesian context help to explain the patterns. The first is dual governance. The contrast between I1–I2 and G1–G3 corresponds to the different expectations placed on Islamic and general higher education (Abdullah, 2014; Direktorat Jenderal Pendidikan Islam, 2019), but G4, an Islamic-studies faculty programme in a general university with faculty-level expectations and no university mandate, shows that the relevant boundary may be the governing unit rather than the institutional label. The second is that the national early childhood curriculum combines religious and moral values with foundations of science, technology, engineering and arts (Kemendikbudristek, 2024), which gives general programmes a legitimate entry point for values education, as the G1 lecturer noted. At the same time, constraints such as lecturer mismatch, placement quality and under-used partnerships cut across both programme types, suggesting that the type of institution shapes values integration more than it shapes STEAM preparation as a whole.

Additive or Epistemic Integration?

The fourth theme shows that a formal mandate did not guarantee pedagogical integration. Most reported practices were additive: religious elements were attached to lessons and syllabi rather than reshaping how STEAM inquiry was taught. Only a few statements, such as the I1 head's description of science as a means of understanding creation, approached the epistemic integration envisaged by the integrative–interconnective paradigm (Abdullah, 2014). The I1 student's account is consistent with this reading: integration was present in documents and in some course content but had not been translated into guidance on how to integrate values into STEAM activities. Research on Islamic kindergartens reports classroom strategies such as Qur'an-integrated science that draws on gratitude and stewardship (Nurhayati et al., 2025) and notes that integration is constrained by resources and training (Nadlifah & Latif, 2024). The present findings suggest that part of this constraint originates earlier, in teacher education: programmes that require integration may not yet teach pre-service teachers how to achieve it. Because this interpretation rests partly on one written student account and on staff accounts given to colleagues from the authors' institution, it should be tested with document analysis and student-level data.

Values Integration in Religiously Diverse Settings

The general-programme accounts caution against simply extending Islamic integration to general programmes. Informants at G2 framed values in non-denominational terms because their students and the children they teach belong to different faiths, and the G2 lecturer separated her personal view from her institution's position. The authors infer that general-programme informants share with Islamic-programme informants a commitment to moral and spiritual formation, but this is an interpretation rather than a finding reported by informants, and expressions of support may partly reflect interview framing. A more defensible implication is that all programmes need pedagogical capacity for values integration that suits the religious composition of their settings and the national curriculum's religious and moral values element, rather than a single faith-specific model.

CONCLUSION

This study explored STEAM preparation and Islamic values integration in six Indonesian early childhood teacher-education programmes in 2022. In answer to the first research question, staff perceived pre-service teachers' conceptual understanding of STEAM as stronger than their ability to enact it, a gap linked to STEAM being taught in separate courses with limited opportunities for supervised enactment, and with engineering the least visible component. Second, the main constraints were lecturer expertise, a narrow conception of technology, pandemic disruption and, at three programmes, placement settings that did not model integrated STEAM; these cut across programme types. Third, informants proposed curriculum revision, more structured and verified practicum and lecturer development, mostly as intentions rather than completed reforms. Fourth, formal expectations for Islamic values integration ranged from institution-wide mandates (I1 and I2) through faculty-level expectations (G4) to none (G1–G3), but reported practices were mostly additive, and the only student account indicated that integration was not yet experienced concretely in STEAM coursework.

The study contributes a cross-site account that links the STEAM preparation gap to the coherence of coursework and the scarcity of supervised enactment, identifies a gradient rather than a binary in values-integration mandates, and distinguishes additive from epistemic integration. Three practical recommendations follow from the discussion; they are context-specific suggestions rather than findings. First, programmes could sequence STEAM preparation so that each component, including engineering and non-digital technology, moves from concept to resource design to supervised enactment. Second, as one informant proposed, programmes could add a verification step before approving placement sites, confirming that supervising teachers implement integrated STEAM and share a broad understanding of technology. Third, lecturer development could direct existing professional-development funds towards STEAM-specific training and, where values integration is expected, towards teaching pre-service teachers how to embed values in STEAM inquiry in ways that suit each setting's religious composition.

These conclusions describe six programmes in 2022 and rest mainly on staff accounts. Future research should analyse curriculum documents, semester learning plans and vision-and-mission statements systematically; collect data from larger samples of students and graduates; observe coursework and placements; include programmes beyond Java; and follow graduates into practice to examine how STEAM and values integration are enacted.

REFERENCES

Abdullah, M. A. (2014). Religion, science and culture: An integrated, interconnected paradigm of science. *Al-Jami'ah: Journal of Islamic Studies, 52*(1), 175–203. https://doi.org/10.14421/ajis.2014.521.175-203

Angelone, L. (2020). STEAM in early childhood education: A blended module to investigate preservice teachers' conceptualizations of STEAM education. *Ohio Journal of Teacher Education, 34*(1), Article 5. https://www.exhibit.xavier.edu/ojte/vol34/iss1/5/

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology, 18*(3), 328–352. https://doi.org/10.1080/14780887.2020.1769238

Brusic, S., Marcum-Dietrich, N., Shettel, J., & White, J. (2023). Building a firm foundation: Preparing Pre-K–4 teachers for integrative STEM pedagogy. *Innovations in Science Teacher Education, 8*(1). https://innovations.theaste.org/index.php/iste/article/view/383

Cohrssen, C., Guarrella, C., Hebden, K., Quinn, F., & Nirmalathas, A. (2025). Situating engineering within the Australian pre-tertiary education system. *The Australian Educational Researcher, 52*(6). https://doi.org/10.1007/s13384-025-00880-y

Direktorat Jenderal Pendidikan Islam. (2019). *Keputusan Direktur Jenderal Pendidikan Islam Nomor 2498 Tahun 2019 tentang pedoman implementasi integrasi ilmu di perguruan tinggi keagamaan Islam* [Decree of the Director General of Islamic Education No. 2498 of 2019 on guidelines for implementing the integration of knowledge in Islamic higher education institutions]. Kementerian Agama Republik Indonesia.

Dong, C., & Mertala, P. (2021). It is a tool, but not a 'must': Early childhood preservice teachers' perceptions of ICT and its affordances. *Early Years, 41*(5), 540–555. https://doi.org/10.1080/09575146.2019.1627293

Drupadi, R., & Zain, A. (2025). Exploring early childhood education teacher's beliefs about STEAM learning in Indonesia. *Southeast Asia Early Childhood Journal, 14*(1), 93–105. https://doi.org/10.37134/saecj.vol14.1.7.2025

Eliasson, S., Peterson, L., & Lantz-Andersson, A. (2023). A systematic literature review of empirical research on technology education in early childhood education. *International Journal of Technology and Design Education, 33*(3), 793–818. https://doi.org/10.1007/s10798-022-09764-z

English, L. D. (2016). STEM education K-12: Perspectives on integration. *International Journal of STEM Education, 3*, Article 3. https://doi.org/10.1186/s40594-016-0036-1

Evagorou, M. (2024). Engaging kindergarten pre-service teachers in the design and implementation of STEM lessons. *Frontiers in Education, 9*, 1277835. https://doi.org/10.3389/feduc.2024.1277835

Fatwikiningsih, N., & Ismaeil, N. (2025). Enhancing early childhood teacher pedagogical competence through STEAM-based instructional training: An experimental study. *Indonesian Journal of Early Childhood Educational Research, 4*(1). https://doi.org/10.31958/ijecer.v4i1.14982

Kay, L., Putri, S., Dewi, F., Buxton, A., & Buyani, T. (2025). STEAM-ECE: Developing a STEAM approach for early childhood education in Indonesia. *Indonesian Journal of Early Childhood Education Studies, 14*(2), 103–115. https://doi.org/10.15294/ijeces.v14i2.33363

Kementerian Pendidikan Dasar dan Menengah. (2025). *Peraturan Menteri Pendidikan Dasar dan Menengah Nomor 13 Tahun 2025 tentang perubahan atas Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 12 Tahun 2024 tentang kurikulum pada pendidikan anak usia dini, jenjang pendidikan dasar, dan jenjang pendidikan menengah* [Regulation No. 13 of 2025 amending the regulation on the curriculum for early childhood, primary and secondary education].

Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi. (2022). *Keputusan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 56/M/2022 tentang pedoman penerapan kurikulum dalam rangka pemulihan pembelajaran* [Decree No. 56/M/2022 on guidelines for curriculum implementation for learning recovery].

Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi. (2024). *Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 12 Tahun 2024 tentang kurikulum pada pendidikan anak usia dini, jenjang pendidikan dasar, dan jenjang pendidikan menengah* [Regulation No. 12 of 2024 on the curriculum for early childhood, primary and secondary education].

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage.

Machmud, H., Abidin, A., Alim, N., & Rasmi. (2025). Bridging knowledge and practice: Evidence from pre-service early childhood teachers' PCK implementation in their teaching practicum. *Journal of Early Childhood Teacher Education*. Advance online publication. https://doi.org/10.1080/10901027.2025.2565691

Miles, M. B., Huberman, A. M., & Saldaña, J. (2020). *Qualitative data analysis: A methods sourcebook* (4th ed.). Sage.

Nadlifah, & Latif, M. A. (2024). Creative freedom and holistic growth: Implementation of the STEAM approach in Islamic early childhood education. *Golden Age: Jurnal Ilmiah Tumbuh Kembang Anak Usia Dini, 9*(4), 689–702. https://doi.org/10.14421/jga.2024.94-09

Nugraha, M. G., Kidman, G., & Tan, H. (2023). Pre-service teacher in STEM education: An integrative review and mapping of the Indonesian research literature. *EURASIA Journal of Mathematics, Science and Technology Education, 19*(5), em2262. https://doi.org/10.29333/ejmste/13155

Nurhayati, S., Marhamah, Taufikin, Sholihah, H., Tri, A., Maemunah, R., & Moreb, M. (2025). Holistic learning through Qurʾānic-integrated STEM: Innovations in early childhood pedagogy. *KIDDO: Jurnal Pendidikan Islam Anak Usia Dini, 6*(2), 490–509. https://ejournal.uinmadura.ac.id/index.php/kiddo/article/view/21280

Pasiningsih, P., Putri, S. R., Nisa, M., Farikhah, A., & Khasanah, N. (2025). Implementasi Kurikulum Merdeka dengan pendekatan pembelajaran STEAMLY PLUS di PAUD. *Dunia Anak: Jurnal Pendidikan Anak Usia Dini, 8*(2), 86–98. http://www.jurnal.stkippersada.ac.id/jurnal/index.php/PAUD/article/view/5237

Patton, M. Q. (2015). *Qualitative research & evaluation methods* (4th ed.). Sage.

Perignat, E., & Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. *Thinking Skills and Creativity, 31*, 31–43. https://doi.org/10.1016/j.tsc.2018.10.002

Presiden Republik Indonesia. (2024a). *Peraturan Presiden Nomor 188 Tahun 2024 tentang Kementerian Pendidikan Dasar dan Menengah* [Presidential Regulation No. 188 of 2024 on the Ministry of Primary and Secondary Education].

Presiden Republik Indonesia. (2024b). *Peraturan Presiden Nomor 189 Tahun 2024 tentang Kementerian Pendidikan Tinggi, Sains, dan Teknologi* [Presidential Regulation No. 189 of 2024 on the Ministry of Higher Education, Science, and Technology].

Rafiq-uz-Zaman, M. (2025). STEAM: A contemporary concept and a set of early childhood education. *Journal of Childhood Literacy and Societal Issues, 4*(1), 122–140. https://doi.org/10.71085/joclsi.04.01.77

Rahmatullah, R., Faeruz, R., Romadhon, D. R., & Rahiem, M. D. H. (2022). Instilling Islamic values on STEAM learning in early childhood education to produce Islamic scientist. *ThufuLA: Jurnal Inovasi Pendidikan Guru Raudhatul Athfal, 10*(2), 325–350. https://doi.org/10.21043/thufula.v10i2.16358

Rahmawati, R., Nurdin, N., Pettalongi, A., & Fatma, F. (2023). Integration of Islamic educational values in teaching of science through games to kindergarten pupils in Palu City, Indonesia. *International Journal of Multidisciplinary Research and Analysis, 6*(2), 555–563. https://doi.org/10.47191/ijmra/v6-i2-13

Ramanathan, G., Cosso, S., & Pool, J. (2024). Engineering in preschool: What little minds can teach us about big skills. *Early Childhood Education Journal, 52*(6), 1245–1257. https://doi.org/10.1007/s10643-023-01512-9

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14. https://doi.org/10.3102/0013189X015002004

Stepić, G. (2025). Future preschool teachers' attitudes towards the integration of the STEM learning approach in early childhood practice. In *STEM/STEAM/STREAM approach in*

theory and practice of contemporary education (pp. 157–168). Faculty of Education, University of Kragujevac. https://doi.org/10.46793/STREAM25.157S

Yuniarti, N., & Suyadi. (2025). Integrating Montessori, neuroscience, and Islamic values in early science and math learning. *Jurnal Pendidikan, Pengasuhan, Kesehatan dan Gizi Anak Usia Dini, 6*(1), 100–121. https://journal.unesa.ac.id/index.php/jt/article/view/45614