

Structural convergences between STEM project-based learning and Islamic educational philosophy

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Abstract: This systematic literature review investigates core STEM-PjBL pedagogical mechanisms and their alignment with Islamic educational principles, as well as the potential implications of this alignment for culturally relevant contextualized higher education STEM pedagogy framed within an Islamic orientation. Methods: Following PRISMA 2020 guidelines, thematic synthesis and quality appraisal of the studies utilising the Mixed Methods Appraisal Tool (MMAT) was conducted on 17 peer-reviewed papers published between 2016-24. It was found that STEM-PjBL stressed collaborative inquiry, authentic problem-solving, iterative refinement, interdisciplinary integration, and community-oriented learning throughout. They have structurally substantive similarities with Wadud implies Shura, Maslaha, Ihsan and Tawhid principles. Simultaneously, it also reveals frictions around learning agency and constructivist inquiry, and contextually situated understandings of the value-practice nexus. This review suggests that contextually situated reimaginings of STEM-PjBL within particular cultural traditions may enhance culturally responsive STEM pedagogy. Future studies may explore comparative contexts in which STEM-PjBL is interpreted, adapted, and enacted within Islamic higher education systems. These studies may help elucidate how institutional culture, educational values, and local pedagogy traditions mediate the tensions between widely circulated STEM pedagogies and contextually rooted local practices.

Keywords: Culturally responsive pedagogy, Islamic educational philosophy, STEM education

Abstrak: Tinjauan pustaka sistematis ini mengkaji mekanisme pedagogis inti STEM-PjBL dan keselarasan-nya dengan prinsip-prinsip pendidikan Islam, serta potensi implikasi dari keselarasan tersebut bagi pedagogi STEM di perguruan tinggi yang kontekstual, relevan secara budaya, dan berorientasi Islam. Metode: Dengan mengikuti pedoman PRISMA 2020, dilakukan sintesis tematik dan penilaian kualitas menggunakan *Mixed Methods Appraisal Tool* (MMAT) terhadap 17 artikel ilmiah yang telah melalui telaah sejawat (*peer-reviewed*) dan diterbitkan antara tahun 2016 hingga 2024. Hasilnya menunjukkan bahwa STEM-PjBL menekankan inkuiri kolaboratif, pemecahan masalah autentik, penyempurnaan iteratif, integrasi lintas disiplin, dan pembelajaran yang berorientasi pada komunitas. Terdapat kemiripan yang substansial secara struktural dengan prinsip-prinsip *Syura, Maslahah, Ihsan, dan Tauhid*. Pada saat yang sama, kajian ini juga mengungkap adanya ketegangan terkait agensi pembelajar dan inkuiri konstruktivis, serta pemahaman kontekstual mengenai hubungan antara nilai dan praktik. Tinjauan ini menyarankan bahwa penafsiran ulang STEM-PjBL yang disesuaikan dengan konteks tradisi budaya tertentu dapat memperkuat pedagogi STEM yang responsif terhadap budaya. Penelitian di masa mendatang dapat mengeksplorasi perbandingan konteks di mana STEM-PjBL ditafsirkan, diadaptasi, dan diterapkan dalam sistem pendidikan tinggi Islam. Studi-studi tersebut dapat membantu menjelaskan bagaimana budaya institusional, nilai-nilai pendidikan, dan tradisi pedagogi lokal memediasi ketegangan antara pedagogi STEM yang tersebar luas dan praktik lokal yang berakar pada konteks setempat.

Kata kunci: Pedagogi tanggap budaya, filsafat pendidikan Islam, pendidikan STEM

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INTRODUCTION

Recent debates in STEM education are increasingly demanding the integration of ethical responsibility, cultural relevance, and social accountability in science and technology

learning. Traditionally, STEM education has focused on technical competency and innovation. However, with growing concerns about sustainability, equity, and the social implications of technological progress, there are increasing calls for more human-centered and culturally responsive approaches to STEM teaching (Krajcik et al., 2023; Usher & Barak, 2024). Today, universities worldwide are challenged to produce graduates with scientific competence, but also to develop their ethical reflection and social responsibility.

One of the most effective evidence-based models to develop twenty-first century skills in current educational approaches is STEM Project-Based Learning (STEM-PjBL). Systematic reviews and meta-analysis consistently report that STEM-PjBL positively influences critical thinking, creativity, collaboration, conceptual understanding, and learner engagement across educational levels (Cao et al., 2025; Chen & Yang, 2019; Kwon & Lee, 2025). Its constructivist approach encourages students to engage with authentic problems, interdisciplinary inquiry, iterative design processes, and collaborative knowledge construction. This approach is especially relevant to current higher education contexts that aim to connect learning to real world challenges.

At the same time, scholars in culturally responsive and decolonial education have questioned the universal applicability of pedagogical models developed mainly in Western educational traditions (Gay, 2018; Paraskeva, 2016). Emerging literature argues that effective pedagogy cannot be fully separated from the epistemological, ethical, and cultural assumptions embedded within particular educational contexts (Mignolo, 2011; Zembylas, 2018). Such concern is particularly salient in religious or culturally-based higher education systems where institutions are expected to maintain distinctive educational identities and at the same time to embrace globally recognized pedagogical innovations.

Yet, concerns remain about the ways in which such pedagogical frameworks, circulating globally, need to be adapted in culturally and religiously based educational systems. Critics of universalized educational reform argue that pedagogical transfer frequently carries implicit educational assumptions about knowledge, authority, learner autonomy, and the social purposes of education (Mignolo, 2011; Paraskeva, 2016). When considering STEM education, this raises unresolved questions about whether evidence-based pedagogies developed primarily in secular Western contexts can be implemented as epistemologically neutral frameworks, or whether their adaptation requires deeper engagement with local ethical and educational traditions. Comparable concerns have been raised about the uncritical transfer of curricular models across cultural settings, with culturally responsive scholars cautioning that pedagogical frameworks are rarely value-neutral (Gay, 2018; Zembylas, 2018), while studies of Islamic higher education specifically note that internationally circulating pedagogies are frequently adopted with limited structural adaptation to local educational values (Irham, 2025)

Islamic higher education institutions represent one such context (Rahman, 2025). Although many institutions in Muslim-majority societies have adopted STEM-oriented curricula and active learning approaches, these pedagogical practices are frequently implemented through frameworks that originated in, and continue to circulate primarily through, secular Western academic and publishing institutions (Tamimi et al., 2024), even though the underlying pedagogical ideas (e.g., collaborative inquiry, iterative design) draw on a heterogeneous intellectual history that is not exclusively Western (Barak & Yuan, 2021). This review does not claim to have traced STEM-PjBL's adoption pattern in Islamic

higher education to a single Western origin; rather, the pattern of limited structural adaptation noted above motivates asking how locally meaningful educational principles might inform its contextual adaptation (Subhan et al., 2024).

Conversely, the Islamic philosophy of education considers knowledge to be intellectual, ethical and spiritual, emphasizing communal responsibility, moral accountability, reflective inquiry and the integration of knowledge with action (Attas, 1999; Memon et al., 2021). Several recent studies have shown that integrating ethical/religious aspects into science education can enhance character building and student engagement without compromising cognitive outcomes (Arizona et al., 2025; Masud et al., 2023). However, these integrations are still very much content-based and have rarely been studied at the level of pedagogical structure. This review does not assume one Islamic epistemology. It refers rather to general educational tenets that are consistently highlighted in various Islamic intellectual and educational traditions. Hence, the study perceives Islamic educational philosophy as a pluralistic and dynamic body of thought rather than a single monolithic framework.

The efficacy of the STEM-PjBL and the integration of Islamic values in educational content and character education have been well studied in existing scholarship. However, much less attention has been paid to whether the pedagogical architecture of STEM-PjBL itself contains epistemological, ethical or cultural assumptions that may interact with non-Western educational philosophies. This concern is especially relevant because the meanings and enactments of curriculum and pedagogy are not necessarily context-neutral. Decolonial scholarship reveals that pedagogical practices are influenced by specific epistemological, institutional, and sociocultural contexts (Shahjahan et al., 2022). Findings from project-based learning also suggest that pedagogical structure may be experienced and interpreted differently by students from different cultural backgrounds, thus indicating the need for cultural sensitivity in pedagogical design. Such questions are further complicated in Islamic higher education as they involve negotiations between academic approaches circulating globally and those rooted locally in Islamic educational purposes, as seen in the contestations surrounding the inclusion of Western scholarship in Indonesian Islamic universities (Rahman & Nurtawab, 2024). Therefore, from the Islamic epistemological perspective, the problem is not whether Islamic values can be injected merely in the content of STEM education.

Contemporary scholarship on Islamic higher education investigates the efforts to bridge the gap between modern scientific knowledge and Islamic values through the creation of more unified curricular structures, such as Tawhidic approaches to knowledge and curriculum. This review therefore asks if globally circulating STEM pedagogies have compatible or tense forms of structural integration with culturally grounded educational traditions and if contextual adaptation requires not only the incorporation of Islamic content but also consideration of the underlying organization of learning, knowledge, interaction, and educational purpose. This structural framing positions STEM-PjBL as a pedagogical form whose assumptions and learning structures warrant examination in relation to Islamic epistemological and educational principles, rather than treating Islamic integration merely as an additional layer of content.

Existing systematic reviews have examined STEM-PjBL primarily in relation to its effectiveness, learning outcomes, and implementation characteristics (Roslina et al., 2022),

while recent scholarship has also reviewed the incorporation of Islamic values into STEM education, focusing on curriculum design, pedagogical strategies, ethical development, and learning outcomes (Judijanto & Yusniar, 2025). However, these reviews have not, to our knowledge, critically examined whether the core pedagogical mechanisms underlying STEM-PjBL, including collaborative inquiry, authentic problem-solving, iterative refinement, interdisciplinary integration, and engagement with real-world or community contexts, exhibit meaningful structural correspondence or tension with principles emphasized in Islamic educational philosophy. This gap is particularly significant because contemporary scholarship increasingly recognizes that pedagogical practices are situated within particular epistemological, cultural, and institutional contexts rather than functioning as culturally neutral instructional technologies (Shahjahan et al., 2022; Tamimi et al., 2024).

Recent work in STEM higher education has likewise begun to examine project-based learning through a decolonial lens, questioning how pedagogical structures shape the production, valuation, and dissemination of knowledge (Lalujan & Pranjol, 2024). Empirical research further suggests that the enactment and experience of PjBL can vary across cultural contexts, indicating that the meaning and potential of particular pedagogical structures may depend on culturally situated forms of learning (Barak & Yuan, 2021). In The negotiation of globally circulating academic approaches with locally grounded educational purposes further demonstrates the importance of contextual adaptation rather than uncritical pedagogical transfer in Islamic higher education (Rahman & Nurtawab, 2024). Hence, the question is not only about the integration of Islamic values into STEM-PjBL, but also about the possibility of meaningfully interpreting, adapting or re configuring the pedagogical architecture of STEM-PjBL in relation to Islamic educational principles. This question may serve as a means of linking STEM-PjBL research to broader bodies of scholarship on epistemic diversity, culturally relevant pedagogy, and the contextualizing of globally circulating educational frameworks.

Filling this gap is important not only for Islamic higher education, but also for wider debates around how pedagogical framings that are circulating globally are interpreted, adapted and localized within different epistemological contexts. The present study systematically reviewed the literature on STEM-PjBL research published from 2016 to 2024 according to the PRISMA 2020 framework. It seeks to identify the central pedagogical attributes of STEM-PjBL and how these attributes might correspond with principles emphasized in Islamic educational philosophy, and if and how these possible alignments have been discussed theoretically or operationalized pedagogically within the existing literature. This review combines empirical findings from across STEM-PjBL studies and makes contributions to discussions on culturally responsive STEM education, ethics-oriented pedagogy, and inclusion of non-Western epistemological perspectives in contemporary educational discourse. The review, in this way, goes beyond content-based conversations on the integration of Islamic values by analyzing whether and how the pedagogical structure of STEM-PjBL can be interpretable and, possibly, adaptable through culturally grounded educational frameworks.

RQ1: What learning outcomes emerge across STEM-PjBL studies conducted within culturally grounded educational contexts between 2016 and 2024?

RQ2: Which core pedagogical attributes of STEM-PjBL align structurally with Islamic educational principles?

RQ3: To what extent has such alignment been theoretically or pedagogically operationalized in existing STEM-PjBL literature, particularly in Muslim-majority educational contexts?

Building on these research questions, this review synthesizes the empirical literature on STEM-PjBL, to investigate how pedagogical practices are understood within the framework of culturally grounded educational contexts, and the possible convergence of such practices with the principles of Islamic educational philosophy. The following sections outline the systematic review methodology, present the thematic findings and discuss their implications for culturally responsive STEM pedagogy, epistemological plurality, and the contextual adaptation of globally circulating educational frameworks. This review does not aim to propose theological equivalence, but to explore whether the recurring pedagogical mechanisms in STEM-PjBL can be interpreted by the educational principles that are reinforced in the Islamic intellectual traditions.

METHOD

Research design

The study applied a systematic literature review based on the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework (Page et al., 2022), for study selection, data extraction, and synthesis. Scopus was chosen as the main database due to its wide multidisciplinary coverage, strict indexing criteria, and authoritative status in research in STEM education, social sciences, and Islamic education (Baas et al., 2020). Its cross-disciplinary indexing was particularly relevant to capture the intersection of STEM pedagogy, values-based education and Islamic educational philosophy.

The small final corpus of 17 articles is an evidence of the gap this study seeks to address, rather than a limitation to the search scope, and reflects the nascent nature of this research intersection. We deliberately included content requirements for values integration and culturally responsive pedagogy to narrow the pool and ensure depth of synthesis over breadth of coverage. The study prioritized theoretical relevance and thematic depth rather than numerical representativeness, in keeping with the review's conceptual and interpretive aims.

Systematic reviews typically use multiple databases to maximize breadth of retrieval. However, several factors influenced the use of Scopus as the primary database in this review. Scopus provides a wide range of interdisciplinary coverage of STEM education, social sciences, humanities, and Islamic studies, with strong indexing standards and consistent metadata which are suitable for systematic review processes (Baas et al., 2020). Scoping searches across alternative databases indicated a substantial overlap in relevant STEM-PjBL literature, which supports the adequacy of Scopus for the interpretive aims of this review. The study was limited to the intersection of STEM-PjBL, culturally responsive pedagogy, and Islamic educational philosophy, focusing on conceptual relevance and methodological consistency rather than exhaustive numerical coverage. However, it is still

possible that other studies indexed only in other databases might shed more light on the context.

Table 1. Systematic review protocol

Component	Specifications
Database	Scopus
Search fields	Title, Abstract, Keywords
Search string	TITLE-ABS-KEY (("STEM" OR "Science Technology Engineering Mathematics") AND ("Project-Based Learning" OR "PjBL") AND ("education" OR "pedagogy" OR "learning" OR "teaching"))
Filters	English-language journal articles; Publication years 2016–2024; Subject areas: Social Sciences, Psychology, Arts and Humanities, and Multidisciplinary
Initial retrieval	114 articles
Inclusion Criteria:	
Publications	Peer-reviewed journal articles; Empirical research (quantitative, qualitative, mixed-methods)
Educational context	K-12; Higher education; Teacher education
Content requirements	Explicit implementation of STEM-PjBL; Evaluation of learning processes or outcomes; Discussion of values integration, culturally responsive pedagogy, or contextual educational dimensions
Geographic scope	No regional restrictions
Exclusion Criteria:	
Publications	Conference papers; Book chapters; Editorials; Opinion papers; Non-empirical/theoretical studies
Implementation gaps	No STEM-PjBL implementation; Single-discipline focus without STEM integration; Inadequate methodological reporting

Search and screening procedure

Using PRISMA 2020 screening procedures over four iterations, 114 articles were initially identified. In the first pass, 68 articles were eliminated based on title and abstract review, leaving 46 for full-text assessment. A further 29 articles were removed due to insufficient STEM-PjBL implementation or inadequate methodological reporting, yielding a final corpus of 17 articles. Recurring pedagogical patterns and interpretive themes were identified across the included studies. Inter-rater reliability for study selection was high (Cohen's $\kappa = 0.85$, $p < .001$), confirming substantial agreement between the two independent reviewers (see Figure 1).

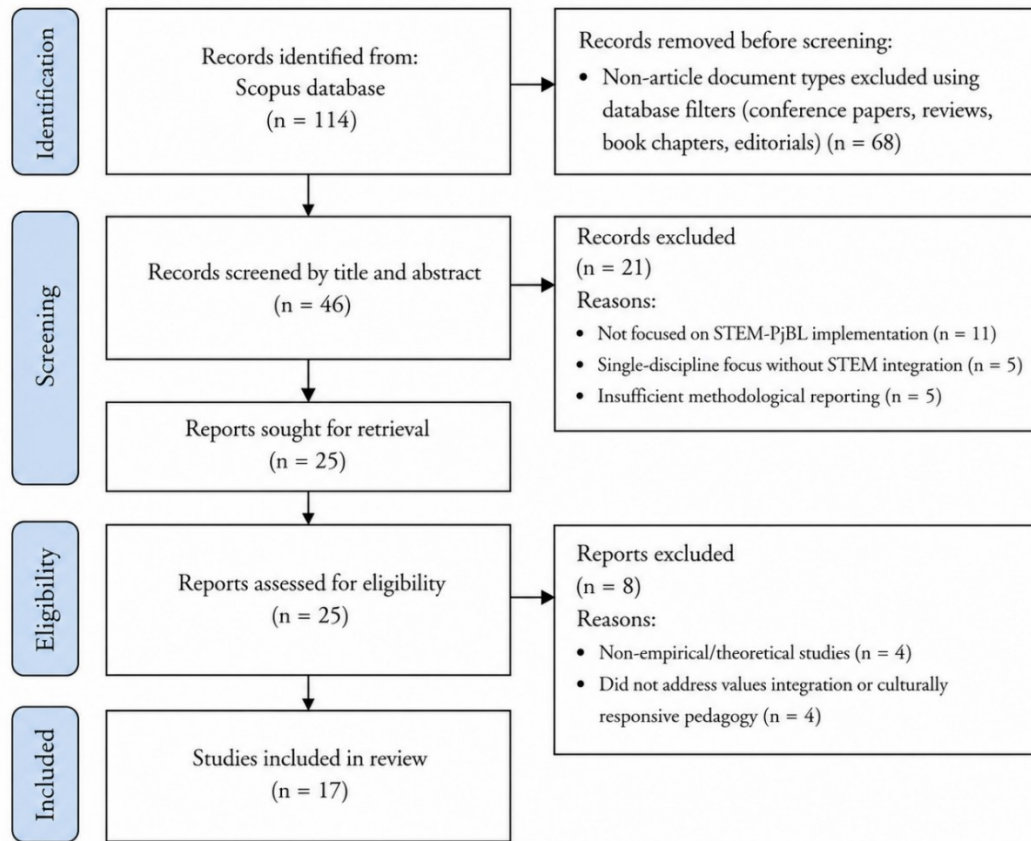


Fig. 1. PRISMA 2020 systematic literature search flowchart

Database filtering procedures were applied prior to manual screening to exclude document types outside the review scope, including conference papers, review articles, editorials, and book chapters. The remaining studies underwent title and abstract screening based on predefined inclusion and exclusion criteria. Full-text assessment was subsequently conducted to evaluate methodological adequacy, explicit STEM-PjBL implementation, interdisciplinary integration, and discussion of contextual or values-oriented educational dimensions.

Quality assessment

Methodological quality was appraised using the Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018). Each study was first assessed using the MMAT's two standard screening questions, namely whether there were clear research questions (S1) and whether the collected data were sufficient to address those questions (S2). Studies meeting the screening requirements were then appraised against the five methodological criteria corresponding to their respective study design category, namely qualitative, quantitative randomized controlled, quantitative non-randomized, quantitative descriptive, or mixed-methods studies. This design-specific approach ensured that studies were assessed using criteria appropriate to their methodological design rather than a single generic set of criteria applied uniformly across all studies. Two reviewers independently assessed each applicable criterion and recorded their judgments as Yes, No, or Can't tell. Inter-rater reliability was assessed using Cohen's kappa, which indicated very high agreement between the two reviewers ($\kappa = 0.82$, $p < .001$).

For descriptive purposes, the authors classified studies meeting four or five of the five applicable criteria as higher-quality and those meeting two or three criteria as medium-quality. This classification was used only to summarize methodological quality and was not part of the original MMAT scoring guidance. Of the 17 articles, 11 (64.7%) were classified as higher-quality and 6 (35.3%) as medium-quality; no studies were excluded on quality grounds. Quality classification was not used to weight or exclude findings in the thematic synthesis reported in the Results and Discussion; all 17 studies, irrespective of high- or medium-quality classification, contributed equally to the outcome counts in Table 3 and to the pedagogical-attribute counts underlying Table 4. This is a limitation of the current synthesis: quality appraisal was conducted but not integrated into the interpretation of findings, and a sensitivity analysis restricted to the 11 high-quality studies is identified as a priority for future revision of this review.

Data extraction

Data extraction documented study characteristics (authors, year, country, educational context), research methodologies (design, sample size, data collection), STEM-PjBL implementation features (disciplines, duration, pedagogy), learning outcomes (instruments, results), and values integration approaches. Two reviewers piloted the extraction form on three articles before applying it across the full corpus to ensure consistency. To allow readers to verify the outcome counts and percentages reported in Table 3, including whether a single study contributes to multiple outcome domains, how outcome constructs such as "collaboration" or "engagement" were operationally defined for coding purposes, and how qualitative and quantitative evidence were combined into a single count, the full study-level extraction table (with columns for Study, Design, Sample, Intervention, Outcome, Measurement, and Result) is available from the corresponding author upon reasonable request, and is referenced at the point Table 3 is first introduced.

Analytical approach

Thematic synthesis followed Braun & Clarke (2006) six-phase framework. Two coders independently coded five articles (29% of the corpus), achieving Cohen's $\kappa = 0.78$ ($p < .001$) for inter-coder reliability. Three analytical themes structured the synthesis: (1) STEM-PjBL learning outcomes, (2) core pedagogical attributes of STEM-PjBL, and (3) structural alignment between STEM-PjBL attributes and Islamic educational principles. The first two themes were developed inductively from the reviewed STEM-PjBL corpus. The third theme was developed through a subsequent theory-informed interpretive matching process, in which the pedagogical attributes identified in the second theme were examined in relation to the four Islamic educational principles described in the theoretical framework below. Thus, the structural alignment was not treated as an inductively derived theme, but as a subsequent interpretive analysis of the empirical patterns identified in the corpus.

Applying the Islamic educational theoretical framework

To examine whether and how potential correspondences between STEM-PjBL and Islamic educational principles have been theoretically or pedagogically operationalized, the review drew on two distinct but deliberately connected sources of evidence. The first was the PRISMA-screened STEM-PjBL corpus described above, which was systematically

identified through Scopus using STEM-PjBL-related search terms. The use of PRISMA 2020 provided a transparent framework for reporting the identification, screening, eligibility assessment, and inclusion of studies in the systematic corpus. The second was an interpretive theoretical framework derived from foundational and contemporary scholarship on Islamic education and epistemology (Attas, 1999; Bakar, 1999; Memon et al., 2021). Four principles, namely Shura, Maslahah, Ihsan, and Tawhid, were used as theoretical and interpretive reference points rather than as themes generated by the systematic STEM-PjBL search. These principles were selected because of their recurrent treatment in Islamic educational scholarship and their relevance to pedagogical and epistemological dimensions of education.

The two sources were connected through a sequential analytical procedure. First, the pedagogical attributes of STEM-PjBL were identified inductively from the systematically reviewed corpus. Second, these attributes were compared with concepts documented in foundational and contemporary Islamic educational scholarship to identify plausible conceptual correspondences in function and orientation. The analysis therefore proceeded from empirical patterns identified in the STEM-PjBL literature to theoretically grounded Islamic educational concepts, rather than testing a pre-specified set of Islamic principles against the corpus. The resulting correspondences were interpreted at the level of pedagogical and epistemological orientation and were not treated as evidence of philosophical or doctrinal equivalence between STEM-PjBL and Islamic educational philosophy.

The four principles were selected using three criteria. First, each principle had to demonstrate recurrence across foundational and contemporary scholarship on Islamic education. Second, the principle had to have an identifiable pedagogical or epistemological dimension rather than being treated primarily as a legal, ritual, or jurisprudential concept. Third, the principle had to possess sufficient conceptual specificity to support a process-level comparison with the pedagogical attributes identified in STEM-PjBL. Other concepts frequently discussed in Islamic educational scholarship, including Amanah, Adl, Tarbiyah, and Ta'dib, were considered against the same criteria but were not included in the primary analytical framework because they offered less direct conceptual specificity for the particular pedagogical processes identified in the STEM-PjBL corpus. The selection of the four principles therefore represents an analytical construction for the purposes of this review rather than a claim that these constitute an exhaustive or universally accepted taxonomy of Islamic educational principles.

The contextual dimension was examined from the institutional and national contexts reported in the included STEM-PjBL studies. Studies conducted in Muslim-majority settings were considered in relation to whether the pedagogical attributes identified in the corpus had been implemented or discussed within educational environments where Islamic cultural and educational traditions may be contextually relevant. This contextual examination was not treated as a separately retrieved empirical corpus, because the systematic search was designed to identify STEM-PjBL studies rather than to conduct an independent systematic review of STEM-PjBL in Muslim-majority educational systems. Instead, contextual information reported within the included studies was considered alongside the theoretical mapping to determine whether the identified pedagogical correspondences had been explicitly or implicitly reflected in educational practice.

The corpus and the theoretical framework were then connected through thematic synthesis. Pedagogical attributes were first coded from the STEM-PjBL corpus and subsequently compared with the selected Islamic educational principles. For example, collaborative decision-making was examined in relation to Shura, community-oriented problem selection and social responsibility in relation to Maslahah, iterative refinement and the pursuit of quality in relation to Ihsan, and interdisciplinary integration in relation to Tawhid. These mappings were treated as conceptual correspondences rather than direct equivalences. The analysis also examined whether such correspondences had been explicitly operationalized in instructional design, project implementation, assessment, or other pedagogical practices reported in the literature.

Because the Islamic educational principles were applied after the STEM-PjBL pedagogical attributes had been identified, the resulting alignment represents a theory-informed interpretive assessment rather than an independently retrieved systematic-review finding. This distinction was maintained throughout the analysis so as to avoid conflating empirical findings from the STEM-PjBL corpus with theoretical readings from Islamic educational scholarship. The framework was then used to analyze the pedagogical relevance of the identified STEM-PjBL attributes and to assess the extent to which their potential alignment with Islamic educational tenets has been exhibited in current educational practice.

RESULTS AND DISCUSSION

Publication trends and geographic distribution

The research activity increased significantly from 2020, with six studies published in 2023 alone. The 17 studies were distributed over eight countries and three continents, of which 62.5% were from Asian countries (see Figure 2 and Table 2). Indonesia was the most dominant (37.5%) followed by Malaysia (18.75%) and Iran (12.5%). This distribution differs from the wider STEM literature wherein approximately 75% of publications are from Western and East Asian contexts (Guo et al., 2025), hinting at an increasing research momentum in Muslim majority educational contexts.

Table 2. Geographic and demographic distribution of reviewed studies

No	Country	Continent	n	%	Muslim Population (%)
1	Indonesia	Asia	6	37.50	87
2	Malaysia	Asia	3	18.75	63
3	Iran	Asia	2	12.50	99
4	United States	Americas	1	6.25	1
5	Taiwan	Asia	1	6.25	<1
6	United Kingdom	Europe	1	6.25	5
7	Türkiye	Europe	1	6.25	99

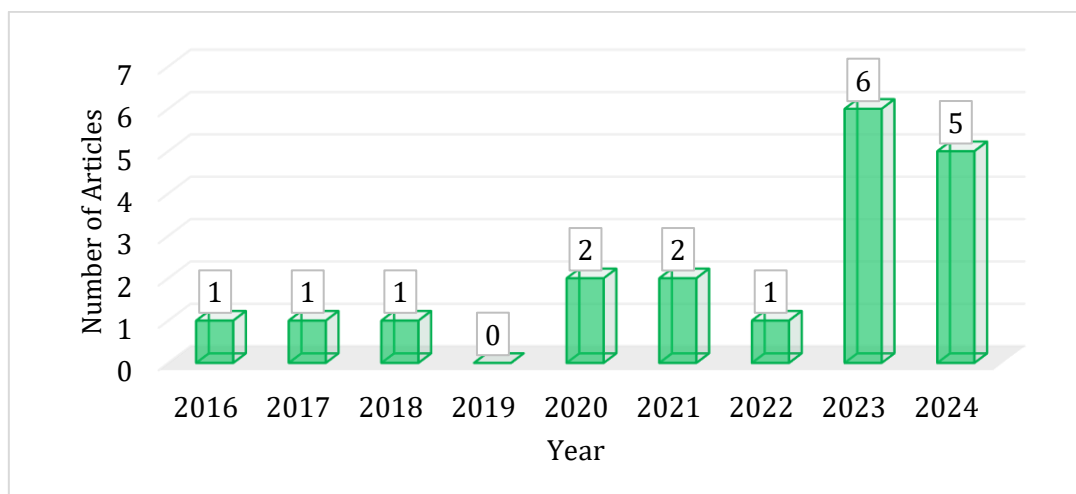


Fig. 2. Article year distribution (2016–2024)

STEM-PjBL learning outcomes (RQ1)

The synthesis revealed a consistent concentration of STEM-PjBL outcomes within higher-order cognitive, affective, and collaborative domains, suggesting that the pedagogical model privileges inquiry-oriented and socially mediated learning processes rather than procedural content acquisition alone (Table 3). The most frequently reported outcomes across the studies reviewed were critical thinking, conceptual understanding, collaboration and learner engagement, showing that STEM-PjBL is consistently implemented as a framework for developing reflective, participatory and application-oriented learning. The following subsections examine each of these four outcome domains in turn, starting with critical thinking and collaboration, the two most consistently reported findings across the corpus.

Critical thinking gains were found in 70.6% of studies ($d = 0.45\text{--}0.87$), with learners demonstrating improved analytical reasoning, problem decomposition, and evaluative judgment. Importantly, these outcomes were rarely decoupled from collaborative and contextual learning processes, suggesting critical thinking in STEM-PjBL does not emerge through individual cognition alone, but through interaction, negotiation and engagement with authentic problems. This is consistent with constructivist interpretations of STEM learning where knowledge development is socially situated and epistemically dialogic rather than individually transmissive.

All 17 studies reported collaboration as a pedagogical feature or outcome domain, but the studies differed in whether they measured collaboration as a discrete outcome, described collaboration as a design feature of the intervention, or documented statistically significant gains through use of a validated instrument. This distinction is maintained throughout the synthesis rather than being treated as uniform evidence of improvement. Yet the consistency with which collaboration presents itself across the corpus is of theoretical import. Instead of being an extra classroom skill, collaboration seems to be structurally embedded in STEM-PjBL as a mode of knowledge production in itself. In this respect, the literature reviewed uniformly conceives learning as a collective construction of inquiry, problem solving and dialogic interaction. Hence, collaboration is epistemological rather than interpersonal.

Table 3. Synthesis of STEM-PjBL learning outcomes with islamic value alignment

Outcome Domain	Studies (n=17)	Key Findings	Effect Size	Islamic Value Alignment
Critical Thinking	12 (70.6%)	Enhanced analytical reasoning, problem decomposition, and evaluation of complex information	$d = 0.45-0.87$	Ihsan (excellence); reflective practice
Creativity	9 (52.9%)	Improved originality, flexibility, and diverse solution generation	$d > 0.70$	Ihsan; independent reasoning
Self-Efficacy	11 (64.7%)	Significant confidence increases across STEM domains	$\eta^2 = 0.14-0.28$	Ethical perseverance; Amanah (trustworthiness)
Collaboration	17 (100%)	Universal teamwork and communication improvements	Varied	Shura (consultation); communal solidarity
Conceptual Understanding	14 (82.4%)	Deeper comprehension through hands-on application	$d = 0.52-0.68$	Tawhid (unity of knowledge)
Engagement	13 (76.5%)	Increased participation and intrinsic motivation	Qualitative	Public benefit; purposeful intention
Metacognitive	8 (47.1%)	Development of self-regulation and reflection	Mixed	Reflective practice; self-accountability
Social Responsibility	6 (35.3%)	Enhanced awareness of societal impact	Qualitative	Maslaha (public benefit); justice

Since this is a thematic synthesis rather than a meta-analysis, and because of the heterogeneity of study designs included, the results are best described as reported associations rather than pooled or causally established effects. Also considered as separate types of evidence throughout are reporting frequency and effect magnitude: the percentages in Table 3 are the proportion of studies reporting a given outcome domain, whilst the associated d and η^2 values represent the range reported by the subset of studies which provided quantitative effect sizes, rather than a pooled estimate across the entire corpus. With this distinction in mind, STEM-PjBL was associated with reported gains in cognitive, affective, and social domains. The reported gains in critical thinking across 70.6% of the studies are broadly consistent with meta-analytic findings reported by Chen & Yang (2019), and extend that evidence into Muslim-majority institutional contexts. The

comparison is indicative rather than statistically pooled. Collaboration was the most common outcome domain reported across the corpus, present in all 17 studies, and the consistency of this finding suggests that the social learning structures of STEM-PjBL are regularly reported to work across different cultural and institutional settings including those influenced by Islamic educational norms, although the studies did not measure collaboration in the same way using similar instruments.

The findings have direct implications for policy and practice in Islamic higher education. Institutions hoping to produce scientifically competent and ethically reflective graduates need not choose between cultural authenticity and effective pedagogy. The evidence discussed in this article indicates that the outcomes of STEM-PjBL often fit with the priorities of Islamic educational philosophy, which has long advocated collaborative reasoning, applied knowledge, critical engagement and self-directed learning. The question isn't whether STEM-PjBL works, but whether it can be implemented in a culturally and epistemologically coherent way.

Core pedagogical attributes of STEM-PjBL and their structural alignment with Islamic educational values (RQ2)

Thematic analysis identified four pedagogical attributes consistently present across the reviewed studies. First, collaborative learning frameworks appeared in 100% of studies, with students engaged in joint decision-making, constructivist discourse, and consensus-building. Second, 82.4% of studies incorporated community-based or real-world problem contexts, including sustainable agriculture, environmental remediation, water purification, and community eco-sustainability challenges. Third, 76.5% of studies employed iterative design-test-refine cycles, cultivating metacognitive development and pursuit of quality. Fourth, 64.7% of studies demonstrated interdisciplinary knowledge integration across two or more STEM fields, encouraging holistic rather than siloed understanding.

It is important to be explicit about what is, and is not, being claimed at this stage. The Scopus search string (Table 1) did not include Islamic, religious, or culturally specific terminology, and the 17 included studies were not selected for, or found to discuss, any correspondence with Islamic educational thought. What follows, therefore, is not a pattern that emerged directly from the corpus; it is a secondary, researcher-conducted interpretive mapping, in which pedagogical attributes inductively coded from the STEM-PjBL literature were subsequently compared against four Islamic educational principles selected in advance for their conceptual relevance.

For the purposes of this mapping, structural alignment is defined operationally as a correspondence between (a) the functional role a pedagogical attribute plays in STEM-PjBL's learning process (e.g., how decisions are reached, how problems are chosen, how quality is pursued, how knowledge domains relate to one another) and (b) the functional role attributed to an Islamic educational principle in the classical and contemporary sources cited for it, evaluated at the level of process and orientation rather than doctrinal content. This criterion is deliberately narrow: many pedagogical theories outside Islamic thought (e.g., deliberative or cooperative learning models) could plausibly satisfy a looser version of this correspondence, and the mapping proposed here does not claim that STEM-PjBL's features are uniquely or exclusively explicable through Islamic categories. Shura, Maslaha, Ihsan, and Tawhid were selected through the deductive matching procedure detailed above:

each was identified as the best-fitting existing Islamic educational principle for a pedagogical attribute already coded from the STEM-PjBL corpus, then confirmed against the three criteria described above, rather than being drawn from an independently pre-specified list applied blind to the corpus; other candidate principles (e.g., Amanah, noted in Table 3 in relation to self-efficacy, or Adl, Tarbiyah, and Ta'dib) were assessed against the same criteria but not carried into the primary framework, for the reasons summarized above, because the review's scope was limited to principles with the most direct process-level correspondence to the four attributes coded from the corpus, a boundary that is itself a researcher judgment rather than an empirical finding. Given all of this, the correspondence reported below should be read as a proposed interpretive framework rather than a claim of direct equivalence between pedagogical constructs and religious doctrine, and rather than a finding that the reviewed literature itself demonstrates such alignment. What the reviewed literature does show is that several characteristics of STEM-PjBL share functional similarities with ethical and epistemological principles emphasized in Islamic educational traditions, as interpreted by the authors.

Collaborative decision-making, present across all reviewed studies, exhibits meaningful structural parallels with Shura, the Islamic principle of consultative deliberation (Qur'an 42:38). In both frameworks, knowledge is approached as emerging through structured dialogue, collective reasoning, and participatory engagement rather than unilateral transmission. The convergence identified here is therefore pedagogical and epistemological in orientation, rather than doctrinal or historical in origin.

Community-centered project selection, present in 82.4% of studies, bears a functional resemblance to Maslaha, the Islamic legal and ethical principle of public benefit. It should be acknowledged that community-embedded project design is also commonly motivated by authentic-learning, relevance, and design-thinking rationales that carry no connection to Islamic ethics; the reviewed studies themselves do not report Maslaha, or any comparable doctrinal justification, as their rationale for community-based project selection. What can be said is that STEM-PjBL's emphasis on authentic, community-embedded problems shares an orientation toward socially meaningful and community-centered applications of knowledge with Maslaha, in which knowledge is valued partly for its serviceability to human welfare (Nasrullah et al., 2025). This resemblance suggests that selecting STEM-PjBL projects based on community needs could plausibly be reinterpreted as a pedagogical practice compatible with educational principles emphasized within Islamic traditions, without implying that such a rationale is already present in, or uniquely explained by, the reviewed studies. Iterative refinement cycles, present in 76.5% of studies, are interpreted here in relation to Ihsan, the prophetic imperative to pursue excellence in every act of work. The two concepts are not equivalent: technical improvement through design-test-refine cycles is a procedural, outcome-oriented practice, whereas Ihsan is a normative and ethical disposition concerned with the quality of intention and conduct, not only the quality of the product. The bridge proposed here is that iterative refinement, understood as a sustained pursuit of quality through repeated evaluation, can be read as a procedural analogue of the disposition toward excellence that Ihsan prescribes, without claiming that the studies' iterative design cycles were themselves motivated by or equivalent to this ethical orientation (Sham et al., 2021).

Table 4. Conceptual structural alignment between STEM-PjBL pedagogical attributes and Islamic educational principles

STEM-PjBL Pedagogical Attribute	Educational Function	Islamic Educational Principle	Conceptual Alignment	Pedagogical Interpretation
Collaborative decision-making	Collective inquiry and shared knowledge construction	Shura (Qur'an 42:38)	Consultative and dialogic learning processes	Knowledge constructed through participatory dialogue
Community-centered project selection	Socially relevant and authentic problem solving	Maslaha (public benefit)	Orientation toward societal welfare	Learning validated through societal relevance
Iterative refinement and reflective improvement	Continuous evaluation and quality enhancement	Ihsan (pursuit of excellence)	Pursuit of excellence and self-improvement	Continuous reflective improvement as learning process
Interdisciplinary knowledge integration	Holistic understanding across disciplines	Tawhid (unity of knowledge)	Unity and interconnectedness of knowledge	Rejection of fragmented disciplinary knowledge

Interdisciplinary knowledge integration, present in 64.7% of studies, is the most tentative of the four mappings proposed here, and is offered as a pedagogical analogy to Tawhid rather than an instance of it. Tawhid is a theological principle concerning the oneness of divine authorship over all creation and knowledge; its meaning is not reducible to, and considerably exceeds, the combination of two or more STEM disciplines within a single project. What can more modestly be claimed is that STEM-PjBL's resistance to disciplinary silos shares a family resemblance, at the level of orientation, with the epistemic unity that Tawhid affirms at a theological level: both resist treating knowledge domains as self-contained and disconnected. Readers should note that most interdisciplinary curricula, including many with no relationship to Islamic thought, would satisfy this same loose resemblance, which is precisely why this mapping is presented as the weakest of the four rather than as evidence of a distinctly Islamic pedagogical feature (Attas, 1999; Bakar, 1999).

The relationships identified across the reviewed literature can be synthesized into a broader conceptual framework illustrating how STEM-PjBL pedagogical structures may converge with selected principles emphasized in Islamic educational philosophy. This framework brings together the four pedagogical attributes discussed above with their corresponding Islamic principles, positioning them side by side as a single interpretive map rather than as separate, unconnected observations. Figure 3 presents this integrative framework.



Fig. 3. Conceptual framework of structural alignment between STEM-PjBL and Islamic educational philosophy

The structural convergences identified in this review should be interpreted cautiously and analytically rather than as evidence of direct philosophical equivalence. A further methodological risk deserves acknowledgment here: because the four Islamic principles were selected specifically for their conceptual fit with attributes already inductively identified from the STEM-PjBL corpus, rather than through an independent literature search conducted without knowledge of those attributes, the analysis carries an inherent risk of confirmatory or tautological reasoning, in which the mapping appears to validate itself. The authors have sought to mitigate this risk by explicitly defining the correspondence criterion (above), by clearly stating the deductive, fit-based nature of this selection in the Methods, rather than presenting it as an independently derived corpus, and by reporting rather than omitting mappings that strain under scrutiny (e.g. Tawhid, discussed below), but the risk cannot be eliminated within an interpretive, non-falsifiable design of this kind; it is a limitation to be weighed by the reader rather than one that has been resolved. The review does not claim that the STEM-PjBL is derived from Islamic educational traditions or that all forms of STEM-PjBL implementation necessarily include Islamic epistemological assumptions. Rather, the synthesis implies that various recurrent pedagogical mechanisms in STEM-PjBL can be understood as structurally compatible with educational orientations emphasized in some parts of Islamic educational thought.

Such convergences are particularly evident in the ways in which STEM-PjBL and Islamic educational traditions converge in their emphasis on collaborative inquiry, ethical responsibility, and holistic knowledge integration. Taken together, these convergences suggest the development of an interpretive framework for understanding STEM-PjBL not only as an instructional model but as a pedagogical structure that can be adapted and interpreted differently in educational contexts shaped by diverse knowledge traditions. It is not about imposing Western pedagogical practices upon Islamic values.

The literature reviewed suggests possible convergence at the level of pedagogical and epistemological orientation rather than direct philosophical equivalence. STEM-PjBL is based on interdisciplinarity and authentic problem solving and Islamic educational scholarship views Tawhid as the basis for integrating knowledge and educational objectives, rather than viewing knowledge as compartmentalized (Attas, 1999; Hamdi, 2023; McLure et al., 2022). Similarly, the emphasis of STEM projects on real and socially significant issues can be viewed as having conceptual similarity with the Islamic teaching of Maslahah that stresses on the importance of benefit and welfare in education and social issues (Silaturrahmi et al., 2023). The collaborative and deliberative aspects of STEM-PjBL may also be understood in relation to Shura, a principle of consultation and collaboration that has been discussed in Islamic educational scholarship (Saputra et al., 2024). Finally, the attention given to refinement and quality improvement in project-based practice can be seen as consistent with Ihsan, which has been associated with continuous and comprehensive improvement in Islamic educational practice (Maulana et al., 2026). These correspondences should not be interpreted as evidence of a philosophical equivalence between the two frameworks. Instead, they point to areas in which their pedagogical and epistemological orientations might fruitfully be brought into dialog.

These findings contribute to ongoing discussions on culturally responsive and decolonial approaches to STEM education, particularly scholarship emphasizing the value of local knowledge, cultural contexts, epistemic diversity, and community engagement to inform STEM curricula and pedagogy (Govender et al., 2026; Porter & Siddiqui, 2024). They suggest that non-Western epistemological traditions need not be treated as inherently incompatible with evidence-based STEM pedagogy. Instead, they may provide culturally and ethically grounded perspectives through which established STEM pedagogies can be interpreted and contextually adapted. This perspective also invites reconsideration of the assumption that effective STEM pedagogy must be detached from culturally and ethically grounded epistemological commitments. Accordingly, the framework proposed in this review should be understood as a heuristic and interpretive model intended to support further empirical and theoretical inquiry rather than as a fixed or universal classification of STEM pedagogies and Islamic educational thought.

Theoretical and pedagogical operationalization of the structural alignment (RQ3)

The reviewed literature indicates that STEM-PjBL commonly emphasizes student-centered inquiry, collaborative investigation, problem solving, creation, revision, and reflection, with learning activities organized around authentic or challenging problems that require students to apply and reconstruct knowledge through project work (Santhosh et al., 2023). These characteristics suggest that STEM-PjBL is not simply a content-delivery approach but involves a particular pedagogical organization of learning in which students actively engage with problems, develop solutions, and revise their approaches throughout the learning process. In Islamic educational contexts, however, the adoption of student-centered and globally circulating pedagogical approaches may involve negotiation with existing epistemological and educational commitments. Recent research on Islamic higher education in Indonesia, for example, shows that lecturers negotiate global pedagogical standards within Islamic epistemological frameworks, adapting global expectations while maintaining religious and moral foundations (Saprin et al., 2026). Similarly, research on

Islamic pedagogy has highlighted the importance of connecting educational purposes with pedagogical practice and of grounding teaching in faith perspectives, local contexts, learner lifeworlds, and educational values (Memon et al., 2021).

This contextual aspect is particularly important in determining whether the pedagogical mechanisms of STEM-PjBL can be meaningfully associated with Islamic educational principles. This review does not assume a direct philosophical equivalence, but understands the relationship as one of conceptual correspondence. From this perspective, collaborative inquiry, interdisciplinary engagement, authentic problem solving, and iterative refinement can be explored for their possible correspondence to principles emphasized in Islamic educational thought. This correspondence does not mean that STEM-PjBL and Islamic educational philosophy are from the same intellectual tradition or that their concepts can be exchanged. It is rather a question of whether specific pedagogical processes can be understood as functionally compatible with principles that have been articulated within the scholarship of Islamic education.

This approach is consistent with broader scholarship on the contextualization of pedagogy. Shahjahan et al. (2022) in their critical review of 207 articles and book chapters on decolonizing curriculum and pedagogy in global higher education, found that the meanings, forms of enactment, and challenges associated with pedagogical transformation vary according to geographical, disciplinary, institutional, and stakeholder contexts and carry political and epistemological consequences. Thus, pedagogical frameworks that circulate internationally cannot necessarily be assumed to acquire identical meanings when implemented across different epistemological and educational contexts. Within Islamic higher education, this suggests the need to examine not only whether Islamic values are added to STEM content, but also how the underlying organization of teaching and learning may be interpreted and adapted within an Islamic epistemological framework.

Thus, the present review considers the connection between STEM-PjBL and the principles of Islamic education as heuristic and contextual correspondence, not as a statement of philosophical equivalence. The analysis therefore examines whether certain pedagogical features identified in the STEM-PjBL literature can be meaningfully related to principles such as *Tawhid*, *Shura*, *Maslahah* and *Ihsan*. Any such correspondence is an interpretive proposition requiring further theoretical and empirical examination, not an established causal or philosophical relationship.

CONCLUSION

This review shows that the relationship between STEM-PjBL and Islamic educational philosophy can be seen not only from the perspective of contextual adaptation, but also as a potential correspondence in the pedagogical and epistemological aspects. Key themes in STEM-PjBL observed across the chosen studies were collaborative inquiry, authentic problem solving, iterative refinement and interdisciplinary integration. These pedagogical attributes were found to have meaningful conceptual correspondence with principles emphasized in Islamic educational thought, notably *Shura*, *Maslahah*, *Ihsan* and *Tawhid*.

The results show that the relationship between STEM-PjBL and Islamic educational principles is not necessarily incidental, but the extent and importance of the relationship are subject to interpretation and context. The review does not establish a philosophical equivalence between STEM-PjBL and the philosophy of Islamic education, nor does it show

the inherent compatibility of STEM-PjBL with the principles of Islamic education. Rather the analysis suggests that a number of core pedagogical mechanisms of STEM-PjBL can be meaningfully interpreted through Islamic educational principles if they are intentionally contextualized within an Islamic epistemological and ethical frame.

This interpretation suggests that pedagogical efficiency and culturally-based educational values are not necessarily competing priorities in Islamic higher education. Instead, meaningful convergence can be achieved by purposefully recontextualizing globally circulating pedagogical approaches. In this sense, the culturally responsive STEM education can be conceptualized as not a departure from evidence-based pedagogy, but an attempt to situate effective pedagogical practices within broader educational, ethical and epistemological traditions. Therefore, the contextual adaptation of STEM-PjBL in Islamic higher education may require more than the symbolic or content-level incorporation of Islamic values into pedagogical redesign that considers locally meaningful educational principles and epistemological orientations.

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