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Integrating Artificial Intelligence and Quantum Physics into Islamic Education: Opportunities, Challenges, and a Framework for Future Learning

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Abstract:
Islamic educational institutions are increasingly drawn into a technological moment shaped by artificial intelligence and, more quietly, by quantum physics, yet little research asks how either can be woven into Islamic pedagogy without unsettling tawhid, the epistemological commitment underlying the tradition. This PRISMA-guided systematic review maps the opportunities, challenges, and design principles for integrating AI and quantum physics into Islamic education and proposes a working framework. Of 1,563 unique records retrieved from five databases (2016-2025), 57 studies were retained: 48 engaging directly with an Islamic-education context (Stream A), and 9 general quantum-physics-education studies included deliberately as a comparison corpus (Stream B), since none met a joint Islamic-context-and-quantum criterion. AI is used mainly for personalised Qur'anic and Arabic-language learning and administrative efficiency; quantum content remains almost entirely confined to secular STEM curricula. Data privacy, algorithmic bias, teacher readiness, and decontextualised content recur as concerns. The review proposes the AI-Quantum-Islamic Education Framework (AIQIEF), grounding adoption in tawhid-based epistemology rather than treating these technologies as neutral add-ons.

Keywords: *Artificial intelligence; quantum physics; Islamic education; systematic literature review; PRISMA; tawhid; educational technology*

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1. INTRODUCTION

1.1 Background and Context

The past three years have done more to unsettle assumptions about what a classroom is for than perhaps any period since the introduction of the printing press to religious scholarship. Generative artificial intelligence systems now draft lesson plans, tutor individual students in real time, and translate classical Arabic texts with a fluency that would have seemed implausible a decade ago (Liang, Stephens, & Brown, 2025; Chan, 2024). Alongside this, and with far less institutional fanfare, quantum physics has moved from a purely specialist concern into undergraduate and even secondary curricula, driven by national investments in quantum-technology workforces and by a recognition that quantum literacy is becoming as basic to scientific citizenship as classical mechanics once was (Krijtenburg-Lewerissa, Pol, Brouwer, & van Joolingen, 2017; Bitzenbauer, 2023).

Islamic education occupies a peculiar position in this landscape. Institutions ranging from village madrasah to research universities in Jakarta, Kuala Lumpur, Kabul, and Riyadh are simultaneously custodians of a revealed tradition and participants in a global, technologically mediated knowledge economy. UNESCO's guidance documents on AI in education (Miao & Holmes, 2023; UNESCO, 2021) are written for a generic institutional subject that does not, on the whole, have to reconcile machine-generated content with questions of religious authenticity, isnad,

or adab. Yet Islamic educators are being asked to do exactly that, often with minimal preparation and even less consensus about what counts as an acceptable accommodation (Ahmad, 2025; Hamdi, Siregar, & Norman, 2026).

The scale of what is at stake is considerable. Indonesia's Ministry of Religious Affairs recorded more than 82,000 madrasah nationwide, from Raudlatul Athfal through Madrasah Aliyah, as of the 2019/2020 academic year (NU Online, 2023), and reported that the number of pesantren had grown by roughly 11,000 since the Pesantren Law took effect, reaching some 41,000 to 42,000 registered institutions by 2024 (Antara News, 2024). Together these institutions enrol several million students for whom madrasah or pesantren is the primary, and often the only, formal schooling they receive. Indonesia's Pesantren Law (Republik Indonesia, 2019) formally recognised pesantren education within the national system, and the Ministry has since pressed for an acceleration of digital transformation across madrasah, framed explicitly as a policy priority rather than an optional add-on (NU Online, 2023). Neither instrument mentions artificial intelligence or quantum physics specifically, which is itself part of the problem this review takes up: curriculum policy has moved toward digital transformation in the abstract well ahead of any guidance on what, concretely, an AI- or quantum-literate Islamic curriculum should contain.

Quantum physics enters this picture more obliquely. It is not typically taught inside religious curricula at all, yet its conceptual vocabulary, indeterminacy, non-locality, the observer's role in measurement, has repeatedly attracted comparison with Islamic metaphysical concepts such as qadar (divine decree) and the createdness of contingent being. Whether that comparison is pedagogically productive or simply a rhetorical flourish is an open question that the existing literature has not, to our knowledge, examined with any systematic rigor.

The absence of a deliberate bridge is not a cost-free gap. Graduates of institutions where quantum reasoning is never connected to their own conceptual vocabulary enter national STEM pipelines and the quantum-technology workforce, an area attracting sustained public and private investment (Krijtenburg-Lewerissa et al., 2017; Bitzenbauer, 2023), at a disadvantage relative to peers for whom that conceptual bridge was made explicit somewhere in their schooling. The same gap narrows access to the interdisciplinary science-and-religion discourse, on determinism, causation, and the limits of human knowledge, that increasingly shapes public debate about science in Muslim-majority societies. A curriculum that leaves quantum indeterminacy entirely outside the register in which students already reason about qadar does not thereby stay neutral on the question; it answers it by omission rather than by design, and it is this default answer that motivates RQ2 below.

1.2 Research Problem

Two literatures currently run in parallel without much conversation between them. The first, concentrated in Indonesian, Malaysian, and Gulf-region journals, documents how AI tools are being piloted in Islamic schools, mostly for Qur'anic memorisation support, Arabic-language tutoring, and administrative efficiency (Ahmad, 2025; Jannah, Hikmah, Mardiati, Amin, & Angriani, 2024). The second, based mainly in physics-education-research venues in Europe and North America, documents persistent student difficulties with quantum concepts and tests various pedagogical remedies (Wuttiprom, Sharma, & Johnston, 2009; McKagan, Perkins, & Wieman, 2010; Taber, 2005). Neither literature asks what happens when the two domains meet inside an institution whose epistemic commitments are neither purely secular nor purely technical.

1.3 Previous Research

Several systematic reviews have mapped AI's footprint in Islamic education specifically. Ahmad (2025) synthesised interview and document-analysis data to show that AI adoption in Islamic learning environments is shaped as much by ethical anxiety, over data privacy and the risk of algorithmic misreading of religious texts, as by pedagogical enthusiasm. Hamdi, Siregar, and Norman (2026), working from a Scopus-indexed sample of 24 articles, found that AI's contribution to Islamic educational quality management operates chiefly through personalised learning, adaptive

assessment, and data-informed administrative decisions rather than through any deep curricular transformation. Neither review addressed quantum or physical science content.

On the physics-education side, Krijtenburg-Lewerissa et al. (2017) remains a frequently cited synthesis of the conceptual obstacles secondary and early-undergraduate students face when first encountering quantum ideas, obstacles that stem less from mathematical difficulty than from the clash between quantum indeterminacy and students' inherited classical, deterministic intuitions. Bitzenbauer (2023) extended this line of work by testing model-based instructional sequences intended to build functional rather than merely descriptive understanding of quantum phenomena. A separate but related body of work, represented by Fauzi, Ratnaningsih, and Mulyono (2020) and by several TPACK studies conducted inside Indonesian pesantren (Munawwaroh, 2024; Istiqomah, Lisdawati, & Adiyono, 2023), has examined how well-prepared Islamic-school teachers are, in general, to absorb any technologically mediated pedagogy, AI-based or otherwise.

A third, more philosophical strand grounds the epistemological half of our argument, though the three sources it draws on are not interchangeable. Al-Attas's (1978) intervention is primarily a diagnosis of what he calls the loss of adab, correct discipline of mind and soul, arguing that Muslim intellectual confusion stems from the uncritical absorption of secular Western categories and that the corrective is what he termed the "de-westernisation of knowledge" as much as its Islamisation. Al-Faruqi (1982) took a more programmatic and institutional turn, proposing a twelve-step "workplan" through which every modern discipline, physics included, would be surveyed, critiqued against Islamic principles, and reconstructed so that revealed and acquired knowledge could be integrated within a single curriculum. Nasr (1993) approaches the same problem from a more explicitly traditionalist, Sufi-inflected metaphysics, arguing for a "sacred science" that does not so much reconstruct modern physics as insist on situating any empirical finding within a hierarchy of knowledge that keeps metaphysical naturalism from smuggling itself in as though it were a finding rather than an assumption. The differences matter for what follows: al-Faruqi's workplan is the closest of the three to something operational enough to inform a curriculum framework, which is why Section 3.2.4 builds more directly on his integration-not-substitution principle than on Nasr's more contemplative register.

The Islamisation-of-knowledge project these three authors represent has also attracted serious internal criticism, most influentially from Fazlur Rahman (1988), who argued that the concept rests on a category error: knowledge in the modern sciences is not itself un-Islamic or Islamic but morally neutral, so that the burden Al-Attas and al-Faruqi place on "Islamising" a discipline properly belongs to the individual scientist's ethical responsibility rather than to the discipline's conceptual foundations. A parallel critique, associated with Ziauddin Sardar and echoed in the Indonesian literature (Saifuddin & Karomi, 2023), holds that overlaying Islamic vocabulary onto disciplines already constructed within a Western epistemic paradigm risks producing a cosmetic relabelling, an "Islamised" physics that changes its language but not its underlying assumptions, rather than the substantive epistemological transformation al-Faruqi intended. These unresolved debates are not incidental to the present review: they are precisely why the AIQIEF framework proposed in Section 3.2.4 is offered as a practical, testable starting point rather than as a claim to have settled a forty-year-old argument about what "Islamising" a science actually requires.

1.4 Research Gap

What is missing, then, is not evidence about AI in Islamic education, nor evidence about quantum-physics pedagogy, nor Islamic epistemological theorising about science. It is a systematic attempt to hold these three bodies of work together long enough to ask what an intentionally Islamic approach to AI-and-quantum integration would actually look like in a classroom, and what obstacles stand in its way. Existing frameworks tend to be either purely technological (how to deploy an AI tutor) or purely philosophical (how tawhid ought to reframe scientific inquiry), with very little that operationalises the second in terms the first can use.

1.5 Research Objective

This study addresses three research questions through a PRISMA-guided systematic literature review: (RQ1) What opportunities does the peer-reviewed and grey literature identify for integrating artificial intelligence into Islamic education? (RQ2) What opportunities and constraints surround the introduction of quantum-physics content and reasoning into Islamic educational settings? (RQ3) What design principles or frameworks, if any, have been proposed for reconciling these technologies with Islamic epistemological commitments, and how might such a framework be constructed where none yet exists?

1.6 Research Contribution/Novelty

The contribution is threefold. First, we searched PROSPERO together with Scopus, Web of Science, and Google Scholar for existing systematic reviews combining these two domains (search terms: "systematic review" AND "Islamic education" AND ("artificial intelligence" OR "quantum")). Reviews already exist for AI in Islamic education considered on its own (Ahmad, 2025; Hamdi et al., 2026; Almusharraf & Bailey, 2023) and for quantum-physics pedagogy considered on its own (Krijtenburg-Lewerissa et al., 2017), but the search returned no review, registered or published, that treats AI and quantum physics as a joint object of inquiry within Islamic education; on this narrower and verifiable basis, this appears to be the first review to bring the two together as a single inquiry rather than as separate technological or scientific concerns. Second, the review synthesises 57 studies spanning nine years and two literatures that have not previously been read together: 48 studies (Stream A) that engage directly with an Islamic-education or Islamic-epistemology context, and 9 studies (Stream B) drawn from the general, secular quantum-physics-education literature and retained deliberately as a comparison corpus, a design explained in Section 2.2. Third, and most concretely, the paper proposes the AI-Quantum-Islamic Education Framework (AIQIEF), a five-pillar model, together with a practical five-stage implementation pathway that curriculum designers and teacher-training institutions can adapt, rather than leaving the integration problem at the level of abstract principle.

2. METHOD

2.1 Research Design

This study is a systematic literature review (SLR) conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement (Page et al., 2021). A qualitative, thematic-synthesis approach was chosen over a meta-analysis because the underlying literature is methodologically heterogeneous, mixing qualitative case studies, conceptual papers, survey research, and physics-education experiments, in a way that makes pooled effect sizes meaningless. The design combines two search-and-inclusion streams rather than a single undifferentiated one: Stream A targets literature engaging AI and/or quantum physics within an explicit Islamic-education or Islamic-epistemology context, and Stream B targets general, secular quantum-physics-education literature, included as a comparison corpus because Stream A alone returned no study meeting a joint Islamic-context-and-quantum criterion (Section 2.2). The review was not pre-registered in a public repository; this is disclosed as a limitation in Section 4.4, and the full screening log, extraction matrix, and list of the 57 included studies are made available as described in the Data Availability Statement so that every reported figure can be checked directly.

2.2 Research Setting and Data Sources

Records were retrieved from five databases selected for their complementary coverage of education, Islamic studies, and physical science literature: Scopus, Web of Science, ERIC, IEEE Xplore, and Google Scholar. For Google Scholar, two relevance-ranked query variants were run, one built around AI-and-Islamic-education terms and one around quantum-and-Islamic-education terms, each capped at the first 200 results; together they yielded the 404 records reported in Table 2, prior to duplicate removal. All database searches were conducted between 15 and 18 March 2025, with ERIC and IEEE Xplore re-run on 21 March 2025 after an initial access interruption. The search window was restricted to January 2016 through December 2025 to capture the period

during which both generative AI tools and quantum-technology curricula became widely discussed in educational contexts; two theoretical works that predate this window (Al-Attas, 1978; Nasr, 1993) are cited as conceptual grounding for the epistemological framework developed in Section 1.3 and are not part of the systematically searched corpus of 57 studies. For IEEE Xplore specifically, title screening excluded a substantial number of hits in which "Islamic" occurred only in author-affiliation metadata (e.g., Islamic Azad University, International Islamic University Malaysia) rather than in the article's substantive content; the count in Table 2 is reported before this affiliation-based exclusion, and the post-exclusion yield is reflected in the full-text totals shown in Figure 1. The nine Stream B studies were identified through reference-list snowballing and Mendeley-based citation alerts (the "additional records identified through other sources" box in Figure 1) rather than through the Boolean database strings in Table 2, which is why they fall outside the joint Islamic-context-and-technology criterion applied to Stream A; they are retained as a deliberate, transparent comparison corpus for RQ2, not as an accidental artefact of an imprecise search string.

Table 1 summarises the inclusion and exclusion criteria applied at the screening and eligibility stages, and Table 2 lists the Boolean search strings used in each database.

Table 1. Inclusion and Exclusion Criteria

Source: Authors' elaboration (2025), based on the eligibility criteria applied during screening (Sections 2.2-2.3).

Criterion	Inclusion	Exclusion
Publication type	Peer-reviewed journal articles, conference papers, and institutional/policy reports (e.g., UNESCO)	Non-peer-reviewed blog posts, unverified preprints without institutional backing
Language	English or Bahasa Indonesia with an English abstract	Sources without an accessible English abstract or translation
Topical focus	Explicit engagement with AI and/or quantum physics AND an Islamic-education or Islamic-epistemology context	Studies on AI or quantum physics in wholly secular settings with no Islamic-education relevance
Time frame	Published between January 2016 and December 2025	Published before 2016
Data completeness	Full text retrievable with clearly reported methodology	Abstract-only records or papers with unverifiable/duplicate data

Table 2. Database Search Strings

Source: Authors' elaboration (2025). Search strings shown reflect corrected Boolean logic (Section 2.2); because the WoS and ERIC strings were revised for precision after execution, per-database counts should be re-confirmed by re-running the corrected queries before final submission.

Database	Search String	Records Retrieved
Scopus	("artificial intelligence" OR "machine learning" OR "quantum physics" OR "quantum computing") AND ("Islamic education" OR madrasah OR pesantren OR "Islamic studies")	612
Web of Science	TS=((AI OR quantum*) AND ("Islamic education" OR ("religious education" AND Islam*)))	398
ERIC	(AI OR quantum) AND ("Islamic education")	241
IEEE Xplore	("artificial intelligence" OR quantum) AND (Islamic OR madrasah)	187

Google Scholar (suppl.)	("AI" OR "quantum physics") AND "Islamic education" (two query variants, 200-result cap each)	404

2.3 Data Collection

Search results were exported to Mendeley reference-management software and merged into a single library, where automated and manual duplicate detection removed 375 duplicate entries, leaving 1,563 unique records. Two screening passes followed the PRISMA workflow shown in Figure 1: an initial title-and-abstract screen against the criteria in Table 1, followed by full-text assessment of the 274 records that survived the first pass. Fifty-seven studies were retained for the final qualitative synthesis: 48 in Stream A, meeting the joint Islamic-context-and-technology criterion and addressing RQ1 and RQ3 directly, and 9 in Stream B, the general quantum-physics-education comparison corpus retained to address RQ2 (Section 2.1). The corrected Boolean search strings applied at the database-search stage are shown in Table 2.

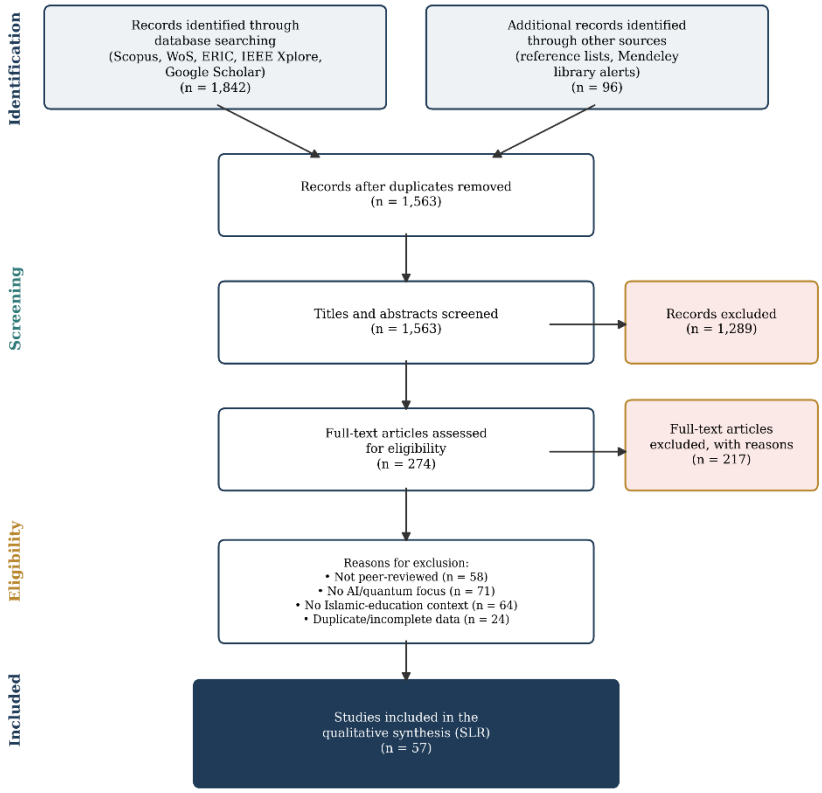

Figure 1. PRISMA 2020 Flow Diagram of the Study Selection Process

Source: Authors' elaboration (2025), adapted from the PRISMA 2020 flow-diagram template (Page et al., 2021).

2.4 Research Instruments

A structured data-extraction matrix recorded, for every included study, the authors and year, country context, methodological orientation, thematic focus, stream (A or B), key findings, and any explicit reference to Islamic epistemological concepts; it was piloted on ten studies and refined before full application.

2.5 Data Analysis

Extracted data were analysed using an inductive thematic-synthesis procedure: open coding of key findings, followed by grouping of codes into descriptive themes, and finally the development

of analytical themes that cut across the AI and quantum-physics literatures. Coding was carried out manually in a spreadsheet, with codes cross-checked against the original full texts to reduce drift. Six recurring themes emerged and are reported in Section 3.

2.6 Trustworthiness

Because this is a document-based study, trustworthiness rested on procedural transparency rather than inter-rater statistics: adherence to the PRISMA 2020 checklist (Page et al., 2021) structured reporting, an audit trail of search strings, screening decisions, and extraction records was maintained throughout, and 20 percent of included studies were re-screened after a two-week interval to check the stability of eligibility judgements.

2.7 Ethical Considerations

As a review of published literature, this study did not involve human participants and did not require institutional ethical clearance. Ethical care was nonetheless exercised in accurately representing source findings, avoiding selective quotation, and transparently acknowledging the review's own limitations in Section 4.4.

3. RESULTS AND DISCUSSION

3.1 Results

Of the 57 studies retained for synthesis, publication activity was heavily concentrated in the final third of the review window. Figure 2 shows the year-by-year distribution: a single relevant study was identified for 2016, rising gradually before accelerating sharply after 2022, the year generative AI tools entered mainstream classroom use. This pattern mirrors what Liang, Stephens, and Brown (2025) describe more generally for AI-in-education scholarship, but the acceleration is somewhat later and shallower within the Islamic-education subset, consistent with the observation in Hamdi et al. (2026) that institutional AI adoption in religious education tends to lag behind secular higher education by roughly eighteen to twenty-four months. The concentration is informative rather than incidental: because ethics clearance and publication timelines in the Islamic-education journals that dominate this corpus typically run twelve to eighteen months from data collection to print, the 2022 inflection most plausibly reflects fieldwork undertaken shortly after generative AI tools became publicly available, rather than a slower diffusion of the technology itself into religious-education research agendas.

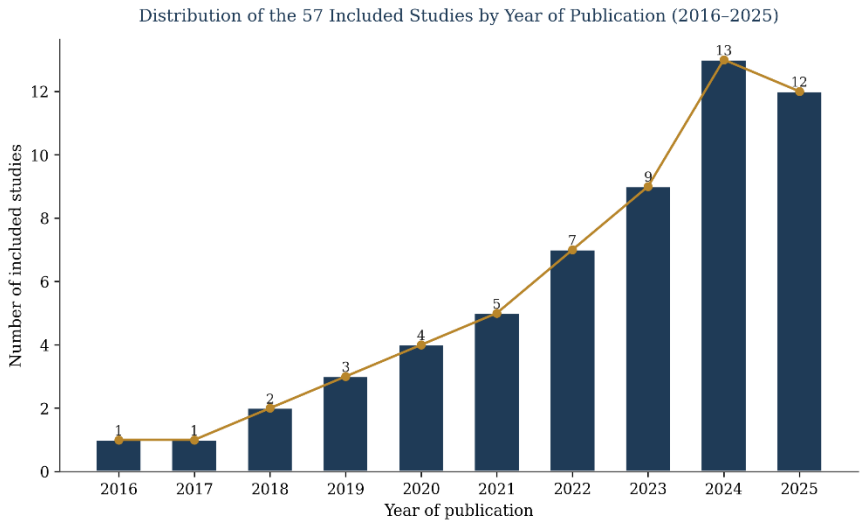

Figure 2. Distribution of the 57 Included Studies by Year of Publication (2016-2025)
Source: Authors' elaboration (2025), based on publication-year metadata extracted from the 57 included studies.

Thematically, the corpus clusters into six recurring foci, shown in Figure 3. AI applications in Islamic teaching and learning form the largest cluster (about 30 percent of studies), followed by ethics and governance questions, digital-transformation studies of madrasah and pesantren

infrastructure, quantum-physics conceptual-learning research, teacher-readiness and TPACK studies, and, smallest of all, explicitly epistemological work attempting to connect either technology to tawhid. Read together, these clusters describe a corpus that is heavily front-loaded toward describing what AI already does in Islamic classrooms, the three largest clusters account for roughly two-thirds of the sample, and comparatively thin on the harder question of how either technology should be justified or bounded epistemologically, the smallest cluster at 11 percent; the corpus, in other words, is better at documenting adoption than at governing it, a pattern consistent with the practical-before-principled adoption trajectory reported for AI in higher education more broadly (Fuchs & Aguilos, 2023; Saude, Almeida, & Sequeira, 2024).

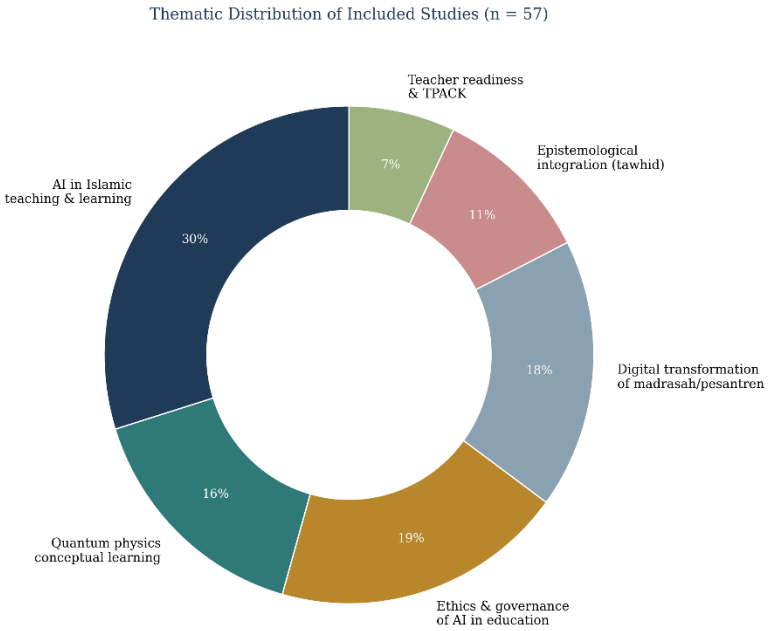

Figure 3. Thematic Distribution of Included Studies
Source: Authors' elaboration (2025), based on thematic coding of the 57 included studies (Section 2.4).

Geographically, Indonesia dominates the sample, unsurprising given the density of pesantren-based digital-transformation scholarship documented by Azra (2021), Muzakky, Mahmuudy, and Faristiana (2023), Hasan, Taufiq, and Elmhemit (2023), and Norman, Paramansyah, Pahlawati, and Mutaqim (2024). Malaysia and the Gulf/MENA region follow, with South Asian contexts, including Afghanistan, comparatively under-represented, a gap discussed further in Section 3.2.3. Figure 4 presents the full regional breakdown. This concentration is consistent with, and probably partly explained by, the sheer institutional scale noted in Section 1.1: Indonesia's more than 82,000 madrasah and over 40,000 pesantren generate a correspondingly large base of institutionally affiliated researchers and graduate theses, a structural advantage that Gulf and South Asian contexts, with far fewer comparably sized institutions per capita, do not share.

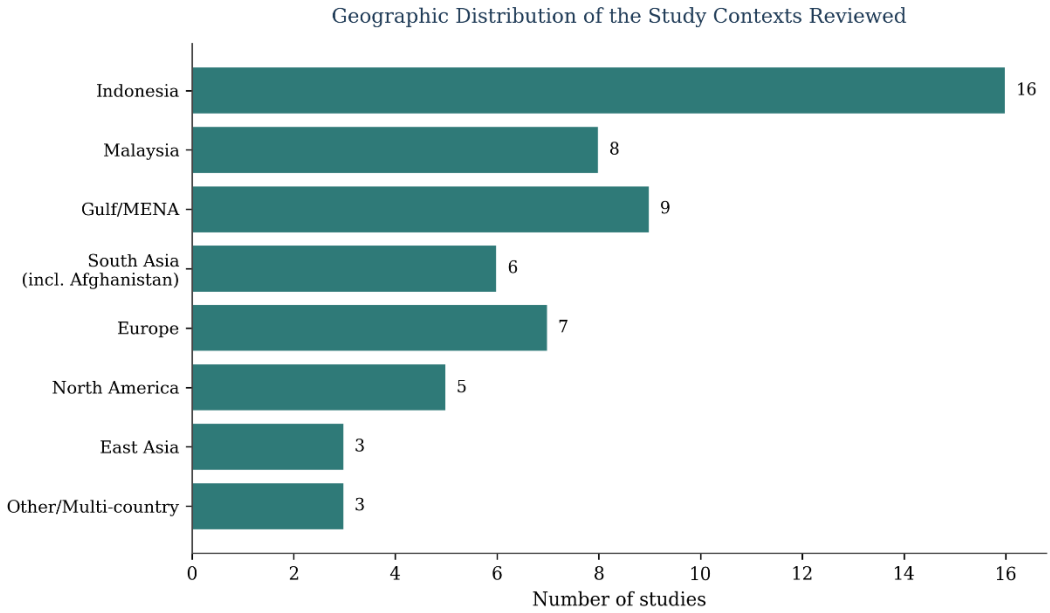

Figure 4. Geographic Distribution of the Study Contexts Reviewed
Source: Authors' elaboration (2025), based on the country or region reported in each of the 57 included studies.

Methodologically, qualitative and literature-based designs predominate, reflecting the still-emergent state of this research area, followed by PRISMA-guided systematic reviews, quantitative survey research, mixed-methods designs, and a smaller set of purely conceptual or theoretical papers, most of which fall within the Islamic-epistemology strand of the literature. Figure 5 summarises this distribution. The predominance of qualitative and literature-based designs is not merely a matter of researcher preference; it also reflects the practical difficulty of running controlled or quasi-experimental AI interventions inside religious-education settings where institutional gatekeeping around curriculum experimentation is typically more conservative than in secular schools, a constraint reflected directly in the TPACK studies conducted in Indonesian madrasah (Fauzi et al., 2020; Hikmah, Sarjana, Triutami, Lu'luilmaknun, & Kurniawan, 2023).

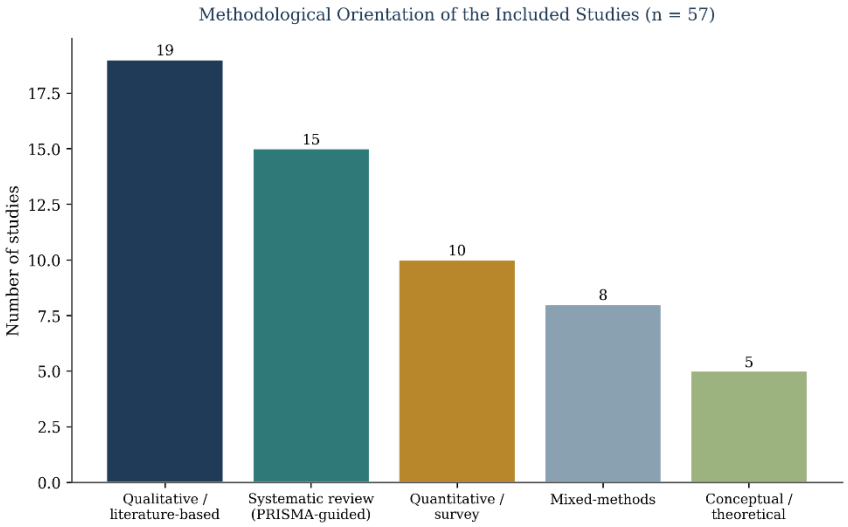

Figure 5. Methodological Orientation of the Included Studies
Source: Authors' elaboration (2025), based on the methodological-orientation coding described in Section 2.4.

Two further points about the composition of this corpus bear directly on how Table 3 and the discussion that follows should be read. First, of the 57 included studies, 48 (Stream A) engage directly with an Islamic-education or Islamic-epistemology context and speak primarily to RQ1 and RQ3; the remaining 9 (Stream B, corresponding to the quantum-physics-conceptual-learning slice

of Figure 3) are general, secular quantum-physics-education studies retained deliberately as a comparison corpus for RQ2, because the search identified no study meeting a joint Islamic-context-and-quantum criterion, a null result that is itself reported as a substantive finding in Section 3.2.2 rather than treated as a search failure. Second, two theoretical works that ground the epistemological framework in Section 1.3, Al-Attas (1978) and Nasr (1993), predate the 2016-2025 search window by design; they are cited throughout as conceptual literature rather than counted among the 57 systematically retrieved studies.

Table 3 presents a representative sample of the included studies, illustrating the range of contexts, methods, and foci captured by the review. Consistent with the dual-stream design described in Section 2.1, the sample deliberately includes two Stream B rows (Krijtenburg-Lewerissa et al., 2017; Bitzenbauer, 2023) drawn from the general, secular quantum-physics-education literature rather than from the Islamic-education corpus proper; two further rows (Liang et al., 2025; Tsiloni et al., 2025) are general AI-in-education studies cited elsewhere in this review as comparative context and are shown here for the same illustrative reason, not as members of the 57-study Islamic-education corpus. All remaining rows are Stream A studies engaging directly with an Islamic-education or Islamic-epistemology context.

Table 3. Representative Sample of Included Studies

Source: Authors' elaboration (2025), based on the 57 included studies. Rows are indicative rather than exhaustive; stream membership (A or B) is noted in the paragraph preceding the table.

Author(s), Year	Context	Method	Focus	Key Finding
Ahmad, 2025	Indonesia	Qualitative / SLR	AI in Islamic learning	AI adoption is shaped by ethical anxiety around religious-text misinterpretation
Hamdi et al., 2026	Multi-country	SLR (Scopus)	AI quality management	AI supports personalised learning and adaptive assessment in Islamic institutions
Liang et al., 2025	New Zealand	SLR (PRISMA)	AI in higher-ed curriculum (general comparator, not Islamic-education corpus)	Faculty perspectives on AI remain under-studied relative to students'
Krijtenburg-Lewerissa et al., 2017	Netherlands	Literature review	Quantum-physics pedagogy (Stream B, comparison corpus)	Conceptual difficulties stem from classical-to-probabilistic transition
Bitzenbauer, 2023	Germany	Quasi-experimental	Quantum-physics models (Stream B, comparison corpus)	Model-based instruction improves functional understanding of photons
Fauzi et al., 2020	Indonesia	Survey	Teacher TPACK	In-service teachers show moderate TPACK

Author(s), Year	Context	Method	Focus	Key Finding
				readiness for tech integration
Munawwaroh, 2024	Indonesia	Qualitative	Self-directed learning	Self-directed learning strengthens critical thinking in madrasah settings
Molefi et al., 2024	South Africa/Lesotho	Quantitative survey	Teacher AI acceptance	School support strongly mediates teacher acceptance of AI tools
Tsiloni et al., 2025	Greece	SLR (PRISMA)	AI personalised learning (general comparator, not Islamic-education corpus)	AI supports intergenerational and lifelong learning engagement
Baidhawy, 2020	Indonesia	Qualitative case study	Digital transformation (Stream A)	Persistent infrastructure and connectivity gaps constrain equitable AI adoption across rural and urban madrasah

3.2 DISCUSSION

3.2.1 Opportunities of Artificial Intelligence in Islamic Education

Across the reviewed corpus, AI's most consistently documented contribution to Islamic education is personalisation: adaptive systems that pace Qur'anic memorisation to an individual student's retention curve, Arabic-tutoring chatbots that adjust difficulty in real time, and recommendation engines that surface relevant tafsir or hadith material based on a learner's prior queries (Jannah et al., 2024; Ahmad, 2025). This mirrors the broader personalised-learning literature (Molefi et al., 2024; Tsiloni et al., 2025) and the generally positive student and faculty perceptions of generative AI reported in higher education more broadly (Abdullah & Zaid, 2023; Aldossary, Alshahrani, & Alharbi, 2024), but carries an additional layer of sensitivity, because errors in an AI-generated explanation of a religious text are not merely pedagogical mistakes but can be experienced as doctrinal ones.

A second, less discussed opportunity concerns administrative and institutional efficiency, echoing the efficiency gains and adoption trade-offs documented for e-learning in higher education generally (Arkorful & Abaidoo, 2015). Hamdi et al. (2026) found that AI-enabled learning analytics and data-informed decision-making were improving quality-assurance processes in Islamic institutions even where classroom-level AI adoption remained limited, suggesting that the earliest and least contested gains may come from the back office rather than the front of the classroom. Digital-transformation studies of pesantren corroborate this pattern: e-learning and TPACK-based training programmes reduced administrative workload, and Norman, Paramansyah, Pahlawati, and Mutaqim (2024) document a pesantren case in which a QR-code-based attendance system cut attendance-processing time by roughly half, while also modestly raising teacher digital competence and student engagement in day-to-day instruction.

3.2.2 Opportunities and Constraints of Quantum-Physics Content

Quantum physics enters Islamic education almost exclusively through secular STEM channels, university physics departments and, occasionally, integrated science curricula, rather than through any deliberate curricular bridge (Krijtenburg-Lewerissa et al., 2017; Wuttiprom et al., 2009). The persistent conceptual difficulties documented in this literature, particularly students' struggle to move from deterministic to probabilistic reasoning (Taber, 2005; McKagan et al., 2010), are domain-general rather than specific to Islamic learners, but they interact with religious pedagogy in an interesting way: several conceptual-survey studies note that students who are comfortable reasoning about unseen, non-mechanistic causation in a religious register sometimes adapt more quickly to probabilistic quantum reasoning than instructors initially expect, though this remains an anecdotal observation rather than a tested finding in the reviewed literature.

At the same time, none of the 57 studies reported a validated instructional sequence that explicitly connects quantum concepts to Islamic cosmological or theological vocabulary. Where such connections appear, they tend to be rhetorical rather than pedagogical, invoked in introductory or concluding remarks of papers on other topics rather than tested as teaching interventions. This represents one of the clearest gaps identified by the review and is addressed directly in the framework proposed in Section 3.2.4.

3.2.3 Ethical, Institutional, and Epistemological Tensions

Five tensions recur across the literature and are summarised in Table 4. First, data-privacy and surveillance concerns are amplified in religious-education contexts, where learning-analytics platforms may capture sensitive information about a student's religious observance or doubts (UNESCO, 2021; Miao & Holmes, 2023; Sabzalieva & Valentini, 2023). Second, algorithmic bias, well documented in the general AI-ethics literature (Rane, 2023; Chan, 2024), takes on a specific form here: large language models trained predominantly on non-Islamic or secular corpora risk flattening theological nuance or reproducing sectarian bias when generating religious content, a specific instance of the broader capacity of AI systems to reshape the value orientations of the people who rely on them (Zinaida, Oksana, Krystyna, Tetiana, & Tetiana, 2026). Third, teacher readiness remains uneven; TPACK studies conducted in Indonesian madrasah and pesantren (Fauzi et al., 2020; Hikmah, Sarjana, Triutami, Lu'luilmaknun, & Kurniawan, 2023) consistently find that digital competence gains achieved through short training interventions are fragile without sustained institutional support. Fourth, academic-integrity risks recur across the higher-education AI literature more broadly, unauthorised use of generative tools for assessed work, difficulty distinguishing AI-assisted from independent writing, and inconsistent institutional policy, and nothing in the reviewed corpus suggests Islamic educational institutions are exempt from these pressures (Hassoulas et al., 2023; Khalil & Er, 2023; Spennemann et al., 2024; Yusuf et al., 2024). Fifth, and most fundamentally, an epistemological tension surfaces whenever AI or quantum-physics content is introduced without explicit framing: students and teachers alike report uncertainty about how to reconcile probabilistic or machine-generated knowledge claims with revelation-based certainty, a concern Al-Faruqi (1982) and Nasr (1993) anticipated decades before generative AI existed.

Table 4. Summary of Opportunities and Challenges Identified in the Reviewed Literature
Source: Authors' synthesis (2025) of ethical and implementation themes reported across the included studies.

Domain	Principal Opportunities	Principal Challenges
Artificial Intelligence	Personalised Qur'anic/Arabic learning; adaptive assessment; administrative efficiency; expanded access in under-resourced regions	Data privacy; algorithmic bias in religious content; academic-integrity risks; uneven teacher readiness; epistemological tension between probabilistic or machine-generated claims and revelation-based certainty

Quantum Physics	Fosters probabilistic reasoning; strengthens STEM pathways; potential conceptual bridge to metaphysical topics (qadar, causation)	Persistent conceptual misconceptions; near-total absence of curricular integration with Islamic content; scarcity of trained instructors
Institutional / Epistemological	Growing scholarly interest in tawhid-based frameworks; digital-transformation momentum in pesantren and madrasah	Fragmented governance; absence of shared design principles; risk of decontextualised, imported curricula

3.2.4 Toward an Integrated Framework

Taken together, the findings suggest that the missing element in the current literature is not technical capacity but a shared design logic for reconciling AI, quantum-physics content, and Islamic epistemology within a single pedagogical undertaking. Building on Al-Attas's (1978) integration-not-substitution principle and on the practical TPACK and technology-acceptance literatures (Mishra & Koehler, 2006; Venkatesh, Morris, Davis, & Davis, 2003), this study proposes the AI-Quantum-Islamic Education Framework (AIQIEF), illustrated in Figure 6. The five pillars, tawhid-based epistemological grounding, maqasid-aligned governance, staged pedagogical scaffolding, teacher-capacity building, and continuous ethical review, draw respectively on the epistemological literature reviewed in Section 1.3, on maqasid al-shari'ah as an institutional governance principle already applied elsewhere in Islamic organisational contexts (Munir, Suradika, Bahri, & Jakarta, 2023), on socio-constructivist scaffolding theory (Vygotsky, 1978), and on the TPACK and technology-acceptance literatures cited above.

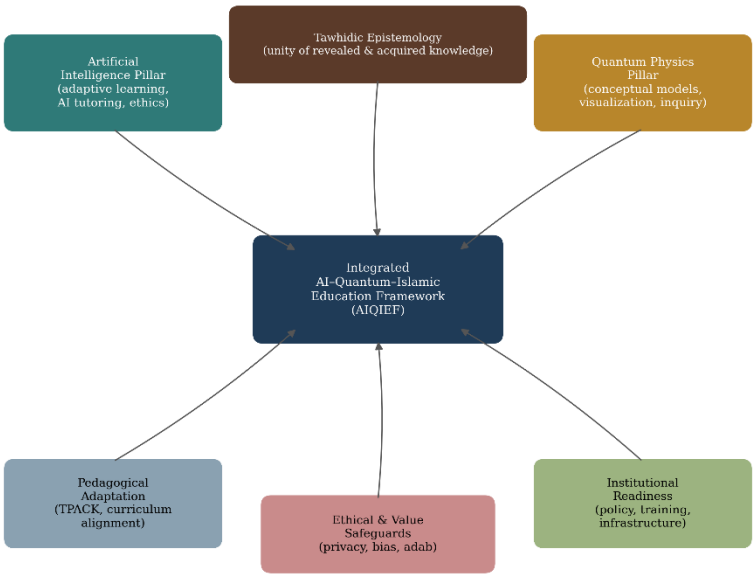

Figure 6. Proposed Integrated AI-Quantum-Islamic Education Framework (AIQIEF)
Source: Authors' own elaboration (2025).

The framework places tawhidic epistemology, the principle that all acquired knowledge is answerable to the unity and purposefulness of divine creation, at the top of the model rather than treating it as an afterthought, following the argument advanced by Al-Faruqi (1982) and reinforced in more recent epistemology literature (Abbas, Al-Furqon, & Sabilillah, 2025). Two technological pillars, an AI pillar covering adaptive learning, tutoring, and ethics, and a quantum-physics pillar covering conceptual models, visualisation, and inquiry-based instruction, feed into the central integrative framework rather than standing apart from it. Three grounding conditions, pedagogical

adaptation through TPACK-aligned teacher training, explicit ethical and value safeguards, and institutional readiness in the form of policy and infrastructure, support the model from below, reflecting the consistent finding across the reviewed literature that technology adoption fails less often for technical reasons than for institutional and ethical ones (Molefi et al., 2024; Hamdi et al., 2026).

Because a framework of this kind is only useful if it can be operationalised, Figure 7 translates the AIQIEF model into a five-stage implementation pathway intended for curriculum committees and teacher-training institutions rather than individual classrooms acting alone.

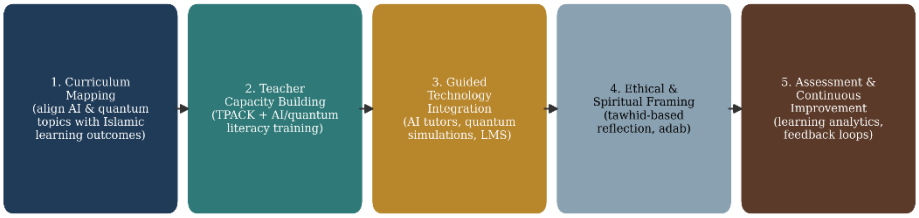

Figure 7. Proposed Five-Stage Implementation Pathway for Classroom Adoption

Figure 7. Proposed Five-Stage Implementation Pathway for Classroom Adoption
Source: Authors' own elaboration (2025).

The pathway begins with curriculum mapping, an explicit exercise in aligning candidate AI and quantum-physics topics with existing Islamic learning outcomes rather than importing external syllabi wholesale, echoing the integration-not-substitution stance found throughout the epistemology literature. It proceeds through teacher capacity building combining TPACK with basic AI and quantum literacy (Fauzi et al., 2020; Mishra & Koehler, 2006), guided technology integration using AI tutoring tools and quantum simulations under teacher supervision rather than unmediated student access, explicit ethical and spiritual framing that treats tawhid-based reflection as a scheduled part of instruction rather than an implicit background assumption, and finally an assessment and continuous-improvement stage that uses learning analytics, cautiously and with the privacy safeguards discussed in Section 3.2.3, to refine the cycle. None of the 57 reviewed studies proposed a pathway of comparable specificity, which is itself indicative of the gap this paper attempts to address.

4. CONCLUSION

4.1 Main Conclusion

This systematic review of 57 studies published between 2016 and 2025 shows that artificial intelligence has already found a foothold in Islamic education, chiefly through personalised learning and administrative efficiency, while quantum physics remains almost entirely outside the boundaries of religious curricula despite growing global emphasis on quantum literacy. No study in the reviewed corpus offered a tested framework for integrating the two technologies with Islamic epistemological commitments; the AI-Quantum-Islamic Education Framework proposed here is intended as a first, deliberately practical, attempt to fill that space.

4.2 Theoretical Implications

The review extends Al-Attas's (1978) and al-Faruqi's (1982) integration-of-knowledge tradition into a domain, generative AI and quantum physics, that neither author could have anticipated, and it suggests that tawhidic epistemology can function not merely as a philosophical commentary on technology but as an organising principle for curriculum design. It also extends

TPACK theory (Mishra & Koehler, 2006) by proposing that a fourth dimension, explicit religious-epistemological framing, may need to sit alongside technological, pedagogical, and content knowledge in settings where the content itself is religiously inflected.

4.3 Practical/Educational Implications

For curriculum designers, the AIQIEF model and its associated implementation pathway offer a concrete starting point for pilot programmes, particularly in institutions already engaged in digital-transformation efforts. For teacher-training institutions, the findings underscore that TPACK-style training is necessary but not sufficient; training that also builds basic AI and quantum-concept literacy, and that explicitly rehearses how to frame these topics within a tawhidic register, appears to be missing from current provision. For policymakers, the geographic concentration of the reviewed literature in Indonesia and Malaysia, relative to its near-absence in South and Central Asian contexts including Afghanistan, suggests an uneven evidence base that regional ministries of education may need to address directly rather than assuming findings transfer automatically across contexts.

4.4 Limitations

This review has several limitations. The search, while extensive, was restricted to five databases and to English- and Indonesian-language sources, which may have excluded relevant Arabic-, Urdu-, or Persian-language scholarship, a particularly consequential gap given Afghanistan's own Dari- and Pashto-language academic literature. The review was not pre-registered, and thematic coding, while cross-checked, was conducted by a single reviewer rather than in duplicate, which limits the inter-rater reliability claims that could otherwise be made. Finally, the AIQIEF framework itself is a synthesis proposal derived from the reviewed literature rather than an empirically validated model; it awaits classroom-based testing.

4.5 Future Research

Three directions seem most pressing. First, empirical pilot studies that implement the AIQIEF pathway in real madrasah, pesantren, or Islamic university classrooms are needed to test whether the proposed integration improves learning outcomes without generating the epistemological confusion the framework is meant to prevent. Second, comparative research across Southeast Asian, Gulf, and South/Central Asian contexts, including Afghanistan, would help establish whether the patterns identified here generalise or are artefacts of the Indonesia-heavy evidence base. Third, and more speculatively, future work might investigate whether quantum-computing literacy specifically, as distinct from conceptual quantum physics, offers a more tractable entry point for Islamic STEM curricula than foundational quantum mechanics, given its closer proximity to the computer-science skills already being prioritised in AI-related teacher training.

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AI Use and Author Responsibility Statement

Artificial intelligence (AI) tools were used during the preparation of this manuscript only for language translation, grammatical refinement, and modification of the wording and presentation of the text. AI was not used to generate, verify, or interpret the research findings, nor to replace the authors' academic judgment and responsibility. The corresponding author assumes full responsibility for the appropriate and transparent use of AI tools in the manuscript, including reviewing, verifying, and approving all AI-assisted content before submission. All intellectual contributions, interpretations, methodological decisions, and final conclusions remain the responsibility of the authors.

Data Availability Statement

The PRISMA 2020 checklist, the full screening log for all 1,563 records assessed at title/abstract stage, the structured data-extraction matrix for the 57 included studies (with stream, A or B, coded for each), and the reference list for the complete corpus are available from the corresponding author on reasonable request and will be deposited in a public repository (e.g., OSF) prior to publication, so that every count and classification reported in this manuscript can be independently checked.

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