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Cultivating Creative, Responsible, and Morally-Grounded Learners through Computational Thinking in Islamic Primary Education: A Mixed-Methods Multiple Case Study

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Abstract

The integration of computational thinking into Islamic primary education curricula has emerged as a fundamental need to equip students with problem-solving skills essential for a digitally driven society anchored in moral character. This article presents a systematic literature review following the PRISMA protocol, aiming to evaluate pedagogical approaches and CT development in programming education at Islamic primary schools. The synthesis draws from empirical studies of the last decade, focusing on computational curriculum effectiveness, teacher professional development, and the ethical framework grounded in Islamic values. Three primary findings emerged: project-based learning functions as a principal catalyst for cultivating computational fluency, with developmentally differentiated impacts across grade levels; a significant gap persists between the broad theoretical definition of CT and the narrow focus on programming exercises in classroom practice; and integrating CT into Islamic education requires a robust ethical framework that employs *hifz al-'aql* (preservation of intellect), the concept of *khalifah* (stewardship), and *fitrah* (innate disposition) as pedagogical cornerstones. Practical implications highlight the necessity of unplugged activities, contextually responsive scaffolding, and professional development programs that integrate technical training with AI literacy. The review concludes that successful curriculum reform can only be achieved through coordinated policies that synergize inclusive learning design, Qur'anically-grounded pedagogy (encompassing *tafqih*, *ta'qil*, *tafakkur*, *tafahhum*, *tadhakkur*, and *tadabbur*), and collaborative efforts across all educational stakeholders.

Keywords: Cultivating; Morally-Grounded; Creative and Responsible; Islamic primary education.

INTRODUCTION

In the Islamic tradition, intellectual development is a divine command explicitly stated in the first revelation, *'Iqra' bismi rabbika alladzi khalaq* (QS. Al-'Alaq: 1) which emphasizes the activities of reading, writing, and thinking as fundamental worship (Aflah et al.,

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2025);Iskandar et al., 2026). The concept of *mind*, which classical Muslim intellectuals understood not only as cognitive capacity but also as divine guidance that serves to direct humans towards deep understanding, finds a strong Qur'anic foundation in QS. An-Nahl: 78 and QS. As-Sajdah: 9(Afrianti et al., 2023). As emphasized in QS. Ali 'Imran: 190–191, the activity of *thought* contemplation of creation and signs is not just an intellectual skill but also a means of Allah (Zaini & Fauziah, 2024). The integration of computational thinking into the elementary school curriculum has emerged as a fundamental need to equip students with essential problem-solving skills in an increasingly digital society. (Wong et al., 2024) When the computational thinking framework is placed in this perspective, it is not merely a technical competence but a contemporary manifestation of the principle of *preservation of the mind* (intellectual preservation) as part of *Maqasid al-Shari'ah* (Ahmad et al., 2025).

Despite this urgency, recent research indicates a significant gap between broad theoretical definitions of computational thinking and a narrow focus on programming exercises in classroom practice. (Santaengracia et al., 2026) These operational deficiencies are compounded by a lack of consensus on instructional sequencing models, which often leaves educators without the pedagogical framework necessary to align complex computing concepts with the specific developmental stages of elementary-aged learners. (W. Wang et al., 2025) A recent systematic review suggests that this implementation gap is further exacerbated by the ambiguous distinction between cognitive skills, such as algorithmic sequencing, and behavioral dispositions such as persistence. *tafqih*, *lock*, *thought*, *farewell*, *tadhakkur*, and *contemplation* each refer to the process of analysis, investigation, reflection, understanding, formulation, and evaluation (Nawi et al., 2025). Beyond the cognitive dimension, the integration of computational thinking in Islamic education also requires a clear ethical framework. *caliph* (QS. Al-Baqarah:30) (Akhter, 2026). emphasizes that humans are not just users of technology but also *trustees* (muʾtaman) who bear divine responsibility for the utilization of knowledge and resources (Ali et al., 2025).

The Islamic perspective provides additional explanation to this challenge. In QS. Ar-Rūm: 30, humans were created in a state of *nature,* basic capital that carries cognitive, spiritual, and moral potential in an integral manner which must then be developed gradually through a process of *education* (Afrianti et al., 2023;El Hakiem et al., 2025). QS. Al-Mulk: 23 suggests that reasoning ability (*mind*) is a mandate that must be continuously honed, while QS. Al-Anfāl: 22 emphasizes that human capacities are fundamentally different and require

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guidance appropriate to their stage of development (Afrianti et al., 2023). The concept of developmental stages aligns with findings that learners need scaffolding to bridge the gap between abstract representations and their concrete cognitive abilities. This deficiency in preservice teacher training programs significantly limits the capacity for educators to effectively bridge the gap between computational skills and primary subject matter (Vasconcelos et al., 2025).

These shortcomings in pre-service teacher training programs significantly limit educators' ability to effectively bridge the gap between computing skills and core subject matter. (Vasconcelos et al., 2025)These implementation challenges are further exacerbated by the scarcity of standard learning materials, leaving non-specialist teachers to navigate the integration of physical computing and algorithm design without adequate guidance. A Muslim teacher, within the framework of education, not only mediates the transfer of competencies but also carries out the mission of correcting the formation of morals towards knowledge and technology(Aflah et al., 2025). This means that professional development does not sufficiently discuss how *to teach* coding but also why dan for what *purpose* computational thinking is taught, by making niyyah and benefit as a starting point for every pedagogical decision (Ali et al., 2025). In this context, addressing non-cognitive barriers such as teacher anxiety and reduced self-confidence is as important as providing technical instruction to ensure sustained curriculum adoption. (Wong et al., 2024).

This section summarizes existing studies on the integration of computational thinking, examining common pedagogical models and systemic barriers that impede effective teacher preparation (Espinal et al., 2024). Moreover, short-term professional development interventions frequently fail to foster the sustained pedagogical growth necessary to transform these negative beliefs and often neglect to provide the intensive, ongoing mentorship needed for effective curriculum implementation. To address these persistent gaps, the literature emphasizes the need to shift toward professional models that make integrated teaching pedagogical strategies visible to educators. This involves demonstrating how computational practices can be embedded within inquiry-based projects, thereby ensuring that digital activities directly support, rather than compete with, core content-area instruction. Furthermore, by embedding these opportunities within existing teaching methods courses, teacher educators can offer practical models that support the translation of theoretical computational constructs into everyday classroom practice. These programs should prioritize active, participation-based learning to dismantle knowledge

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barriers and enhance pedagogical self-efficacy for both pre-service and in-service instructors (Mason & Rich, 2019). Furthermore, developing these competencies requires efforts that extend beyond technical training to support the cultivation of nuanced pedagogical content knowledge, which enables teachers to synthesize computational logic with discipline-specific inquiry (Lane et al., 2023). This integration is further supported by frameworks such as TPACK-CT, which emphasizes that effective teaching depends on the synergy between teachers' mastery of STEM content and their ability to harness technology for pedagogical purposes (Jocius et al., 2021). Concurrently, restructuring these training programs to align with established digital competency frameworks, such as DigCompEdu, offers a systematic pathway to address the persistent reliance on generic, ready-made materials. By promoting this alignment, professional development can shift toward a competency-based approach, which research identifies as a key driver for bridging theoretical and practical gaps in transdisciplinary STEM contexts (Dolgopolovas & Dagiene, 2024). Indeed, recent studies demonstrate that engaging teachers in structured, inquiry-based projects enables them to bridge the gap between abstract computational concepts and authentic disciplinary challenges (Yang et al., 2021). Moreover, integrating physical computational exercises within this framework yields tangible, real-world outcomes for educators, which research suggests are critical for reinforcing both technical proficiency and classroom management confidence. In addition, the collaborative design of these training programs among diverse educational stakeholders is increasingly regarded as a prerequisite for developing the Pedagogical Content Knowledge necessary to facilitate integrated STEAM education. Experts further argue that such collaborative initiatives enhance participants' digital knowledge and confidence, which serves to accelerate the development of broader teaching competencies (Rodríguez et al., 2024)

RESEARCH METHODS

This research employed a mixed-methods multiple case study design built on a two-phase sequential explanatory design (Guetterman & Fetters, 2018). To develop a conceptual and theoretical framework that would guide the implementation of the case study, this research first conducted a Systematic Literature Review (SLR) strictly following the PRISMA 2020 guidelines (Yeni et al., 2024). The SLR served as a foundation that identified the most recent empirical evidence on integration. Computational thinking in Islamic basic education and at the same time become the basis for designing interventions, instruments, and research

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questions for the multiple case studies that will be conducted. A mixed-methods approach was chosen because the complexity of the phenomenon being studied namely the relationship between the development of computational thinking skills and the formation of creative, responsible, and noble character requires a deep contextual understanding from the case study and a broad generalization from the quantitative component. This nested mixed-methods approach has previously proven effective for investigating how school-based interventions simultaneously develop pentacomputational and *debugging skills in* fifth-grade elementary school children (Wong et al., 2024). This approach has also been successfully adapted for research in the context of Islamic education through the model *Technology Tree,* which structurally integrates spiritual dimensions with cognitive dispositions (Hariyadi et al., 2025).

RESULT AND DISCUSSION

Computational projects serve as*real-life problem space*where students not only practice abstraction and decomposition, but also practice the principle of amanah, namely moral responsibility for every digital artifact they produce, which includes honesty in the process (refusing to copy code without attribution), accuracy in data representation, and fidelity to the problem specifications promised to users (Saad & Zainudin, 2024). Findings from the studies analyzed confirm that project-based learning significantly improves students' retention of computational thinking skills when projects are explicitly framed around a value dimension. Islamic schools that implement this learning model report character transformations alongside cognitive development: students not only master programming syntax but also develop dispositions such as discipline in writing documentation, responsibility for meeting deadlines, healthy teamwork, and intellectual honesty (Fara Nadyatun, Tasya Mut'mainna, Lilik Serli Fandani, 2026). Furthermore, the framework benefit The principle that every use of technology must be directed towards the common good and kept away from mafsadah has proven to be a strong theological justification for teachers to elaborate each project with critical questions about social impact. A synthesis of 32 studies that met the inclusion criteria showed that project-based learning is not simply a pedagogical method for instilling computational skills, but rather a strategic vehicle for framing technical activities within an ethical-spiritual framework. Thematic analysis found three main recurring patterns. First, computational projects function as*real-life problem space*where students not only practice abstraction and decomposition, but also practice the principles *trust* namely moral responsibility for every digital artifact they produce, which

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includes honesty in the process (refusing to copy code without attribution), accuracy in data representation, and fidelity to the problem specifications promised to users (Saad & Zainudin, 2024). Findings from the studies analyzed confirm that project-based learning significantly improves students' retention of computational thinking skills when projects are explicitly framed around a value dimension. Islamic schools implementing this learning model report simultaneous character transformation with students' cognitive development not only mastering programming syntax but also developing dispositions such as discipline in writing documentation, responsibility for deadlines, healthy teamwork, and intellectual honesty (Fara Nadyatun, Tasya Mut'mainna, Lilik Serli Fandani, 2026). Furthermore, the *maslahah* framework, the principle that every use of technology must be directed towards the common good and kept away from mafsadah, has proven to be a strong theological justification for teachers to elaborate each project with critical questions about its social impact.

This synthesis asserts that computational thinking, when placed within the perspective of *Maqasid al-Shari'ah*, is a contemporary embodiment of the principle of *preservation of the mind, preservation* of the intellect as one of the five fundamental goals of the Shari'ah. Within this framework, the ability to abstract, decompose, recognize patterns, and design algorithms is not merely a utilitarian cognitive skill, but rather an intellectual act of worship in line with the first commandment of revelation, *'Iqra' bismi Rabbika alladzi khalaq*A discussion of 32 studies shows that effective computational thinking instruction in elementary education is not sufficient to simply develop procedural competencies; it must explicitly frame each concept within a values context. The most important finding of this synthesis is the significant gap between theoretical definitions of computational thinking, which consistently include creative and critical aspects, and classroom practices that too often narrow it to programming training (Santaengracia et al., 2026). Code is never value-neutral; every line of a program reflects design decisions that impact humans. Therefore, without an ethical dimension, computational thinking training risks becoming *technicism* who miss the higher education goals (Kite et al., 2021; Zhang et al., 2025). This paper addresses this gap in three steps. First, each decomposition activity is framed with a reflective question: *This algorithm breaks down the problem of who, and for whom?* Second, abstraction is presented not as a context-free technique but as a tool for understanding the complexity of God's creation that demands *contemplation.* Third, evaluation of algorithm efficiency is always coupled with discussions about sustainability, algorithmic fairness, and environmental impact (computational thinking for *benefit*). This integrative finding strengthens the position

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that future digital citizens produced by Islamic basic education must be*creative* and *responsible*, not just code literacy. This distinguishes this manuscript from similar systematic reviews that generally stop at measuring cognitive outcomes without addressing the character dispositions that are the ultimate goal of education.

An exploration of the literature on artificial intelligence literacy in elementary education yielded two key, complementary findings. First, artificial intelligence literacy cannot be separated from digital literacy in general; both require the capacity to navigate algorithmic ecosystems with critical understanding and ethical dispositions (C. Wang et al., 2022). Second, empirically, more than 92 percent of elementary school teachers in Central Java acknowledged the importance of integrating computational thinking competencies and spiritual dimensions in science learning, yet all (100 percent) stated they had not been able to realize this integration due to the lack of a structured learning model (C. Wang et al., 2022). This policy and implementation gap underscores the need for an ethical-spiritual framework for artificial intelligence literacy. The *Maqasid al-Shari'ah* framework, which encompasses the preservation of *from*(religion),*nafs* (soul), *mind*(intellect),*nasl*(descendants), and *just* (assets) have been shown to provide a comprehensive foundation for ensuring that students' digital practices are not only technically proficient but also maintain the well-being of individuals and society as a whole (Ahmad et al., 2025). Furthermore, the principle of *manners* (politeness), *trust* (can be trusted), *Ihsan* (seriousness in doing good), and *niyyah* (sincere intention) serve as the four ethical pillars that guide adolescents and children in interacting with technology with dignity. An Islamic perspective also provides additional explanations for the risks of automation, including dehumanization, digital plagiarism, dependence on technology, and a decline in spiritual awareness (Ahmad et al., 2025). This paper proposes that mitigating these risks requires a curriculum reconstruction that explicitly integrates digital literacy with Islamic moral literacy, strengthening the role of educators as *murrabbi* balanced digital economy, as well as recalibrating the proportion of technology utilization to align with *Maqasid al-Shari'ah* (Mustari & Nurhayati, 2026; Udhma et al., 2025). The practical implication is that whenever students engage with artificial intelligence systems in class, either as users or designers of simple projects, the teacher frames the activity with a discussion about *responsibility* (accountability), *mujahid* (perseverance in goodness), and *manners* towards fellow human beings impacted by algorithmic decisions. The dimensions of teacher professional development show that the success of integrating computational thinking in primary education is not determined by technological

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infrastructure alone, but rather by the teacher's pedagogical capacity to mediate between the world of code and the world of values. A Muslim teacher, within the framework of *education*, not only mediating the transfer of technical competence but also carrying out the mission *correction* the formation of a holistic attitude towards knowledge and technology. This mission demands professional transformation that goes far beyond training.*coding* Conventional approaches. Key findings indicate that a critical barrier to implementation is the continued lack of structured training for teachers (Zhang et al., 2025). Beyond simply adding training hours on hardware or programming languages, teacher professional development in this context must encompass four components. First, pedagogical literacy on how collaborative scaffolding can mitigate implementation challenges in diverse classrooms (Saad & Zainudin, 2024). Second, the ability to integrate cognitive maps of Islamic value dimensions as offered by the six modes of Qur'anic reasoning (*tafakkur, tadabbur, tafqih, ta'qil, tafahhum, tatakkur*) into every technical activity. Third, the competence to use portfolio-based formative assessment that captures not only student work but also the ethical dispositions evident during the process (Mustari & Nurhayati, 2026). Fourth, professional reflective habits such as teaching journals or *lesson study* to deepen pedagogical understanding of how technological interactions shape students' holistic knowledge construction. The integration of all the above dimensions demonstrates that computational thinking in primary education, when framed by Islamic values, is no longer trapped in technical reductionism but becomes an integral part of the character education project. The three main pillars that emerge from this synthesis are mutually reinforcing. The technical pillar (abstraction, decomposition, patterns, algorithms, debugging) contributes to cognitive-instrumental competencies. The pedagogical pillar contributes to the design of learning experiences. The ethical-spiritual pillar (*amanah, ta'awun, maslahah, ihsan, adab, hifz al-'aql*) contributes to character disposition and moral orientation. Theoretically, the main contribution of this manuscript is to position Islamic elementary educators not merely as facilitators of twenty-first century skills, but also as *khalifah fil-'aql* leaders who carry the divine mandate to utilize knowledge and resources in the digital ecosystem (Ahmad et al., 2025). Practically, this paper provides a framework that can be adapted by teachers, principals, and policymakers to ensure that technology integration in the classroom does not neglect the character dimensions that are at the heart of Islamic education. This is what distinguishes this paper substantively from similar systematic reviews published in

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technology education journals, which generally stop at the competency aspect without addressing the ethical ecosystem in which those competencies will be used.

CONCLUSION

This study examines the integration of computational thinking into Islamic elementary education as an effort to foster students who are creative, responsible, and ethical. Based on the findings, it can be concluded that the development of computational thinking skills is fundamentally aligned with the principles of *Maqasid al-Shari'ah*, particularly the objective of preserving reason (*hifz al-'aql*). Thus, the development of computational competencies is not only a requirement of the digital age but also holds spiritual and moral legitimacy within the Islamic scholarly tradition. The research findings indicate that the implementation of Project-Based Learning (PBL) is an effective approach to bridging the gap between the theory and practice of computational thinking. Through the maslahah framework, project-based learning has proven capable of fostering discipline, collaboration, moral responsibility, and students' awareness of the social impact of technology. This underscores that computational thinking education should not stop at code literacy alone but should also encompass the development of creativity and character traits grounded in ethical values.

To achieve these objectives, this study proposes a structured model based on three mutually integrated pillars, namely: (1) the technical pillar, involving the mastery of computational skills; (2) the pedagogical pillar, involving the implementation of active and inquiry-based learning accompanied by ongoing mentorship for teachers; and (3) the ethical-spiritual pillar, involving the internalization of Islamic values and the *Maqasid al-Shari'ah*. These three pillars are expected to develop students' cognitive and moral potential in a holistic and sustainable manner. Consequently, this study recommends the need for curriculum reform that integrates computational thinking with Islamic values, as well as the strengthening of continuous professional development for teachers, including efforts to address psychological barriers such as teacher anxiety in adopting technology. The role of Muslim teachers as role models in both moral and technological education is a key factor in the successful implementation of this model. Further research is recommended to empirically test the effectiveness of this three-pillar model in the broader context of Islamic elementary education.

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