

Original Article

Designing Adaptive Artificial Intelligence to Integrate 21st Century Competencies into Islamic curricula

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Abstract

Traditional Islamic curricula often emphasize religious knowledge while underrepresenting competencies, which is important for thriving in the 21st century. This phenomenon creates a tension between religious aims and contemporary educational demands. This qualitative study explores how adaptive artificial intelligence (AI) tools can be designed and integrated to support holistic student development within a traditional madrasah setting. Using a multiple-case, design-based qualitative approach, data were collected through semi-structured interviews (n=18), focus groups (n=5), classroom observations, and curriculum documents across four institutions in Malaysia and Cambodia. Findings make four themes relatively: (1) alignment tensions between religious epistemologies and competencies, (2) flexible opportunities for skills development, (3) pedagogical redesign requirements such as teacher roles, assessment, and learning pathways, and (4) ethical, cultural, and infrastructural constraints shaping uptake. Participants emphasized adaptive AI's potential to scaffold critical thinking, collaboration, and values-based decision-making when technologies are co-designed with scholars and teachers. However, success depends on careful value alignment, transparent algorithms, professional development, and contextualized assessment practices. The study concludes that adaptive AI can bridge traditional Islamic education and 21st-century competencies when being guided by a responsive design culture and government participation. It will significantly offer a scalable pathway to holistic student development and policy recommendations for curriculum reform.

Keywords: Adaptive Artificial Intelligence; Islamic curricula; Reflective Learning; Value-Based Education

Introduction

Traditional *Islamic* educational institutions have been central to the transmission of religious knowledge, moral formation, and community identity across Muslim societies ¹. These institutions excel at instilling scriptural literacy, devotional practices, and ethical norms. Meanwhile, global shifts in labor, technology, and social complexity have raised demand for a broader set of student capabilities, known as the 21st-century competencies, comprising critical thinking, creativity, collaboration, communication, digital literacy, and socio-emotional skills ². Policymakers, education practitioners, and parents increasingly expect the school system to prepare students not only for

¹ Satibi, 'Character Building in the Tradition of Islamic Education in Indonesia', *Islamic Perspective on Communication and Psychology*, 1.1 (2024), 12–23 <<https://doi.org/10.61511/ipercomp.v1i1.2024.831>>; Akhmad Nurul Kawakip and Sulanam Sulanam, 'The Practice Of Shared Of Values And Islamic Educational Identity: Evidence from a Pesantren in East Java, Indonesia', *Journal Of Indonesian Islam*, 17.1 (2023), 27 <<https://doi.org/10.15642/JIIS.2023.17.1.27-53>>.

² Junaid Qadir and others, 'Engineering Education, Moving into 2020s : Essential Competencies for Effective 21st Century Electrical & Computer Engineers', in *2020 IEEE Frontiers in Education Conference (FIE)* (IEEE, 2020), pp. 1–9 <<https://doi.org/10.1109/FIE44824.2020.9274067>>; Branden Thornhill-Miller and others, 'Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education', *Journal of Intelligence*, 11.3 (2023), 54 <<https://doi.org/10.3390/jintelligence11030054>>.



spiritual life but also for civic participation and dynamic economies³. This creates a visible curricular tension: How can long-standing *Islamic* pedagogical aims coexist with or even incorporate these contemporary competencies without compromising theological integrity or community values?

Scholarly and policy literature identify multiple strands relevant to this question. First, competency frameworks, such as those advanced by the Partnership for 21st Century Learning and OECD, argue that curricula must prioritize transferable skills alongside disciplinary knowledge to enable lifelong learning in an uncertain world⁴. Second, literature on *Islamic* education highlights its strengths in character formation and training, while also noting critiques that some programs remain exam-driven and knowledge-centric⁵. Therefore, it limits the opportunities for problem-solving and collaborative inquiry. Third, research on educational technology and adaptive learning systems demonstrates that AI-driven platforms can personalize instruction⁶. In such a situation, it will provide timely formative feedback and support metacognitive scaffolding that may align with competency development. These streams suggest a promising intersection by using adaptive AI to mediate between traditional and contemporary skill demands⁷.

However, theoretical and empirical gaps persist. Many competency frameworks are grounded in liberal and secular educational norms, assuming that solid infrastructure, liberal epistemologies, and assessment cultures support creativity and debate⁸. *Islamic curricula*, on the other hand, operate within distinct epistemic and moral frameworks. Knowledge may be valued for spiritual ends⁹, while authority relations, such as teacher-student and scholar-laymen, are structured differently¹⁰. It is worth emphasizing that pedagogical aims in Islam include moral habituation and spiritual refinement. Therefore, these differences raise several concerns: Will AI models inadvertently encode values misaligned with *Islamic* moral aims? Can adaptive systems respect the teacher's role as a moral guide and interpreter? What pedagogical redesigns are necessary to preserve theological commitments while cultivating critical, collaborative, and digital literacies?

This study addresses these questions: 1) How can adaptive AI solutions be designed and integrated into traditional curricula to nurture 21st-century competencies while maintaining theological and moral values? Sub questions include: (a) What perceptions do stakeholders have about integrating competency learning into religious curricula? (b) What design principles and governance mechanisms do teachers, scholars, and administrators require for acceptable AI integration? (c) How do contextual factors such as infrastructure, assessment practices, and teacher

³ Mohammad Ismail Stanikzai, 'Critical Thinking, Collaboration, Creativity and Communication Skills among School Students: A Review Paper', *European Journal of Theoretical and Applied Sciences*, 1.5 (2023), 441–53 <[https://doi.org/10.59324/ejtas.2023.1\(5\).34](https://doi.org/10.59324/ejtas.2023.1(5).34)>; Susan M. Drake and Joanne L. Reid, '21st Century Competencies in Light of the History of Integrated Curriculum', *Frontiers in Education*, 5 (2020) <<https://doi.org/10.3389/educ.2020.00122>>.

⁴ Laura Icela González-Pérez and María Soledad Ramírez-Montoya, 'Components of Education 4.0 in 21st Century Skills Frameworks: Systematic Review', *Sustainability*, 14.3 (2022), 1493 <<https://doi.org/10.3390/su14031493>>.

⁵ St. Jumaeda, 'Evaluating the Effectiveness of Islamic Religious Education Learning in Implementing 2013 Curriculum in Madrasah', *Jurnal Pendidikan Islam*, 8.1 (2022), 101–12 <<https://doi.org/10.15575/jpi.v8i1.19017>>.

⁶ Wadim Strielkowski and others, '<sc>AI</Sc>-driven Adaptive Learning for Sustainable Educational Transformation', *Sustainable Development*, 33.2 (2025), 1921–47 <<https://doi.org/10.1002/sd.3221>>; David Holman and Eva Švejdárová, 'The 21st-Century Empowering Wholeness Adaptive (EWA) Educational Model Transforming Learning Capacity and Human Capital through Wholeness Systems Thinking towards a Sustainable Future', *Sustainability*, 15.2 (2023), 1301 <<https://doi.org/10.3390/su15021301>>.

⁷ Tarang Gupta, 'Adaptive Learning Systems: Harnessing AI to Personalize Educational Outcomes', *International Journal for Research in Applied Science and Engineering Technology*, 12.11 (2024), 458–64 <<https://doi.org/10.22214/ijraset.2024.65088>>.

⁸ Xiaoqing Xu and others, 'Enhancing Self-regulated Learning and Learning Experience in Generative <sc>AI</Sc> Environments: The Critical Role of Metacognitive Support', *British Journal of Educational Technology*, 56.5 (2025), 1842–63 <<https://doi.org/10.1111/bjet.13599>>.

⁹ Basri Asyibli and others, 'Epistemological Dimensions in Islamic Educational Philosophy: A Critical Analysis', *Journal of Islamic Education Research*, 6.1 (2025) <<https://doi.org/10.35719/jier.v6i1.464>>.

¹⁰ Mahmudulhassan Mahmudulhassan and others, 'The Integration of Islamic Epistemology in Ethical and Multicultural Education: Pedagogical Strategies and Challenges', *Multicultural Islamic Education Review*, 2.2 (2025) <<https://doi.org/10.23917/mier.v2i2.7612>>.



capacity shape possible implementation? To address these questions, this study will adopt a qualitative, multiple-case design in participatory design-based research. Empirically, it investigates four institutions selected for diversity in size, urbanicity, and technology exposure. Data sources include semi-structured interviews with administrators, teachers, and religious scholars. The focus group includes students, classroom observations, and analyses of syllabus and assessment materials. The aims are to produce empirically grounded design principles and policy recommendations that adapt local epistemologies and holistic student development through adaptive AI.

Method

This research employed a qualitative design grounded in design-based research (DBR) principles and interpretive phenomenology. DBR was selected because the study aims not only to understand stakeholder perspectives but also to provide practical design principles for adaptive AI systems, enabling their embedding in real educational contexts¹¹. DBR is a methodology that emerged in the early 1990s through the work of Ann Brown and Allan Collins. It is designed to bridge the gap between educational research and practice. DBR developed solutions through iterative cycles of design, implementation, and analysis in authentic contexts¹². Interpretive phenomenology supports a deep exploration of participants' lived experiences regarding education, technology, and values¹³. These approaches allow a smooth transition between empirical description, theory building, and practical design guidance, which is suitable for research that is contextually sensitive and action-oriented. While many frameworks emphasize complex cognitive and sociocognitive aspects in secular areas, putting this vision into practice necessitates coordinating curriculum, pedagogy, and evaluation¹⁴. Therefore, this study aims to examine how AI might support alignment in *Islamic* educational contexts.

The study was conducted in four institutions: two *madrasabs* in Kuala Lumpur and two *madrasabs* in Phnom Penh City. These *madrasabs* were chosen to capture diversity in pedagogical styles, governance structures, and access to technology. Institutional characteristics also vary in terms of moderate ICT infrastructure and ministry oversight in urban *madrasabs*, while rural *madrasabs* still rely on community funding and maintain strong ties to traditional ulama (scholars). On average, each *madrasab* has common age cohorts (secondary level, aged 13-17) who study *Qur'an*, *hadith*, *Fiqh*, and Arabic together, along with some secular subjects. Purposive and variation sampling includes four religious scholars/ustadz from *madrasabs*, four administrators, and fifteen students (mixed gender). In total, 23 individuals participated in interviews or focus groups.

Interview and focus group guides were developed from literature on competencies, *Islamic* pedagogy, and adaptive learning design. Guides include open-ended questions to explore pedagogical aims, perceptions on 21st-century competencies, attitudes toward AI, ethical concerns, and governance preferences. For observation protocols, the pattern of teacher-student interaction, assessment practices and classroom tasks were used to map competency development. In terms of data processing, audio recordings were transcribed verbatim by trained research assistants fluent in Malay, English, and Khmer languages. Transcripts went through two stages: first, they were passed by a transcriber, and second, they were reviewed by the primary researcher to check for accuracy and contextual annotations. Analytics procedures combined thematic analysis with pattern-matching to

¹¹ Anthony J. Onwuegbuzie, Elena Forzani and Julie A. Corrigan, 'A Fully Integrated Systematic Review of Mixed Methods Design-Based Research', *Journal of Mixed Methods Studies*, 2023, 24–51 <<https://doi.org/10.59455/jomes.34>>; Luís Tinoca and others, 'Design-Based Research in the Educational Field: A Systematic Literature Review', *Education Sciences*, 12.6 (2022), 410 <<https://doi.org/10.3390/educsci12060410>>.

¹² Christopher Hoadley and Fabio C. Campos, 'Design-Based Research: What It Is and Why It Matters to Studying Online Learning', *Educational Psychologist*, 57.3 (2022), 207–20 <<https://doi.org/10.1080/00461520.2022.2079128>>.

¹³ Margie Burns and others, 'Constructivist Grounded Theory or Interpretive Phenomenology? Methodological Choices Within Specific Study Contexts', *International Journal of Qualitative Methods*, 21 (2022) <<https://doi.org/10.1177/16094069221077758>>.

¹⁴ Joke M. Voogt and Natalie N. Pareja Roblin, 'Curriculum and 21st Century Skills', in *International Encyclopedia of Education (Fourth Edition)* (Elsevier, 2023), pp. 49–55 <<https://doi.org/10.1016/B978-0-12-818630-5.03007-4>>.



theoretical constructs (competency frameworks and *Islamic* pedagogical principles). Initial coding used an inductive approach to tackle stakeholder categories, needs, tensions, and imagined solutions. Codes were organized into themes through coding memos. A secondary coder independently coded 20% of transcripts, while inter-coder agreement exceeded acceptable thresholds (Cohen's Kappa = .82). Axial coding related to subthemes and their relationships is being analyzed to refine the themes across various contexts. Pattern-matching, comparing empirical patterns with existing models of adaptive learning and theory on curriculum change, was used to generate design principles.

Triangulation of data sources, including interviews, focus groups, observation, and document analysis, along with researcher reflexivity, member checking, and peer debriefing with the local advisory panel, has been conducted to enhance the trustworthiness of data reporting.

Results and Discussions

Analysis of the data has revealed four major themes that describe how adaptive AI could be integrated into traditional *Islamic curricula* to support 21st-century competencies: (1) Problems with aligning knowledge, (2) flexible opportunities for skills development, (3) pedagogical redesign and teacher roles, (4) ethical, cultural, and infrastructural constraints. Each theme includes subthemes, with illustrative evidence links to theoretical models. Where relevant, findings are compared across the four case *madrasabs* to illuminate contextual variation.

Theme 1: Problems with aligning knowledge: Balancing educational objectives and administrative power?

Subtheme 1.1: Objective Diversion. One is to impart knowledge, while the other is to foster competence. The majority of participants agree that a central theme of religious formation is to impart accurate scriptural knowledge and foster moral formation. Teachers often prioritized religious observance, correct recitation, and memorization (*hifẓ*).

“Our first duty is to ensure the *Qur'an* and *Fiqh* are learned correctly,” one senior teacher (*Madrasah A*) remarked. While having the appropriate skills is helpful, having the correct information is more important. “Employers ask for soft skills, parents ask for life chances.” This was in stark contrast to the views held by administrators of urban *madrasabs*. Consequently, they felt compelled to include digital literacy and critical thinking in their course offering. “We need both” (Head Administrator of the *Madrasah B*).

Subtheme 1.2: Authority and interpretive roles. Religious scholars emphasized the teacher (*ustadz/ustadzah*) as the moral interpreter. Machines do not easily delegate the pedagogical authority. One *madrasah* teacher (*Madrasah C*) remarked that “An AI can teach rules, but in terms of jurisprudence and spiritual guidance, it comes from human intervention.” This perception raised questions about where AI should be interfered. Observations corroborated that classrooms with strong teacher-led discussion resisted automated feedback that seemed to reframe interpretive issues. These tensions align with scholarship on epistemic cultures and knowledge legitimation. Technical affordances must respect institutional epistemologies to be accepted.

Theme 2: Flexible opportunities for skills development: What AI can genuinely add?

Subtheme 2.1: Personalization and scaffolding for diverse learners. Both teachers and students highly valued the use of flexible scheduling for differentiated instruction. A student from *Madrasah D* said: “When I struggle with grammar, the system gives me more exercises; when I am ready, it moves me to debating topics.” To allocate more time for in-depth dialogic training, the instructors emphasized adaptive diagnostics, which can identify students’ misconceptions about tafsir or Arabic syntax and then provide formative assignments appropriate to those assumptions.

Subtheme 2.2: Promoting reflective and metacognitive practices. Several teachers reported that software prompts encouraging reflection (e.g., “Why did you choose this interpretation?”) supported metacognition and moral reasoning. An Arabic teacher in *Madrasah B* observed, “The reflection prompts made students pause and justify, to repeat. That is how critical thinking grows.” After each class, instructors took field study notes on how students wrote brief reflective entries, which they then used to spark class debate during the following session.

Subtheme 2.3: Facilitation of collaborative problem solving within moral frames. Adaptive platforms with scaffolded peer-review modules enabled structured collaboration. Students could



propose interpretations, and peers could provide evidence-based feedback under teacher moderation. A focus group participant (student *Madrasah A*) described a collaborative module that simulated community dilemmas. “We discussed a case about technology ethics and applied *Fiqh* principles together.” These modules made it easier for people to communicate and collaborate, and they based activities on acceptable models. Interestingly, designing models with metacognitive scaffolding and collaborative frameworks aligns with competency development (Brusilovsky & Luckin).

Theme 3: Pedagogical redesign and teacher roles: From deliverer to facilitator.

Subtheme 3.1: Redefining assessment to capture competencies. Participants noted that existing summative assessments focused on memorization. Teachers supported integrating formative, performance-based assessments (portfolios, reflective essays, project tasks) enabled by AI analytics that track progress across competency dimensions. A headteacher (*Madrasah C*) commented: “We praise wrong things if we only check for memorization. Over time, AI can help accumulate proof of skills”. “When the app asked me why I thought this ruling applied, I had to write and then explain. That changed how I study.” Student, *Madrasah A*.

Subtheme 3.2: Teacher professional development and role transformation. Successful integration required substantial teacher training, including technical fluency and pedagogical shifts. Teachers express anxiety “I was trained to transmit, now I must coach and assess soft skills” (Teacher, *Madrasah B*). It was best for professional growth to include discussions about teaching, theology, and technology. Participants wanted workshops co-facilitated by technologists and senior religious educators.

Subtheme 3.3: Co-design as legitimacy vehicle. Sites that participated in co-design workshops demonstrated higher openness to prototypes. When instructors viewed prototypes that matched local instances, field notes captured enthusiastic interactions. One teacher remarked: “When the scenarios used our local texts, I felt that the technology was speaking our language.”

Theme 4: Ethical, cultural, and infrastructural constraints: Real limits on uptake.

Subtheme 4.1: Value alignment and algorithmic transparency. Scholars feared complicated recommendation systems that promoted exclusive interpretations. A senior scholar (*Madrasah A*) insisted that “It is not okay if the machine favors one *madzhab* over another or turns moral details into ratings.” Participants demanded transparency as an alternative for human override and documented ethical guidelines. In a field study, teachers pointed up a feed that assigned “correct/incorrect” ratings to student interpretations during a co-design session. They asked for rubric that displays criteria instead of binary numbers.

Subtheme 4.2: Cultural sensitivity and content curation. Content needs to be mindful of the diversity of local law and the norms of the local language. Parents were concerned about exposure to secular content being incompatible with religious norms. “We will never let a machine tell our children what is right without a teacher’s approval.” Ustadz, *Madrasah C*. Stakeholders responded by suggesting local review groups and tiered content regulation.

Subtheme 4.3: Infrastructure and equity barriers. Rural *madrasahs* faced unreliable connectivity and limited devices. Building an adaptive system that relies heavily on the cloud and cannot work offline is, in a way, not practical. Administrators emphasized incremental deployment: “Before giving all of your students accounts, start with teacher dashboards and offline lessons.” (Administrator, *Madrasah D*).

Subtheme 4.4: Data privacy and governance. Concerns about student data misuse were prominent. Participants suggested methods for parental consent, encrypted analytics, and decentralized data governance as tools for policymakers

Integration model and design principles. Combining these themes yielded an emergent integration model with six actionable design principles: (1) Integrate mechanisms for content and theological assessment to safeguard intellectual consistency; (2) Person intervention to warrant teachers’ oversight and override; (3) Focus on reflective topics and portfolios to facilitate self-reflection; (4) Personalized assessment to integrate formative AI metrics and performance tasks; (5) Document data use and algorithm policies to guarantee transparent governance; (6) infrastructure flexibility by offering tiered deployment and offline modes.



The emergent paradigm is like social and technological design literature. Distributed cognitive theories maintain teachers' interpretive authority while adaptive AI serves as a distributed scaffold. By incorporating performance tasks and longitudinal data, the model also reflects the guidelines of foreign agencies for competency assessments.

Conclusion

With a focus on cultural responsiveness, epistemological alignment, and governance, this study discovered that adaptive AI can significantly contribute to modernizing conventional *Islamic curricula* by incorporating 21st-century competencies. All parties involved acknowledged that AI's customization, metacognitive scaffolding, and collaborative frameworks facilitate learning in the areas of socio-emotional intelligence, communication, and critical thinking. Adoption, however, is dependent on resolving fundamental conflicts, such as maintaining the autonomy of professors and students-rethinking evaluations to capture skills beyond rote memorization, guaranteeing algorithmic openness, and eliminating infrastructure disparities. By providing empirically supported design principles, these findings expand the literature at the border of *Islamic* education and edtech. By going beyond generalized demands for modernization, this study confirms previous criticisms of the *Islamic* curriculum as being too focused on facts and figures (e.g., studies that emphasize exam-driven instruction)¹⁵. It also adds variation to that criticism by showing that *Islamic* educators are not against competencies in. Their opposition arises from a desire to maintain their interpretive authority and protect students' moral development¹⁶. Although this study verifies the benefits of personalization and scaffolding in learning, it also draws attention to domain-specific restrictions in religious settings. Apparently, these personalizations have received little attention in the literature on artificial intelligence in education, which aligns with adaptive learning research.

The study introduces a sociotechnical integration model that emphasizes epistemological integration as the main regulating factor. While many models of educational technology focus on how easy it is to use and how well it helps students learn, this one prioritizes cultural and theological fit as necessary conditions for validity¹⁷. This adds to theories about how people use technology by demonstrating that legitimacy in faith-based settings depends on collaborating with religious leaders to create something. It also involves incorporating theological review into the process of deciding what to include and how the algorithm functions. As a design criterion, this study is unique because it talks about epistemic alignment as well as cultural awareness. Many adaptive AI projects focus on algorithmic accuracy and engagement measures¹⁸. However, the people who took part in this project wanted algorithms to be understandable in a way that fits with religious standards. This creates new problems for technology and government: how to show normative thinking in recommender systems without turning moral thought into measurable proxies?

First, the sample is focused on Malaysia and Cambodia; therefore, the findings may not apply to other Muslim countries with diverse legal, cultural, and educational frameworks. Second, because this research is qualitative and exploratory, it did not test an adaptive AI implementation at scale, so claims about learning outcomes are just speculation. Third, potential social desirability bias may have influenced participant responses during co-design workshops. Consequently, the presence of researchers and technologists may have led to more positive sentiments. Adaptive AI has the potential to serve as a bridge between traditional and modern competency expectations. However, its effectiveness depends on socially negotiated design, transparency, and capacity building rather

¹⁵ Zainuddin, Abdul Malik Karim Amrullah and Indah Aminatuz Zuhriyah, 'The Challenges of Developing Islamic Education Curriculum and Strategies for Its Development in Facing Future Competency Demands', *Tafkir: Interdisciplinary Journal of Islamic Education*, 6.1 (2025), 111–26 <<https://doi.org/10.31538/tijie.v6i1.1316>>.

¹⁶ Zahraini Zahraini and others, 'Islamic Education Reform in the Digital Age: Challenges and Opportunities for a Modern Curriculum', *Journal of Noesantara Islamic Studies*, 2.1 (2025), 1–11 <<https://doi.org/10.70177/jnis.v2i1.1841>>.

¹⁷ Baharuddin Baharuddin, Ellychia Isnaini and Lusiana Lusiana, 'Islamic Education Curriculum That Is Relevant to the Challenges of the Times', *East Asian Journal of Multidisciplinary Research*, 3.3 (2024), 1045–60 <<https://doi.org/10.55927/eajmr.v3i3.8103>>.

¹⁸ Timothée Schumde and others, 'On the Impact of Explanations on Understanding of Algorithmic Decision-Making', in *2023 ACM Conference on Fairness Accountability and Transparency* (New York, NY, USA: ACM, 2023), pp. 959–70 <<https://doi.org/10.1145/3593013.3594054>>.



than on pure technological capabilities. If stakeholders view AI as a tool to enhance teacher skills, foster introspection, and collect longitudinal evidence of competencies, rather than as a replacement for moral education, integration can promote truly holistic student growth. The task ahead involves practical and political challenges, particularly in creating, administering, and funding systems that respect religious beliefs while educating students for an unpredictable century.

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