PROCEEDINGS
Kalijaga International Conference on Education 2026
Faculty of Tarbiyah and Teacher Training, UIN Sunan Kalijaga
*Innovation Toward Education: Shaping the Future of Learning*
15 September 2026 | Convention Hall, UIN Sunan Kalijaga, Yogyakarta

CONFERENCE PAPER • KICE 2026 • YOGYAKARTA, INDONESIA

# Islamic Religiosity and AI Literacy in Shaping Responsible Artificial Intelligence Use: The Mediating Role of Ethical AI Awareness among Pre-Service Teachers

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Proceedings of the Kalijaga International Conference on Education 2026

**Abstract.** The expanding use of generative artificial intelligence in higher education has created ethical challenges related to plagiarism, academic dependency, misinformation, algorithmic bias, and declining critical thinking among students. These concerns are particularly critical for pre-service teachers because they are expected to become future educators and ethical role models in increasingly technology-driven classrooms. In many universities, students frequently use AI tools to complete assignments, generate essays, summarise readings, and produce classroom materials without fully understanding ethical boundaries. Although prior studies on artificial intelligence in education have primarily emphasised technology adoption, learning effectiveness, and digital competency, limited attention has been given to the role of religious values and ethical awareness in shaping responsible artificial intelligence behaviour. This gap remains significant in Islamic higher education institutions where moral education constitutes an essential component of academic development. Grounded in Social Cognitive Theory, Islamic Ethical Framework, and Responsible Innovation Theory, this study examines the influence of Islamic religiosity and AI literacy on responsible artificial intelligence use through the mediating role of ethical AI awareness. A cross-national quantitative design was employed involving 387 pre-service teachers from teacher education institutions in Indonesia and Malaysia. Data were collected through structured questionnaires and analysed using Structural Equation Modeling-Partial Least Squares (SEM-PLS). The findings indicate that Islamic religiosity and AI literacy significantly improve ethical AI awareness, which subsequently promotes responsible artificial intelligence use. Ethical AI awareness partially mediates both relationships. This study proposes a novel framework integrating moral values, technological competence, and ethical awareness while offering practical implications for ethical AI governance and curriculum development in teacher education institutions.

**Keywords:** *Islamic Religiosity; AI Literacy; Ethical AI Awareness; Responsible AI Use; Pre-Service Teachers*

## INTRODUCTION

The adoption of generative artificial intelligence in higher education is advancing far more rapidly than the readiness of its ethical frameworks, as confirmed by a systematic review of forty-one studies concluding that GenAI carries significant risks to academic dishonesty while cross-national quantitative research remains very limited [1]. A recent book on AI, academic integrity, and the internationalisation of higher education likewise confirms that institutions worldwide are still groping for adequate ethical guidelines to keep pace with the speed of technology adoption [2]. A bibliometric analysis of AI research in Islamic education for the period 2018 to 2025 found that international collaboration networks in this field remain very limited, indicating that Muslim academic voices have not yet been well represented in the global discourse on the ethics of artificial intelligence.

This issue becomes more complex once narrowed to the domain of Islamic higher education. A comparative study of AI integration in Islamic higher education in Indonesia and Thailand found that institutional responses vary considerably, shaped by infrastructure and policy readiness, although that study remained qualitative and descriptive without statistically testing the relationships between variables [3]. Other research on Islamic higher education institutions in Indonesia identifies key challenges in human-resource readiness and ethical guidelines, alongside as-yet underexploited opportunities for personalised Islamic learning [4]. An AI-based pedagogical model for strengthening Qur'anic interpretation literacy has also been developed and shown to be effective among Islamic religious education students, indicating that the integration of AI with Islamic studies has indeed begun, although it has not yet addressed the ethical dimension of AI use in a measurable way [5].

Two intertwined forces appear to shape the direction of responsible AI use within this population: the Islamic values held by students and the AI literacy they possess technically. A quasi-experimental study on the use of AI tools for Qur'anic literacy found a significant positive effect on the Islamic learning outcomes of Indonesian Islamic higher education students, although that study did not address the ethical dimension

or religiosity as a structural antecedent [6]. An AI ethics framework grounded in Maqasid al-Shariah, which draws on five foundational Shariah values, has been shown to protect the principles of dīn, nafs, ʿaql, nasl, and māl in technology development [7], while the principle of amanah from Al-Ghazali's thought has been shown to balance spiritual values with AI governance at the organisational level [8]. Social Cognitive Theory, the Islamic Ethical Framework, and Responsible Innovation Theory together explain how religiosity and AI literacy shape ethical awareness, which ultimately determines responsible AI use among pre-service teachers. Research on AI ethics grounded in Maqasid al-Shariah has also selectively integrated international standards such as the UNESCO AI Ethics guidelines and the NIST AI Risk Management Framework, showing that Islamic values and global standards can genuinely be reconciled rather than opposed [9].

Three major gaps are evident from this body of work. Empirically, research on AI in Islamic education remains very scarce, as shown by a bibliometric analysis that identified only twenty-nine Scopus-indexed articles between 2018 and 2025, and the Indonesia-Thailand comparative study has not yet included Malaysia as an additional point of comparison [3]. Methodologically, research on AI ethics grounded in Maqasid al-Shariah remains qualitative and comparative without quantitative operationalisation [7], and research on the challenges of AI adoption in Indonesian Islamic education remains exploratory, with samples limited to a handful of institutions [4]. Conceptually, the principles of amanah and Maqasid al-Shariah have never been tested alongside AI literacy as twin antecedents of the same ethical awareness, and responsible AI use as a structural outcome has never been tested among a cross-national population of Islamic higher education pre-service teachers. A conceptual framework on the erosion of tacit knowledge due to artificial intelligence also notes that AI is effective for explicit knowledge but cannot replace the role of tacit knowledge in shaping akhlak (moral character) and hikmah (wisdom), a conceptual reminder that technical literacy alone is insufficient without a solid value foundation.

This study builds on Habib's [7] conceptual argument regarding an AI ethics framework grounded in Maqasid al-Shariah by operationalising it quantitatively through SEM-PLS, while also extending Syukur et al.'s [3] comparative design from a two-country qualitative study to a cross-national Indonesia-Malaysia quantitative study. The aim of this study is to analyse the effect of Islamic religiosity and AI literacy on responsible artificial intelligence use through ethical AI awareness as a mediator, among pre-service teachers at Islamic higher education institutions in Indonesia and Malaysia. The novelty of this study lies in the first quantitative operationalisation of an AI ethics framework grounded in Islamic values, previously discussed only conceptually, as well as in including religiosity and technical literacy as two antecedents operating jointly towards ethical awareness. Its theoretical contribution bridges the Islamic Ethical Framework with Responsible Innovation Theory within a single measurable empirical model, while its practical contribution provides a foundation for Islamic higher education institutions to design AI literacy curricula rooted in Islamic values to encourage more responsible technology use, while also strengthening the position of Muslim scholarship within the global discourse on ethical AI governance.

## Theoretical Background and Hypothesis Development

### *Theoretical Foundation*

Social Cognitive Theory explains that individual behaviour is formed through reciprocal interaction between personal factors, environment, and behaviour itself, including how a person's beliefs and values shape their awareness of, and actions towards, new technology.

The Islamic Ethical Framework, grounded in the principle of amanah from Al-Ghazali's thought and the five foundational values of Maqasid al-Shariah, namely dīn, nafs, ʿaql, nasl, and māl [7], [8], emphasises that every individual action, including the use of technology, must be accounted for as an amanah (trust) that protects the welfare of oneself and others.

Responsible Innovation Theory views technological innovation as a process that must consider ethical, social, and environmental impacts from the design stage through to implementation, rather than being evaluated only after the technology has already come into widespread use [10]. The three theories complement one another: Social Cognitive Theory explains the process by which awareness is formed, the Islamic Ethical Framework provides the value standard that awareness draws upon, and Responsible Innovation Theory directs that awareness towards responsible technology-use behaviour.

Related Islamic workplace research links spiritual well-being and spiritual leadership with lower job stress and reduced deviant behavior [11], [12], [13]. Adjacent organizational and community studies by Zuhaena and colleagues examine digital leadership, work environment, community empowerment, and digital work stress in contemporary work settings [14], [15], [16], [17].

### *Hypothesis Development*

Students with strong Islamic beliefs, worship practices, and moral character tend to be more sensitive to the ethical dimensions of technology use, because these values form the moral framework they bring to every technology-use decision. The Islamic Ethical Framework affirms that amanah is the principle that guides individuals to account for their every action, including AI use [8]. An AI ethics framework grounded in Maqasid al-Shariah shows that the five foundational Shariah values can protect individuals from technology misuse [7]. Research on moral development, religiosity, and AI self-efficacy among students in Ghana and Namibia confirms a significant structural relationship between religiosity and ethical engagement in AI use. Based on the foregoing, the hypothesis proposed is:

H1: Islamic religiosity has a significant positive effect on ethical AI awareness.

Students' ability to understand how artificial intelligence tools work, their limitations, and their risks also determines how critically they assess the ethical implications of everyday AI use. An AI literacy framework encompassing both cognitive and affective dimensions has been shown to contribute significantly to the acceptance of, and intention to adopt, responsible AI. Research on awareness, literacy, and social influence shows that AI literacy is the strongest predictor of AI ethics compared with other social factors. A systematic review of AI ethics education at the primary and secondary levels also confirms that ethical awareness, as an affective construct, depends heavily on an individual's level of literacy regarding the technology concerned. Accordingly, the following hypothesis can be formulated:

H2: AI literacy has a significant positive effect on ethical AI awareness.

Students who already possess mature ethical awareness of artificial intelligence tend to be more careful and responsible when they actually use the technology in their academic activities. Responsible Innovation Theory affirms that ethical awareness formed at an early stage is a prerequisite for responsible technology use [10]. Research on the pathway towards responsible AI adoption shows that the affective and cognitive dimensions of AI literacy contribute to responsible adoption intention through ethical awareness as the key connecting link. An AI ethics framework grounded in Maqasid al-Shariah also confirms that awareness of foundational Shariah values guides individuals towards more carefully safeguarded technology use [7]. This argument leads to the following hypothesis:

H3: Ethical AI awareness has a significant positive effect on responsible artificial intelligence use.

Islamic religiosity and AI literacy do not automatically produce responsible AI use without passing through a process of ethical awareness that bridges both with actual conduct. Ethical AI awareness, shaped jointly by religious values and technical literacy ability [10], [18], may serve as the explanatory pathway for why similar levels of religiosity and literacy can produce different AI-use behaviour between individuals. Bibliometric research on AI in Islamic education confirms that studies integrating religious values with the cognitive-technical process of AI use remain very rare, indicating a gap that this dual mediation test is well positioned to fill. The bootstrapping procedure for testing the significance of indirect effects has become an established methodological standard in SEM-PLS [19]. The above explanation supports the formulation of the following two mediation hypotheses:

H4a: Ethical AI awareness mediates the effect of Islamic religiosity on responsible artificial intelligence use.

H4b: Ethical AI awareness mediates the effect of AI literacy on responsible artificial intelligence use.

## METHODS

This study employs a quantitative approach with a cross-national explanatory survey design involving pre-service teachers in Indonesia and Malaysia, aiming to test the causal relationships among variables through Structural Equation Modeling-Partial Least Squares. This approach was chosen because the research model operationalises an Islamic ethics framework previously discussed only qualitatively into measurable constructs, a predictive-exploratory step better suited to testing through a variance-based approach than Covariance-Based SEM.

The study population comprises pre-service teachers at Islamic higher education institutions who use artificial intelligence tools in their academic activities. The sample comprised 387 students determined through purposive sampling, with the criteria being active enrolment in a teacher-education study programme, prior use of generative AI for coursework, and voluntary willingness to participate. This number exceeds the minimum SEM-PLS requirement and provides adequate scope for multigroup analysis between the Indonesian and Malaysian samples to test the model's cross-national stability. Sampling was carried out across several Islamic higher education institutions in both countries to preserve diversity in respondents' study programme background, year of study, and institutional affiliation.

All variables were measured using a five-point Likert scale, ranging from strongly disagree to strongly agree, with unfavourable items reverse-coded prior to analysis. Table 1 summarises the operationalisation of the study variables together with their sources of adaptation.

The instrument, originally developed in Indonesian, was translated into Malay through a back-translation procedure carried out by two independent translators to preserve equivalence of meaning across countries, before being piloted at each data-collection site. The readability test in the pilot study involved thirty respondents in each country to ensure that the religious and technical AI terminology used could be consistently understood by pre-service teachers from a range of study-programme backgrounds. Data were collected through an online questionnaire distributed to pre-service teachers in both countries, preceded by expert judgement from academics in Islamic education and technology ethics. Data analysis was carried out using SmartPLS through two sequential stages of evaluation. Outer-model evaluation comprised tests of convergent validity via outer loadings above 0.70 and Average Variance Extracted above 0.50, reliability testing via Composite Reliability and Cronbach's Alpha above 0.70, and discriminant-validity testing via the Heterotrait-Monotrait Ratio below 0.90. Inner-model evaluation comprised the coefficient of determination, effect size, predictive relevance via the blindfolding procedure, and path-significance testing via a bootstrapping procedure with 5,000 subsamples to obtain the t-statistic and p-value for each proposed structural hypothesis. Testing of the H4a and H4b mediation hypotheses was carried out via bootstrapping of specific indirect effects following the procedure of Zhao, Lynch, and Chen [19], with the classification of full mediation, partial mediation, or no mediation determined based on the joint significance of the direct and indirect effects. A Multi-Group Analysis was then carried out to test whether the strength of the structural paths differed significantly between the Indonesian and Malaysian samples, given that this study was designed as cross-national from the problem-formulation stage onwards. Common method bias was assessed via Harman's single-factor test, while research ethics approval was obtained from the researchers' home institutional ethics committee, with every respondent receiving an informed consent form explaining the purpose of the study, data confidentiality, and the right to withdraw at any time without consequence. Incomplete data or data showing a uniform response pattern were excluded from the analysis prior to model estimation, so that only quality data were used in this study's structural path and mediation testing.

**Table 1. Measurement of Research Variables**

| Variable | Dimension/Indicator | Number of Items | Source/Adaptation |
|---|---|---|---|
| Islamic Religiosity | Dimensions of akidah (faith), ibadah (worship), and akhlak (moral character) in technology use | 6 | Adapted from studies on Islamic religiosity and technology [20], [10] |
| AI Literacy | Understanding of how AI works, critical evaluation of AI output, practical usage skills | 6 | Sperling et al. [21]; Celik [22] |
| Ethical AI Awareness | Awareness of bias risk, transparency, and responsibility in AI use | 6 | Hayat [10]; Khreisat et al. [18] |
| Responsible AI Use | Transparent AI use, source attribution, compliance with ethical and Shariah principles | 6 | Items developed by the researchers; adapted from Responsible Innovation Theory [10] |

## RESULTS AND DISCUSSION

### Results

This study involved 387 pre-service teachers from Islamic higher education institutions in Indonesia and Malaysia who met the purposive sampling criteria. The demographic characteristics and academic background of the respondents are summarised in Table 2.

**Table 2. Respondent Characteristics**

| Characteristic | Category | n | % |
|---|---|---|---|
| Country | Indonesia | 232 | 59,9% |
| | Malaysia | 155 | 40,1% |
| Gender | Female | 223 | 57,6% |
| | Male | 164 | 42,4% |
| Age | Mean = 22.55 years; SD = 2.06; range 19–28 | | |
| Semester | Semester 3–4 | 138 | 35,7% |
| | Semester 5–6 | 132 | 34,1% |
| | Semester 7–8 | 117 | 30,2% |
| Study Programme | Islamic Religious Education | 108 | 27,9% |
| | Civic Education (PPKn) | 72 | 18,6% |
| | Economics Education | 62 | 16,0% |

| Characteristic | Category | n | % |
|---|---|---|---|
| | English Language Education | 51 | 13,2% |
| | Mathematics Education | 51 | 13,2% |
| | Indonesian Language Education | 43 | 11,1% |
| Experience using generative AI for teaching preparation | Yes | 336 | 86,8% |
| | No | 51 | 13,2% |

Table 2 shows that the sample was composed predominantly of Indonesian students (59.9%) compared with Malaysian students (40.1%), with a slightly higher proportion of female students (57.6%) than male students (42.4%). The average respondent age was 22.55 years (SD = 2.06), with an age range of 19 to 28 years, and a relatively even distribution across semesters three to eight. Respondents were drawn from six teacher-education study programmes, with the largest proportion from Islamic Religious Education (27.9%). The majority of respondents (86.8%) had used generative AI for teaching preparation, confirming the relevance of the study population to this study's central focus on the responsible use of generative AI among pre-service teachers.

### *Measurement Model Evaluation (Outer Model)*

A total of 387 questionnaires collected from pre-service teachers at teacher-education institutions in Indonesia and Malaysia were processed using the PLS-SEM algorithm via SmartPLS software to test the fit of the measurement model prior to estimating the structural relationships. Evaluation of the measurement model proceeded through three main stages: examination of the outer loading for each indicator, convergent-validity testing via Average Variance Extracted (AVE), and discriminant-validity testing via the Fornell-Larcker criterion, following standard PLS-SEM procedures for reflective models [23]. The outer loading values for all four constructs are presented in Table 3.

**Table 3. Outer Loading of the Measurement Model**

| Construct | Indicator | Outer Loading |
|---|---|---|
| Islamic Religiosity | IR1 | 0,780 |
| Islamic Religiosity | IR2 | 0,743 |
| Islamic Religiosity | IR3 | 0,775 |
| Islamic Religiosity | IR4 | 0,655 |
| Islamic Religiosity | IR5 | 0,754 |
| Islamic Religiosity | IR6 | 0,761 |
| AI Literacy | AL1 | 0,741 |
| AI Literacy | AL2 | 0,793 |
| AI Literacy | AL3 | 0,711 |
| AI Literacy | AL4 | 0,766 |
| AI Literacy | AL5 | 0,739 |
| AI Literacy | AL6 | 0,777 |
| Ethical AI Awareness | EAA1 | 0,783 |
| Ethical AI Awareness | EAA2 | 0,737 |
| Ethical AI Awareness | EAA3 | 0,823 |
| Ethical AI Awareness | EAA4 | 0,732 |
| Ethical AI Awareness | EAA5 | 0,803 |
| Ethical AI Awareness | EAA6 | 0,753 |
| Responsible AI Use | RAU1 | 0,807 |
| Responsible AI Use | RAU2 | 0,766 |
| Responsible AI Use | RAU3 | 0,822 |
| Responsible AI Use | RAU4 | 0,780 |
| Responsible AI Use | RAU5 | 0,796 |
| Responsible AI Use | RAU6 | 0,794 |

Table 3 shows that all outer loading values range from 0.655 to 0.823. One indicator, IR4 on the Islamic religiosity construct, falls slightly below the ideal threshold of 0.70, but was nonetheless retained because the overall Average Variance Extracted (AVE) for the Islamic religiosity construct remains above 0.50, meaning that removing this indicator was not necessary to achieve convergent validity [23]. The remaining twenty-three indicators are all above 0.70, confirming adequate convergent validity at the individual level.

Convergent and discriminant validity were then tested via the Fornell-Larcker criterion, which compares the square root of each construct's AVE, itself also a reflection of the construct's convergent-validity strength, with that construct's correlations with other constructs [24]. The results are presented in Table 4.

**Table 4. Discriminant Validity and Average Variance Extracted (Fornell-Larcker Criterion)**

| Construct | AI Literacy | Ethical AI Awareness | Islamic Religiosity | Responsible AI Use |
|---|---|---|---|---|
| AI Literacy | 0,755 | | | |
| Ethical AI Awareness | 0,510 | 0,773 | | |
| Islamic Religiosity | 0,180 | 0,489 | 0,746 | |

| Construct | AI Literacy | Ethical AI Awareness | Islamic Religiosity | Responsible AI Use |
|---|---|---|---|---|
| Responsible AI Use | 0,472 | 0,638 | 0,464 | 0,794 |

Table 4 shows the square roots of the AVE on the main diagonal: 0.755 for AI literacy, 0.773 for ethical AI awareness, 0.746 for Islamic religiosity, and 0.794 for responsible AI use, corresponding to AVE values of 0.570, 0.597, 0.556, and 0.630 respectively, all above the minimum threshold of 0.50 [23]. These square-root AVE values are consistently greater than the correlations of the corresponding construct with other constructs in the model, so the discriminant validity of all four constructs is satisfied [24].

### *Structural Model Evaluation (Inner Model) and Hypothesis Testing*

The structural model was evaluated through the coefficient of determination (R Square), the significance of path coefficients via a bootstrapping procedure with 5,000 subsamples, and the model's predictive relevance, following standard PLS-SEM inner-model evaluation procedures [23], [25]. The R Square values for the two endogenous variables are presented in Table 5.

**Table 5. R Square and R Square Adjusted Values**

| Endogenous Variable | R Square | R Square Adjusted |
|---|---|---|
| Ethical AI Awareness | 0,424 | 0,421 |
| Responsible AI Use | 0,472 | 0,468 |

Table 5 shows that Islamic religiosity and AI literacy jointly explain 42.4 per cent of the variance in ethical AI awareness, while Islamic religiosity, AI literacy, and ethical AI awareness jointly explain 47.2 per cent of the variance in responsible AI use. Based on Chin's [25] criteria, the R Square values for both endogenous variables are classified as moderate. Hypothesis testing of the direct relationships between constructs was carried out via a bootstrapping procedure with 5,000 subsamples, using a significance criterion of t-statistics above 1.96 and a p-value below 0.05 [23]. The path-coefficient testing results are presented in Table 6.

**Table 6. Hypothesis Testing Results (Path Coefficients)**

| Hypothesis | Structural Path | Coefficient (O) | T Statistics | P Values | Remarks |
|---|---|---|---|---|---|
| H1 | Islamic religiosity -> Ethical AI awareness | 0,410 | 11,378 | 0,000 | Supported |
| H2 | AI literacy -> Ethical AI awareness | 0,437 | 11,919 | 0,000 | Supported |
| H3 | Ethical AI awareness -> Responsible AI use | 0,418 | 8,435 | 0,000 | Supported |

Table 6 shows that all structural paths tested have t-statistic values above 1.96 with a p-value of 0.000, so all direct relationships are declared significant at the 95 per cent confidence level. Islamic religiosity has a positive effect on ethical AI awareness (H1) and AI literacy has a positive effect on ethical AI awareness (H2). Ethical AI awareness in turn has a positive effect on responsible AI use (H3). Two further direct paths, from Islamic religiosity to responsible AI use and from AI literacy to responsible AI use, also show positive and significant coefficients, providing the basis for testing the mediating role in H4.

Testing of the mediating role of ethical AI awareness in the relationship between Islamic religiosity, AI literacy, and responsible AI use was carried out via a specific indirect effects procedure with bootstrapping of 5,000 subsamples [23]. The results of the mediation testing are presented in Table 7.

**Table 7. Mediation Testing Results (Specific Indirect Effects)**

| Hypothesis | Mediation Path | Coefficient (O) | T Statistics | P Values | Remarks |
|---|---|---|---|---|---|
| H4a | Islamic religiosity -> Ethical AI awareness -> Responsible AI use | 0,172 | 6,827 | 0,000 | Supported |
| H4b | AI literacy -> Ethical AI awareness -> Responsible AI use | 0,183 | 6,741 | 0,000 | Supported |

Table 7 shows that both mediation paths for ethical AI awareness, from Islamic religiosity as well as from AI literacy towards responsible AI use, have t-statistic values above 1.96 with a p-value of 0.000, so the mediating effect of H4 is declared significant for both paths. Given that the direct effects of Islamic religiosity and AI literacy on responsible AI use in Table 6 are also significant, the type of mediation observed on both paths is classified as partial mediation.

The model's predictive relevance was then tested via the PLSpredict and blindfolding procedures [26], [23]. Table 8 presents the PLSpredict-based $Q^2$predict values for the endogenous variables, as well as the blindfolding-based $Q^2$ values for all constructs (cross-validated communality).

**Table 8. Model Predictive Relevance ($Q^2$predict and $Q^2$)**

| Construct | RMSE | MAE | $Q^2$predict | $Q^2$ (Blindfolding) |
|---|---|---|---|---|
| Ethical AI Awareness | 0,770 | 0,641 | 0,412 | 0,434 |
| Responsible AI Use | 0,803 | 0,649 | 0,362 | 0,480 |
| AI Literacy | - | - | - | 0,396 |
| Islamic Religiosity | - | - | - | 0,378 |

Table 8 shows that all $Q^2$predict and $Q^2$ values for the constructs are positive, with the highest value for responsible AI use for $Q^2$blindfolding and for ethical AI awareness for $Q^2$predict. The positive $Q^2$ values for all constructs indicate that the model has predictive relevance for data outside the estimation sample [23], [26].

## Discussion

### *Islamic Religiosity and Ethical AI Awareness*

The first finding of this study confirms that Islamic religiosity plays an important role in fostering ethical AI awareness among pre-service teachers, consistent with the first hypothesis proposed. This finding confirms that strong religious conviction is not a barrier to ethical readiness for new technology, but rather a source of moral sensitivity that drives pre-service teachers to consider ethical and spiritual implications before making use of generative AI in their teaching practice. This pattern challenges the assumption that associates religiosity with excessive caution that hinders digital transformation and instead positions Islamic values as a productive foundation for ethical readiness.

This result reinforces Harun et al.'s [20] argument that maqashid syariah values provide a transcendent moral lens that shapes pre-service teachers' ethical sensitivity to the consequences of technology use and is consistent with Hayat's [10] assertion that an Islamic ethical perspective on artificial intelligence demands full awareness of the principles of justice, transparency, and the protection of human dignity. This finding also supports the conclusion of Achruh, Rapi, Rusdi, and Idris [4] that Islamic values serve as an important reference point for educators navigating the ethical challenges of AI integration in Islamic education institutions, while extending Alwaqdani's [27] argument regarding Islamic educators' need for a specific ethical awareness that combines pedagogical and spiritual considerations.

The strength of the effect observed indicates that Islamic religiosity functions not merely as a normative identity, but as an active cognitive-moral resource that shapes how pre-service teachers assess the ethical propriety of a technological action. This pattern is relevant to addressing the mixed findings of prior research on religiosity and AI adoption, showing that religiosity is in fact positively associated with ethical readiness when measured specifically in the context of generative AI use, rather than in general technology acceptance.

### *AI Literacy and Ethical AI Awareness*

AI literacy is shown to have a positive effect on ethical AI awareness, confirming this study's second hypothesis and confirming that technical competence alone does not operate separately from ethical readiness. Pre-service teachers who adequately understand how generative AI works, its limitations, and its potential risks are in fact more sensitive to recognising the ethical dimensions of that technology's use, rather than becoming less cautious as a result of feeling technically proficient.

This result is consistent with Celik's [22] finding that professional knowledge of the ethical integration of AI, conceptualised as Intelligent-TPACK, contributes significantly to educators' ethical readiness, and reinforces Sperling et al.'s [21] argument that educators' AI literacy needs to be built not only from a technical standpoint but also through users' ethical awareness. This finding also supports Wazir, Iqbal, and Shafia's [28] assertion that digital literacy in the AI era needs to combine technical competence with an understanding of its ethical implications for future learners and reinforces Khreisat et al.'s [18] warning that weak AI ethics literacy contributes to morally problematic educational decisions.

The slightly stronger effect of AI literacy compared with Islamic religiosity on ethical AI awareness suggests that technical understanding remains an important cognitive prerequisite before moral sensitivity can be translated into applicable ethical awareness. Pre-service teachers require sufficient knowledge of how generative AI works so that the ethical values they hold can be applied in a well-targeted manner, rather than amounting to mere normative caution without adequate technical understanding.

### *Ethical AI Awareness and Responsible AI Use*

Ethical AI awareness is shown to have a positive effect on responsible AI use, confirming this study's third hypothesis and confirming that ethical awareness is a direct prerequisite before responsible AI-use

behaviour can actually materialise. Pre-service teachers with adequate awareness of bias risk, the need for transparency, and responsibility in AI use tend to apply these ethical principles more consistently in practice, from source attribution through to compliance with ethical and Shariah boundaries.

This result reinforces Sperling et al.'s [21] finding that educators' ethical readiness is a strong predictor of the wise application of AI in teaching practice, and confirms Celik's [22] argument that the ethical integration of AI technology in teaching requires ongoing reflective awareness, rather than mere compliance with formal rules. This finding is also consistent with the conclusion of recent work on digital literacy and AI ethics [28] that critical AI literacy, rather than normative rules alone, is the primary determinant of responsible technology use.

This consistently positive effect suggests that responsible AI use in pre-service teacher education cannot be shaped by institutional policy or formal prohibition alone, but requires the strengthening of reflective ethical awareness at the individual level, one capable of persisting across a range of learning situations, including where institutions have not yet issued explicit guidance on generative AI use.

***The Mediating Role of Ethical AI Awareness***

Ethical AI awareness is shown to significantly mediate the effect of both Islamic religiosity and AI literacy on responsible AI use, confirming this study's fourth (H4a) and fifth (H4b) hypotheses. The type of mediation observed on both paths is classified as partial, because Islamic religiosity and AI literacy continue to show a significant direct effect on responsible AI use even once the path through ethical AI awareness is taken into account. This dual pattern illustrates that religious values and technical competence each have a direct pathway towards responsible behaviour, alongside an indirect pathway that is reinforced through the process of reflective ethical awareness.

This dual mediation finding addresses the conceptual gap raised in the Introduction, namely the scarcity of research positioning ethical AI awareness as a mediator rather than merely as an outcome variable [10]. This result reinforces Harun et al.'s [20] argument that maqashid syariah values operate through a process of ethical awareness before manifesting in Shariah-compliant technology behaviour, and supports Hayat's [10] assertion regarding the importance of intermediate cognitive-ethical mechanisms in explaining the relationship between moral principles and responsible technology implementation.

The existence of partial mediation on both paths carries strategic implications for the design of pre-service teacher education programmes. Institutions cannot rely on a single pathway alone, whether strengthening religious values or improving technical literacy, without also incorporating the strengthening of reflective ethical awareness as the connecting bridge. Programmes that target only one antecedent risk losing much of their impact on genuinely responsible AI-use behaviour, given that both pathways, direct and via ethical AI awareness, have each been shown to contribute.

***Theoretical Implications***

This set of findings makes a meaningful contribution to the three theoretical perspectives underlying this study. Social Cognitive Theory [29] is enriched through empirical evidence that personal factors in the form of religious belief and technical knowledge both contribute to forming reflective awareness before it manifests as actual behaviour, confirming the relevance of the principle of reciprocal interaction between personal factors, environment, and behaviour within the domain of religiously grounded technology adoption, a combination previously rarely tested simultaneously.

The Islamic Ethical Framework, through the principle of maqashid syariah [20], is further enriched by evidence that this framework can be operationalised empirically, rather than being discussed only in normative-descriptive terms as is common in the prior literature. Repositioning ethical AI awareness as a mediator provides a concrete bridge between abstract Islamic values and measurable technology-use behaviour, making the maqashid syariah framework easier to integrate into future quantitative research designs in technology education.

Responsible Innovation Theory [10] also receives empirical support through the pattern of relationships observed, in which mature ethical awareness is shown to be a prerequisite for technology use that takes into account anticipation of impact, reflexivity, inclusiveness, and responsiveness to social values. The integration of all three perspectives within a single estimated model, which constitutes this study's novelty, is shown to explain the religious-cognitive mechanism bridging Islamic values and technical literacy with responsible AI-use behaviour more comprehensively than the partial models found in prior research, while also confirming that religiosity deserves to be positioned as an antecedent that strengthens, rather than hinders, ethical readiness for educational technology.

***Practical and Managerial Implications***

This study's findings offer several concrete foundations for Islamic teacher-education institutions, curriculum administrators, and higher-education policymakers. Teacher-education institutions need to design AI-literacy strengthening programmes that explicitly combine technical competence with maqashid syariah values, rather than separating the two into standalone courses. Such a module should ideally include real case scenarios on potential bias, transparency issues, and source attribution in generative AI use, combined with reflective discussion grounded in Islamic values.

Given that Islamic religiosity and AI literacy each have both a direct pathway and a pathway via ethical AI awareness towards responsible AI use, teacher-education institutions need to design dual interventions that target both antecedents simultaneously. Spiritual development programmes grounded in maqashid syariah can be combined with technical training in generative AI use within a single integrated curriculum, rather than treating the two as separate activities that fail to reinforce one another.

Strengthening reflective ethical awareness also needs to become an explicit focus, given its role as a significant mediator on both paths. Case-based learning methods, reflective group discussions, and simulations of ethical decision-making related to generative AI can be integrated into pre-service teachers' field-experience practice, so that ethical awareness is not only understood cognitively but also practised in situations approaching real classroom conditions.

Cross-national Indonesia-Malaysia teacher-education policy should also consider developing ethical guidelines for generative AI use that explicitly accommodate Islamic values, given that both countries share a significant Muslim population base within their teacher-education institutions. Such guidelines could serve as a shared reference point without erasing the particular context of each country, while also strengthening Islamic identity as a comparative advantage in technology education, rather than as an obstacle to be overcome.

## CONCLUSION

This study concludes that Islamic religiosity and AI literacy consistently drive responsible generative AI use among cross-national Indonesia-Malaysia pre-service teachers, both directly and through strengthening ethical AI awareness. All five hypotheses proposed are supported by the field data, comprising the positive effect of Islamic religiosity on ethical AI awareness (H1), the positive effect of AI literacy on ethical AI awareness (H2), the positive effect of ethical AI awareness on responsible AI use (H3), and the partial mediating role of ethical AI awareness on the path from Islamic religiosity (H4a) as well as from AI literacy (H4b) towards responsible AI use. This set of findings fully addresses the aims of the study, namely confirming that Islamic religiosity and technical literacy each serve as important antecedents of ethical readiness and responsible behaviour in the face of generative AI technology in pre-service teacher education.

The primary novelty of this study lies in integrating Social Cognitive Theory, the Islamic Ethical Framework, and Responsible Innovation Theory within a single estimated model tested among cross-national pre-service teachers, a combination rarely found in the prior AI ethics and Islamic education literature. Repositioning ethical AI awareness as a dual mediator, rather than merely as an outcome variable, constitutes a conceptual contribution that enriches the literature's perspective on the mechanism underlying responsible AI-use behaviour. This study's practical contribution provides a concrete reference point for Islamic teacher-education institutions in designing AI-literacy curricula grounded in maqashid syariah values, while also challenging the assumption that religiosity hinders technological readiness.

The long-term impact of these findings is expected to extend beyond the curriculum level alone, given that pre-service teachers formed with strong ethical awareness have the potential to pass on similar patterns of thinking to the generations of pupils they will eventually teach. Strengthening ethical AI awareness from the pre-service education stage onwards is therefore not merely a short-term strategy for institutional compliance, but a long-term investment in building an educational ecosystem that sustainably integrates technological progress with the integrity of religious values.

### Limitations and Directions for Future Research

This study has several limitations that should be acknowledged candidly. The cross-sectional design used does not allow for definitive causal conclusions, so the relationships between variables observed should be interpreted as structural associations rather than absolute evidence of cause and effect. Measurement of all variables via self-report questionnaire also carries the potential for social-desirability bias, particularly for indicators related to ethical compliance and religiosity. One Islamic religiosity indicator also shows relatively weaker measurement strength than the other indicators, indicating a need to refine items in future research.

Future research is advised to adopt a longitudinal design to test the dynamics of the relationships between variables over time, in particular to examine whether the ethical AI awareness formed during pre-service education persists once students enter actual teaching practice. Developing an Islamic religiosity instrument more specifically tailored to the context of technology use, rather than religiosity in general, should also become a priority agenda. Future researchers are also advised to test the moderating role of teacher-education institution type or prior level of AI-training exposure, in order to deepen understanding of the conditions that strengthen or weaken the mechanisms identified by this study.

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