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Artificial Intelligence Literacy Scale: Adapting and Validating a Contextualised Scale for Pre-Service Teachers in Northern Malaysia

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ABSTRACT - Artificial intelligence (AI) is transforming education, making AI literacy a vital competency for teachers. Defined across four dimensions of awareness, usage, evaluation, and ethics, AI literacy enables educators to integrate technology effectively while upholding ethical standards. Although robust instruments exist internationally, Malaysia lacks culturally and linguistically relevant tools for assessing pre-service teachers' AI literacy. This study adapted and validated the Artificial Intelligence Literacy Scale (AILS) developed by Wang et al. (2023) for use in northern Malaysia. Using back-to-back translation, expert review, and quantitative survey methods with 385 pre-service teachers, the scale underwent face and content validity testing followed by reliability analysis. Results confirmed strong face validity, unanimous content validity (S-CVI = 1.00), and high internal consistency (α = 0.933 overall). The validated scale provides an essential diagnostic tool for teacher education, supporting curriculum design, research, and policy development aimed at cultivating future-ready educators.

INTRODUCTION

Artificial intelligence (AI) has rapidly become a defining force in contemporary education, reshaping classroom practices and teacher responsibilities. AI literacy, which comprises awareness, practical usage, evaluation, and ethical engagement with AI technologies, is now viewed as a critical competency for educators in the digital era (Nuangchalerm et al., 2024; Meylani, 2024). For pre-service teachers, developing AI literacy is essential not only to strengthen instructional practices but also to prepare learners with skills required in future-oriented societies. AI integration promotes personalised learning, adaptive tutoring, and evidence-based instructional decision-making, which collectively foster inclusivity and innovation in classrooms (Bekdemir, 2024). Furthermore, cultivating AI literacy among teachers contributes to sustainable teacher education by embedding ethical considerations and accountability in technology use (Rütti-Joy et al., 2023).

Despite its significance, Malaysia lacks instruments that are culturally and linguistically adapted to measure AI literacy among pre-service teachers. This gap limits efforts to assess teacher readiness and to design appropriate interventions, hindering effective AI integration in teacher training programmes (Ogunsola et al., 2019). Although various instruments exist internationally, they often do not reflect the Malaysian sociocultural and educational landscape. For example, the Artificial Intelligence Literacy Scale (AILS) developed by Wang et al. (2023) offers a strong theoretical basis for measuring AI literacy but does not incorporate linguistic or contextual considerations relevant to Malaysia (Ding et al., 2024). Applying such tools directly could lead to limited validity and practical misalignment.

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The present study addresses this gap by adapting and validating the AILS for Malaysian pre-service teachers. The adaptation prioritises contextual suitability, linguistic clarity, and psychometric robustness, following established procedures for cross-cultural instrument adaptation (Ogunsola et al., 2019). By providing a validated and contextually appropriate measure, this study supports teacher training programmes in identifying areas requiring further development and enhances curriculum design for AI-focused teacher education. This work also contributes to broader educational reforms by ensuring that teacher preparation incorporates ethical and responsible approaches to AI use in classrooms.

BACKGROUND OF STUDY

Artificial Intelligence in Malaysia Context

Artificial intelligence (AI) is increasingly recognised as a transformative force in education, reshaping pedagogical practices through adaptive learning systems, intelligent tutoring, and data-driven instructional support. In Malaysia, AI integration is framed not merely as a technological enhancement but as a strategic approach to modernising teaching and learning across educational levels, including schools, teacher education institutions, and higher education settings (Ramalingam & Maniam, 2024; Noor, 2025). AI-enabled tools have been associated with improved learning efficiency, personalised instruction, and enhanced decision-making, particularly within STEM and language education contexts (Amdan et al., 2024; Krishnan & Zaini, 2025).

Despite these opportunities, empirical evidence indicates that AI adoption in Malaysian education remains uneven and constrained by factors related to readiness, skills, and perceptions. Studies show that Malaysian students' and educators' engagement with AI applications is moderate, influenced by perceived usefulness, social influence, and confidence in using AI tools meaningfully (Mustaffa, 2025; Nasidi et al., 2025). These findings suggest that access to technology alone is insufficient; effective AI integration requires structured competency development, particularly among future teachers who are expected to implement AI-supported pedagogies responsibly and effectively.

Furthermore, ethical and governance-related concerns such as data privacy, algorithmic bias, and digital inequality have been highlighted in Malaysian educational discourse. Without adequate literacy, AI use risks undermining critical thinking, fairness, and professional judgement in teaching practice (Noor, 2025; Amdan et al., 2024). These challenges reinforce the importance of developing AI-related competencies among pre-service teachers and underscore the need for valid, contextually adapted measurement instruments. Against this backdrop, Artificial Intelligence Literacy emerges as a critical construct for understanding how pre-service teachers comprehend, apply, evaluate, and ethically engage with AI in Malaysian educational contexts (Nasidi et al., 2025).

Artificial Intelligence Literacy

Artificial Intelligence Literacy (AIL) is increasingly recognised as a foundational competence in education. It refers to the capacity to understand AI concepts, interact effectively with AI technologies, critically evaluate their outcomes, and engage with them ethically (Gaete, 2022; Allen & Kendeou, 2023). AIL extends beyond technical skills to include cognitive and evaluative abilities, as well as ethical awareness, which are vital for teachers navigating AI-supported classrooms (Asrifan et al., 2024). Within teacher education, AIL prepares future teachers to make informed pedagogical choices, integrate AI in instruction, and encourage students' critical engagement with technology (Nuangchalerm et al., 2024).

Artificial Intelligence Literacy Dimension

AIL is typically conceptualised in four dimensions: awareness, usage, evaluation, and ethics (Wang et al., 2023). Awareness involves a basic understanding of AI systems, including their presence in everyday tools such as digital assistants, recommendation engines, and automated decision-making platforms (Gaete, 2022). For pre-service teachers, awareness provides an entry point to recognising AI's educational applications.

Usage refers to the ability to apply AI in practice, such as through adaptive learning systems, learning analytics, or intelligent tutoring platforms. This dimension emphasises functional competence and

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adaptability in integrating AI into teaching contexts (Meylani, 2024). Evaluation involves critical analysis of AI outputs and their educational value. Pre-service teachers need to assess the reliability of AI-generated recommendations and identify potential algorithmic bias to ensure pedagogical alignment and fairness (Allen & Kendeou, 2023).

Ethics highlights the societal and moral implications of AI. Teachers must be able to recognise issues of privacy, transparency, and equity when applying AI in classrooms (Rütti-Joy et al., 2023). Ethical awareness also supports the development of digital citizenship among students. Together, these four dimensions provide a holistic framework for preparing pre-service teachers to use AI effectively and responsibly in their professional practice.

AIL in Teacher Education

The integration of AI in education places teachers at the centre of technology-enhanced learning environments. Their roles extend from delivering instruction to managing intelligent platforms and personalised learning systems (Sperling et al., 2024). However, research shows that teachers often lack sufficient preparation to use AI meaningfully, despite being open to its adoption (Meylani, 2024). This situation underscores the need for structured AI literacy development in teacher education programmes (Rütti-Joy et al., 2023). Pre-service teachers, in particular, must be trained to balance technical competence with ethical judgement while also maintaining their critical role in shaping students' socio-emotional and moral development (Septiani & Ramadani, 2025).

Overview of Original Instrument

The Artificial Intelligence Literacy Scale (AILS) was developed by Wang et al. (2023) to measure user competence in AI literacy. Based on theoretical models of digital literacy and ethical engagement, the AILS comprises four constructs: awareness, usage, evaluation, and ethics. After rigorous validation processes including exploratory and confirmatory factor analyses, the instrument was refined to 12 items with strong reliability (Cronbach's alpha ranging from .73 to .78 for each subscale and .83 overall). The scale has demonstrated theoretical robustness and practical utility in assessing AI literacy in diverse contexts.

Rationale for Adaptation

Although the AILS provides a validated structure, its direct use in Malaysia may not adequately capture the local linguistic and cultural nuances. Prior studies emphasise that educational assessments must undergo localisation to ensure contextual appropriateness and linguistic clarity (Jizat, 2012). Moreover, adaptation ensures the preservation of validity and reliability, which are essential for the instrument's practical use in teacher education (Delcker et al., 2024; Hwang et al., 2024). This study therefore adapts the AILS through translation and validation processes, ensuring cultural equivalence and alignment with Malaysia's educational context.

METHODOLOGY

This study employed a quantitative approach using a survey-based research design to conduct the adaptation and validation of the Artificial Intelligence Literacy Scale (AILS) for pre-service teachers in Malaysia. The process involved the systematic translation, cultural adaptation, and psychometric evaluation of the original instrument to ensure its suitability for the local educational context. The validation procedure included face and content validity analysis by expert panels, followed by reliability testing through internal consistency measurement.

Participants

The participants in this study comprised 385 pre-service teachers enrolled in three teacher education institutes in Malaysia. The sample included 174 male (45.2%) and 211 female (54.8%) students. Most participants were 21 years old (63.9%), followed by those aged 22 (29.4%) and 20 (6.8%), indicating a predominantly young adult population, typical of second-year undergraduate teacher trainees. Participants were drawn from diverse areas of specialisation. The most represented fields were Mathematics (18.7%), Physical Education (16.1%), and Islamic Education (15.3%), followed by Malay

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Language and TESL (both 13.2%), Science (12.2%), and Early Childhood Education (11.2%). In terms of academic progression, the vast majority (95.1%) were in their second year of study, with only 4.9% in their first year.

Regarding digital access, most respondents reported using three devices (87.0%) during their studies, indicating a high level of technological readiness. A smaller percentage used two devices (11.4%), while only 1.6% reported relying on a single device. This digital accessibility profile aligns with the requirements for AI integration in teacher education and reflects the increasing reliance on multiple platforms and tools for learning and instructional development.

Translation of Instruments

To ensure linguistic accuracy and cultural equivalence of the Artificial Intelligence Literacy Scale (AILS) in the Malaysian context, the study employed a back-to-back translation method. Also known as back-translation, this process is widely used in cross-cultural research to maintain semantic equivalence between the source and target languages (Colina et al., 2017; Ozolins et al., 2020). The procedure involved two independent bilingual experts. In the first phase, the original English version of the AILS was translated into Malay by a professional translator with experience in educational terminology. The translated version was then independently translated back into English by a second bilingual expert who was unfamiliar with the original version.

The original and back-translated English versions were compared and examined by the research team to identify any discrepancies or semantic shifts. Necessary refinements were made to ensure that the meaning of each item was preserved and contextually appropriate for Malaysian pre-service teachers. This iterative review process supports the goal of achieving semantic equivalence, cultural relevance, and terminological consistency, which are essential for valid cross-cultural instrument use (Steinbuechel et al., 2021).

The back-to-back translation approach also functioned as a quality assurance mechanism, enabling the researchers to identify ambiguous or culturally loaded items early in the adaptation process. Its use in this study was vital for enhancing the validity and reliability of the adapted scale prior to empirical testing. As supported by previous research, back-translation remains a robust and systematic strategy to safeguard instrument integrity across languages and cultures (Ozolins et al., 2020; Colina et al., 2017).

FINDING

Face Validity Analysis

The face validity of the adapted Artificial Intelligence Literacy Scale (AILS) was evaluated by five experts in educational technology using a four-point agreement scale, ranging from 1 (very disagree) to 4 (very agree). Six criteria were assessed, including writing spacing, font size, spelling accuracy, item arrangement, formatting neatness, and language clarity. Based on Table 1, the expert agreement means for each criterion ranged from 3.33 to 4.00, with an overall mean face validity score of 3.80 out of 4.00, indicating a high level of consensus on the instrument's clarity and presentation. The lowest ratings were observed for items related to font size and formatting, which were subsequently reviewed and refined to improve the visual structure and readability of the instrument.

Table 1. Face Validity of Instrument

Face validity criteria		Scale of Agreement				
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
1	Writing spacing is suitable	4	4	4	4	3
2	Font size is convenient to be read	4	4	4	4	3
3	Free from misspelling	4	4	4	3	3
4	Item arrangement is suitable	4	4	4	4	4
5	The instrument formatted neatly	4	4	4	4	3
6	The language used is clear	4	4	4	3	4
Mean of face validity by Expert		4.00	4.00	4.00	3.67	3.33

continued

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Mean of face validity by Expert (Overall)	3.80

The results suggest that the instrument was considered suitably formatted, linguistically appropriate, and visually acceptable for the target population. Minor feedback was provided regarding consistency in font sizing and alignment of certain items. Based on this feedback, several wording refinements were made to improve linguistic clarity and visual coherence. For example, rephrasing "AI tool use proficiency" to “my ability to use AI tools effectively” for greater comprehension among local respondents.

Content Validity Analysis

The content validity of the instrument was evaluated using the Content Validity Index (CVI), a well-established method for quantifying the degree to which individual items and the overall scale represent the intended construct. The CVI offers a systematic, transparent, and resource-efficient approach that has been widely applied in education and healthcare research (Polit et al., 2007). It comprises two components: The Item Content Validity Index (I-CVI), which evaluates the relevance of individual items, and the Scale Content Validity Index (S-CVI), which reflects the overall content validity of the instrument (Shi et al., 2012).

In this study, five experts rated each of the 12 items in the scale using a four-point scale, which was dichotomised to calculate the Item Content Validity Index (I-CVI). Items rated as “quite relevant” or “very relevant” were assigned a value of 1, while other responses were assigned a value of 0. According to established guidelines by Polit et al. (2007), when five experts are involved, an I-CVI value of 0.78 or higher is recommended, which equates to at least four experts agreeing on the item’s relevance.

Table 2. Content Validity of Instrument

Item	Scale of Agreement					No. of Expert Agree	I-CVI	Acceptance of Item
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
AW1	4	4	4	4	3	5	1.00	Accepted
AW2	4	4	4	4	4	5	1.00	Accepted
AW3	4	3	3	4	3	5	1.00	Accepted
US1	4	3	3	4	3	5	1.00	Accepted
US2	4	3	3	4	3	5	1.00	Accepted
US3	4	4	4	4	3	5	1.00	Accepted
EV1	4	3	3	4	3	5	1.00	Accepted
EV2	4	3	3	4	3	5	1.00	Accepted
EV3	4	4	4	4	3	5	1.00	Accepted
ET1	4	4	4	4	3	5	1.00	Accepted
ET2	4	4	4	4	3	5	1.00	Accepted
ET3	4	4	4	4	3	5	1.00	Accepted
						S-CVI	**1.00**	

Based on Table 2, all 12 items in this study achieved an I-CVI of 1.00, indicating unanimous agreement among the panel of experts. The Scale Content Validity Index (S-CVI), calculated as the average of the I-CVI values, was also 1.00, far exceeding the accepted threshold of 0.90 (Shi et al., 2012). These results confirm that each item in the adapted instrument was deemed highly relevant, contributing to excellent overall content validity and strong construct alignment with the original AILS framework.

Reliability Analysis

The internal consistency of the adapted Artificial Intelligence Literacy Scale (AILS) was assessed using Cronbach’s alpha, a widely endorsed statistical coefficient in educational and psychological research for determining the reliability of multi-item instruments. A total of 285 responses were analysed using the Reliability Analysis function in IBM SPSS Version 30. Cronbach’s alpha was selected due to its strength in measuring the extent to which items within a scale are interrelated and consistently reflect the same underlying construct (Cortina, 1993).

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Table 3. Cronbach's Alpha Value Based on Each Dimension and Overall

Dimension	No. of Item	Cronbach's Alpha	Interpretation of Reliability Level (based on Kilic, 2016)
Awareness	3	0.765	Acceptable
Usage	3	0.842	High
Evaluation	3	0.825	High
Ethics	3	0.846	High
Overall	**12**	0.933	**Very high**

Based on Table 3, the reliability coefficients for each dimension of the AILS demonstrate satisfactory to excellent internal consistency. The Awareness dimension, consisting of three items, yielded a Cronbach's alpha of 0.765, indicating an acceptable level of internal consistency based on thresholds proposed by Kilic (2016). The Usage subscale recorded a coefficient of 0.842, while Evaluation and Ethics scored 0.825 and 0.846 respectively, all of which fall within the high reliability range. Notably, the overall scale, comprising 12 items, achieved a Cronbach's alpha of 0.933, which is considered very high, reflecting excellent internal consistency across all dimensions.

These findings affirm the psychometric soundness of the adapted AILS and support its suitability for use in the Malaysian pre-service teacher context. The strong alpha values across all four dimensions which are awareness, usage, evaluation, and ethic highlight the coherence of items within each domain and their alignment with the intended constructs. As such, the use of Cronbach's alpha in this study provides robust evidence for the internal consistency of the scale and strengthens its potential application in both research and instructional settings.

DISCUSSION AND CONCLUSION

Interpretation of Result

The results of this study demonstrate that the Artificial Intelligence Literacy Scale was successfully adapted and validated for use among Malaysian pre-service teachers. The findings show strong consistency with the original instrument developed by Wang et al. (2023). All four dimensions which include awareness, usage, evaluation and ethics recorded satisfactory to high internal consistency values, with Cronbach's alpha coefficients ranging between 0.765 and 0.846 and an overall reliability value of 0.933. These results indicate that the adapted instrument can measure artificial intelligence literacy in a stable and consistent manner within the Malaysian teacher education context.

The expert evaluation process further confirmed the quality of the adapted scale. The high face validity mean score reflects clarity in language, structure and presentation of items. In addition, the perfect agreement achieved for both item level and scale level content validity indices indicates that the instrument content is highly relevant and well aligned with the intended constructs. These findings exceed recommended validity thresholds and demonstrate that the localisation process preserved conceptual accuracy while ensuring linguistic clarity and cultural appropriateness for Malaysian respondents (Polit et al., 2007; Shi et al., 2012; Ogunsola et al., 2019; Jizat, 2012). Such outcomes are particularly significant given previous concerns regarding contextual mismatch in technology related assessment tools used in Malaysia.

The reliability of each dimension is also supported by theoretical and contextual evidence. The awareness dimension reflects foundational understanding of artificial intelligence concepts, which is essential in Malaysia where exposure to artificial intelligence varies across educational settings (Mustaffa, 2025). The usage dimension captures the ability to apply artificial intelligence tools in teaching practice, aligning with national discussions on the role of artificial intelligence in enhancing instructional efficiency and personalised learning (Amdan et al., 2024). The evaluation dimension represents critical judgement of artificial intelligence outputs, a competency increasingly emphasised to ensure informed pedagogical decision making (Allen & Kendeou, 2023; Noor, 2025). The ethics dimension addresses concerns related to privacy, fairness and accountability, which are central to discussions on responsible artificial intelligence adoption in Malaysian education (Noor, 2025). Together, these findings confirm that the adapted scale reflects the multidimensional nature of artificial intelligence literacy required in contemporary educational practice.

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Implications for Teacher Education in Malaysia

The validated Artificial Intelligence Literacy Scale provides a valuable assessment tool for teacher education programmes in Malaysia that aim to strengthen digital competence and artificial intelligence literacy among pre-service teachers. As artificial intelligence increasingly influences teaching strategies, learning personalisation and educational decision making, systematic assessment of teacher readiness across cognitive, practical and ethical domains becomes essential (Ramalingam & Maniam, 2024). The adapted scale enables teacher educators and curriculum developers to identify specific areas of strength and areas requiring improvement, thereby supporting targeted professional preparation and curriculum refinement (Nuangchalerm et al., 2024).

The instrument also responds to evidence that artificial intelligence adoption in Malaysia is shaped by confidence, perceived usefulness and social influence rather than access alone (Mustaffa, 2025; Nasidi et al., 2025). By offering a structured means of assessing artificial intelligence literacy, the scale supports informed planning and equitable integration of artificial intelligence across diverse educational contexts. This aligns with broader national aspirations to ensure that artificial intelligence use in education remains ethical, inclusive and sustainable (Rütti Joy et al., 2023; Noor, 2025).

In addition to its instructional value, the scale holds strong potential for research use. It can support investigations into teacher attitudes toward artificial intelligence, patterns of classroom adoption and longitudinal development of artificial intelligence competence among educators. Its linguistic clarity and contextual relevance enhance its applicability across varied institutional and regional settings in Malaysia, contributing to more inclusive understanding of artificial intelligence literacy development.

Limitations and Recommendations

Despite the strong psychometric performance of the adapted scale, several limitations should be recognised. The data were collected from three teacher training institutes located in northern Malaysia, which may limit the extent to which the findings can be generalised to other regions or institutional contexts. Although the inclusion of multiple institutes improves representativeness, future research should involve a wider range of teacher education institutions across different states, as well as in service teachers and comparisons between urban and rural settings, to capture broader variation in artificial intelligence readiness.

In addition, while internal consistency results were satisfactory, further validation is recommended through factor analysis to confirm the underlying structure of the scale. Supplementary validation using external indicators such as classroom implementation of artificial intelligence or student learning outcomes would enhance the practical relevance of the instrument. The inclusion of qualitative methods such as interviews or reflective narratives may also provide deeper understanding of contextual challenges and ethical considerations related to the use of artificial intelligence in teaching.

CONCLUSION

This study successfully adapted and validated the Artificial Intelligence Literacy Scale for Malaysian pre-service teachers, demonstrating strong face validity, content validity and internal consistency. The instrument maintains the conceptual framework of awareness, usage, evaluation and ethics while ensuring relevance to the Malaysian educational context. Its application can enhance teacher preparation, support curriculum development and inform policy decisions related to artificial intelligence integration in education.

As Malaysia continues to advance toward digitally empowered education systems, the validated scale offers a reliable and context appropriate mechanism for assessing and developing artificial intelligence competencies among future educators. By supporting informed and ethical engagement with artificial intelligence, this study makes a meaningful contribution to educational assessment research and aligns with national goals for sustainable digital transformation in teacher education.

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DECLARATION OF GENERATIVE AI

During the preparation of this manuscript, the researchers used OpenAI ChatGPT solely for language editing and improving the clarity of writing. No generative artificial intelligence tools were used to produce or interpret any scientific content. After using the tool, the authors carefully reviewed and revised the text as necessary and took full responsibility for the final content of this publication.

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