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Bridging Artificial Intelligence Literacy and Technology Acceptance Among Elementary School Teachers: Evidence from a Structural Equation Model

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Abstract

This study investigates the correlation between artificial intelligence (AI) literacy and acceptance among Indonesian elementary school teachers using a structural equation model. A cross-sectional survey of 409 teachers indicated elevated AI acceptance and literacy levels. AI literacy strongly predicted acceptance and vice versa, suggesting a bidirectional relationship between these two variables. Demographic factors exerted minimal influence, whereas the frequency of AI use showed a moderate correlation between the two constructs. The structural equation model revealed that social influence, facilitating conditions, and the progressive development of AI competencies significantly influenced teachers' behavioral intentions and ethical awareness. These findings underscore the necessity of comprehensive, experiential professional development programs that promote deep, reflective, and ethical engagement with AI technologies. This study advocates for a systemic, culturally responsive approach to AI integration in elementary education, aligning training, infrastructure, collaborative culture, and personalized support to prepare teachers for effective and responsible AI utilization.

Keywords: *artificial intelligence, AI literacy, UTAUT, teacher acceptance, elementary education.*

Abstrak

Penelitian ini menyelidiki korelasi antara literasi dan penerimaan kecerdasan arifisial (artificial intelligence/AI) di kalangan guru sekolah dasar di Indonesia dengan menggunakan model persamaan struktural. Sebuah survei cross-sectional terhadap 409 guru mengindikasikan adanya peningkatan tingkat penerimaan dan literasi AI. Literasi AI secara kuat memprediksi penerimaan dan sebaliknya, menunjukkan adanya hubungan dua arah antara kedua variabel ini. Faktor demografis memberikan pengaruh yang minimal, sedangkan frekuensi penggunaan AI menunjukkan korelasi yang moderat antara kedua variabel tersebut. Model persamaan struktural mengungkapkan bahwa pengaruh sosial, kondisi yang memfasilitasi, dan perkembangan kompetensi AI secara signifikan mempengaruhi niat perilaku dan kesadaran etis guru. Temuan ini menggarisbawahi perlunya program pengembangan profesional yang komprehensif dan berbasis pengalaman yang mendorong keterlibatan yang mendalam, reflektif, dan etis dengan teknologi AI. Studi ini mengadvokasi pendekatan sistemik dan responsif secara budaya terhadap integrasi AI dalam pendidikan dasar, menyelaraskan pelatihan, infrastruktur, budaya kolaboratif, dan dukungan pribadi untuk mempersiapkan guru dalam pemanfaatan AI yang efektif dan bertanggung jawab.

Kata kunci: *kecerdasan artifisial, literasi AI, UTAUT, penerimaan guru, pendidikan dasar.*

INTRODUCTION

The integration of artificial intelligence (AI) in education is increasingly transforming personalized learning, collaborative environments, and administrative processes. AI technologies enhance personalized learning by tailoring educational content to meet the distinct needs of each student, resulting in heightened engagement and improved learning outcomes (Msambwa et al., 2025; Strielkowski et al., 2024). These technologies offer real-time feedback and establish individualized learning pathways, which are essential for promoting learners' motivation and performance (Chen et al., 2020). Additionally, AI fosters collaborative learning by facilitating peer interactions and enhancing engagement with learning materials, which is crucial in cooperative educational settings (Msambwa et al., 2025). For instance, AI platforms such as Quizizz AI and QuizGecko create gamified learning experiences, whereas DreamBox and Century Tech personalize instruction by adjusting content difficulty based on each student's performance. Regarding administrative functions, AI reduces teachers' workloads by automating tasks such as assessments, allowing teachers to focus more on instructional activities (Ahmad et al., 2022).

The growing global interest in harnessing Artificial Intelligence (AI) for educational purposes necessitates a comprehensive exploration of teachers' understanding and acceptance of AI in primary schools, especially in diverse contexts such as Indonesia. Although the potential benefits of AI in education are increasingly acknowledged, the practical and ethical implementation of these technologies in elementary classrooms presents significant challenges (Kasneci et al., 2023; Yan et al., 2024). For instance, many teachers express limited practical experience with AI tools and feel that they lack the necessary skills to incorporate AI into their pedagogical strategies (Erol & Erol, 2024; Hazzan-Bishara et al., 2025; Pan & Wang, 2025). Furthermore, ethical concerns regarding student data privacy, algorithmic bias, and the lack of transparency in AI decision-making processes undermine

teachers' trust in these technologies (Farooqi et al., 2024; Lucas et al., 2024). Additionally, teachers' acceptance of AI is influenced by insufficient facilitation conditions, such as unreliable Internet access, limited technical support, and the absence of clear policies governing the use of AI in the learning process (Acosta-Enriquez et al., 2024; Fathurrachman & Saputri, 2025).

The effective integration of AI in elementary schools significantly depends on teachers' literacy and acceptance, as they play a central role in managing student interactions with AI (Choi et al., 2023; Granström & Oppi, 2025; Yusuf, 2025). Teacher acceptance refers to their willingness to embrace AI tools, which is influenced by factors outlined in the Unified Theory of Acceptance and Use of Technology (UTAUT), including performance expectancy, effort expectancy, social influence, and facilitating conditions (Tekin, 2024; Venkatesh et al., 2003; Zhang & Wareewanich, 2024). Furthermore, demographic and psychological factors, such as educational background, trust, self-efficacy, and anxiety, also affect teachers' acceptance levels (Choi et al., 2023; Guo et al., 2025; Schiavo et al., 2024; Yao & Abd Halim, 2023). This body of literature suggests that individual characteristics and external enablers influence teachers' acceptance of AI integration in teaching practices.

In addition, AI literacy is crucial for teachers to effectively integrate AI into elementary schools. AI literacy encompasses an understanding of AI concepts, proficient use of AI tools, and evaluation of ethical implications (Long & Magerko, 2020). This literacy involves not only technical skills but also ethical awareness and critical thinking (Sperling et al., 2024). Within the UTAUT framework, AI literacy enhances both performance and effort expectancy, thereby influencing teachers' acceptance of AI.

This study introduces a conceptual framework that highlights the importance of AI literacy for teachers as a vital element in facilitating effective and ethical AI integration in elementary schools. The framework incorporates four key theoretical perspectives: Digital Literacy, AI-TPACK, Diffusion of Innovation Theory, and the UTAUT. Each perspective offers a unique yet interconnected lens for comprehending AI integration in educational settings.

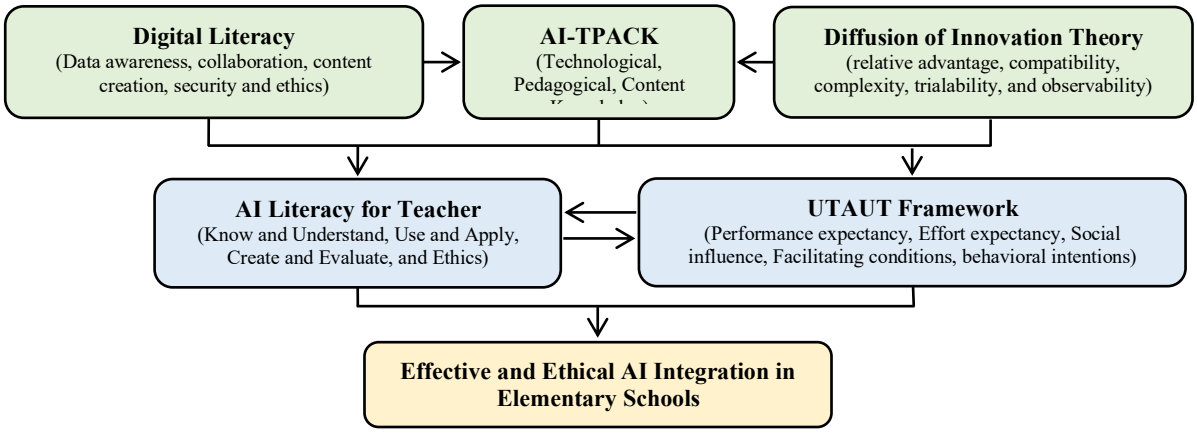

Figure 1. Synthesized Conceptual Model of AI Adoption in Elementary Schools

Digital literacy encompasses the ability to identify, access, manage, integrate, communicate, assess, and produce secure and appropriate information through digital technologies and networks to participate in economic and social activities (Laily & Binasdevi,

2023; Susanto, 2021). As such, digital literacy is defined as a fundamental competency that includes several key components, such as information and data awareness, digital communication and collaboration, digital content creation, digital security, and ethics (Martínez-Bravo et al., 2022). With the increasing integration of artificial intelligence (AI) technologies into digital tools, it has become essential for educators to foster the capacity to engage with digital content and environments critically. Thus, AI literacy has emerged as an advanced competency within the broader framework of digital literacy, encompassing not only the responsible use of data but also heightened sensitivity to ethical considerations (Arnaud et al., 2024).

The AI-TPACK framework expands on the traditional model of Technological Pedagogical Content Knowledge (TPACK) by integrating AI-specific dimensions into instructional planning. This integration necessitates an understanding of the operational mechanisms of AI tools, their alignment with pedagogical strategies, and their coherence with curricular content (Ning et al., 2024). The design of learning experiences that effectively incorporate AI requires a harmonious synthesis of these domains (Dharmawati et al., 2023; Runge et al., 2025).

Furthermore, the Diffusion of Innovation Theory elucidates the variability in AI adoption among educators, influenced by five salient characteristics: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003). These dimensions significantly impact teachers' inclination and readiness to experiment with and integrate AI tools into classroom environments (Bokolo, 2023). These attributes facilitate broader adoption by aligning with perceived instructional benefits and institutional objectives.

The UTAUT offers additional insights into technology acceptance. Educator behavior is molded by professional expectations, personal experiences, attitudes, willingness, and behaviotal intentions to adopt new technologies (W. Zhang & Hou, 2024). These sociocognitive factors shape perceptions of AI tools in terms of their usefulness, usability, and alignment with teachers' professional identities and values.

At the core of this framework lies the AI Literacy for Teachers concept, which consists of five interrelated dimensions: Know and Understand, Use and Apply, Create and Evaluate, and Ethics (Ayanwale et al., 2024; Zhao et al., 2022). This construct represents a developmental pathway that evolves from basic awareness of AI to ethical and innovative integration within teaching practices. By combining elements of digital fluency, pedagogical design, adoption processes, and motivational dynamics, this model underscores the essential role of teacher literacy in promoting effective and ethically responsible AI use in elementary education settings.

Given teachers' essential role in shaping students' understanding of technology, their proficiency in AI is critical for promoting effective AI literacy education. This study addresses the existing gap in the literature regarding the relationship between AI literacy and AI acceptance, aiming to identify the factors that influence teachers' intentions to integrate AI into their instruction. This study offers practical recommendations for policymakers and teachers to enhance AI literacy and acceptance, facilitating meaningful AI integration into elementary education.

METHODS

This study used quantitative research to examine the relationship between AI literacy and acceptance among elementary school teachers. The primary objective was to assess the existing levels of AI literacy within this demographic and identify critical factors influencing their acceptance of AI in instructional contexts. To address these aims, a cross-sectional survey approach was adopted, which enabled data collection from a diverse and representative sample of participants. This design facilitated the identification of emerging trends and illuminated the complex dynamics involved in AI integration within educational ecosystems (Abbitt, 2021).

The participants comprised 409 elementary school teachers from urban (19.1%) and suburban (80.9%) environments, selected using convenience sampling. Demographically, the sample consisted of 313 female (76.5%) and 96 male (23.5%) teachers. Regarding age, 233 respondents (57%) were aged between 30 and 40 years, 110 (26.9%) were aged 41 to 50 years, 45 (11%) were under 30 years, and 21 (5.1%) were over 50 years. Most held a bachelor's degree (83.4%), while smaller proportions possessed a professional teaching certification (12.5%), master's degree (3.9%), or doctoral degree (0.2%). Regarding AI usage frequency, 52.8% reported using AI tools occasionally, 19.6% rarely, 14.4% somewhat frequently, and 13.2% frequently.

The survey instrument was carefully designed using Google Forms to ensure effective distribution and data collection. The questionnaire was structured into three primary sections: demographic information, AI literacy, and AI acceptance. Tailored for elementary teachers, the AI literacy section comprises 12 items designed to measure understanding, application, creation, evaluation, and ethical considerations related to artificial intelligence, all grounded in extensive literature reviews (Ayanwale et al., 2024; Lim & Lee, 2023; Zhao et al., 2022). To assess AI acceptance, the instrument employs the UTAUT framework, focusing on key factors such as performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioral intention (Tekin, 2024; Venkatesh et al., 2003; Yao & Abd Halim, 2023). Both the AI literacy and AI acceptance instruments underwent a thorough validation process, reviewed by two experts to ensure completeness, appropriateness, and readability. Additionally, results from a pilot test conducted with 34 elementary school teachers demonstrated that all items for both variables exhibited good construct validity, as indicated by the Pearson correlation analysis ($p < .001$). The internal consistency of the scales was high, with Cronbach's alpha values of .912 for AI literacy and .915 for AI acceptance.

Ethical clearance was obtained from the Institutional Ethics Committee of the Universitas Islam Negeri Walisongo Semarang. The survey was administered online via WhatsApp professional networks over four weeks. Participation was entirely voluntary. Before data collection, the respondents received detailed information outlining the study's purpose, confidentiality safeguards, and the voluntary nature of participation. Informed consent was obtained digitally, and the participants were assured of their right to withdraw immediately. The data collection procedures adhered to the ethical principles outlined in the Declaration of Helsinki, ensuring participant anonymity and data protection.

Descriptive statistics were employed to categorize the levels of AI literacy and AI acceptance, with mean scores interpreted on a three-tier scale: 1.00–2.33 (low), 2.34–3.67 (moderate), and 3.68–5.00 (high), following Alkharusi (2022). Furthermore, ANOVA,

Pearson's correlation, multiple regression, and path analyses were conducted to identify significant relationships and predictive patterns. These analytical procedures provided a robust foundation for understanding the interconnections between AI-related competencies and attitudinal factors among elementary teachers.

RESULTS AND DISCUSSION

Teacher AI Acceptance and AI Literacy Levels

The descriptive analysis presented in Table 1 indicates that both AI acceptance (M = 3.80) and AI literacy (M = 3.79) among teachers were at high levels. Within the UTAUT framework, performance expectancy (M = 4.04) and effort expectancy (M = 3.91) emerged as the primary drivers of acceptance, highlighting the Technology Acceptance Model's emphasis on perceived usefulness and ease of use (Bayaga, 2024; Lu et al., 2024). In contrast, facilitating conditions recorded the lowest acceptance score (M = 3.67), which aligns with the "complexity" and "compatibility" barriers outlined in the Diffusion of Innovation Theory, revealing that teachers perceive existing infrastructural or support systems as inadequate (Dearing & Cox, 2018).

Regarding AI literacy, teachers achieved high scores in the areas of "Know and Understand," "Ethics," and "Use and Apply," but demonstrated only moderate proficiency in "Create and Evaluate" (M = 3.67). This indicates a gap in AI-TPACK development, particularly in the creative and evaluative domains, where effective pedagogical integration requires higher-order thinking and critical design skills (Ning et al., 2024; Runge et al., 2025). Additionally, this gap aligns with the requirements set forth by Digital Literacy concerning content creation, evaluative skills, and the essential ethical awareness embedded in AI literacy models (Martínez-Bravo et al., 2022; Zhao et al., 2022).

This result aligns with the literature documenting the gap between positive perceptions of AI and the systemic readiness required for effective implementation (Acosta-Enriquez et al., 2024; Nikolic et al., 2024). In addition, this finding echoes prior studies emphasizing the importance of evaluative and reflective skills in preventing superficial AI usage (Cheah & Kim, 2025; Ng et al., 2023). Therefore, professional development should move beyond operational instructions to cultivate analytical and ethical capacities.

Table 1. Summary of Teacher AI Acceptance and AI Literacy Levels

Category	Dimension	Mean (M)	Std. Dev. (SD)	Classification
AI Acceptance	Overall	3.80	0.62	High
	Performance Expectancy	4.04		High
	Effort Expectancy	3.91		High
	Social Influence	3.68		High
	Behavioral Intention	3.68		High
	Facilitating Conditions	3.67		Medium
AI Literacy	Overall	3.79	0.56	High
	Know and Understand	3.89		High
	Ethics	3.88		High
	Use and Apply	3.71		High
	Create and Evaluate	3.67		Medium

Demographic Influences on AI Literacy and Usage

The One-way ANOVA results in Table 2 indicate that statistically significant differences in AI literacy were found based on age, $F(3, 405) = 3.271$, $p = .021$, with younger teachers exhibiting higher AI literacy than older teachers. This suggests that AI literacy is more influenced by generational familiarity with technology (digital natives) and frequent use (Celik, 2023; Smith et al., 2020), in line with the Digital Literacy and Diffusion of Innovation Theory (Adigwe et al., 2024; Rogers et al., 2014). However, the fact that education level and gender did not impact acceptance and AI literacy reflects UTAUT's view and AI literacy concept that psychosocial variables and engagement with technology matter more than demographics (Celik, 2023; Li et al., 2024; Lucas et al., 2024; Ng et al., 2023).

Table 2. Summary of Demographic Influences on AI Literacy and Usage

No.	Aspect	*F*	*p*	Conclusion
1.	AI acceptance based on age	1.574	.195	Non-significant
2.	AI acceptance based on education level	1.231	.298	Non-significant
3.	AI acceptance based on gender	.156	.693	Non-significant
4.	AI literacy based on age	3.271	.021	**Younger > Older**
5.	AI literacy based on education level	1.028	.380	Non-significant
6.	AI literacy based on gender	.122	.727	Non-significant

Interrelation of Core Constructs and Demographic Variables

The Pearson's correlation results in Table 3 reveal a strong positive correlation between AI acceptance and AI literacy ($r = .665$, $p < .001$). Furthermore, the frequency of AI usage showed a moderate correlation with both constructs, highlighting that usage enhances learning and vice versa—concepts central to the "Use and Apply" dimension of AI Literacy and the "Personal Experience" aspect of the UTAUT framework. The weak correlations associated with education suggest that pre-service training often lacks specific AI-related content, reflecting the criticisms articulated by Cheah and Kim (2025). These findings support a reciprocal model in which usage and literacy mutually reinforce each other, similar to the feedback loops described by Du et al. (2024). Zhao et al. (2022) also underscored the importance of actively engaging with AI tools to foster deeper understanding and positive attitudes.

Table 3. Pearson Correlation Analysis Results

	AI Acceptance	AI Literacy	Frequency of Using AI	Education Level	Age	Gender
AI Acceptance	1	.665**	.364**	.100*	-.049	.021
AI Literacy	.665**	1	.342**	.123*	-.095	-.029

*Note: *p < .05, **p < .01*

Predictive Factors for AI Acceptance and Literacy

The hierarchical multiple regression results in Table 4 indicate that AI literacy strongly predicted AI acceptance ($\beta = .679$). Conversely, AI acceptance significantly predicted AI literacy ($\beta = .557$), confirming a bidirectional influence. This finding aligns with the UTAUT

model, particularly in terms of performance and effort expectancy, and reflects key concepts in the Diffusion of Innovation Theory, such as trialability and observability; increased exposure leads to improved judgment and heightened motivation (Acosta-Enriquez et al., 2024; Rogers et al., 2014). Additionally, frequency of use was a weaker yet statistically significant predictor, suggesting that hands-on experience contributes to both literacy and acceptance (Ali et al., 2024). However, this highlights the need for reflective learning to maximize its effectiveness, supporting the AI-TPACK's focus on contextual and pedagogical alignment (Al-Abdullatif, 2024; Ning et al., 2024).

Surprisingly, the consistently non-significant role of formal education indicates that current teacher education programmes may inadequately address the competencies necessary for AI integration. These findings emphasize the importance of targeted hands-on training programs that prioritize conceptual depth and critical engagement over general academic qualifications (Ali et al., 2024). Furthermore, they suggest that efforts to enhance AI readiness should concentrate on fostering reflective, ethically grounded learning experiences rather than treating AI merely as a technical tool for operational use (Kizilcec, 2023).

Table 4. Multiple Regression Results Predicting AI Acceptance and AI Literacy

Dependent Variable	**Predictor**	***β***	***t***	***p***	***R²***	***F(df) / p***
AI Acceptance	AI Literacy	.679	15.683	<.001	.464	F(3, 405) = 116.71 / p < .001
	Frequency of Using AI	.106	4.000	<.001		
	Education	.015	0.340	.734		
AI Literacy	AI Acceptance	.557	15.683	<.001	.456	F(3, 405) = 113.27 / p < .001
	Frequency of Using AI	.069	2.840	.005		
	Education	.057	1.426	.155		

Structural Equational Model of AI Acceptance and Literacy among Teachers

Structural Equation Model (SEM) analysis was conducted to illustrate the interrelationships among various constructs within the AI literacy and acceptance framework. The model (Figure 2) demonstrated an acceptable fit with the observed data (SRMR = 0.078, NFI = 0.742), indicating satisfactory alignment between the model and data.

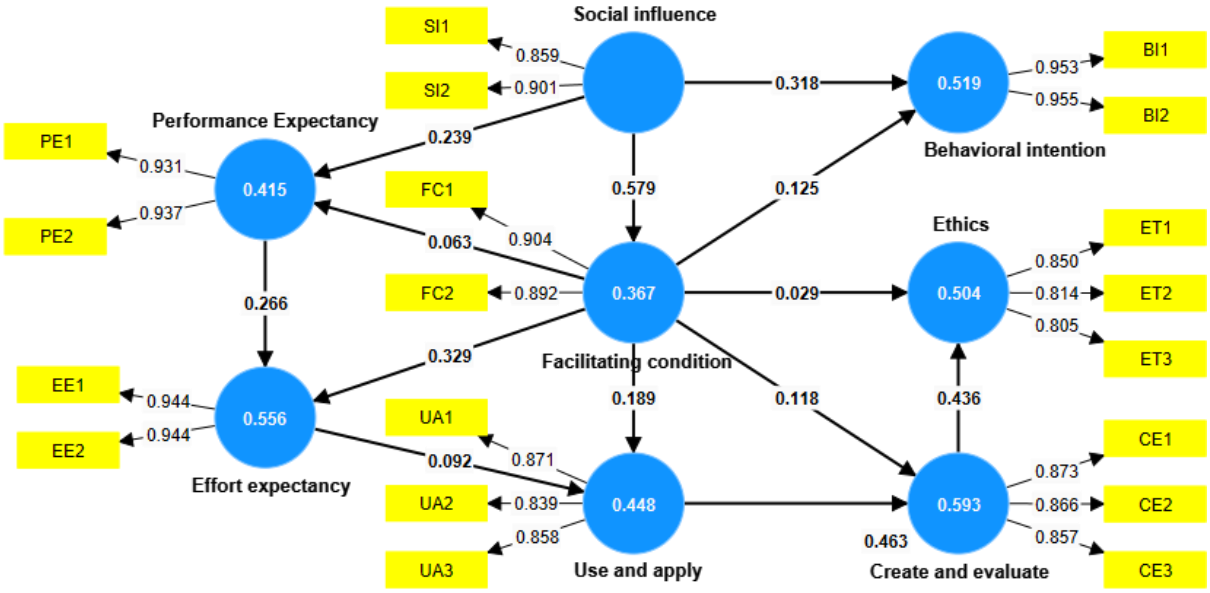

Figure 2. Model Structural Equation of AI Literacy and AI Acceptance among Teachers

Table 5 shows that the most pronounced direct relationship was identified between social influence and facilitating conditions (β = 0.605), signifying that teachers' perceptions of peer, institutional, and societal expectations greatly influenced their sense of support within their work environment. This finding aligns with the UTAUT framework, which suggests that social expectations can indirectly promote acceptance by enhancing infrastructure and support systems (Nikolic et al., 2024; Tekin, 2024). Furthermore, Social Influence significantly impacted both Behavioral Intention (β = 0.491) and Performance Expectancy (β = 0.470). This indicates that social validation not only motivates usage but also shapes teachers' perceptions of the utility of AI. These insights confirm that the effective integration of AI in educational settings hinges not only on the technological tools themselves but also on fostering a collaborative culture in which teachers feel encouraged and supported to use these tools.

Regarding AI literacy, the model revealed a clear progression in knowledge acquisition: "Use and Apply" leading to "Create and Evaluate" (β = 0.560), followed by "Create and Evaluate" to "Ethics" (β = 0.602). This progression suggests that foundational usage skills lay the groundwork for more advanced evaluative capabilities, which in turn promote ethical understanding, reflecting the developmental structure of the AI literacy framework (Allen & Kendeou, 2024). These connections are crucial, as they imply that the ethical integration of AI is not a standalone result but the outcome of a progressive sequence of cognitive and practical competencies. Additionally, Facilitating Condition directly influenced several variables, such as Use and Apply (β = 0.431) and Effort Expectancy (β = 0.449). These findings imply that institutional readiness, encompassing technical support, infrastructure, and policies, is vital for empowering teachers to engage meaningfully with AI tools (Celik, 2023; Du et al., 2024), consistent with the perspectives of digital literacy (security and infrastructure) and AI-TPACK (pedagogical implementation) (Arnaud et al., 2024; Lixia & Lee Jun, 2024).

Table 5. Direct Effects (Standardized Path Coefficients)

Pathway	*B*	*t*	*p*	f^2	Effect Size
1) Social influence → Facilitating condition	0.605	14.801	0.000	0.579	Large
2) Use and apply → Create and evaluate	0.560	13.660	0.000	0.463	Large
3) Create and evaluate → Ethics	0.602	14.258	0.000	0.436	Large
4) Facilitating condition → Effort expectancy	0.449	8.806	0.000	0.329	Medium
5) Social influence → Behavioral intention	0.491	8.312	0.000	0.318	Medium
6) Performance Expectancy → Effort expectancy	0.404	6.626	0.000	0.266	Medium
7) Social influence → Performance Expectancy	0.470	9.594	0.000	0.239	Medium
8) Facilitating condition → Use and apply	0.431	7.889	0.000	0.189	Medium
9) Facilitating condition → Behavioral intention	0.308	5.487	0.000	0.125	Small
10) Facilitating condition → Create and evaluate	0.283	6.122	0.000	0.118	Small
11) Effort expectancy → Use and apply	0.301	5.114	0.000	0.092	Small
12) Facilitating condition → Performance Expectancy	0.240	4.457	0.000	0.063	Small
13) Facilitating condition → Ethics	0.154	3.383	0.000	0.029	Small

Table 6 illustrates the indirect (mediated) effects between various constructs, highlighting how layered processes contribute to developing ethical AI literacy and behavioral intentions. The most prominent indirect pathway observed was from Use and Apply to Create and Evaluate to Ethics ($\beta = 0.337$). This indicates that simply knowing how to use AI tools is inadequate; teachers must also cultivate the ability to assess and adapt these tools critically, ultimately leading to enhanced ethical awareness among teachers. This finding is particularly significant in the context of teacher professional development, where workshops often focus solely on technical skills without advancing to deeper evaluative or ethical training (Runge et al., 2025). Another key finding revealed that Social Influence affected Behavioral Intention through Facilitating Conditions ($\beta = 0.186$). This demonstrates that organizational norms and peer influences must be transformed into practical support to shape the intention to use AI effectively (Al-Abdullatif, 2024). This insight aligns with the Diffusion of Innovation Theory, which posits that social validation and institutional compatibility are critical drivers of adoption (Rogers et al., 2014).

More intricate multi-step pathways further underscore the systemic nature of ethical AI integration. For example, the pathway from Social Influence to Facilitating Conditions to Effort Expectancy to Use and Apply to Create and Evaluate to Ethics ($\beta = 0.028$) illustrates how ethical AI literacy arises from an interconnected chain of sociocultural, infrastructural, cognitive, and behavioral factors (Du et al., 2024; Lavidas et al., 2024). These multi-step connections emphasize the necessity of constructing a scaffolded ecosystem: social endorsement paves the way for institutional support, which enhances perceptions of ease of use, encourages active engagement, and ultimately fosters evaluative and ethical utilization of AI. These nuanced insights challenge the notion of simplistic cause-and-effect relationships and reinforce Kizilcec's (2023) argument that effective ethical AI integration necessitates both grassroots competence and top-down support. Ultimately, these findings urge policymakers and school leaders to design professional learning pathways encompassing the entire

continuum, from usage to critical evaluation to ethical reflection, rather than viewing AI adoption as a technical enhancement alone.

Table 6. Indirect Effects (Standardized Path Coefficients)

Medium Pathway	*β*	*t*	*p*
1) Use and apply → Create and evaluate → Ethics.	0.337	9.809	0.000
2) Social influence → Facilitating condition → Behavioral intention.	0.186	4.875	0.000
3) Facilitating condition → Create and evaluate → Ethics	0.170	5.683	0.000
4) Facilitating condition → Use and apply → Create and evaluate → Ethics.	0.145	6.555	0.000
5) Social influence → Facilitating condition → Create and evaluate → Ethics.	0.103	5.296	0.000
6) Effort expectancy → Use and apply	0.101	4.085	0.000
7) → Create and evaluate → Ethics.			
8) Social influence → Facilitating condition → Ethics.	0.093	3.287	0.001
9) Social influence → Facilitating condition → Use and apply → Create and evaluate → Ethics.	0.088	5.483	0.000
10) Facilitating condition → Effort expectancy	0.046	3.647	0.000
11) → Use and apply → Create and evaluate → Ethics.			
12) Performance Expectancy → Effort expectancy	0.041	3.330	0.000
13) → Use and apply → Create and evaluate → Ethics.			
14) Social influence → Facilitating condition → Effort expectancy	0.028	3.458	0.000
15) → Use and apply → Create and evaluate → Ethics.			
16) Social influence → Performance Expectancy → Effort expectancy → Use and apply → Create and evaluate → Ethics.	0.019	2.950	0.002
17) Facilitating condition → Performance Expectancy → Effort expectancy → Use and apply → Create and evaluate → Ethics.	0.010	2.696	0.004
18) Social influence → Facilitating condition → Performance Expectancy → Effort expectancy → Use and apply → Create and evaluate → Ethics.	0.006	2.652	0.004

Practical Implications for Elementary Education

The findings of this study underscore the interconnectedness of AI literacy, behavioral intention, and systemic support, emphasizing that the ethical and effective integration of AI into elementary education relies not only on teachers' individual competencies but also on the broader institutional and societal ecosystem. The robust reciprocal relationship between AI literacy and acceptance highlights the need for comprehensive, experiential professional development programs that go beyond superficial familiarity with tools and foster deep, reflective, and ethical engagement.

Professional development should be restructured into tiered, hands-on learning pathways that evolve from "Know and Understand" to "Use and Apply," "Create and Evaluate," and ultimately, "Ethics." These pathways must encompass: 1) AI-enhanced lesson planning workshops that empower teachers to incorporate AI tools within authentic curricular contexts; 2) critical evaluation sessions where teachers assess the accuracy, bias, and pedagogical relevance of AI-generated outputs; and 3) ethics-focused case study discussions

that address vital concerns such as student data privacy, algorithmic bias, and transparency in AI decision-making. This approach aligns with the AI Literacy Framework and supports the AI-TPACK model, assisting educators in bridging technological capabilities with pedagogical strategies and content requirements.

Given that facilitating conditions directly influence multiple core constructs, including effort expectancy, usage, and ethical outcomes, policy initiatives must prioritize infrastructure readiness. Educational policymakers should: 1) ensure high-speed Internet access and the availability of AI-compatible devices in all schools; 2) establish technical support units at the district or school level to assist with AI-related troubleshooting; and 3) develop clear, school-level policy frameworks that define ethical standards, usage guidelines, and accountability mechanisms for AI deployment in classrooms. These measures are essential to ensure that technology adoption is not impeded by logistical barriers, as highlighted in the Digital Literacy and UTAUT frameworks.

The significant role of social influence in shaping behavioral intentions and facilitating conditions suggests that AI integration should be viewed as a collaborative and cultural transformation rather than merely an individual endeavor. School leaders are encouraged to: 1) Establish AI-focused Professional Learning Communities (PLCs) to promote peer mentoring and the exchange of ideas; 2) identify and empower "AI champions" among teachers to act as peer facilitators and innovation leaders; and 3) promote collaborative action research projects that allow teachers to examine AI's impact on teaching and learning collectively. These strategies foster a socially supportive environment in which AI practices become normalized, reinforcing behavior through social modeling and observability, which are key principles of the Diffusion of Innovation Theory.

Importantly, pathways to ethical AI use have been shown to rely on earlier stages of practical experience and critical evaluation, highlighting that ethical competence is a developmental process. To advance this, teacher education programs should: 1) integrate ethical reflection throughout practical modules, rather than treating it as a separate theoretical topic; 2) utilize scenario-based simulations to challenge teachers with ethical dilemmas in authentic classroom contexts; and 3) encourage the development of school-based AI ethics codes co-created by teachers, fostering ownership and internalizing ethical standards.

The lack of significant effects from demographic variables such as age, gender, and educational level underscores the necessity for personalized, readiness-based training instead of uniform, one-size-fits-all approaches to training. Education authorities and school administrators should: 1) use diagnostic self-assessment tools to evaluate AI literacy and readiness levels; 2) offer modular training content that adapts to varying competency levels and teaching contexts; and 3) provide certification or micro-credentials aligned with the mastery of each phase of AI literacy. This ensures equitable capacity building and aligns with the principles of inclusive professional development.

Ultimately, any strategy for AI integration must consider Indonesia's rich cultural, linguistic, and pedagogical diversity. This entails localizing AI training materials in Bahasa Indonesia and incorporating culturally relevant examples to ensure alignment with the national curriculum and existing pedagogical practices. Integrating Indigenous ethical perspectives and local educational values is essential for enhancing authenticity and fostering teacher engagement. This study advocates for a systemic, culturally responsive, and ethically

informed approach to AI integration in elementary education. By synchronizing experiential training, infrastructural readiness, collaborative culture, and personalized support, Indonesia can equip its teachers to utilize AI effectively and guide the next generation in employing it wisely and responsibly.

Limitations and Future Research Directions

This study had several limitations that necessitate careful consideration. The cross-sectional design restricts causal inferences regarding the relationship between AI literacy and technology acceptance, indicating that future research should adopt a longitudinal approach. Furthermore, the use of convenience sampling, particularly with a predominance of suburban participants, limits the generalizability of these findings. Including educators from rural and urban settings would provide a more comprehensive perspective of Indonesia's diverse educational landscape.

Additionally, reliance on self-reported surveys may introduce biases; employing mixed methods, such as observations or in-depth interviews, could enhance the depth and validity of the research. While this study utilizes the UTAUT framework and AI literacy constructs, it overlooks critical factors such as school leadership support, student readiness, and institutional policies that are essential for successful AI adoption. Moreover, the discussion of AI use remains general, lacking differentiation between specific applications that could provide more actionable insights. To ensure the equitable implementation of AI in schools, policymakers and curriculum developers should design sustainable, context-sensitive training programs that align with Indonesia's cultural and pedagogical needs.

CONCLUSION

This study examined the relationship between AI literacy and acceptance among Indonesian elementary school teachers, revealing high levels of both constructs. AI literacy emerged as a strong predictor of AI acceptance, and vice versa, indicating a bidirectional influence. The frequency of AI usage moderately correlated with both literacy and acceptance, suggesting that hands-on experience enhances understanding of and attitudes towards AI. The structural equation model highlights the importance of social influence and facilitating conditions in shaping teachers' AI acceptance and literacy. A clear progression in AI literacy was observed, from basic usage skills to more advanced evaluative capabilities and ethical understanding of AI. The study also revealed that demographic factors had a limited impact on AI literacy and acceptance, emphasizing the importance of psychosocial variables and technology engagement. These findings have significant implications for elementary education in Indonesia. They underscore the need for comprehensive, experiential professional development programs that foster deep, reflective, and ethical AI engagement. This study advocates for a systemic, culturally responsive, and ethically informed approach to AI integration, emphasizing the importance of infrastructure readiness, collaborative culture, and personalized support. Future research should address the limitations of this study by adopting longitudinal designs, including more diverse samples, and employing a mixed-methods approach. Additionally, investigating factors such as school leadership support, student readiness, and institutional policies could provide more comprehensive insights into successful AI adoption in elementary education.

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