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Research Article

AI transformation in education: Examining teachers' perceptions using an integrated TAM-TPACK-GenAI framework

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ABSTRACT

Artificial intelligence (AI) is transforming educational systems by enhancing teaching, assessment, and learning personalization. This study investigated teachers' perceptions of AI integration using an integrated technology acceptance model (TAM), technological pedagogical content knowledge (TPACK), and generative artificial intelligence (GenAI) framework. The main constructs used are perceived usefulness (PU), attitudes toward use (ATU), and behavioral intention (BI), with GenAI dimensions (agency, amplification, adaptivity, and authenticity) embedded within them. The study employed a cross-sectional design with 332 teachers in the emirate of Al Ain, United Arab Emirates. Results showed that PU was the strongest predictor of both ATU and BI, while ATU did not significantly mediate the PU-BI relationship. Amplification and adaptivity were positively perceived, whereas concerns about authenticity and agency tempered attitudes. Teachers aged 30-49 and those with 1-10 years of experience reported higher BI, and teachers of grades 4-9 showed greater PU. The findings highlight the need for professional development that fosters both practical integration and ethical understanding of AI in education.

Keywords: AI in education, technology acceptance model, TPACK, TPACK-GenAI

INTRODUCTION

Background

Artificial intelligence (AI) is rapidly transforming education, introducing new ways to teach, assess, and personalize learning. Educators and institutions worldwide are exploring AI tools designed for various purposes, including real-time data analysis, adapting to students' learning needs, and reorganizing administrative and instructional tasks to promote individualized learning, increase engagement, and bridge learning gaps (Holmes et al., 2019; Luckin et al., 2016). For instance, in the teaching process, AI enhances

pedagogy by enabling differentiated instruction, providing constructive feedback, and supporting teachers in identifying students' learning needs more effectively (Shi et al., 2024). In assessment, AI tools can provide rapid grading, learning analytics, and performance prediction, leading to a reduction in teacher workload and an enhancement of evaluation accuracy (Zhao, 2025). Furthermore, AI contributes to more interactive and inclusive classrooms through speech recognition, translation, and accessibility features that support students with diverse backgrounds and learning needs (Silva et al., 2025). In many education systems, including those in the United Arab Emirates (UAE), AI is being introduced into curricula either as a subject or as a tool for learning.

Gaps and Rationale

This transition presents new challenges, particularly in terms of teacher readiness and professional development. Teachers play a crucial role in the successful implementation of AI in classrooms; however, many educators face uncertainties about how to effectively integrate these tools into their instructional practices (Davis, 2024). Their perceptions, whether positive or negative, can significantly influence the adoption, effectiveness, and ethical integration of AI technologies in schools. Many studies explored the capabilities of AI or its impact on student learning outcomes; however, fewer have focused on the beliefs, attitudes, and behavioral intentions (BIs) of teachers themselves (Scherer et al., 2019; Tovar & Ocegueda, 2025). Teachers' acceptance and pedagogical judgment of AI tools transform their passive use of technology into active adoption.

Existing research tends to emphasize general technology use in education or theoretical frameworks, such as technological pedagogical content knowledge (TPACK) or technology acceptance model (TAM), in isolation. However, the emerging capabilities of generative artificial intelligence (GenAI), including agency, adaptivity, amplification, and authenticity, introduce new pedagogical opportunities and ethical dilemmas that traditional models alone cannot fully address (Mishra et al., 2023). These GenAI dimensions influence not only instructional practices but also raise concerns around teacher agency, content authenticity, and equitable access, making their integration into acceptance frameworks essential for capturing the full scope of teachers' perceptions. The newly emerging TPACK-GenAI framework addresses this need, offering insight into AI's pedagogical transformation and ethical concerns (Crompton & Burke, 2023; Lan et al., 2025). These models can provide a robust understanding of teachers' readiness to adopt AI, especially when combined with the TAM model, which captures user beliefs and BIs (Davis, 1989; Kemp et al., 2024), What remains unclear is how these theoretical elements play out in real classroom settings: Do teachers believe AI enhances teaching and assessment? Do they see it as inclusive, ethical, or threatening? Are they ready to use it in interdisciplinary contexts, and what concerns might hold them back?

Purpose of the Study

This study examines how teachers perceive the integration of AI in educational practice, specifically investigating their perceived usefulness (PU), attitudes toward use (ATU), and BI through an integrated TAM-TPACK-GenAI framework. The goal is to explore how AI's pedagogical and ethical dimensions, such as amplification, adaptivity, agency, and authenticity, influence teachers' readiness to adopt AI tools in education. Accordingly, the following questions were developed to guide this study:

1. What pedagogical tasks do teachers perceive as most enhanced by AI, and how do these perceptions reflect PU in the TAM-TPACK framework?
2. How do teachers' attitudes toward AI use in education relate to their perceptions of AI's usefulness, and what ethical or pedagogical concerns do they express?
3. To what extent do PU and ATU predict teachers' BI to integrate AI in their instructional practices?
4. Are there significant differences in teachers' perceptions, attitudes, and BIs based on demographic variables such as teaching level, gender, and years of experience?
5. How do teachers' perceptions of AI's GenAI dimensions, amplification, adaptivity, agency, and authenticity influence their acceptance and intended use of AI in education?

Although there is a growing body of research exploring teachers' adoption of AI, most studies either use single theoretical frameworks or remain at a general technology-use level. This study contributes by

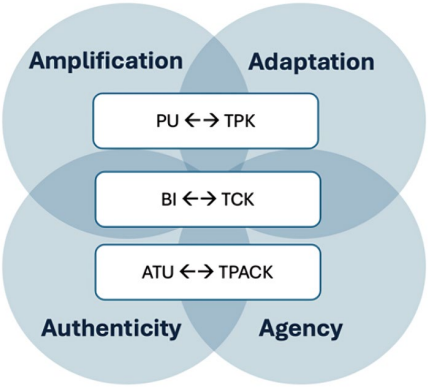

Figure 1. Conceptual framework guiding this study of AI adoption by teachers (Figure created by the authors)

integrating the TAM, TPACK, and the newly emerging TPACK-GenAI framework, thereby capturing both pedagogical and ethical dimensions unique to GenAI. Additionally, focusing on teachers in the UAE provides important contextual insights aligned with national AI policies, which are underrepresented in the international literature.

LITERATURE REVIEW

Theoretical Framework

The integration of AI in education introduces a new transformation in the use of technology, curriculum design, and the learning environment. This study employs an integrated theoretical approach that draws upon the TAM (Davis, 1989) and selected dimensions of the TPACK framework (Mishra & Koehler, 2006), with emphasis on the emerging TPACK-GenAI extension (Crompton & Burke, 2023; Lan et al., 2025; Mishra et al., 2023). Recent studies have expanded these models to capture teachers' evolving interactions with AI-powered tools, emphasizing adaptive feedback, co-creation, and instructional personalization supported by generative technologies (Adıgüzel et al., 2023; Aldossary et al., 2024). These developments position GenAI not merely as a technological innovation but as a catalyst for rethinking pedagogy and teacher agency within AI-enriched learning ecosystems.

Technological pedagogical knowledge (TPK), technological content knowledge (TCK), and TPACK were selected from the TPACK model, as the aim is to study the use of technology in more depth and in relation to the TAM and GenAI constructs. The integration of TAM-TPACK-GenAI, as shown in **Figure 1**, provides a comprehensive framework for analyzing how teachers perceive and respond to AI in education. TAM captures their beliefs, attitudes, and BIs, while TPACK places these responses within technological, pedagogical, and content-specific knowledge. The TPACK-GenAI dimensions add depth by incorporating AI's unique authenticity, adaptation, amplification, and agency. The TAM provides a robust foundation for understanding how teachers form beliefs and intentions regarding the use of new technologies. Three central constructs were used to guide this study:

(1) PU which reflects the TPK,

(2) ATU also reflects TPACK, and

(3) BI that presents TCK (Kemp et al., 2024).

Building on these constructs, Eleftheriou et al. (2025) and Torres-Hernández and Arrufat (2023) highlight that ethical readiness and data protection awareness should be viewed as moderating elements within teachers' BIs, reinforcing the need to embed responsible AI literacy within TAM-based models. The GenAI dimensions, authenticity, adaptation, amplification, and agency, which are set as the foundation of the three main constructs, provide unique insights into AI's transformative role in education. These dimensions are reflected in teachers' evaluations of AI's impact on learning freedom and student-centered pedagogy, as well as their acknowledgment of AI's relevance to real-world application (Mishra & Varshney, 2024). Recent frameworks (e.g., Lan et al., 2025; Tawafak et al., 2025) further connect these GenAI dimensions with

educators' digital competence and self-efficacy, showing that teachers who perceive AI as both useful and authentic demonstrate higher confidence and innovation in practice. Moreover, concerns about AI replacing teachers or worsening existing inequities reflect ethical and implementation issues that this framework might address (Zhao, 2025). By integrating these perspectives, the present model aligns theoretical constructs with current empirical evidence on GenAI acceptance, ethical awareness, and pedagogical transformation in education.

Perceived Usefulness and Technological Pedagogical Knowledge

PU, a core construct of the TAM, refers to the extent to which individuals believe that using a particular technology will enhance their job performance (Davis, 1989). Numerous studies have confirmed that when teachers perceive AI as useful in achieving pedagogical goals, they are more likely to adopt it in their practice (Kemp et al., 2024; Scherer et al., 2019). Recent evidence reinforces this relationship in the context of GenAI, showing that PU is a strong predictor of teachers' willingness to integrate GenAI tools such as ChatGPT, Copilot, and Gemini into lesson planning and assessment (Adıgüzel et al., 2023; Aldossary et al., 2024). These studies highlight that GenAI supports instructional innovation through real-time feedback, content generation, and problem-based learning design, which teachers perceive as enhancing both efficiency and engagement. These perceptions of usefulness align strongly with the TPK domain of the TPACK framework. TPK refers to teachers' knowledge of how teaching and learning can change when particular technologies are used effectively (Mishra & Koehler, 2006). Teachers who perceive AI as pedagogically useful often articulate a shift from traditional teaching strategies to a more student-centered learning environment. For instance, Torres-Hernández and Arrufat (2023) found that teachers who recognize AI's pedagogical value also develop stronger awareness of data privacy and responsible use, suggesting that usefulness perceptions increasingly include ethical and social dimensions. The usefulness of AI also corresponds with two core TPACK-GenAI dimensions: amplification and adaptivity (Lan et al., 2025; Mishra et al., 2023). Amplification refers to AI's ability to extend and enhance the teacher's instructional capabilities, such as providing instant feedback, automating routine tasks, or supporting large-scale personalized learning. Adaptivity, on the other hand, captures AI's ability to modify instructional content and pacing based on individual student data, offering more personalized learning pathways (López, 2024). Current research emphasizes that these adaptive features not only improve teaching efficiency but also foster teachers' confidence and creativity in digital instruction (Muslimin et al., 2023; Njiku et al., 2021).

Teachers recognized the usefulness of AI in various ways. First, AI is increasingly viewed as a way to support instructional delivery and enhance interactivity in classrooms. Systems such as intelligent tutoring tools, adaptive learning platforms, and automated content generators enable more responsive teaching tailored to student needs (ElSayary, 2023; Dann et al., 2024). Furthermore, organizing formative and summative assessment processes, particularly through features such as automatic grading and analytics-based feedback, saves time and enhances assessment accuracy (Zhao, 2025). In addition, AI has the potential to create more inclusive and adaptive learning environments. AI-driven tools can offer real-time language translation, speech-to-text functions, and adaptive learning content, making instruction more accessible to students with diverse linguistic, cognitive, and physical needs (Pawar & Khose, 2024). Teachers perceive these benefits of AI as increasing equity in the classroom and allowing for more differentiated instruction (Shi et al., 2024). Collectively, these findings highlight that PU in the GenAI era extends beyond efficiency; it includes personalization, inclusion, ethical awareness, and creativity in teaching.

Behavioral Intention to Use and Technological Content Knowledge

BI is one of the constructs in the TAM, referring to an individual's willingness to adopt and use a particular technology (Kemp et al., 2024). In educational contexts, BI reflects teachers' readiness or ability to incorporate AI into their instructional practice. Recent studies have shown that BI is strongly influenced by teachers' perceptions of GenAI's reliability, pedagogical usefulness, and ethical transparency (Aldossary et al., 2024; Eleftheriou et al., 2025). When teachers trust the output of GenAI systems and feel confident in their digital competence, their BI to use such tools increases significantly (Muslimin et al., 2023). Research indicates that teachers with high BI aimed to explore how AI can facilitate cross-curricular innovation and interact with disciplinary content. This aligns closely with the TCK domain in the TPACK framework, which focuses on

understanding how technology intersects with content-specific knowledge (Mishra & Koehler, 2006). TCK involves knowing what technology can do and how it can be tailored to support the learning of specific concepts and skills within a discipline. Emerging evidence from teacher education programs suggests that when instructors engage in AI-embedded lesson design, they develop stronger BI by recognizing AI's potential to contextualize abstract disciplinary concepts (Adıgüzel et al., 2023; Torres-Hernández & Arrufat, 2023).

Studies also show that BI is enhanced when teachers believe that AI tools are not supplementary but fundamentally promote the way knowledge is taught and assessed (Crompton & Burke, 2023; Lan et al., 2025; Mishra et al., 2023). This links BI to the amplification dimension of the TPACK-GenAI framework, where AI technologies are seen to extend teachers' capacity to present, differentiate, and assess content more effectively. Tawafak et al. (2025) further confirm that teachers' BI toward GenAI is strengthened by positive prior experiences with digital technologies and institutional encouragement to experiment with intelligent tools, indicating that professional support structures play a key mediating role. Furthermore, teachers with strong BI often see AI as an opportunity for multidisciplinary integration, particularly when curricula require students to work on real-world, problem-based projects involving data, computation, and critical thinking. For example, project-based learning tasks that combine science, technology, and ethics can be supported through AI platforms that manage complexity, adapt to learning pace, and scaffold interdisciplinary content (Pawar & Khose, 2024). Recent classroom applications show that GenAI assists teachers in designing authentic, inquiry-based activities that blend STEM and humanities, reflecting a new form of content-technology interaction focused on creativity, ethical reflection, and real-world relevance (Aldossary et al., 2024; Eleftheriou et al., 2025). The GenAI concept of amplification further supports the idea that teachers are not simply adopting tools but transforming how knowledge is delivered within and across disciplines, making this construct a crucial component for understanding AI integration in education (Luik & Taimalu, 2021; Scherer et al., 2019). In this context, BI becomes not only a measure of adoption but an indicator of teachers' pedagogical innovation and ethical readiness in AI-enhanced classrooms.

Attitudes Toward Use and TPACK-GenAI Factors

ATU in the TAM reflect the emotional and evaluative responses individuals have toward using a technology. These attitudes are affected by ethical beliefs, professional identity, and socio-cultural factors (Kemp et al., 2024). A positive attitude generally predicts stronger BIs and a greater likelihood of adoption. At the same time, negative perceptions may discourage teachers from engaging in new technologies, even when their usefulness is recognized (Luik & Taimalu, 2021). Recent research highlights that teachers' attitudes toward GenAI are becoming increasingly complex, shaped not only by PU but also by trust in algorithmic decisions, transparency of AI systems, and alignment with educational ethics (Aldossary et al., 2024; Eleftheriou et al., 2025). These diverse emotional responses align with the TPACK-GenAI extension, which highlights the unique pedagogical and ethical challenges posed by GenAI technologies. The four key dimensions of the TPACK-GenAI framework, authenticity, adaptivity, agency, and amplification, are particularly relevant to understanding teacher attitudes (Crompton & Burke, 2023; Lan et al., 2025; Mishra et al., 2023). For example, teachers concerned about academic integrity and the misuse of generative content (e.g., AI-written essays) may hold negative attitudes in questioning its authenticity. Similarly, those skeptical about AI decision-making or worried about losing control over instruction reflect anxiety about AI's agency and autonomy in the classroom (Suello & Alda, 2025). Teachers' attitudes are also shaped by their confidence in interpreting AI outputs and by institutional expectations around ethical use; when educators feel they lack guidance, uncertainty often shows as caution or avoidance (Torres-Hernández & Arrufat, 2023). Another concern is about AI replacing human teachers, widening the digital divide, and raising ethical questions about data privacy and authorship (Santos, 2024). Moreover, some teachers question the appropriateness of AI education at the elementary level and advocate for introducing AI only in higher grades. This perspective reveals both a pedagogical concern and a lack of confidence in students' readiness for such complex technologies (Tovar & Gutiérrez, 2025). Similarly, resistance to making AI a compulsory subject suggests a cautious attitude reflecting practical and ethical considerations. Recent studies emphasize that these reservations often arise from broader social and institutional contexts, where teachers' attitudes are not simply personal preferences but reflections of systemic readiness and equity challenges (Paidicán & Herrera, 2022; Sadık, 2020). The digital divide is another major attitudinal concern. Teachers working in under-

resourced schools may fear that AI will further disadvantage students lacking access to high-speed internet or digital literacy training. These concerns align with TPACK-GenAI's emphasis on equity, suggesting that negative attitudes are often not about the technology itself, but rather about systemic barriers to its equitable implementation (Pawar & Khose, 2024). Addressing these concerns through targeted professional development and ethical AI literacy initiatives has been shown to transform attitudes from fear to empowerment (Muslimin et al., 2023; Tawafak et al., 2025). Despite these concerns, many teachers view AI as a valuable complement to instruction when integrated responsibly. Educators express enthusiasm about AI's potential to enhance engagement and support personalized learning. Aldossary et al. (2024) reported that teachers who experienced GenAI-supported lesson planning expressed heightened motivation and curiosity, perceiving AI as a partner in creativity rather than a threat to professionalism. For example, teachers report that students enjoy learning with AI tools, particularly in gamified or interactive formats (Zhao, 2025), which fosters more favorable perceptions of AI-enhanced classrooms. Studies have shown that professional development opportunities and institutional support significantly improve teachers' attitudes toward AI (Celik, 2022; ElSayary, 2023; Shi et al., 2024). When teachers feel empowered and informed, they are more likely to appreciate AI's amplifying potential rather than fear replacement. Similarly, Eleftheriou et al. (2025) argue that structured mentorship and peer collaboration in AI-supported teaching environments can strengthen emotional readiness and promote ethically grounded enthusiasm among educators. When teachers feel empowered and informed, they are more likely to appreciate AI's amplifying potential rather than fear replacement.

Study Context

This study was conducted in Al Ain, a major city in the Emirate of Abu Dhabi, UAE. In alignment with the UAE's national agenda, education has become a main objective of innovation and sustainable development. The UAE vision 2031 and the centennial plan 2071 emphasize the importance of integrating advanced technologies such as AI to foster a knowledge-based, future-ready society. The launch of the UAE National AI Strategy 2031 positions the country as a global hub for AI, aiming to transform sectors such as healthcare, government, and education (UAE Government, 2023). This research aligns both the UAE's innovation goals and the global sustainable development goal 4 (quality education), which promotes inclusive and equitable education and lifelong learning opportunities. As AI rapidly integrates into education, it is important to understand how teachers perceive its usefulness, ethical implications, and implementation challenges to ensure a responsible approach that serves both local and global educational priorities (Du, 2024). This study was conducted in the emirate of Al Ain, where 332 teachers participated from ten national and international schools. To collect data, a structured survey instrument was designed to capture teachers' perceptions of AI usefulness in teaching, assessment, and curriculum, their attitudes, and BI to use it. The survey was categorized based on the main constructs from the TAM model: PU, ATU, and BI, which are aligned with TPK, TPACK, and TCK, respectively. The embedded dimensions of GenAI, agency, amplification, adaptivity, and authenticity, were also explored and validated through the survey items.

METHODOLOGY

This study employed a quantitative, cross-sectional survey design to investigate teachers' perceptions of AI integration in education, guided by an integrated TAM-TPACK-GenAI framework.

Participants

A total of 332 in-service teachers in Al Ain, UAE, participated in the study. Participants were recruited using a convenience sampling approach, as access was granted through school administrators in Al Ain. Invitations were distributed electronically via school mailing lists and professional teacher networks, and participation was voluntary. Although this method enabled access to a diverse pool of in-service teachers, it may not capture the perspectives of all teachers across the UAE. The majority of participants were female (91%), while the males represented 9% only. This gender imbalance may affect the generalizability of findings and is acknowledged as a limitation (see limitations section). Regarding participants' age, nearly half (47.6%) were under 25, followed by participants aged 25-29 (18.4%) and 30-39 (16%). Most teachers hold a bachelor's degree (78.9%), with few holding master's (15.1%), doctoral (4.5%), or postdoctoral (1.5%) qualifications.

Table 1. Survey items mapped to key constructs and dimensions of the integrated framework

Survey items	TAM	TPACK	GenAI
1. Integration of AI helps in the teaching process.	PU	TPK	Agency
2. AI integration helps in the assessment and evaluation process.	PU	TPK	Agency
3. AI integration in curriculum made teaching more interactive.	PU	TPK	Amplification
4. AI integration in curriculum improved the delivery and understanding of subject-specific content.	BI	TCK	Amplification
5. AI promotes an interdisciplinary/multidisciplinary approach to teaching other subjects.	BI	TCK	Amplification
6. AI integration allows more time and freedom to provide understanding and adaptability.	PU	TPK	Adaptivity
7.Students enjoy learning about AI.	ATU	TPACK	Authenticity
8. AI should not be taught as a compulsory subject.	ATU	TPACK	Authenticity
9. AI should be taught in higher classes only.	ATU	TPACK	Authenticity
10. AI helps in creating an inclusive learning environment.	PU	TPK	Adaptivity
11. AI integration will reduce the drop-out rate and enhance students' performance.	ATU	TPACK	Adaptivity
12. AI integration will enhance the digital divide in society.	ATU	TPACK	Authenticity
13. Mechanical teachers will replace human teachers in future.	ATU	TPACK	Agency
14. AI can be applied in real life.	PU	TPK	Agency/amplification

Participants represented a range of teaching experience, with almost half (47.3%) in their first year, and others having 1-2 years (9.6%) to more than 20 years (5.1%) of experience. Respondents also varied in teaching grade levels, with the largest groups teaching grade 1-grade 3 (22.6%), KG 1-2 (22%), and Pre-KG (18.7%), while teachers teaching grades 4-6 (15.10%), 7-9 (8.7%), and 10-12 (13%) were minors.

Instrument

Data were collected using a structured, self-administered survey consisting of 14 items mapped to constructs within the TAM-TPACK-GenAI framework. The survey instrument was adapted based on established constructs from the TAM (Davis, 1989), TPACK framework (Mishra & Koehler, 2006), and the recent TPACK-GenAI extension (Lan et al., 2025; Mishra et al., 2023). To ensure content validity, the survey items were reviewed by three experts in AI in education and instructional design. The feedback received was positive; however, they suggested rewording on two items that were changed and confirmed by them. Additionally, a pilot test was conducted with a group of 30 teachers who were not included in the final sample using Cronbach's alpha. The results showed high reliability in PU (α = .907), ATU (α = .783), and overall (α = .864). However, the category BI (α = .409) shows low reliability and was confirmed by experts' feedback to minor adjustments in wording for clarity and comprehension. The final version of the instrument demonstrated strong internal consistency and construct validity (see results section). Survey items were designed to reflect core constructs, including PU, ATU, and BI, and were mapped onto corresponding TPACK domains and GenAI dimensions (agency, amplification, adaptivity, and authenticity), see **Table 1**. Each item was rated on a five-point Likert scale ranging from 1-strongly disagree to 5-strongly agree.

Procedures

This study employed a two-phase analytical approach, utilizing SPSS and SmartPLS, to investigate teachers' perceptions of AI integration in education within an integrated TAM-TPACK-GenAI framework. Ethical approval for the study was obtained from the university's research ethics committee. All participants were provided with an explanation of the study's purpose, procedures, and data confidentiality, and they gave informed consent before completing the survey. Data were collected through a structured online survey administered via a secure platform. Teachers received the survey link from their schools and completed it independently. The anonymity of responses was assured to encourage openness, and no identifying information was collected. Survey items for PU, ATU, and BI were computed using the mean of associated items. Cronbach's alpha was used to assess internal consistency, with $\alpha \geq 0.70$ considered acceptable (Nunnally, 1978). Descriptive statistics (means, standard deviations, frequencies) were computed in SPSS to explore how teachers perceive AI's pedagogical value (RQ1). To address RQ2, Pearson correlations and a linear regression analysis were performed to assess the predictive relationship between PU and ATU. For RQ3 and RQ5, structural equation modeling (SEM) was conducted using SmartPLS, which includes confirmatory factor analysis (CFA) and structural model testing. For the CFA, convergent validity was verified through standardized

Table 2. Descriptive statistics and reliability for the main constructs

Construct	M	SD	α	1	2
1. PU	3.71	.94	.896		
2. BI	3.66	1.02	.839	.845**	
3. ATU	3.37	.811	.792	.587**	.560**

** Correlation is significant at the 0.01 level (2-tailed)

loadings (≥ 0.70), composite reliability (CR) (≥ 0.70), and average variance extracted (AVE) (≥ 0.50). Discriminant validity was evaluated using the Fornell-Larcker criterion and Heterotrait-Monotrait (HTMT) ratio. For structural model testing**,** path coefficients (β), effect sizes (f^2), and variance explained (R^2) were interpreted. Model fit was assessed using the standardized root mean square residual (SRMR), with values under 0.08 considered acceptable. To address demographic differences (RQ4), independent-samples t-tests and one-way ANOVAs were conducted to examine variations in PU, ATU, and BI by teaching level, gender, and years of experience. Tukey HSD post hoc tests were applied where significant differences were found. Finally, GenAI-related dimensions (agency, amplification, authenticity, and adaptivity) were examined using embedded items across TAM constructs. Their influence was explored through descriptive and correlational analyses, enhancing interpretation of how AI's pedagogical and ethical features influence acceptance. These analyses ensured robust construct validation and meaningful interpretation, supporting both theory testing and contextual understanding of AI integration in educational settings.

RESULTS

Descriptive Statistics and Reliability

Although the BI construct initially showed lower internal consistency during preliminary testing, the final Cronbach's alpha improved to α = .839. Overall, the internal consistency for the three main constructs, PU, BI, and ATU, was high, with Cronbach's alpha ranging from .792 to .896 and an overall model reliability of α = .915. This confirms strong internal reliability across the instrument, exceeding the conventional threshold of α ≥ .70 (Nunnally, 1978). **Table 2** summarizes the descriptive and reliability statistics.

While all constructs showed moderate to high average agreement (means between 3.37 and 3.71), the highest-rated construct was PU (mean [M] = 3.71, standard deviation [SD] = .94), indicating that teachers perceive AI as particularly helpful for instructional and pedagogical enhancement. This supports previous findings emphasizing teachers' recognition of AI's pedagogical utility in areas such as lesson interactivity, adaptive instruction, and inclusive learning design. Notably, BI (M = 3.66, SD = 1.02) also reflected strong teacher intention to integrate AI into subject-specific teaching and curriculum development. This suggests growing awareness of AI's role in disciplinary and cross-curricular content application, resonating with the *amplification* dimension of TPACK-GenAI. ATU had the lowest mean (M = 3.37, SD = .811), presenting comparatively greater caution or mixed feelings about AI integration. This includes concerns about age-appropriate use, the digital divide, and teacher replacement. These issues are connected to GenAI's more disruptive characteristics, specifically *agency* and *authenticity*, which appear to moderate overall enthusiasm for AI in schools.

Correlations among the three core constructs were statistically significant and strong ($p < .01$), with PU showing particularly high associations with BI (r = .845) and ATU (r = .587). This confirms the theoretical expectation from TAM that PU is a central predictor of both positive ATU and BI (Kemp et al., 2024). The significant correlation between BI and ATU (r = .560) further supports the model's structural validity and suggests that teachers' emotional and ethical orientations toward AI shape their likelihood of future integration.

Measurement Model and Confirmatory Factor Analysis

CFA was conducted to assess the reliability and validity of the measurement model. The model included three latent constructs: PU, ATU, and BI, each presented the variables drawn from the integrated TAM-TPACK-GenAI framework.

Table 3. Convergent validity using CR and AVE and discriminant validity using HTMT

	CR (rho_c)	AVE	BI	PU
ATU	0.849	0.500	.700	.744
BI	0.926	0.862		.971
PU	0.920	0.659		

Table 4. Model fit indices from SmartPLS

	Saturated model	Estimated model
SRMR	0.098	0.098
d_ULS	1.009	1.009
d_G	0.311	0.311
Chi-square	590.293	590.293
NFI	0.793	0.793

Table 5. Path coefficients and significance

Path	β	t	p	Supported
PU → ATU	0.692	19.647	0.000	Yes
PU → BI	0.780	15.247	0.000	Yes
ATU → BI	0.094	1.635	0.102	No
PU → ATU → BI	0.065	1.598	0.110	No

Convergent and discriminant validity

Convergent validity was evaluated using CR and AVE. As shown in **Table 3**, all constructs demonstrated strong internal consistency, with CR values exceeding the recommended minimum of 0.70 (Hair et al., 2021). AVE values met or exceeded the minimum threshold of 0.50 for ATU and were well above for PU and BI, confirming adequate convergent validity (Fornell & Larcker, 1981). Discriminant validity was examined using the HTMT ratio of correlations. All HTMT values were below the conservative threshold of 0.85 (Henseler et al., 2014), indicating acceptable discriminant validity between constructs. While the HTMT value between PU and BI was relatively high (0.971), it remains below the critical value of 1.00, suggesting acceptable but close convergence between these constructs, consistent with TAM's theoretical expectation that PU strongly influences BI.

Model Fit Indices

Model fit was assessed using multiple criteria, including the SRMR, d_ULS, and normed fit index (NFI). The SRMR for both the saturated and estimated models was 0.098, which is slightly above the recommended threshold of 0.08, indicating a moderate fit with some limitations (Hu & Bentler, 1999). This indicates that although the overall model structure is acceptable for exploratory theory testing, there may be some unaccounted variance or model complexity that warrants cautious interpretation. The NFI value of 0.793 indicates a reasonable but not optimal fit. Although some indices (e.g., SRMR = 0.098, NFI = 0.793) fall below the ideal cutoffs, they remain within acceptable ranges for exploratory PLS-SEM studies (Hair et al., 2021). This suggests that while the model fit is moderate rather than optimal, it is sufficient for theory testing in this context (**Table 4**).

Structural Model and Path Analysis

To test the hypothesized relationships among the three core constructs, PU, ATU, and BI, a SEM was estimated using SmartPLS. The model examined the direct and indirect relationships among the study constructs within the TAM-TPACK-GenAI framework.

Path coefficients were analyzed to evaluate the direct relationships between constructs. As shown in **Table 5**, PU had a significant positive influence on both ATU (β = 0.692, p < .001) and BI (β = 0.780, p < .001). However, ATU did not significantly predict BI (β = 0.094, p = .102). Mediation analysis tested whether ATU mediates the relationship between PU and BI. The specific indirect effect (PU → ATU → BI) was not statistically significant (β = 0.065, p = .110), indicating that ATU does not significantly mediate this relationship. This aligns with the weak direct path from ATU to BI. This finding suggests that while positive attitudes (ATU) are related to teachers' intentions to adopt AI, they do not meaningfully explain the pathway from PU to BI in this model.

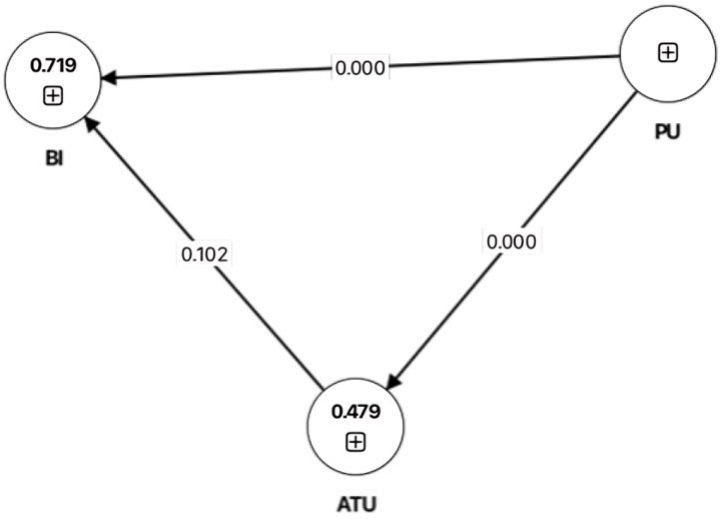

Figure 2. Structural model illustrating the direct and indirect relationships among the study constructs within the TAM-TPACK-GenAI framework (Figure created by the authors)

Rather, the practical benefits teachers perceive (PU) seem to drive intention (BI) more directly and strongly outweigh emotional or ethical attitudes in this context.

The model demonstrated strong explanatory power, where PU accounted for 47.9% of the variance in ATU (R^2 = 0.479). Together, PU and ATU explained a substantial 71.9% of the variance in BI, indicating high model adequacy in predicting teachers' BI to adopt AI. Effect sizes assessed using Cohen's f^2. PU showed a large effect on both ATU (f^2 = 0.918) and BI (f^2 = 1.130). The effect of ATU on BI was small (f^2 = 0.017), in line with its non-significant path coefficient.

The large PU→BI effect (β = 0.780) indicates that teachers' perceptions of AI's usefulness, such as its ability to enhance teaching efficiency, engagement, and content delivery, significantly influence their decision to adopt AI tools. In practical terms, this suggests that if teachers are convinced that AI will help them teach better, they are highly likely to integrate it, regardless of other concerns. This highlights the importance of emphasizing the practical and visible benefits of AI in professional development and implementation strategies.

As shown in **Figure 2**, the structural model provides strong empirical support for the TAM-TPACK-GenAI framework, especially highlighting the main role of PU in shaping both teachers' ATU and BI. However, ATU did not significantly predict BI, suggesting that PU outweighs emotional or ethical concerns in driving AI adoption among teachers. The findings also highlight the limited mediating role of ATU, reinforcing the primacy of practical value over affective disposition. The SRMR value and nonsignificant ATU→BI path suggest that while the model captures the dominant drivers of AI adoption intentions well, it may underrepresent the detailed emotional factors influencing adoption. Future research could explore additional constructs to capture this space better.

Regression Analysis

To further validate the structural relationships in the TAM-TPACK-GenAI framework, supplementary regression analyses were conducted using SPSS.

Predicting ATU from PU

A simple linear regression was conducted to determine the extent to which PU predicts ATU. As shown in **Table 6**, results indicate a statistically significant model, F (1,330) = 173.53, $p < .001$, with PU accounting for 34.5% of the variance in ATU (R^2 = .345). The regression coefficient was also significant (β = .587, $p < .001$), suggesting that teachers who perceive AI as pedagogically useful tend to hold more favorable attitudes toward its use in education.

Table 6. Regression of ATU on PU

Coefficients[a]						
Model		Unstandardized coefficients		Standardized coefficients	t	Significance
		B	Standard error	Beta		
1	(Constant)	1.496	.147		10.154	< .001
	PU	.506	.038	.587	13.173	< .001

[a] Dependent variable: ATU

Table 7. Regression of BI on PU and ATU (SPSS output)

Coefficients[a]						
Model		Unstandardized coefficients		Standardized coefficients	t	Significance
		B	Standard error	Beta		
1	(Constant)	.077	.139		.556	.578
	PU	.855	.039	.787	21.827	< .001
	ATU	.123	.045	.098	2.705	.007

[a] Dependent variable: BI

Table 8. GenAI-related dimensions, mapped from embedded items across PU, BI, and ATU

Construct	M	SD	α	1	2	3
1. Agency	3.44	.923	.691			
2. Adaptivity	3.56	.913	.782	.768**		
3. Amplification	3.70	.891	.839	.798**	.825**	
4. Authenticity	3.27	.891	.736	.643**	.529**	.471**

** Correlation is significant at the 0.01 level (2-tailed)

Predicting BI from PU and ATU

A multiple regression analysis examined the combined influence of PU and ATU on BI. The overall model was highly significant, $F(2,329) = 421.95$, $p < .001$, explaining 71.9% of the variance in BI ($R^2 = .719$). PU emerged as a strong predictor ($\beta = .787$, $p < .001$), while ATU had a weaker but significant effect ($\beta = .098$, $p = .007$), see **Table 7**.

These findings reinforce the central role of PU in shaping both teachers' ATU and BI toward AI, consistent with the TAM framework.

Group Differences by Gender, Qualifications, and Experiences

Teachers' PU, ATU, and BI regarding AI integration differ across age, qualifications, teaching levels, and years of experience. A one-way ANOVA and independent-samples t-tests were used to evaluate statistically significant differences in the three TAM-TPACK-GenAI constructs: PU, ATU, and BI.

For different age groups, significant differences were found in BI $F(5,326) = 2.268$, $p < .05$, $\eta^2 = .034$, with teachers aged 30-49 reporting the highest perceptions of BI toward integrating AI. There were no significant differences among ages in PU and ATU. Another significant difference was found in the BI with the teachers' experiences $F(6, 325) = 2.523$, $p < .05$, $\eta^2 = .045$, with teachers who have 1-10 years of experience reporting higher in BI than other teachers exceeding 10 years of experience. Regarding the PU, there was a significant difference found with regards to the teaching level $F(5, 326) = 2.600$, $p < .05$, $\eta^2 = .40$, with teachers teaching grades 4-9 reporting higher in PU. Regarding ATU, there was no significant difference in any demographics, suggesting attitudes are stable across different demographics.

Internal Consistency With GenAI Dimensions

In addition to the TAM constructs, GenAI-related dimensions, mapped from embedded items across PU, BI, and ATU, were examined to gain a deeper understanding of the nature of teachers' perceptions. As shown in **Table 8**, amplification ($M = 3.70$, $SD = .891$) and adaptivity ($M = 3.56$, $SD = .913$) emerged as the most positively perceived traits, with strong internal consistency and high intercorrelations. Authenticity ($M = 3.27$, $SD = .891$) and agency ($M = 3.44$, $SD = .923$), while still moderately rated, reflect areas of greater concern and conceptual tension, particularly in relation to teacher replacement and digital ethics. All dimensions demonstrated acceptable reliability, with Cronbach's alpha values ranging from $\alpha = .691$ (agency) to $\alpha = .839$ (amplification), supporting the internal consistency of the GenAI subscales.

Furthermore, strong positive correlations were observed among agency, adaptivity, and amplification, with the highest correlation between adaptivity and amplification ($r = .825$, $p<.001$). These results indicate that teachers who perceive AI as adaptable also view it as an amplifier of their instructional capacity. By contrast, authenticity concerns correlated more moderately with the other dimensions, particularly with agency ($r = .643$), suggesting that perceptions of AI's autonomy may trigger ethical concerns regarding authorship and human oversight.

The findings confirm the importance of integrating GenAI dimensions into TAM. Teachers appreciate AI's amplifying and adaptive roles, supporting its use for instructional enhancement and learner personalization. However, remaining concerns around authenticity and agency hinder enthusiasm and highlight the need for critical TPACK and ethical AI literacy in professional development.

DISCUSSION

Perceived Usefulness and Pedagogical Enhancement

The findings from this study reveal that teachers overwhelmingly perceive AI as pedagogically useful, with PU emerging as the highest-rated construct. This aligns with existing literature suggesting that PU is the most critical factor in shaping educators' acceptance of new technologies (Kemp et al., 2024; Scherer et al., 2019). Teachers in this study associated AI integration with enhancements in lesson interactivity, classroom engagement, and instructional personalization. Specifically, participants endorsed the value of AI in both teaching and assessment processes, with many recognizing that tools such as automated grading and real-time analytics can reduce teacher workload while improving the precision of feedback (Shi et al., 2024; Zhao, 2025).

Furthermore, the data suggest that teachers value AI's capacity to support inclusive and adaptive learning environments, addressing student diversity, such as providing differentiated instruction for learners with varying needs (Pawar & Khose, 2024; Shi et al., 2024). The strong correlation between PU and both ATU and BI further emphasizes that when AI is perceived to meaningfully enhance teaching effectiveness, teachers are more likely to adopt it regardless of broader ethical or institutional concerns (Davis, 1989; Kemp et al., 2024). Additionally, AI's perceived ability to support cross-disciplinary and real-world learning applications may reflect a shift toward problem-based and student-centered approaches (Dann et al., 2024; Mishra & Varshney, 2024).

Attitudes Toward Artificial Intelligence and Ethical Concerns

While teachers in this study generally acknowledged the PU of AI, their ATU was more cautious and mixed, as reflected in the comparatively lower mean score. This suggests that emotional, ethical, and contextual considerations continue to shape teachers' willingness to engage with AI in educational settings, highlighting concerns about autonomy, ethics, and job security (Luik & Taimalu, 2021; Suello & Alda, 2025). Other concerns about authenticity and agency, in items such as "*Mechanical teachers will replace human teachers*" and "*AI integration will enhance the digital divide,*" reflect anxieties around professional displacement and societal inequities (Pawar & Khose, 2024; Santos, 2024). It is also important to note that teachers may have interpreted the term "AI" differently, ranging from generative tools such as ChatGPT to design platforms like Canva or classroom applications such as gamma. This variation in interpretation may partly explain the diversity of responses across items.

Teachers' uncertainty also extended to curriculum decisions. Many expressed reservations about introducing AI as a compulsory subject or at lower grade levels, as noted in recent literature advocating for age-sensitive AI curricula (Lan et al., 2025; Mishra et al., 2023; Tovar & Gutiérrez, 2025). Notably, the regression results indicate that while ATU is positively associated with BI, its effect is modest compared to PU. This highlights that teachers' practical perceptions of usefulness outweigh ethical or emotional concerns when it comes to actual adoption behavior (Kemp et al., 2024). However, addressing ethical concerns remains important for fostering deeper engagement and sustainable adoption. Professional development should foster ethical AI literacy, equip teachers to critically evaluate algorithmic decisions, and support dialogue around pedagogical values in AI-rich environments (Celik, 2022; Shi et al., 2024).

Predicting Behavioral Intentions to Use Artificial Intelligence

One of the most robust findings in this study was the strong predictive relationship between PU and BI to use AI, a result consistent with the foundational assumptions of the TAM (Davis, 1989; Kemp et al., 2024). In both SEM and regression analyses, PU emerged as the dominant factor influencing BI, confirming that teachers are most likely to adopt AI when they see clear, practical benefits in their pedagogical practice. This finding aligns with previous research, which shows that educators are more likely to adopt educational technologies when they align with teaching goals and improve efficiency (Celik, 2022; Scherer et al., 2019).

In the context of this study, teachers identified PU of AI in enhancing classroom interactivity, enabling more effective assessment, and facilitating subject-specific delivery, particularly in interdisciplinary contexts. These affordances correspond to the Amplification dimension, wherein AI extends teachers' capabilities by automating tasks, scaling personalization, and managing complex instructional workflows (Lan et al., 2025; López, 2024; Mishra et al., 2023). Interestingly, ATU had only a weak predictive effect on BI. This suggests that even teachers who are ethically cautious or emotionally uncertain toward AI may still intend to use it, as they believe it offers substantial instructional value, which reinforces that PU often balances ATU in technology acceptance (Luik & Taimalu, 2021).

The limited mediating role of ATU suggests a need to reframe professional development around usefulness and direct applicability rather than attitude change alone. When AI tools are introduced as solutions to real classroom problems, such as time constraints, differentiation challenges, or inclusive instruction, teachers are more likely to adopt them, regardless of broader concerns. This aligns with recent scholarship promoting the subject-aligned integration of AI (Davis, 2024; Pawar & Khose, 2024).

It is important to recognize that AI adoption in education is evolving rapidly. As new tools and practices emerge, teachers' perceptions may change within short periods. Nevertheless, capturing perceptions during this stage provides valuable insights into how educators respond at the early phases of implementation. These data offer a timely baseline that can inform both ongoing policy initiatives and longitudinal comparisons in future studies.

Teacher Readiness and Demographics Differences

The study found that teachers' perceptions and intentions to use AI varied significantly based on demographic factors, especially age, teaching experience, and grade level taught, while attitudes toward AI remained relatively consistent across groups. These findings offer insight into how exposure, career stage, and pedagogical context influence AI adoption in education.

Teachers aged 30-49 and those with 1-10 years of experience showed significantly higher BI to adopt AI, suggesting that mid-career educators may be particularly open to innovation. This aligns with research indicating that teachers in this range often balance sufficient experience with openness to new pedagogical approaches (Luik & Taimalu, 2021). These educators may feel more confident experimenting with new tools, yet still feel pressure to improve outcomes, especially in rapidly transforming educational systems such as the UAE's.

Similarly, higher PU scores among teachers of grades 4-9 suggest that perceptions of AI effectiveness may vary by curriculum demands. Upper primary and lower secondary educators may encounter more opportunities to use AI for subject-specific instruction, interdisciplinary projects, or assessment automation, features highlighted under the amplification and TCK domains in the integrated framework (Crompton & Burke, 2023; Lan et al., 2025; Mishra et al., 2023). In contrast, teachers in earlier grades may see fewer immediate applications or feel that AI lacks developmental appropriateness for their students (Tovar & Gutiérrez, 2025).

Interestingly, ATU toward AI did not differ significantly across gender, teaching level, or years of experience. This consistency suggests that emotional and ethical concerns, such as fears of teacher replacement, digital inequity, or the appropriateness of AI as a subject, may be broadly shared among educators, regardless of background. These concerns map closely to the agency and authenticity dimensions, indicating that while practical readiness may vary, ethical reservations are widespread (Santos, 2024; Suello & Alda, 2025). The absence of gender-based differences in PU or ATU indicates that both male and female

teachers perceive AI's pedagogical potential and ethical risks similarly, which reinforces the need for profession-wide engagement on these issues.

These findings emphasize the importance of differentiated professional development. Rather than one-size-fits-all training, support initiatives should consider teachers' subject areas, career stage, and grade level. For example, early-grade teachers may benefit from guidance on age-appropriate AI integration, while mid-career teachers might be more open to advanced applications in data modeling or adaptive learning. In contrast, mid-career educators, particularly those in grades 4-9, may benefit from more advanced training focused on utilizing AI for subject-specific innovation, adaptive learning, and data-driven instruction. Furthermore, given the widespread nature of ethical concerns, all training should incorporate critical reflection on AI's role in teaching and learning, ensuring that both pedagogical goals and professional values guide adoption.

GenAI Dimensions and Teacher Acceptance

The inclusion of GenAI dimensions, amplification, adaptivity, agency, and authenticity, in this study provides a deeper lens through which to interpret teacher acceptance of AI. Among these, amplification and adaptivity were the most positively perceived, with strong internal consistency and high intercorrelations. This indicates that teachers primarily view AI as a means of extending their instructional capacity and personalizing learning, confirming the relevance of these constructs to educational practice (Lan et al., 2025; López, 2024; Mishra et al., 2023). Teachers' strong agreement with amplification-related items (e.g., *AI making lessons more interactive or improving content delivery*) suggests that AI is seen not as a replacement for human teaching, but as a co-teaching partner that enhances efficiency, engagement, and content accessibility. This aligns with existing literature describing AI's role in automating routine tasks and supporting large-scale personalized instruction (Crompton & Burke, 2023; Shi et al., 2024). Similarly, the high rating for adaptivity reflects educators' appreciation for AI's potential to respond to diverse learner needs, which is aligned with studies emphasizing inclusivity and differentiation in AI-enhanced classrooms (Pawar & Khose, 2024; Silva et al., 2025).

In contrast, authenticity and agency received comparatively lower ratings, highlighting greater teacher concern over AI's disruptive potential. Concerns about authorship, instructional control, and the potential for AI to undermine human-centered pedagogy emerged consistently across both analyses (Santos, 2024; Suello & Alda, 2025). The moderate correlation between authenticity and agency suggests these concerns are interconnected and may be influenced by broader societal narratives about AI. When educators question whether students truly understand content generated by AI or whether teaching decisions should be delegated to algorithms, they are expressing doubts about pedagogical integrity and teacher autonomy (ElSayary, 2023; Tovar & Gutiérrez, 2025).

These findings confirm that teachers' ethical concerns are not about AI's capabilities, but about how AI fits within their professional values and educational goals. To foster acceptance, it is essential to engage teachers not only in technical training but in critical reflection about AI's role in learning. Professional development should explicitly address the ethical dimensions of AI, promote human-AI complementarity, and include guidance on evaluating and adapting AI tools to support equity and authenticity in student learning.

Theoretical and Practical Implications

The findings of this study offer important implications for educational practice and policymaking, particularly as schools and governments continue to embed AI into teaching and learning systems. First, the strong influence of PU on both ATU and BI highlights the need to center AI professional development around practical pedagogical benefits. Teachers are more likely to adopt AI when they see it directly enhancing instruction, assessment, and student engagement (Davis, 1989; Kemp et al., 2024; Shi et al., 2024). Therefore, training programs should go beyond tool demonstrations and focus on subject-specific applications, interdisciplinary integration, and classroom management with the aid of AI. This includes emphasizing amplification and adaptivity, which were the most positively rated GenAI dimensions, reflecting teacher confidence in AI's ability to personalize instruction and extend instructional reach (Lan et al., 2025; Mishra et al., 2023; Pawar & Khose, 2024). Second, the study identified greater contradictions in teacher attitudes, particularly concerning the ethical and social implications of AI. Concerns about AI's agency (e.g., automation of teaching roles) and authenticity (e.g., AI-generated content) suggest that teachers' uncertainty is not from

a lack of technical understanding, but from value-based and ethical concerns (Santos, 2024; Suello & Alda, 2025). To address this, AI literacy initiatives must include critical reflection on data privacy, authorship, equity, and the evolving role of educators. The findings also suggest that teachers' readiness to adopt AI is not only shaped by perceptions of usefulness and attitudes but may also depend on contextual factors such as the training provided by schools, opportunities for self-education, and peer mentoring (ElSayary, 2023). Embedding these elements in both research models and professional development programs would provide a more holistic perspective on how AI can be sustainably integrated into teaching practice.

For policymakers, the findings indicate a need to develop national standards and curriculum guidelines that clarify the role of AI in education, not only in terms of content coverage but also ethical implementation. Given the UAE's AI strategy, efforts should ensure that infrastructure, training, and resource allocation reach schools across all socioeconomic contexts, preventing the amplification of the digital divide (Abbas, 2024; UAE Government Portal, 2023). The relatively lower ratings in authenticity and agency highlight the risk of top-down AI mandates without sufficient teacher voice, professional preparation, or contextual adaptation. Finally, results showed that younger teachers and those with fewer years of experience were more enthusiastic about AI integration. This suggests a generational shift in readiness and a potential for peer-led communities of practice to support AI implementation. Schools can capitalize on this by creating collaborative learning environments where teachers co-develop AI strategies, mentor one another, and share classroom innovations.

Finally, the integrated TAM-TPACK-GenAI framework applied in this study should be regarded as an exploratory model. Although it highlights meaningful relationships between PU, attitudes, BIs, and GenAI dimensions, it does not capture all contextual and pedagogical variables relevant to AI adoption. Future research should expand the model by incorporating additional constructs, such as institutional support and teacher professional development, and by employing more detailed measurement tools. This will allow for a more comprehensive and predictive framework for AI integration in education.

Limitations and Recommendations

Several limitations in this study must be acknowledged. First, although the convenience sample of 332 teachers provides valuable insights, it was drawn from a single region (Al Ain) and therefore may not be generalizable to all teachers in the UAE or internationally. The study should be regarded as an exploratory contribution that provides an indicative perspective and a foundation for more extensive, representative, and comparative research in the future.

Another limitation concerns the precision of measurement. The survey items referred broadly to "AI integration," which teachers may have interpreted in different ways (e.g., GenAI, adaptive platforms, and design tools). Such variability in understanding could have introduced inconsistencies in responses. Future research should therefore specify tool categories or provide clear definitions to improve measurement accuracy. It is also important to investigate how different types of AI tools can help clarify which technologies enhance teacher agency and which may inadvertently undermine it. AI tool-specific studies are essential for providing actionable recommendations, especially in identifying best-fit technologies for different grade levels, disciplines, and school environments. These insights can inform more intentional design and adoption strategies.

Furthermore, the data are based solely on self-reported perceptions from teachers, which may be subject to social desirability bias or individual interpretation. The absence of triangulation with classroom observations, student feedback, or actual AI tool usage limits the depth of behavioral validation. Future research should expand beyond teachers to include the voices of students, school administrators, and parents across the UAE and the wider Gulf Region.

Also, Cultural, institutional, and policy differences across the broader UAE and Gulf Region may influence perceptions of AI integration. Future studies should therefore expand to include participants from other Emirates and Gulf countries to capture more diverse educational contexts. Such comparative work would help illuminate how sociocultural and systemic factors shape AI adoption.

This research employed a cross-sectional survey design, which captures a single point in time. This limits the ability to track how teachers' perceptions evolve with increased exposure to or training in AI technologies,

making cross-sectional data quickly outdated. Future research should therefore employ longitudinal designs to track how attitudes and intentions shift as teachers gain more exposure to emerging AI applications. Additionally, it is recommended to examine how attitudes and adoption behaviors develop over time, especially after professional development interventions or direct classroom implementation. Mixed-method studies could complement this by exploring the qualitative dimensions of teachers' experiences.

Regarding the internal consistency, the BI construct showed weaker reliability during early validation; its final Cronbach's alpha of .839 indicates strong internal consistency. Nevertheless, future studies should continue to refine measurement items to ensure stability across diverse teacher populations. Another limitation relates to model fit, as not all PLS-SEM indices achieved the highest recommended thresholds. However, given that PLS-SEM is particularly suited for exploratory research and theory development, the model still provides meaningful insights into the relationships between TAM, TPACK, and GenAI constructs.

From a practical standpoint, professional development programs must go beyond technical training to include ethical reasoning, pedagogical alignment, and critical reflection. Programs that address teachers' real concerns and contexts are more likely to improve confidence, engagement, and ultimately classroom implementation of AI.

Additionally, the research tool did not include several contextual variables that could significantly influence teachers' perceptions and intentions. These include institutional preparation for AI integration (e.g., training or professional development provided by schools), teachers' self-directed learning efforts, and peer-to-peer support. The absence of these variables limits the ability to fully capture the ecosystem in which AI adoption occurs. Future studies should incorporate these dimensions to provide a more comprehensive understanding.

Policy makers are encouraged to embed equity considerations at the heart of AI implementation strategies. This includes ensuring that schools with limited resources are not left behind and that guidelines are developed collaboratively with educators, considering ethical, pedagogical, and infrastructural needs. Policies should also support culturally responsive AI integration by aligning national educational values and institutional priorities.

Finally, the study integrates constructs from the TAM, TPACK, and TPACK-GenAI frameworks, but it does not assess the effectiveness or usability of particular technologies. Thus, continued refinement of context-sensitive theoretical models, such as TPACK-GenAI, is essential. Empirical testing of such models with specific AI tools across culturally varied settings will enhance our understanding of how educators interpret, evaluate, and adapt AI innovations in real-world practice. Overall, the research model and tool should be considered exploratory and general in scope. While they provide a valuable starting point, future research should refine the constructs and employ more specialized instruments to capture the complexity of AI adoption in education.

CONCLUSION

This study validates the TAM-TPACK-GenAI framework, demonstrating that PU is the primary driver of teachers' BI to adopt AI, with amplification and adaptivity viewed as key pedagogical enablers. At the same time, ethical concerns surrounding agency and authenticity emphasize the need for critical engagement with AI integration. Future professional development and policy must balance innovation with ethical and contextual considerations to foster responsible AI adoption. Empowering teachers to lead this transformation, grounded in pedagogical integrity and professional values, will be essential to ensuring that AI enhances, rather than displaces, human-centered education.

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the study and their rights. Data were anonymized, stored securely, and handled confidentially in line with institutional policies. Results are reported in aggregate to protect participant anonymity.

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