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Preservice Teachers' Readiness Towards Integrating AI-Based Tools in Education: A TPACK Approach

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Abstract

Background/Purpose – Technological pedagogical content knowledge (TPACK) emphasizes the effective integration of artificial intelligence (AI)-based tools in education, where specific knowledge is measured individually. This research determines the readiness of preservice teachers (PSTs) to integrate AI-based tools in education through the TPACK approach.

Materials/Methods – This descriptive study involves 429 PSTs from Don Mariano Marcos Memorial State University in the Philippines through a face-to-face survey. Exploratory factor analysis was employed using a minimum residual extraction method with oblimin rotation. Partial least squares structural equation modeling was performed, and goodness of fit indices (GFI, AGFI, PGFI, RMSEA, and TLI) were tested.

Results – The PSTs' readiness to integrate AI-based tools in education revealed their readiness based on their technical knowledge (TK), technical pedagogical knowledge (TPK), technical content knowledge (TCK), and TPACK, as well as their ethical readiness. The study found that the PSTs' TK, TPK, TCK, and TPACK were positively related to their ethical readiness.

Conclusion – When PSTs enhance their technological competencies, their ethical considerations in the use of AI tools also improve. Relationships between TK, TPK, TCK, TPACK, and ethical readiness emphasize the need for teacher training approaches that nurture not just technical abilities, but also students' ethical consciousness. This highlights the interconnectedness of these knowledge frameworks in fostering effective and responsible technology integration in education.

1. Introduction

Artificial intelligence (AI) was described by Harry (2023) as machine learning and natural language that can be used to make predictions or patterns through the analysis of vast amounts of data. It is clear that AI has begun to transform educational environments (Ning et al., 2024), enabling more personalized teaching and learning of preservice teachers (PSTs). AI provides numerous opportunities to enhance learning processes in order that they become more engaging, efficient, and even more personalized, which is beneficial to PSTs' teaching and learning (Karakose & Tülübas, 2023; Ning et al., 2024; Tülübas et al., 2023). Similarly, these opportunities may lead to improved teaching through the automation of curricula development, tailored student engagement, interactive instruction, intelligent content generation, and improved learning outcomes (Gupta & Bhaskar, 2020). In a study by Ramirez and Fuentes Esparrell (2024), it was noted that AI tools present a more significant potential impact on revolutionizing educational settings by strengthening adaptive learning and students' problem-solving skills.

Preservice teachers' readiness to teach based on their knowledge of technology, pedagogy, and content, and the overall interrelation of these aspects is critical to the successful integration of AI-based tools in both their teacher education and in their subsequent classroom teaching. This also showcases their profound knowledge in dealing with ethical issues or concerns that may arise from the use of AI in education. This is based on the transparency and application of their technological, pedagogical, and content knowledge, or combined in what is termed as technological pedagogical content knowledge (TPACK), in using AI in their classroom teaching. This overall combined quality can lead PSTs to perform various functions based on their knowledge of technology, pedagogy, content, and overall TPACK to enhance their classroom teaching through the integration of AI-based tools.

While AI readiness is one of the competencies with which today's PSTs need to be equipped, there is still a lack of research in the current literature on the preparedness of PSTs on how to incorporate AI-based tools in the classroom (Istenic et al., 2021; Kaban & Ergül, 2020). These AI tools play a vital role in today's education, offering expansive advantages in the classroom to study contemporary emerging fields in educational technology (Luckin et al., 2016). Moreover, these AI-based tools enable classroom settings to be customized to be more adaptable, inclusive, and collaborative, leading to classroom environments that offer an advanced learning atmosphere (Luckin et al., 2016).

In addressing these gaps, Edwards et al. (2018) asserted that to integrate these AI-based tools fully, PSTs must exhibit a different knowledge set to select and choose the most appropriate AI tools for teaching, and the required knowledge is based on the implementation of TPACK. Based on that approach, the researchers in the current study considered the application of TPACK as an approach to further investigate PSTs' readiness towards integrating AI-based tools in the classroom setting, with a focus on the interplay between their technological knowledge, pedagogy, and learning information.

The current study, therefore, aims to provide answers to the following research objectives:

1. *To determine PSTs' level of readiness to integrate AI-based tools in teaching based on TPACK.*
2. *To determine the significant relationship between PSTs' ethical readiness and level of readiness to integrate AI-based tools in education based on TPACK.*
3. *To determine the significant relationship of PSTs' level of readiness to integrate AI-based tools in education based on TPACK.*

2. Literature Review

2.1. Integration Readiness for AI-Based Tools

AI readiness to integrate AI-based tools refers to the fundamental intent of PSTs (in this case) in predicting their intention by looking at their behavior toward AI (Chiu & Chai, 2020), such as their apprehension tendency to adopt and utilize cutting-edge AI-based tools in the classroom (Bai & Wei, 2023). PSTs may have little awareness that AI readiness is crucial to their incorporating AI in teaching practice and that it requires the development, maintenance, and support of teacher-education programs so that they gain the required knowledge about AI. In summary, the more AI is used in the classroom, the more teachers will be familiarized with its application (Luckin & Cukurova, 2019). UNESCO (n.d.) reported in a global survey of 450 schools and universities on their readiness to use AI applications in the classroom that only 10% mentioned the use of generative AI applications in developing their institutional policies.

According to Celik (2023), regardless of the improvement that AI may contribute to education, there remains a lack of accessibility to AI tools, meaning that they are still not widely employed in today's education. The Philippines is one such country that experiences deficits in educational technology infrastructure, teacher training, digital divide, resistance to change, and technical difficulties experienced by educators (Matsul et al., 2023).

"Technological Knowledge" (TK) refers to the understanding of different technologies and their functions and limitations. Several studies pointed out that preservice teachers showed satisfactory levels when it comes to TK. However, preservice teachers' ability to apply these into pedagogical and meaningful ways is still limited. Rafiq et al. (2022) pointed out that preservice teachers have a high level of TK in English as a Foreign Language (EFL), and effective application of this knowledge in the teaching and learning process was inconsistent. PSTs lack an understanding of the technology content that will be used to deliver the subject matter. Also, they struggle to choose the appropriate tools for teaching specific subjects since they also lack knowledge about the technological tools they may integrate into teaching (Apau, 2017). Even though preservice teachers manifest self-confidence with regard to their skills in technological knowledge, they are still inadequate in terms of their actual integration of technology in delivering their lessons (Valtonen et al., 2020). These may result in a critical gap between the preservice teachers' technological knowledge and their lack of pedagogical skills to effectively apply technological tools in teaching and learning.

"Technological Pedagogical Knowledge" (TPK) focuses on understanding the integration of technology in teaching practices. Studies show that even preservice teachers can recognize the importance of TPK, but they find it difficult to put this knowledge into their actual delivery of instruction. Tiba and Condy (2021) stressed that preservice teachers should have extensive guidance to enhance their readiness in using technology in their classrooms. This gap proposes that teacher education institutions should focus on bridging the preservice teachers' theoretical knowledge to their practical application into teaching practice. TPK needs to be included in the preservice teachers' competencies, which need to be developed as it is seen to be a problematic area (Drummond & Sweeney, 2017).

"Technological Content Knowledge" (TCK) refers to how technology can be integrated and used to teach a specific learning or content area. Studies show that while preservice teachers have foundational knowledge about TCK, they lack in-depth knowledge with regard to the particular content areas. Holmes et al. (2021) mentioned that utilizing the TPACK approach in integrating AI-based educational tools may require various applications of knowledge based on pedagogical knowledge (PK). Agyei and Kafyulilo (2019) identified that TCK is crucial, especially in integrating technology tools into teaching. They also noted that preservice teachers do not have an adequate and in-depth understanding of content knowledge and how to effectively use technology in delivering their lessons. This suggests that TEIs need to revisit their curricula to address this gap in integrating technological tools into education.

"Technological Pedagogical Content Knowledge" (TPACK) explains the interconnectedness of TK, PK, and CK and their importance in effectively teaching in the digital era. The preservice teachers' self-assessment of their TPACK competence showed significant challenges in integrating technological tools into their teaching practices (Valtonen et al., 2017). PSTs face challenges in fully comprehending how AI actually works, what it really is, and how it should be integrated into the classroom and applied in their teaching; or to put that differently, PSTs can lack sufficient technology knowledge for the integration of AI-based tools in the classroom (Hayes & Kraemer, 2017; Long & Magerko, 2020).

Additionally, Kim's (2004) research on AI convergence education demonstrated that while improvements in TPACK were observed, there remained a pressing need for more tailored educational programs that specifically address the integration of AI tools in teaching processes. This indicates a gap in current educational frameworks that fail to fully prepare preservice teachers for the complexities of integrating AI in their future pedagogical practices.

2.2. Ethical Concerns of Integrating AI-Based Tools

Research has indicated that the ethical training of preservice teachers is crucial for their professional development. For example, Turgut and Yakar (2021) emphasized the importance of bioethical values in teacher training, particularly in the context of biotechnology applications. Their findings suggested that as preservice teachers progress through their education, they develop a more nuanced understanding of ethical issues, which is essential for the responsible integration of technological tools in teaching and learning processes. Similarly, Yıkmış and Akbıyık (2022) advocated for structured training programs that focus on professional ethics, asserting that such initiatives can significantly enhance preservice teachers' acquisition of ethical competencies.

Moreover, research has shown that ethical education should not be limited to theoretical knowledge, but should also include practical applications. Kumar (2015) posited that an effective approach to professional ethics education involves experiential learning, which allows preservice teachers to engage with real-world ethical dilemmas. This hands-on experience is vital for fostering a deeper understanding of ethical principles and their implications in educational contexts.

Despite the growing body of literature on ethical readiness, several gaps remain unaddressed. First, there is a lack of comprehensive research with specific focus on the ethical implications of AI integration in education. While some research considers general ethical principles, the unique challenges posed by AI technologies require targeted investigation. Oddone et al. (2023) noted that the expectation for teachers to be "AI ready" includes understanding the ethical dimensions of AI, yet this area remains relatively underexplored in the current literature.

Additionally, the published literature often overlooks the longitudinal impact of ethical training on preservice teachers' professional practices. For instance, while studies like those by Ribeiro-Silva and Amorim (2020) may have highlighted the importance of ethical training during teacher preparation, there lacks sufficient evidence on how these ethical frameworks are applied in real classroom settings over time. This calls for longitudinal studies that track the ethical decision-making processes of preservice teachers as they transition into their professional roles.

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Accordingly, the current study hypothesized the following:

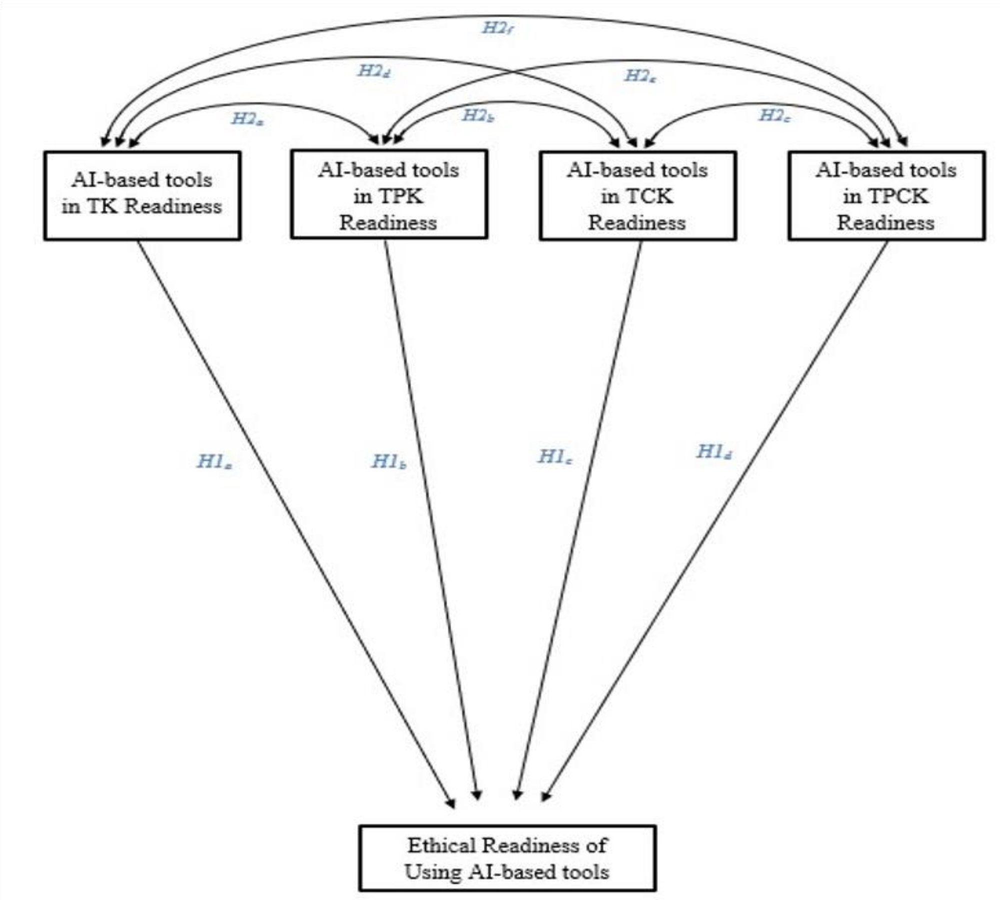

Figure. 1. Hypothesized Research Model

H1a – A significant relationship exists between TK readiness and ethical readiness of AI-based tools integration.

H1b – A significant relationship exists between AI-based tools in TPK readiness and the ethical readiness of AI-based tools integration.

H1c –As a significant relationship exists between AI-based tools in TCK readiness and ethical readiness of AI-based tools integration.

H1d – A significant relationship exists between TPACK readiness and ethical readiness in AI-based tools integration.

H2a – A significant relationship exists between TK readiness and TPK readiness in AI-based tools integration.

H2b – A significant relationship exists between TPK readiness and TCK readiness in AI-based tools integration.

H2c – A significant relationship exists between TCK readiness and TPACK readiness in AI-based tools integration.

H2d – A significant relationship exists between TK readiness and TCK readiness in AI-based tools integration.

H2e – A significant relationship exists between TPK readiness and TPACK readiness in AI-based tools integration.

H2f – A significant relationship exists between TK readiness and TPACK readiness in AI-based tools integration.

TPACK is widely used in distinct methodologies to explore the enrichment of PSTs' TPACK knowledge (Wang et al., 2018; Willermark, 2017). The current study aims to address how the TPACK knowledge of PSTs affects their integration of AI-based tools. Hence, the researchers' focus in the current research considers the specific individual components of the TPACK framework, which are TK, TPK, and TCK. Since PSTs are considered as the building blocks of our educational future, the researchers in the current study sought to understand PSTs' readiness based on these components when planning the integration of AI-based tools into their teaching and learning processes.

The current study expects to reveal significant correlations among the various readiness components and ethical readiness, suggesting that a robust understanding of technology, pedagogy, and content is essential for responsible AI integration. The study also aims to contribute to the existing literature by providing empirical evidence supporting the interconnectedness of these readiness frameworks, thereby offering insight into how educators can be better prepared to navigate the complexities of AI's usage within educational contexts. By elucidating these relationships, the current research seeks to inform training programs and policy decisions aimed at enhancing educators' readiness for AI integration, ultimately fostering a more ethical and effective use of technology in education (Alami et al., 2020).

2.3. Theoretical Framework

The integration of AI-based tools in education necessitates a theoretical framework that can effectively guide preservice teachers in their readiness to utilize these technologies. Two prominent theories that can be applied to this context are the Technological pedagogical content knowledge (TPACK) framework and Constructivist learning theory.

The *TPACK framework* is pivotal in understanding how preservice teachers can integrate technology into their teaching practices. TPACK emphasizes the intersection of three primary forms of knowledge: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). The framework posits that effective teaching with technology first requires an understanding of how these three knowledge domains interact. For instance, highlighting the importance of TPACK in preparing preservice teachers to effectively integrate information and communication technology (ICT) into their teaching suggests that a robust TPACK framework can enhance PSTs' pedagogical practices and thereby help to improve student learning outcomes (Chai et al., 2013; Habibi et al., 2019). Furthermore, studies have shown that preservice teachers with a strong TPACK foundation are better equipped to design technology-enhanced lessons that foster meaningful learning experiences (Chai & Koh, 2017; Chai et al., 2011). This approach and outcome are considered particularly relevant in the context of using AI-based tools in the classroom, since these technologies require educators to not only understand the tools themselves, but also how best to apply them in pedagogical terms within specific content areas (Padmavathi, 2017).

Constructivist learning theory complements the TPACK framework by emphasizing the active role of learners in constructing their own understanding and knowledge through experience. This theory posits that learning is most effective when students are engaged in authentic, real-world tasks that require them to think critically and solve problems (Rohmitawati, 2018). In the context of integrating AI-based tools, constructivist principles encourage preservice teachers to create learning environments that promote collaboration, exploration, and the application of knowledge in meaningful ways. For example, Chai et al. (2020) discussed how a Web 2.0 learning design framework aligned with constructivist principles could be used to enhance preservice teachers' capabilities to design learning experiences that are effective in promoting the use of digital technologies. This approach not only prepares teachers to use AI-based tools, but also helps foster a classroom environment where students can actively engage with the educational content, thereby enhancing their learning outcome success likelihood (Bower, 2012).

3. Methodology

3.1. Participants

The primary data sources of the current study were 429 PSTs studying for a bachelor's degree; of whom, 227 (52.9%) were studying elementary education (BEEd), 128 (29.9%) were studying early childhood education (BECEd), and 74 (17.2%) were studying special needs education (BSNEd) at Don Mariano Marcos Memorial State University's South La Union campus in the Philippines. The respondents were selected through total enumeration sampling from the total of 506 PSTs enrolled across the three teacher education bachelor degree programs. However, the resulting lower number of total participants was due to issues such as students' conflicting schedules, their unavailability when contacted regarding participation in the study, and withholding voluntary consent to join the research study. The resulting participatory response rate was revealed as 84.8%.

3.2. Instruments

The study utilized a closed-ended questionnaire to assess the PSTs' readiness to integrate AI-based tools according to their TK, TPK, TCK, and TPACK, as well as their ethical readiness. The survey was generated by the researchers, with items based on the published research of Celik (2023), Ning et al. (2024), and Schmid et al. (2020). The survey was comprised of 50 items, with 10 for each respective area. The validity results from five expert validators resulted in a calculated value of OWM = 4.46, which implied that the researcher-constructed instrument was rated as being highly valid.

As a reliability test, the instrument was pilot tested with 113 PSTs from the Polytechnic College of La Union and Philippine College of Northwestern Luzon, which resulted in a Cronbach alpha value calculated as .977, which implied the instrument's reliability to be excellent.

3.3. Procedure

The researchers sought and received approval from the university's chancellor to conduct the proposed survey. After explaining the study's purpose, risk, and benefits of the study, the researchers distributed informed consent forms and questionnaires to potential participants. The data collection took place between March 11 and March 29 of 2024, spanning a period of approximately 3 weeks. The researchers ensured the anonymity and confidentiality of the respondents' data and implemented appropriate measures to protect the security of the collected data.

3.4. Ethical Consideration

Prior to initiating the study, the researchers submitted the study protocol and informed consent form to the university's ethics committee for thorough review and approval. The committee conducted a comprehensive evaluation to ensure the study adhered to ethical principles and guidelines, including protecting participant rights and minimizing any potential risks. Following a rigorous assessment, the committee issued a Certificate of Ethical Clearance (reference: RETC Code 2024-084) to grant official authorization for the study to proceed.

3.5. Data Analysis

The data gathered in this study were analyzed using Jamovi and AMOS 22 statistical software. The median descriptive statistic was used to determine the PSTs' level of readiness according to TK, TPK, TCK, and TPACK, as well as their ethical readiness to integrate AI-based tools in the classroom. PLS-SEM was employed to assess the observed and latent variables with the complexities of the model, as well as the multiple robustness of the data (Memon et al., 2021). For the overall correlation, the relationships between the PSTs' ethical readiness and level of readiness according to TK, TPK, TCK, and TPACK were examined. Kaiser-Meyer-Okin (KMO) sampling adequacy, with a suggested value of ≥ 0.9, was tested, indicating a highly suitable condition (Izquierdo et al., 2014), and Barlett's sphericity test was used to investigate the suitability of the sample for factor analysis. Exploratory factor analysis (EFA) was then performed to assess the factor loadings of the relationships using minimum residual extraction method in combination with oblimin (direct oblimin = 0), which are factors that are correlated but not independent factors (De Bruin, 2006).

To test the model, goodness of fitness index (GIF), adjusted goodness-of-fit index (AGFI), and Tucker-Lewis index (TLI) were measured according to a recommended value of > 0.90, which indicates what is termed as a good fit (Hair et al., 2016). Root mean square error of approximation (RMSEA) was also measured according to a recommended value of < 0.08, indicating an excellent fit, while 0.10 indicates a reasonable fit. If a value is greater than 0.10, this indicates the model has a poor fit to the date (Hair et al., 2016). In addition, the parsimony goodness-of fit index (PGFI) was measured against a recommended threshold of 1, which represents a perfect fit or > 0.50 which indicates an acceptable fit (Jöreskog & Sörbom, 1993). Lastly, the acquired chi-square (x^2 / *df*) value of 3, when compared to the recommended value of ≤ 3.1, indicated a good level of fit for the model (Tabachnick & Fidell, 2007), and the *p*-value of < .001 indicated a high degree of significance, being less than the suggested *p* value of < .05.

4. Results and Discussion

4.1. Readiness of PSTs to Integrate AI-Based Tools in Teaching in Terms of TPACK

To analyze the PSTs' readiness towards integrating AI-based tools in education according to the collected data, the median value was calculated for each item, which revealed readiness according to the PSTs' TK, TPK, TCK, TPACK, and ethical readiness. The descriptive statistics of the PSTs' readiness are presented in Table 1.

Table 1. Descriptive Statistics of PSTs' Readiness

Item	Median
I. AI-Based Tool Integration Readiness Based on Technological Knowledge (TK)	
1. I understand the basic functionalities and capabilities of various AI-based tools used in education.	4
2. I can differentiate between different types of AI and their potential applications in teaching and learning.	4
3. I feel comfortable navigating and using the interfaces of popular AI-based educational tools.	4
4. I can troubleshoot minor technical issues related to AI tools and access relevant support resources when needed.	3
5. I am confident in staying informed about emerging trends and advancements in AI technology relevant to education.	4
6. I can evaluate the technical requirements and compatibility of AI tools within my classroom environment.	4
7. I understand the potential safety and security risks associated with using AI tools and can implement data privacy best practices.	4
8. I can identify reliable sources for learning more about the technical aspects of AI-based educational tools.	4

Item	Median
9. I feel empowered to experiment with and explore new AI tools as they become available.	4
10. I believe my understanding of technology enables me to make informed decisions about using AI tools in my teaching.	4
II. AI-Based Tool Integration Readiness Based on Technological and Pedagogical Knowledge (TPK)	
1. I can explain the pedagogical ideas underlying different AI-based educational tools.	4
2. I am comfortable using AI tools to promote active learning, critical thinking, and problem-solving skills in students.	4
3. I can design assessments that measure students’ learning beyond simple factual recall when using AI tools.	4
4. I understand how to use AI tools to differentiate teaching strategies and to provide for the diverse needs of students and their learning styles.	4
5. I feel confident in facilitating engaging learning experiences that integrate AI tools within a well-structured lesson plan.	4
6. I can create opportunities for students to reflect on their learning and provide feedback on their experiences using AI tools.	4
7. I am comfortable using data collected from AI tools to inform my teaching and personalize learning pathways for students.	4
8. I can effectively integrate AI tools within various teaching strategies, such as collaborative learning, flipped classrooms, and project-based learning.	4
9. I understand the potential challenges and limitations of using AI tools in the classroom and can develop strategies to address them.	4
10. I believe my understanding of both pedagogy and technology allows me to leverage AI tools effectively to enhance student learning.	4
III. AI-Based Tool Integration Readiness Based on Technological and Content Knowledge (TCK)	
1. I can identify how specific AI tools can be used to support different learning objectives across various subjects.	4
2. I am comfortable integrating AI-based assessments and feedback mechanisms into my teaching practice.	4
3. I can design learning activities that leverage the unique features and functionalities of AI tools effectively.	4
4. I understand how AI can personalize learning experiences based on individual student needs and learning styles.	4
5. I feel confident in adapting educational resources and lesson plans to incorporate AI-based learning opportunities.	4
6. I can identify and access existing educational resources that utilize AI to enrich student learning.	4

Item	Median
7. I understand the ethical considerations of using AI for educational purposes, such as potential bias and algorithmic fairness.	4
8. I can evaluate the effectiveness of AI tools in achieving specific learning outcomes in my classroom.	4
9. I am familiar with best practices for integrating AI tools with other instructional strategies and resources.	4
10. I believe my understanding of content and how it intersects with technology empowers me to choose the most appropriate AI tools for my students.	4
IV. AI-Based Tool Integration Readiness Based on Technological Pedagogical Content Knowledge (TPACK)	
1. I can confidently articulate the specific learning objectives that can be achieved by integrating AI-based tools into a particular subject area.	4
2. I am comfortable selecting and using the most appropriate AI tools based on the specific needs of my students and learning objectives.	4
3. I can design engaging and effective learning activities that seamlessly integrate AI tools within a broader pedagogical framework.	4
4. I understand how to use AI tools to promote higher-order thinking skills and deeper understanding of content in my students.	4
5. I feel confident in adapting and customizing existing AI tools to align with my unique teaching style and curriculum goals.	4
6. I can effectively assess student learning and provide meaningful feedback based on their interactions with AI tools.	4
7. I am comfortable reflecting on and refining my use of AI tools over time to continuously improve my teaching practice.	4
8. I can advocate for the responsible and ethical use of AI tools in education and create a safe and inclusive learning environment for all students.	4
9. I believe my ability to blend my knowledge of technology, pedagogy, and content empowers me to integrate AI tools in a way that maximizes student learning.	4
10. I am excited to explore the potential of AI to reform the educational process.	4
V. Ethical Readiness to Integrate AI-Based Tools in Education	
1. I understand the potential ethical concerns associated with using AI in education, such as bias, fairness, and privacy.	4
2. I can critically evaluate AI tools for potential biases based on factors like race, gender, and socioeconomic status.	4
3. I believe it is my responsibility to ensure that data collected through AI tools is used ethically and securely.	4
4. I am comfortable explaining the ethical implications of using AI tools to students and fostering open discussions about potential risks and benefits.	4

Item	Median
5. I can design learning activities that promote responsible and ethical use of AI technology by students.	4
6. I feel confident in collaborating with other educators and stakeholders to develop ethical guidelines for integrating AI in schools.	4
7. I am aware of relevant policies and regulations governing data privacy and security in the context of educational technology.	4
8. I understand the importance of transparency and accountability when using AI tools in teaching and learning.	4
9. I am committed to continuously learning and updating my knowledge about the ethical implications of emerging AI technologies in education.	4
10. I believe integrating AI ethically requires constant reflection and a commitment to responsible innovation in education.	4

4.2. Relationship Between PSTs' Readiness in TK, TPK, TCK, and TPACK with Ethical Readiness

There was a positive relationship (estimate = .362, $p < .001$) revealed between "TK" and "Ethical" and a positive relationship (estimate = .377, $p < .001$) between "TPK" and "Ethical." A positive relationship was also found between "TCK" and "Ethical" (estimate = .517, $p < .001$) as well as between "TPACK" and "Ethical" (estimate = .559, $p < .001$). The relationship between the factors is presented in Table 2.

Table 2. Relationship Between TPACK Components and Ethical Readiness

Hypothesis Path	TPACK Subscale	Estimate	β	*p*	*Decision*
H_{1a}	TK <--> Ethical	.362	0.691	***	accepted
H_{1b}	TPK <--> Ethical	.377	0.746	***	accepted
H_{1c}	TCK <--> Ethical	.517	0.816	***	accepted
H_{1d}	TPACK <--> Ethical	.559	0.858	***	accepted

*** $p < .001$; β = > 0.50

4.3. Relationship Between TK, TPK, TCK, and TPACK

There were positive correlations (estimate = .327, $p < .001$) revealed between "TK" and "TPK," between "TPK" and "TCK" (estimate = .446, $p < .001$), and between "TCK" and "TPACK" (estimate = .603, $p < .001$). A positive correlation was also found between "TK" and "TCK" (estimate = .392, $p < .001$), followed by between "TPK" and "TPACK" (estimate = 454., $p < .001$). Lastly, a positive correlation was also revealed between "TK" and "TPACK" (estimate = .406, $p < .001$). Table 3 presents the correlations among the factors.

Table 3. Correlation Between TPACK Subscales

Hypothesis Path	TPACK Subscale	Estimate	β	*p*	*Decision*
H_{2a}	TK <--> TPK	.327	0.783	***	accepted

Hypothesis Path	TPACK Subscale	Estimate	β	*p*	*Decision*
H_{2b}	TPK <--> TCK	.446	0.881	***	accepted
H_{2c}	TCK <--> TPACK	.603	0.924	***	accepted
H_{2d}	TK <--> TCK	.392	0.747	***	accepted
H_{2e}	TPK <--> TPACK	.454	0.874	***	accepted
H_{2f}	TK <--> TPACK	.406	.754	***	accepted

****p* < .001; β = > 0.50

4.4. Exploratory Factor Analysis

Exploratory factor analysis was performed to analyze the loadings of ethical readiness and overall TPACK (TK, TPK, TCK, TPACK). In determining the suitability of the item's relationship matrix for factor analysis, the KMO or adequacy sampling value was calculated and confirmed, and Barlett's sphericity test was utilized. The method used for factor loadings was minimum residual extraction, while for factor rotation, it was oblimin rotation (delta = 0). If any factor loading was found to be less than .40, the factor item would be subsequently removed from the analysis to identify the relevant factors.

The factor analysis results for "TK, TPK, TCK, TPACK, and Ethical" are presented in Table 4. The KMO value was reported to be greater than .90, and the sphericity test was significant; therefore, the item was considerable for factor analysis. The factor loadings result under TK, items 9 and 10; TPK items 9 and 10, TCK items 1, 2, 4, 5, 7, 9, and 10; TPACK items 1, 2, 3, 4, 6, and 7 were removed due to their lower loading value; therefore, the final result was a 33-item model with a three-factor structure.

Table 4. Factor Loadings on TK, TPK, TCK, TPACK, and Ethical

	Factor		
	1	2	3
TK1			.725
TK2			.688
TK3			.539
TK4			.493
TK5			.699
TK6			.703
TK7			.649
TK8			.571
TPK1	.658		
TPK2	.656		
TPK3	.819		
TPK4	.680		

	Factor		
	1	2	3
TPK5	.745		
TPK6	.600		
TPK7	.653		
TPK8	.585		
TCK3		.431	
TCK6	.447		
TCK8	.530		
TPACK5	.466		
TPACK8	.551		
TPACK9	.498		
TPACK10	.458		
ETH1		.510	
ETH2		.526	
ETH3		.632	
ETH4		.723	
ETH5		.644	
ETH6		.734	
ETH7		.714	
ETH8		.818	
ETH9		.775	
ETH10		.761	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy			0.970
Bartlett's Test of Sphericity		Approx. Chi-Square	8604
		df	494
		p	.001

4.5. Partial Least Squares Structural Equation Modeling

Table 5 shows the goodness of fit from PLS-SEM. The overall model was found to have a significantly good fit ($x^2 / df = 3$; $p = < .001$) value. The acquired value for x^2 / df was 3, indicating a good fit model as reflected in the recommended value of ≤ 3.1 (Tabachnick & Fidell, 2007), while its

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p-value indicated a high-level of significance since it was less than the suggested value of $p = < .05$. This implies that the overall fit of the proposed model was highly acceptable. From examination of the individual fit indices (GFI = 0.996; AGFI = 0.991; PGFI = 0.415; RMSEA = 0.068; and TLI = 0.996), the results indicate a good fit according to Hair et al. (2016) who posited that if the obtained values for GFI, AGFI, and TLI were ≥ 0.90, a model would be said to have a good fit. While the PGFI value was lower than the recommended > 0.50, the parsimony fit was revealed to be poor; however, this index is not commonly used or emphasized in terms of model fit according to Mulaik et al. (1989). When subjected to RMSEA, the model revealed a value that indicated an excellent fit, as noted by Hair et al. (2016), since it was less than the recommended value of < 0.08 (see Table 5).

Table 5. Model Fit Index

Model	GFI	AGFI	PGFI	RMSEA	TLI	X^2	*df*	X^2 / *df*	*p*
Value	0.966	0.991	0.415	0.068	0.996	105	35	3	<. 001

Figure 2. PLS – Structural Equation Model of Proposed Model

5. Discussion

The study investigated the participant PSTs' readiness towards integrating AI-based tools in education using the TPACK approach. The results revealed readiness among PSTs from Don Mariano Marcos Memorial State University, Philippines, with a positive relationship in dealing with the ethical issues in accordance with their TK, TPK, TCK, and TPACK. These findings are discussed as follows:

5.1. Readiness of PSTs in Integrating AI-Based Tools in Teaching in Terms of TPACK

First, the study revealed that the PSTs were ready to utilize AI-based tools in their teaching and learning due to their familiarity with the currently available AI tools (TK), their pedagogical contributions (TPK), and how these tools could be effectively integrated into both their subject of specialization (TCK) and their overall knowledge in TPACK.

The PSTs were revealed to be increasingly familiar with AI tools, which is a positive sign for their readiness to incorporate such technologies into their teaching practices (Santos & De Regla Castro, 2020). As a comparative example, research conducted in Ghana revealed a significant uptick in awareness and usage of generative AI tools among PSTs, with many expressing familiarity with platforms like OpenAI's ChatGPT (Nguyen et al., 2024) and Google Bard (Nyaaba et al., 2023). This familiarity is essential, since it lays the groundwork for PSTs to explore the pedagogical contributions of AI tools and how they may be effectively integrated into their subject specializations (Arvin et al., 2023; Hastomo et al., 2024). Furthermore, the findings from Al-Qerem et al.'s (2023) study on health profession students in Jordan underscored the importance of understanding AI's role in education, suggesting that insights from such studies can guide curriculum development to better prepare future educators (Al-Qerem et al., 2023; Kim & Kwon, 2023). Likewise, the study of Agbo et al. (2022) revealed PSTs to be sufficiently knowledgeable when operating and adopting new AI tools, and noted how these tools were readily incorporated within classroom settings. In addition, Irwanto et al. (2022) found that PSTs' responses indicated a high level of TPK, which means they were sufficiently aware and ready to integrate AI-based tools into their teaching, having displayed awareness facilitating effective teaching with the use of specific tools in the classroom. In the study of Azam et al. (2023), educators perceived themselves as being highly ready when it came to identifying specific pedagogy through AI, thereby allowing them to create meaningful and interactive learning environments. In the results of a study by Mohamed (2023), it was reported that PSTs experienced the use of technology, especially AI-based tools, in their pedagogical practices.

The implications of this readiness extend beyond mere technological familiarity. As PSTs develop their TPACK, they must also cultivate a critical understanding of how AI can transform their pedagogical practices. As an example, the integration of AI in STEM education has been shown to enhance instructional strategies and learning experiences (Xu & Ouyang, 2022). However, this requires educators to not only possess an awareness of AI tools, but also to understand the pedagogical implications of their use and how they can be tailored to meet specific content needs (Widodo & Hidayati, 2023). PSTs with a higher level of understanding of TPACK will likely possess in-depth comprehension on how to integrate generative AI effectively in their teaching and learning processes (Baidoo-Anu & Ansah, 2023). In other words, possessing such understanding is likely to lead to the effective integration of GenAI for the development of instructional aides, for the creation and designing of content matter, as well as in personalizing the classroom and in learner assessment. Along the same lines, PSTs' TPACK was revealed to sway the readiness of their integrating AI-based tools in their teaching and learning, leading to the likely successful integration of AI-based tools in terms of subject content, pedagogies, and understanding the functionality of specific AI tools (Ning et al., 2024). The challenge, however, lies in ensuring that PSTs are adequately equipped with the necessary skills to navigate the complexities of AI integration, which includes addressing ethical considerations and understanding the limitations of AI technologies (Nazaretsky et al., 2022).

Moreover, the readiness of PSTs to utilize AI tools is influenced by their perceptions and attitudes towards these technologies. Studies have shown that educators who possess a positive attitude towards AI are more likely to integrate it within their teaching practices (Alnasib, 2023). This highlights the need for teacher education programs to foster a supportive environment that encourages PSTs to explore AI tools and develop confidence in their use. Initiatives such as micro-teaching and simulations can provide PSTs with practical experiences that enhance their readiness and self-efficacy in the use of AI technologies (Ledger & Fischetti, 2020).

In terms of the ethical readiness of preservice teachers to integrate AI-based tools in the classroom, a significant level of preparedness is required in order to navigate the ethical complexities associated with AI's usage within educational contexts. This readiness is considered crucial as the integration of AI technologies in education raises multifaceted ethical issues, including concerns about data privacy, algorithmic bias, and the implications of AI integration on teaching practices and student learning experiences (Akgun & Greenhow, 2021; Holmes et al., 2021, 2023).

PSTs who feel more prepared to address the potential ethical dilemmas are better equipped to effectively utilize AI-based tools in their teaching whilst maintaining educational integrity and equity (Alelaimat et al., 2020; D'Souza et al., 2024). On this, Holmes et al. (2023) emphasized the importance of stakeholder perspectives on AI ethics in education, highlighting the need for frameworks that address ethical concerns related to data and algorithms. The finding of the current study support that of previous research in that the readiness of PSTs to utilize AI in the classroom is affected by their stance on AI ethics, as in they were deemed ready to incorporate AI in education and that they considered themselves to be responsible for the use of AI in transforming their teaching and learning practices (Agbo et al., 2022; Fundi et al., 2024; Luckin et al., 2022; Nazaretsky et al., 2022). Likewise, this also aligns with the findings of Russell et al. (2022), who outlined the essential competencies for professionals using AI, which include understanding the social and ethical implications of AI technologies. These competencies are similarly vital for PSTs, since they will likely encounter ethical challenges in their future teaching careers. In the same manner, the integration of AI-tools in education should be implemented in a way that aligns with the ethical discipline and readiness of preservice teachers (Adam et al., 2023), and must have educational necessity in ethical competency for the use of generative AI in order to minimize dependency on the information's reliability (Hong & Han, 2023). Hence, in order to respond to the educational needs of students through the use of AI-based tools, PSTs will need to be able to draw a balance between increased efficiency and the avoidance of data bias; leading to PSTs' effective utilization of AI tools in their teaching and learning practices (Karina & Kastuhandani, 2024).

Moreover, the ethical readiness of PSTs is seen to facilitate a deeper understanding of the broader implications of AI's usage in education. As they become more adept at recognizing and addressing the key ethical issues of AI's use within the educational context, PSTs will be better equipped to contribute to the development of a more responsible and equitable educational landscape. The integration of AI in education necessitates a comprehensive understanding of its ethical dimensions, which can only be achieved through targeted training and education (Akgun & Greenhow, 2021). Hence, there is a necessity to equip educators with the necessary fundamental knowledge of how to navigate the ethical considerations of implementing AI-based tools in teaching (D'Souza et al., 2024).

The implications of this perceived readiness extend beyond individual preparedness; suggesting a need for educational institutions to prioritize training for PSTs in AI ethics. By embedding ethical considerations into teacher education programs, institutions can ensure that future educators are not only technologically proficient, but also have sufficient ethical awareness (Alelaimat et al., 2020; Borenstein & Howard, 2020). Torda (2020) concluded that being AI literate and understanding the ethical issues related to the use of AI in education can facilitate the learning progress of students, and also for teachers to be prepared ready rather than fearing that AI may replace the role of teachers. This approach aligns with the findings of Lee (2024), who advocated for a content framework that incorporates ethical factors into AI-integrated education.

5.2. Relationship Between Ethical Readiness and PSTs' Level of Readiness in AI-Based Tools Integration with TPACK

The relationship between preservice teachers' technological knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and their overall technological pedagogical content knowledge (TPACK) with ethical readiness is a critical area of investigation in contemporary education. The findings of the current study indicate a significant correlation, suggesting that as PSTs develop their TPACK, their ethical readiness also improves, which presents profound implications for teacher education programs.

First, TPACK is a framework that integrates technology, pedagogy, and content knowledge, and its components are considered essential to teach effectively in the digital age. Research has shown that each component of TPACK contributes differently to the overall readiness of teachers. For instance, content knowledge (CK) has been found to have the largest contribution to pedagogical content knowledge (PCK), while TCK and TPK contribute moderately to TPACK (Fakhriyah et al., 2022). This indicates that a strong foundation in content knowledge is crucial for PSTs to effectively integrate technology into their teaching practice, which in turn enhances their ethical readiness to navigate the complexities of modern educational environments.

Moreover, the integration of ethics into teacher education is paramount. Studies have highlighted that a lack of emphasis on ethical and moral dimensions in teacher training can undermine the profession (Chukwuedo & Nathaniel, 2020). The ethical readiness of PSTs is not merely an add-on, but is intertwined with their ability to make informed decisions in the classroom, especially in terms of their technology usage. As PSTs become more adept in TPACK, they are likely to encounter ethical dilemmas related to technology use, such as issues of digital equity and student privacy. Therefore, teacher education programs must ensure that ethical considerations are embedded within TPACK training in order to prepare PSTs for these types of challenges in their future careers (Kim & Kwon, 2023). This also aligns with the findings of Deng and Zhang (2023), who examined ethical knowledge according to the TPACK framework through an assessment of Chinese PSTs. In their study, it was revealed that a positive relationship existed from their measurement of both TCK and ethical knowledge.

The readiness of PSTs to utilize technology effectively also correlates with their ethical preparedness. For example, teachers who are well-equipped with technological skills are more likely to engage in ethical practices, as they can critically assess the implications of their technological choices in educational settings (Özen & Özkara, 2023). This is supported by findings from research by Polat et al. (2022), who indicated a significant relationship exists between teachers' technical competence and their ethical and pedagogical readiness. This also aligns with the findings of Glikson and Woolley (2020), in that the more probable it is to evaluate ethical assessment critically, the more frequently preservice teachers are acquainted with AI tools. This was also evident in the study of Akgun and Greenhow (2021), in which it was stated that preservice teachers' interactions with emerging technology, specifically intelligent tools, resulted potentially in the evaluation of the decision to use such AI tools. Thus, enhancing PSTs' technical skills through targeted training can lead to improved ethical decision making in their future classroom teaching careers.

Furthermore, the implications of these findings extend to the design of teacher education curricula. As such, teacher training programs should prioritize the development of TPACK alongside ethical training, ensuring that PSTs are not only proficient in the use of digital technology, and AI-based tools especially, but also that they understand the ethical ramifications of their teaching practices. This dual focus can help foster a generation of educators who are not only technologically savvy but also ethically grounded, capable of making decisions that positively impact their students and the broader educational community (Özsayın, 2023).

5.3. Relationship Among PSTs' Level of Readiness in AI-Based Tool Integration with TPACK

Research indicates that PSTs' self-efficacy in TPACK significantly influences their teaching practices. A study by Muslimin et al. (2022) found that technology-based instruction (TbI) lesson plans not only improved PSTs' confidence in their use of technology, but also equipped them with diverse teaching strategies tailored to various contexts This aligns with the findings of Aktaş and Özmen (2020), who noted that PSTs' development in TPACK positively affected their peer interactions and cognitive structures during class discussions, suggesting that collaborative learning environments enhance TPACK readiness. Such interactions are considered essential in order for PSTs to refine their understanding of how best to integrate digital and AI technologies effectively into their pedagogical practices.

Moreover, the integration of AI in education has shown that PSTs often perceive their knowledge in content (CK), pedagogy (PK), and technology (TK) as separate entities. However, a holistic approach is necessary for effective technology integration, as isolated knowledge alone is deemed insufficient (Belda-Medina & Calvo-Ferrer, 2022). This sentiment emphasizes the importance of understanding the interactions among CK, PK, and TK and the development of a comprehensive TPACK framework (Celik, 2023). Wilson et al. (2021) posited that PSTs can recognize the pedagogical potential to transform learning processes through the acquisition of knowledge regarding the essential functions of AI tools. Ku et al. (2020) stressed that technological knowledge and confidence are strongly connected with other types of knowledge, such as pedagogical and content knowledge. The interconnectedness of these knowledge domains is crucial, since it enables PSTs to adapt their teaching methods to seamlessly incorporate technology, thereby enhancing student engagement and learning outcomes.

The implications of developing TPACK readiness among PSTs extend beyond individual teaching practices. For example, the TPACK framework serves as a guiding structure for teacher education programs, encouraging a shift towards learning by design, where PSTs synthesize their knowledge across the three domains (Chai & Koh, 2017). This pedagogical shift fosters creativity and innovation in teaching, as PSTs learn to navigate the complexities of effectively integrating technology into their lessons. Furthermore, studies have shown that professional development programs focusing on TPACK can lead to significant improvements in teachers' technological, pedagogical, and content knowledge (Irwanto et al., 2022). This underscores the necessity for ongoing support and training for PSTs to ensure they are well-prepared to meet the demands of the modern-day technology integrated classroom.

Limitations and suggestions for future research

This study was delimited to a particular demographic: preservice teachers from the BEEd, BECEd, and BSNEd programs at Don Mariano Marcos Memorial State University, Philippines. These findings may not be applicable to other demographics, within or outside the Philippines. Another of the study's limitations is considered its reliance on self-reported measures of readiness, which can introduce a level of bias since individuals often overestimate their own abilities. Additionally, the study did not account for external factors influencing PSTs' readiness, such as institutional support, access to technology, and prior experiences with AI tools, which could skew the understanding of their preparedness. Finally, the current study did not consider other important dimensions of readiness, such as emotional and psychological factors that can impact AI integration.

The current study contributed to the literature by broadening the comprehension of TPACK by connecting it to readiness, thereby emphasizing the significance of ethical concerns in incorporating AI tools within educational settings. The research emphasized the need for PSTs to not only acquire technical expertise, but also to critically evaluate the ethical implications of AI's place in education (Nguyen et al., 2024).

The research also presented real-world evidence that backs up the connections among technological knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), technological pedagogical content knowledge (TPACK), and ethical readiness in education settings. This reinforces the theories supporting the integration of technology in education. By outlining these connections, the current study provides insight into the elements that play a role in technology integration. This information can be valuable for teacher training programs aiming to equip future educators for the complexities of a landscape shaped by AI advancements. This multifaceted approach not only bridges the gap between technology integration and educational theory, but also indicates how these frameworks could be adapted to enhance and deepen the understanding of new technologies like AI-based tools.

Furthermore, the current study's focus on the readiness of PSTs in the context of an AI-infused educational landscape is considered both timely and relevant given its exploration of gaps in the existing literature concerning the specific skills needed for successful integration of AI within educational practices. This emphasis not only enriches the scholarly discussion, but also offers tangible recommendations for designing curricula and implementing training programs that can better equip PSTs for the educational challenges they will likely face in their future teaching careers.

6. Conclusion

TPACK fundamentally impacts PSTs' readiness towards integrating AI-based tools in the classroom. The strong relationship among the individual elements of TPACK and ethical preparedness indicates that improving one aspect may also positively impact the others. For example, as future teachers enhance their subject-matter knowledge and pedagogical knowledge, they are likely to gain confidence in incorporating technology efficiently in the classroom; thus, potentially boosting their ethical reflections on its application, highlighting the interconnectedness of these knowledge frameworks in fostering effective and responsible technology integration in education.

PSTs readiness to incorporate AI-driven tools in the education context involves various aspects, such as their technological, pedagogical and content knowledge along with their ethical readiness. The relationships between their technical knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), technological pedagogical content knowledge (TPACK), and ethical readiness emphasize the need for an improved approach to teacher training that nurtures not just PSTs' technical abilities but also their ethical consciousness.

In the era of technological advancements shaping today's institutions, it is considered crucial that they focus on fostering these skills in future educators in order that they will be able to effectively adapt to the intricacies of contemporary teaching and learning settings.

7. Suggestions

The current study suggests the following:

PSTs practice their use of AI-based tools in the lens of their TK, TPK, TCK, and TPACK in order to improve and maintain their readiness. Additionally, PSTs may offer their knowledge and skills of using AI-based tools to solve current educational problems such those seen during the recent COVID-19 pandemic when PSTs struggled to adjust to the emergency implemented temporary teaching practices.

PSTs may take the lead in the use of AI, particularly within their teaching careers, in order to promote technologically advanced, high-quality education. Furthermore, PSTs can take advantage of their ethical readiness to use AI-based tools in teaching so as to inspire their teaching peers or inservice teachers, particularly those still uncertain about embracing AI to improve teaching and learning.

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PSTs should maximize their usage of AI tools to participate and engage in high-quality teaching and learning processes in order to promote interactive and engaged classrooms for future practices.

Future studies could consider exploring other variables such as life experiences towards the use of AI in their teaching and learning. Furthermore, they may focus on content knowledge for effective integration into their subject areas and add more respondents, including other stakeholders. Additionally, mixed-method research studies could be considered as a means to assessing PSTs' readiness towards the integration of AI-based tools in education.

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Appendix I. Overall Factor Loadings

ITEM	Factor			
	1	2	3	4
TK1			.721	
TK2			.717	
TK3			.563	
TK4			.547	
TK5			.670	
TK6			.728	
TK7			.604	
TK8			.534	
TK9		.421	.347	
TK10		.542		
TPK1		.429		
TPK2		.742		

ITEM	Factor			
	1	2	3	4
TPK3		.714		
TPK4		.572		
TPK5		.646		
TPK6		.560		
TPK7		.549		
TPK8		.451		
TPK9	.384	.361		
TPK10	.303			
TCK1				.316
TCK2		.316		.316
TCK3				.431
TCK4		.396		
TCK5		.369		
TCK6				.484
TCK7	.333			
TCK8				.440
TCK9				.387
TCK10				.327
TPACK1				.342
TPACK2				.335
TPACK3				.391
TPACK4	.317	.333		
TPACK5				.415
TPACK6	.318			.365
TPACK7	.374			.315
TPACK8	.484			
TPACK9	.521			
TPACK10	.498			
ETH1	.500			
ETH2	.481			
ETH3	.647			
ETH4	.709			
ETH5	.644			
ETH6	.722			
ETH7	.705			
ETH8	.820			
ETH9	.795			
ETH10	.818			

Minimum residual extraction method was used in combination with an oblimin rotation.

Appendix II. Removed Items in the Overall Loadings

Statement	Factor loadings			
	1	2	3	4
TK 9. I feel empowered to experiment with and explore new AI tools as they become available.			.347	
TPK 9. I understand the potential challenges and limitations of using AI tools in the classroom and can develop strategies to address them.	.384			
TPK 10. I believe my understanding of both pedagogy and technology allows me to leverage AI tools effectively to enhance student learning.	.303			
TCK 1. I can identify how specific AI tools can be used to support different learning objectives across various subjects.				.316
TCK 2. I am comfortable integrating AI-based assessments and feedback mechanisms into my teaching practice.		.316		
TCK 4. I understand how AI can personalize learning experiences based on individual student needs and learning styles.		.396		
TCK 5. I feel confident in adapting curriculum materials and lesson plans to incorporate AI-based learning opportunities.		.369		
TCK 7. I understand the ethical considerations of using AI for educational purposes, such as potential bias and algorithmic fairness.				.374
TCK 9. I am familiar with best practices for integrating AI tools with other instructional strategies and resources.				.387
TCK 1O. I believe my understanding of content and how it intersects with technology empowers me to choose the most appropriate AI tools for my students.				.342
TPACK 1. I can confidently articulate the specific learning objectives that can be achieved by integrating AI-based tools into a particular subject area.				.327
TPACK 2. I am comfortable selecting and using the most appropriate AI tools based on the specific needs of my students and learning objectives.				.342
TPACK 3. I can design engaging and effective learning activities that seamlessly integrate AI tools within a broader pedagogical framework.				.335
TPACK 4. I understand how to use AI tools to promote higher-order thinking skills and deeper understanding of content in my students.		.317	.333	
TPACK 6. I can effectively assess student learning and provide meaningful feedback based on their interactions with AI tools.	.318			
TPACK 7. I am comfortable reflecting on and refining my use of AI tools over time to continuously improve my teaching practice.	.374			.365

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