Investigating Pre-Service English Teachers I-TPACK and Perceptions to Incorporate Generative Ai-Based Tools in Education: A Case Study in A Public University

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Abstract. Generative Artificial Intelligence (Gen-AI) in the education sector is burgeoning with potential, but gaps in the literature remain. Assessing pre-service teachers' knowledge and competencies in utilizing GEN-Gen-AI, along with factors affecting these and their perceptions towards GEN-Gen-AI, is essential. This study investigates the level of Intelligent-Technological Pedagogical Content Knowledge (I-TPACK) among pre-service English teachers, examining demographic differences (gender, year of enrolment, Gen-AI-based tools usage frequency) and perceptions of Gen-AI-based tools in future teaching. The study sampled 190 TESL students from a selected public university using purposive sampling. An online questionnaire adapted from Celik's (2023) study was administered via Google Form, with data collected automatically. Descriptive and inferential statistics, including paired sample t-tests and one-way ANOVA analysis, were used to analyze the data. Findings indicated that pre-service teachers exhibit higher competencies in Technological Knowledge (TK) and Technological Content Knowledge (TCK) than in Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPACK). This disparity is attributed to their experience with Gen-Gen-AI tools for personal use and limited in-class teaching experience. Inferential analysis revealed no significant differences in I-TPACK levels by gender or year of enrolment. Recommendations for public universities include enhancing pre-service teachers' competencies and readiness to incorporate Gen-Gen-AI tools in English classrooms and suggestions for future research.

Keywords: Generative Artificial Intelligence, Intelligent-Technological Pedagogical Content Knowledge (I-TPACK), Pre-Service English Teachers

1   Introduction

In today's modern day, Gen-AI-based tools and technologies have the potential to revolutionize the field of education. These tools can assist teachers in identifying specific learning challenges and provide targeted support to individual students, resulting in more efficient and effective learning outcomes. For instance, [1] demonstrated that Gen-AI tools can help teachers identify areas where students are struggling and provide personalized support. Additionally, [2] found that Gen-AI can schedule assignments and educational activities according to learners' needs, improving overall grades and satisfaction. Gen-AI tools also positively impact students' learning behavior and technology acceptance. [3] noted that Gen-AI tools provide formative

feedback, enhancing learning behavior, while [4] showed they improve writing skills and make learning less boring.

The Technological Pedagogical Content Knowledge (TPACK) framework, developed by [5], is a valuable model emphasizing the importance of teachers' knowledge, abilities, and competencies to integrate technology into teaching effectively. Numerous studies have shown that TPACK can guide and support teachers in using technology within the classroom. It is crucial for teachers to have a wide range of skills, including pedagogical, technological, collaborative, and creative abilities [6]. Pre-service teachers, in particular, benefit from the TPACK framework, as it helps them develop the necessary knowledge and skills to use technology in their future classrooms. This framework provides a structured approach for integrating technology in ways that enhance students' learning experiences, preparing them for 21st-century education. Emphasizing the TPACK framework equips pre-service teachers with the guidance needed to become effective and tech-savvy educators, especially with the increasing use of Gen-AI-based tools in education.

The Intelligent-Technological Pedagogical Content Knowledge (i-TPACK) framework, developed by [7], refines the original TPACK framework to focus specifically on teachers' knowledge and capabilities in using AI-based tools and technologies for teaching. Unlike the original, it includes only Intelligent-Technological Knowledge (i-TK), Intelligent-Technological Pedagogical Knowledge (i-TPK), Intelligent-Technological Content Knowledge (i-TCK), and Intelligent-Technological Pedagogical Content Knowledge (i-TPACK). Celik also emphasized the importance of ethics in AI use, identifying four main factors: accountability, transparency, fairness, and inclusiveness. Various analyses, including Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM), were conducted to ensure the framework's validity and reliability. The study found positive associations between several components, with the exception of TK, which was not associated with TPACK.

This study focuses on the capabilities of pre-service teachers in using generative AI-based tools for educational purposes in TESL programs. The AI tools discussed here refer to the generative AI tools, which align better with the current AI landscape.

2. Research Objectives

The primary objective of this study is to investigate the pre-service English teachers' level of Intelligent-Technological Pedagogical Content Knowledge (i-TPACK) to integrate generative AI-based tools in future teaching. This investigation will focus on the following areas of TPACK: Technological Knowledge (TK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK).

3.0   Technological Pedagogical Content Knowledge (TPACK) Model

The TPACK framework, known in the ICT field, integrates multiple concepts and serves as a guide for assessing teachers' abilities to use technology in teaching their primary subjects. It comprises seven key components: Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK) itself. The framework originated from [8] notion of PCK, which includes PK and CK, relating to how teachers use suitable teaching techniques and strategies to teach particular content or subjects. [5] later added the technological aspect, resulting in a comprehensive yet flexible framework to assess teachers' knowledge for integrating technologies in teaching, now known as TPACK. For this study, the focus will be on the capabilities of pre-service teachers in using Gen-AI-based tools, addressing only TK, TCK, TPK, and TPACK.

Past research has adapted the TPACK framework for teachers' training in various contexts, from vocational education and training (VET) focusing on nutritional science and home economics to special education and social studies [9], [10]. A case study was also conducted with TPACK as the base on music technology integration in Liberal Music Education at a vocational college in Perak, Malaysia, to observe students' engagement and learning outcomes [11]. Various other subject matters and contexts can adapt TPACK with the purpose of improving the overall process of teaching and learning. [10] in their study argue the importance of understanding how teachers develop and apply TPACK in different contexts, which can widen the understanding of teacher knowledge development and inform efforts to support the use of digital communication tools in specialeducation settings. Thus, this study will utilize the framework as a basis to study the pre-service teachers' confidence in their capabilities of using Gen-AI-based tools for pedagogical purposes.

3.1   Intelligent-TPACK (Technological Pedagogical Content Knowledge)

The Intelligent-TPACK framework, developed by [7], refines the original TPACK framework to focus specifically on teachers' knowledge and capabilities in using Gen-AI-based tools and technologies for teaching. Unlike the original, it includes only Intelligent-TK (ITK), Intelligent-TPK (ITPK), Intelligent-TCK (ITCK), and Intelligent-TPACK. Celik also emphasized the importance of ethics in Gen-AI use, identifying four main factors: accountability, transparency, fairness, and inclusiveness. Various analyses, including Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM), were conducted to ensure the framework's validity and reliability. The study found positive associations between several components, with the exception of TK, which was not associated with TPACK. Figure 1 below shows the summary of the results while Figure 2 shows the Intelligent-TPACK framework.
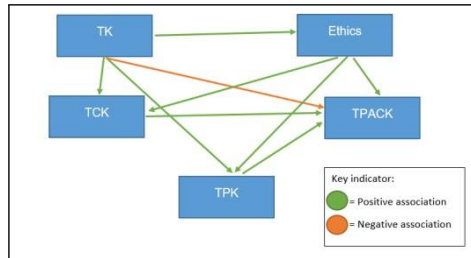

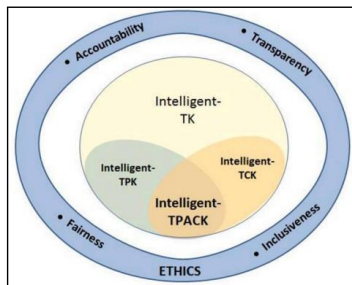Fig. 1. A summary of the interplay between Intelligent-TPACK and ethics [7]

Fig. 2. Intelligent-TPACK Framework [7]

3.2   Gen-AI-based Tools in English as a Second Language (ESL)

The integration of Gen-AI-based tools in English as a Second Language (ESL) instruction significantly impacts language learning by enhancing effectiveness, student engagement, and motivation. Studies have revealed the benefits of Gen-AI tools on ESL learners, such as increased engagement, perceived usefulness, and improved language acquisition. For instance, using an Gen-AI chatbot for vocabulary learning showed high engagement and usefulness among participants, offering insights for teachers to optimize learning experiences. Gen-AI-powered tools have been found to boost motivation and proficiency compared to traditional methods [12]. However, concerns about overdependence on Gen-AI tools and decreased face-to-face learning participation have also been noted [13].

Gen-AI tools positively influence learners' affective aspects, such as acceptance and motivation, by making learning less monotonous and more engaging [4]. They enable students to practice English outside the classroom, enhancing proficiency and preference over traditional methods [14].

Gen-AI-powered chatbots offer personalized support, fostering language comprehension and transforming learning practices [15]. For teachers, Gen-AI integration improves lesson planning, resource allocation, and automated grading, helping identify learning challenges and provide targeted support [1]. This reduces teachers' workload and allows more focus on personalized instruction, enhancing overall teaching efficiency and learning outcomes.

3.3   Teachers' Perceptions on Gen-AI-Based Tools in Education

Previous studies indicate a growing focus on understanding the perceptions and attitudes of pre- and in-service teachers towards Gen-AI-based tools in education. Research reveals that while many teachers have positive attitudes towards Gen-AI integration, acknowledging its benefits for enhancing learning and teaching practices, there are also concerns about its impact on critical thinking, social interactions, and ethical use of data [15]. Some studies highlight mixed attitudes, with enthusiasm from some teachers and reservations from others about potential negative impacts on teaching practices and the role of teachers [16]. Additionally, barriers such as technical, linguistic, and conceptual challenges, along with ethical considerations and biases, influence teachers' perceptions [17]. Despite more literature on in-service teachers, there is a notable lack of research on pre-service teachers, indicating a need to further explore their perceptions, knowledge, and capabilities in using Gen-AI for English teaching and learning.

4.0   Research Methodology

This study aims to investigate the pre-service English teachers' self-efficacy in TPACK knowledge to integrate Gen-AI-based tools in future teaching and their perceptions. The population for this study is the 190 undergraduate students who are pursuing the Bachelor of Education Teaching English as a Second Language (TESL) program as they can be defined as pre-service English teachers. s. The samples that were selected to answer the questionnaire were TESL students who (1) have experiences in using AI-based tools whether for personal or teaching use and (2) are enrolled in the Bachelor of Education in TESL program. The random sampling was conducted by selecting students from different cohorts and classes, ensuring a diverse representation of the TESL program.   The participants completed an online questionnaire adapted from [7] study, which included a 7-point Likert scale and four open-ended questions. The data collection was carried out automatically through Google Forms, and both descriptive and inferential statistical analyses were employed. The instrument adaptation process included verifying the relevance of [7] items to the context of TESL education, ensuring that the questionnaire accurately reflects the pre-service teachers' experience with

AI tools in their field. Methods of data analysis used in this study are presented in the Table 1 below.

Table 1. Data Analysis

Research Objectives	Instrument	Types of Analysis
To investigate the pre-service English teachers' level of Intelligent TPACK to integrate Gen-AI-based tools in future teaching	Questionnaire	Descriptive statistics was used where the mean score was observed

5.0 Findings

The findings of the study gathered from the questionnaire for both quantitative and qualitative. The responses were analysed using Statistical Package for the Social Sciences (SPSS) version 21.0 for Windows.

5.1 Profile of Respondents

According to the table below, there were 37 (19.5%) male respondents and 183 (80.5) female respondents. Their ages range from 20 to 31 years old where the majority is 22 years old followed by 23 years old. For the year of enrolment, majority is the third-year students with 52 responses (27.4%) while the first-year students with 41 responses (21.6%). As for the Gen-AI-based tools usage frequency, majority of the respondents chose "Always" with 68 responses (35.8%) while the minority chose "Rarely" with 4 responses (2.1%). Meanwhile, the most used type of Gen-AI-based tools is Generative Pre-trained Transformer (GPT) with 162 responses (44.8%) followed by Gen-AI chatbots with 95% responses (26.2%) and only 4 responses (1.1%) for other types of Gen-AI-based tools used.

Table 2. Demographic Profile

Demographic		Frequency	Percentage (%)
Gender	Male	37	19.5
	Female	153	80.5
Age	20	26	13.7
	21	45	23.7
	22	54	28.4
	23	52	27.4
	24	10	5.3
	25	1	0.5
	26	1	0.5

		31	1	0.5
Year of Enrolment	First Year	41	21.6
	Second Year	48	25.3
	Third Year	52	27.4
	Fourth Year	49	25.8
AI-based Tools Frequency Usage	Always	68	35.8
	Often	85	44.7
	Sometimes	33	17.4
	Rarely	4	2.1
Types of AI-based Tools	Generative Pre-Trained Transformer (GPT)	162	44.8
	AI Image and Video Platforms	54	14.9
	AI Learning Modules/Tutors	47	13
	AI Chatbots	95	26.2
	Other	4	1.1

Note: The most used Generative AI-based tool, according to the participants, was Generative Pre-trained Transformer (GPT), used by 44.8% of the respondents.

5.1 The pre-service English teachers' level of Intelligent TPACK to integrate Gen-AI-based tools in future teaching

5.1.1 Intelligent - Technological Knowledge (I-TK) to integrate Gen-AI based tools in future teaching Based on Table 3, it can be determined that the highest mean score for the pre-service teachers' level of ITK is 5.75 for the second item followed by the first item with 5.72. This means that the pre-service teachers agree that they have the knowledge in using Gen-AI-based tools to execute some tasks and "to interact with Gen-AI-based tools in daily life". The lowest mean is for the fourth item with a mean score of 5.49. This shows that they agree to say that they might not have "sufficient knowledge" in utilizing Gen-AI-based tools. This could be because the term 'sufficient' makes them think that they still have a long way to explore and master the knowledge to use these tools.

Table 3. Descriptive analysis of pre-service teachers' level of I-TK

Item	Mean	Standard Deviation
I know how to interact with Gen-AI-based tools in daily life.	5.72	**1.11**
I know how to execute some tasks with Gen-AI-based tools.	5.75	**1.02**
I know how to initialize a task for	5.64	**1.15**

Gen-AI-based technologies by text or speech.		
I have sufficient knowledge to use Gen-AI-based tools.	5.49	**1.28**
I am familiar with Gen-AI-based tools and their technical capacities.	**5.66**	1.18

5.1.2 Intelligent - Technological Pedagogical Knowledge (I-TPK) to integrate Gen-AI-based tools in future teaching

Based on Table 4, it is shown that the highest mean score for the pre-service teachers' level of ITPK is 5.54 for the second item followed by the first item with 5.47. This equates how the pre-service teachers agree that they have the ability to "evaluate the usefulness of feedback from Gen-AI-based tools for teaching and learning" and able to comprehend "pedagogical contribution of Gen-AI-based tools" to their teaching field (English). Meanwhile, the lowest mean is for the fourth item with a mean score of 5.04. This means that they agree to say that they might have lesser knowledge to monitor students' learning through Gen-AI-based tools compared to other abilities and knowledge under ITPK. This might be due to their lack of teaching and full utilization of these tools for their students learning.

Table 4. Descriptive analysis of pre-service teachers' level of I-TPK

Item	Mean	Standard Deviation
I can understand the pedagogical contribution of Gen-AI-based tools to my teaching field.	6.45	0.63
I can evaluate the usefulness of feedback from Gen-AI-based tools for teaching and learning.	6.29	0.74
I can select Gen-AI-based tools for students to apply their knowledge.	6.38	0.76
I know how to use Gen-AI-based tools to monitor students' learning.	6.43	0.67
I can interpret messages from Gen-AI-based tools to give real-time feedback.	6.52	0.59
I can understand alerting (or notification) from Gen-AI-based tools to scaffold students' learning.	6.33	0.87
I have the knowledge to select Gen-AI-based tools to sustain students' motivation.	6.33	0.95

5.1.3 Intelligent - Technological Content Knowledge (I-TCK) to integrate Gen-AI-based tools in future teaching

Based on Table 5, the highest mean score for the pre-service teachers' level of ITCK is 5.83 for the third item followed by the first item with 5.72. This shows how the pre-service teachers agree that they possess the ability to utilize Gen-AI-based tools to develop deeper understanding about the contents in their teaching field (English) and "to search for educational material" for English. The lowest mean is for the fourth item with a mean score of 5.45. This means that they agree to say that they might have less knowledge in utilizing Gen-AI-based tools specifically for English such as using intelligent tutor for teaching English. This might be stemmed from their inexperienced with various other types of Gen-AI, rather than just using GPT as how majority had chosen.

Table 5. Descriptive analysis of pre-service teachers' level of I-TCK

Item	Mean	Standard Deviation
I can use Gen-AI-based tools to search for educational material in my teaching field.	5.72	1.11
I am aware of various Gen-AI-based tools which are used by professionals in my teaching field.	5.55	1.27
I can use Gen-AI-based tools to better understand the contents of my teaching field.	5.83	1.00
I know how to utilize my field-specific Gen-AI-based tools (e.g., intelligent tutor for English).	5.45	1.28

5.1.4 Intelligent – Technological Pedagogical Content Knowledge (I-TPACK) to integrate Gen-AI-based tools in future teaching

Based on Table 6, the highest mean score for the pre-service teachers' level of I-TPACK is 5.47 for the fifth item followed by the fourth item with 5.45. This indicates how the pre-service teachers agree that they are able to appropriately integrate English content, Gen-AI-based tools and teaching strategies to teach lessons along with the ability to teach a subject with various teaching strategies using Gen-AI-based tools. The lowest mean is for the sixth item with a mean score of 5.09. This showcases the agreement between the pre-service teachers on how they possibly do not have the confidence to "take a leadership role" among their colleagues or groupmates to integrate Gen-AI-based tools in English.

Table 6. Descriptive analysis of pre-service teachers' level of I-TPACK

Item	Mean	Standard Deviation
In teaching my field, I know how to use different Gen-AI-based tools for adaptive feedback.	5.26	1.25
In teaching my field, I know how to use different Gen-AI-based tools for personalized learning.	5.42	1.21
In teaching my field, I know how to use different Gen-AI-based tools for real-time feedback.	5.31	1.34
I can teach a subject using Gen-AI-based tools with diverse teaching strategies.	5.45	1.25
I can teach lessons that appropriately	5.47	1.24

combine my teaching content, Gen-AI-based tools, and teaching strategies.		
I can take a leadership role among my colleagues/groupmates in the integration of Gen-AI-based tools into our teaching field.	5.09	1.03

As a whole, the pre-service teachers highest mean score lies in their Intelligent Technological Knowledge (ITK) and Intelligent Technological Content Knowledge (ITCK) with a similar mean score of 5.65. This shows how they have the ability and knowledge in using Gen-AI-based tools not just in general but also for enhancing their comprehension on English as a subject. However, the lowest mean score is for Intelligent Technological Pedagogical Content Knowledge (I-TPACK) with 5.18 which indicates how their ability and knowledge to integrate Gen-AI-based tools to teach English effectively are still not too concrete and strong just yet.

6.0   Conclusion

The descriptive analysis data has depicted that the pre-service teachers are most confident in their ability to "execute some tasks with Gen-AI-based tools". This could be explained through their personal experience of utilizing Gen-AI-based tools for various purposes as captured under the first theme such as enhancing English or language skills, aid in generating ideas and creative lesson plans and allow a more efficient lesson planning. It was also found that there is a significant difference between the usage of frequency for ITK, indicating that those with high usage of Gen-AI-based tools possess more confidence in their knowledge for ITK with medium effect. In other words, their previous personal experiences of using Gen-AI-based tools reinforce their Technological Knowledge which is to integrate the tools for future teaching.

The descriptive analysis also showed how the pre-service teachers think that they possibly do not have enough knowledge to use Gen-AI-based tools. This might be explained by the limited types of the tools used. Majority, 162 or 44.8% of the respondents stated that they use GPT or have experience in using it. However, only 54 or 14.9% had chosen Gen-AI Image and Video Platforms, 47 or 13% chosen Gen-AI Learning Modules/Tutors and only 4 or 1.1% chose other types. This clearly shows how most of them only use one or two types of Gen-AI-based tools and thus felt that they lack the knowledge to use Gen-AI-based tools. [18] implied in his study about the idea of user's familiarity with the tools and their potential benefits can be seen in the way they integrate the tools for teaching. Thus, pre-service teachers past experiences will allow higher familiarity with the tools and help them improve their Intelligent TK. Consequently, they also should use various types of tools to improve this familiarity to contribute more towards their ITK level.

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