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Perception vs. Performance: Unpacking Pre-Service EFL Teachers' TPACK Gaps in AI-Enhanced Learning Design

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ABSTRACT

This study investigated how pre-service EFL teachers' perceived Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK) relate to their demonstrated TPACK performance when designing AI-enhanced lessons. It employed a correlational research design with multiple linear regression. Seventy-seven Indonesian pre-service teachers who had used AI-enhanced tools during practicum completed perceived PCK, TCK, and TPK questionnaires. Actual TPACK competence was scored with a performance rubric (lesson plans, supporting documents, and teaching observations). Descriptively, participants reported the most substantial confidence in PCK (M = 3.61, SD = 0.54, 5-point scale), while TCK (M = 3.00, SD = 1.14) and TPK (M = 3.02, SD = 0.50) were moderate. Performance data showed that, on average, teachers achieved 70 percent of the maximum TPACK score, indicating adequate yet improvable integration of technology, pedagogy, and content. Multiple-regression analysis revealed that perceived PCK, TCK, and TPK together did not significantly predict demonstrated TPACK ($F(3,73) = 1.98$, $p = .125$). These findings suggest a disconnect between what teachers think they know and what they can enact. It contributes to teacher knowledge research by highlighting the gap between self-perceived and demonstrated competence, underscoring the need for practice-oriented training that explicitly links AI tool use to pedagogical and content goals.

ARTICLE INFORMATION

Keywords:
ai-enhanced instruction; efl teaching; perceived competence; pre-service teachers; tpack performance

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INTRODUCTION

The integration of Artificial Intelligence (AI) into education is rapidly transforming how teachers design, deliver, and assess learning (Hava & Babayiğit, 2024; Kessler, 2018; Pitura et al., 2024). In the English as a Foreign Language (EFL) context, AI-powered tools such as ChatGPT, Grammarly, Canva, and other intelligent applications are increasingly used to enhance vocabulary learning, speaking practice, writing development, and reading comprehension (George, 2023; Ning et al., 2024; Owan et al., 2023). However, in Indonesia, the use of AI in learning design is still in its early stages, especially among pre-service teachers (Rahman, 2021; Syahnaz & Fithriani, 2023; Williyan et al., 2024). Many teacher education programs have yet to systematically incorporate AI literacy and digital pedagogical strategies into their curricula (Bachtiar, 2025; Haetami, 2025). This lack of structured preparation creates uncertainty about how pre-service teachers can meaningfully apply AI in their learning design.

Building on this concern, this early-stage development of AI integration in Indonesia presents a dual challenge. On one hand, there is immense potential for innovation and pedagogical renewal, especially in EFL learning, where technology can help bridge the gap between classroom learning and real-world communication. On the other hand, without proper frameworks, training, and policies, the implementation of AI-enhanced tools may remain superficial or misaligned with pedagogical goals.

Pre-service teachers may view these technologies merely as supplementary rather than transformative tools. Additionally, language classrooms that aim to use AI tools effectively require significant pedagogical rethinking—from teacher-centered to more student-driven approaches that foster exploration, problem-solving, and self-directed learning (Thornhill-Miller et al., 2023).

In light of these challenges, teacher preparation should ensure that future educators are not only pedagogically competent and subject-matter proficient but also confident and skilled in integrating AI to improve learning outcomes. This ideal is echoed in national policies such as the Merdeka Belajar Kampus Merdeka (MBKM) initiative and the Peta Jalan Pendidikan Indonesia 2020–2035, which emphasize the importance of digital transformation in education and the need to strengthen teacher capacity in using technology for learning innovation (Ismail et al., 2024; Kusumawati & Umam, 2025; Sudarto, 2023). The Indonesian Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) has also highlighted digital competency and technological adaptability as critical areas for teacher professional development (Widiastuti, 2025; Wijanarko, 2024). At the same time, there is concern that AI-enhanced learning might discourage students from engaging in deeper thinking, potentially leading to an over-reliance on technology rather than the development of their cognitive and metacognitive skills (Haetami, 2025; Ismail et al., 2024; Ning et al., 2024).

These policy directions further emphasize not only access to digital tools but also their pedagogically sound implementation. In the EFL classroom, digital transformation must move beyond surface-level tool use to deeper learning design that intentionally fosters 21st-century competencies such as critical thinking, creativity, communication, and collaboration. As AI technologies become more accessible to pre-service teachers, there is an urgent need to support their professional identity development in a digital context. This includes fostering ethical considerations in AI use, encouraging reflective practice, and preparing them to navigate the socio-technical complexities of modern classrooms (George, 2023). Taken together, teacher education programs must not only respond to policy mandates but also proactively address the pedagogical challenges of integrating AI into language-learning environments.

These developments and concerns underscore the crucial role of Technological Pedagogical Content Knowledge (TPACK) in equipping pre-service teachers to respond to the growing demands of AI-enhanced learning. As a dynamic framework, TPACK reflects the integrated knowledge teachers need to design and implement learning that aligns technological tools with appropriate pedagogical strategies and relevant content (Chai et al., 2010; Nordin, 2014; Redmond & Lock, 2019; Tuysuz, 2014). In the context of English language teaching, the ability to select and use AI tools such as ChatGPT or Grammarly to support learning objectives requires more than basic technological familiarity (Rasheed et al., 2025; Taj & Khan, 2024). It also demands a cohesive understanding of how technology intersects with pedagogy and subject matter (Andersson et al., 2024; Floris & Renandya, 2025; Syahnaz & Fithriani, 2023). Teachers also need to leverage AI to promote active, learner-centered environments where students engage in critical thinking and language use (Mutohhari et al., 2021; Thornhill-Miller et al., 2023; Wei, 2023).

The TPACK framework, first conceptualized by Koehler et al. (2013), provides a foundation for this integration. It suggests that effective technology integration occurs when teachers understand how technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) intersect to form a transformative practice. Subcomponents such as Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Knowledge (TPK) further highlight the nuanced relationships teachers must navigate when designing learning. For example, in EFL writing learning, a teacher using Grammarly must understand not just how the tool works (TK), but also how to guide students to use it for feedback (TPK), how to align its suggestions

with genre-based writing learning (PCK), and how it supports learning objectives (TCK). The balance and integration of these knowledge domains are what ultimately constitute strong TPACK.

Building on this framework, recent studies have examined the relationship between teachers' self-perceived TPACK competencies and their actual performance in technology-enhanced learning environments, including those supported by AI tools. Findings suggest that digital proficiency significantly predicts AI-TPACK competence (Hava & Babayiğit, 2024), yet pre-service teachers often overestimate their capabilities, particularly among lower-performing individuals (Max et al., 2022). This discrepancy highlights the limitations of relying solely on self-assessment to understand teachers' readiness for technology integration. In response, some researchers have developed rubrics to assess enacted TPACK in authentic teaching contexts (Aumann et al., 2023; Lyublinskaya & Kaplon-Schilis, 2022). While these tools help validate classroom performance, there remains a limited understanding of how perceived TPACK components relate to demonstrated competence, particularly in EFL contexts involving AI tools. Furthermore, there is a lack of studies that evaluate not only whether pre-service teachers use AI tools, but also how appropriately these tools are integrated to achieve pedagogical and content alignment in EFL learning settings.

This gap is further complicated by the growing body of literature on teacher digital competence, which often neglects the layered complexity of learning decisions in multilingual and multicultural contexts. In Indonesia, pre-service teachers may face additional barriers, including limited access to AI-compatible devices, varying institutional support, and uneven digital literacy training. These systemic inequities can further complicate the relationship between perceived confidence and actual classroom performance. For instance, a teacher may express high perceived TPK in surveys due to exposure in coursework, but without field experience or mentorship, the transfer to classroom performance may not materialize (Haetami, 2025).

Therefore, the lack of alignment between perceived and demonstrated competence is not merely a reflection of individual weakness but signals a structural gap in how teacher education programs support authentic technology integration practices. Understanding the gap between what teachers believe they know (perceived competence) and what they can actually do (demonstrated competence) is essential to ensuring that professional preparation is both practical and relevant. To address this gap, the present study investigated whether perceived PCK, TCK, and TPK can predict demonstrated TPACK competence among pre-service EFL teachers, particularly in AI-enhanced learning. Specifically, it examined three key questions: how pre-service teachers perceive their Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK) in AI-enhanced EFL learning; what their actual TPACK performances look like when demonstrated in AI-enhanced learning design; and to what extent their perceived PCK, TCK, and TPK predict their actual TPACK performance in this context.

METHOD

This study employed a correlational research design to examine the extent to which pre-service English teachers' perceived Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK) predict their demonstrated TPACK competence in designing AI-enhanced learning. A correlational research design is used to explore the strength and direction of relationships among variables without manipulating them (Creswell & Clark, 2011). It does not establish causation but rather identifies whether and to what extent variables are related. In this study, the correlational design was appropriate because the aim was to determine whether pre-service teachers' self-perceptions of their knowledge domains (PCK, TCK, and TPK) are statistically associated with their actual performance in designing AI-integrated lessons, as measured by a TPACK rubric. By using this design, the researchers were able to analyze patterns of association

between perceived and demonstrated competence, uncovering potential gaps between belief and practice without introducing experimental interventions. The research design is shown in Figure 1.

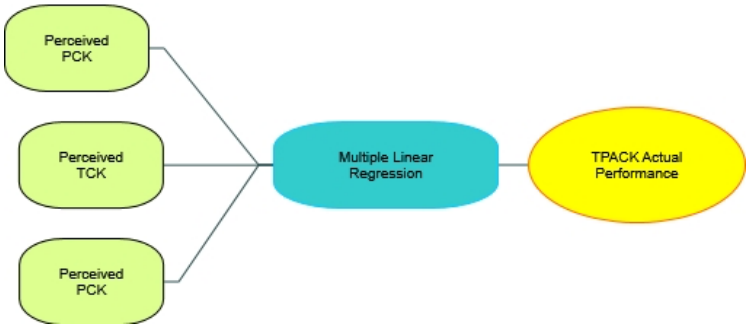


Figure 1. Research Design

A total of 77 pre-service EFL teachers from three private universities in Indonesia participated in the study. Participants were selected through a preliminary screening survey designed to identify those who had used Artificial Intelligence (AI) tools in their teaching practicum. Inclusion criteria required participants to have designed or implemented learning activities using AI applications such as ChatGPT, Canva, Grammarly, or YouGlish during their practicum sessions. This purposive sampling ensured that the participants were relevant to the research aims and represented a range of perceived competencies in PCK, TCK, and TPK, as well as varying levels of demonstrated TPACK performance.

To measure participants' perceived competence, a modified TPACK self-assessment questionnaire was developed based on the framework by Koehler et al. (2013). The items were adapted to reflect the specific context of English language teaching and to integrate AI tools. Each construct was measured using a separate questionnaire consisting of 12 items for PCK and 10 items each for TCK and TPK. Sample items included statements such as, "I can use AI tools such as ChatGPT to assist students' writing activities" (TCK) and "I have sufficient knowledge of English language structures appropriate for learning planning" (PCK). All items were rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The instruments were tested for validity and reliability using a sample of 46 pre-service English teachers who were not part of the main study. The item validity, assessed through corrected item-total correlation, ranged from 0.61 to 0.89, indicating strong construct validity. Reliability analysis showed high internal consistency, with Cronbach's alpha coefficients of .91 for PCK, .89 for TCK, and .90 for TPK. These results confirm that the instruments were both valid and reliable for assessing perceived competence in AI-integrated English language teaching.

To assess demonstrated TPACK, a performance scoring rubric was adapted to suit the context of EFL learning and AI integration from Herring et al. (2016), which included three major dimensions: 1) Technology Integration Assessment Rubric that the appropriateness and alignment of AI tools used with learning goals; 2) Evaluation of Design Tasks and Learning Activities that evaluate the clarity, coherence, and content relevance of learning tasks; and 3) Fluency of Integrating AI in Learning that assess how seamlessly AI tools were integrated to support pedagogical strategies and language learning outcomes. The adapted rubric underwent expert judgment validation by three scholars specializing in EFL pedagogy, learning design, and educational technology. Based on their feedback, minor revisions were made for clarity and contextual appropriateness. The final version was deemed valid, with a content validity index (CVI) of 0.91, indicating strong agreement among the experts on the rubric's relevance and clarity (Grant & Davis, 1997). Each dimension was rated on a 4-point scale from "emerging" to "exemplary."

The data were first analyzed using descriptive statistics to examine pre-service teachers' perceived competence in Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK), as well as their actual TPACK performance in AI-enhanced EFL learning design. Next, a multiple linear regression analysis was used to investigate the predictive contribution of perceived PCK, TCK, and TPK to pre-service teachers' demonstrated TPACK competence. Prior to conducting the regression analysis, preliminary assumption checks were performed, including tests of normality using the Shapiro-Wilk test, tests of linearity through scatterplots, multicollinearity diagnostics using the Variance Inflation Factor (VIF), and heteroskedasticity diagnostics to ensure the validity of the regression model.

RESULTS AND DISCUSSION

The first objective of the study was to investigate pre-service EFL teachers' perceived competence in three core domains of knowledge in the context of AI-enhanced learning: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK). Understanding how pre-service teachers perceive their preparedness in these areas is essential for evaluating their confidence and readiness to integrate AI tools into English language teaching. To address this objective, the data were analyzed using descriptive statistics, including mean scores and standard deviations, and then converted to a 100-point scale to facilitate more straightforward interpretation and comparison. These analyses provide insight into the levels of self-reported competence among pre-service teachers and serve as a basis for understanding the alignment between perceived knowledge and actual performance.

The descriptive statistics revealed that the highest mean score was for pre-service teachers' Pedagogical Content Knowledge (PCK) ($M = 3.61$, $SD = 0.539$). In contrast, the mean score for Technological Content Knowledge (TCK) was moderate ($M = 3.00$, $SD = 1.135$). For Technological Pedagogical Knowledge (TPK), the mean score was also moderate ($M = 3.02$, $SD = 0.497$). The standard deviation values also offer important insight. While PCK had a lower SD (0.539), indicating relatively consistent responses across participants, TCK showed the highest variation ($SD = 1.135$), suggesting substantial differences in how pre-service teachers rated their knowledge in this area. This variation may reflect diverse prior experiences with digital tools, inconsistent exposure to AI technologies, or differences in training across institutions or courses.

The moderate mean scores for TCK and TPK indicate developing, but not yet robust, confidence in using technology effectively in content delivery or pedagogy. While pre-service teachers may have some exposure to AI-powered tools or educational technologies, they do not consistently view themselves as proficient in integrating these tools with subject content (TCK) or pedagogical methods (TPK). This is particularly relevant in the context of AI-enhanced learning, where technology is not merely supplemental but becomes integral to task design, feedback provision, and personalized learning experiences.

The scores were converted to a 100-point scale to provide a clearer illustration of pre-service teachers' perceived competence and to offer a stronger basis for comparison with their actual TPACK performance. The distribution of perceived Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK) is shown in Figure 2. This visualization highlights how pre-service teachers rated their own knowledge domains, which serves as an important point of reference before examining their demonstrated TPACK competence.

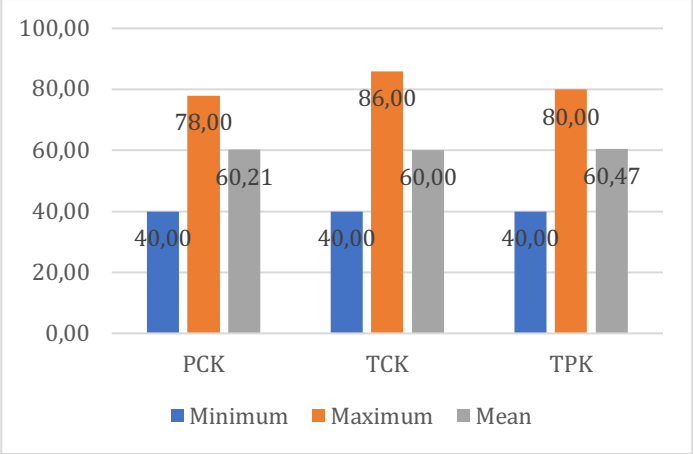


Figure 2. Pre-service EFL teachers perceived PCK, TCK, and TPK

The converted scores for the three domains cluster around 60 percent, indicating moderate self-confidence. These results revealed that participants believe they know enough to get by with AI-enhanced tools and methods, yet they are not entirely sure of their ability to integrate technology, pedagogy, and content at an advanced level. In general, it implies that while pre-service teachers feel more confident in their foundational pedagogical and content knowledge (PCK), their confidence and experience vary more when integrating technology with content (TCK) and pedagogy (TPK), especially in the context of AI-enhanced learning.

The data indicate that pre-service teachers generally perceived themselves as most confident in their ability to connect pedagogical methods with subject content—reflecting their foundational training and academic preparation in these areas. This relatively high perception of PCK suggests that participants were comfortable with tasks such as choosing suitable learning strategies, sequencing content logically, and aligning learning activities with learning outcomes. The lower scores in TCK and TPK, however, suggest a more cautious self-assessment in areas where technology plays a prominent role. Overall, the descriptive results suggest that while pre-service teachers feel relatively confident in their traditional teaching knowledge (PCK), they are less assured when it comes to blending technology meaningfully with pedagogy and content.

The second objective of the study was to examine the actual TPACK performance of pre-service EFL teachers in designing AI-enhanced learning. While self-perceived knowledge offers insight into confidence and perceived readiness, performance-based evidence is essential to evaluate the extent to which pre-service teachers can effectively integrate technological tools with appropriate pedagogical approaches and content knowledge in practice. To gain a more comprehensive understanding of Pre-service EFL teachers' ability to integrate technology into their teaching practice, this study examined their actual TPACK performance during lesson planning and microteaching activities. Unlike self-reported perceptions, actual performance data offer more concrete insights into how well pre-service teachers can apply technological, pedagogical, and content knowledge in real learning contexts.

The assessment focused on how effectively they designed AI-integrated lessons aligned with learning objectives, learning materials, and learning strategies. Participants were asked to produce lesson plans that incorporated AI tools in meaningful ways, accompanied by relevant supporting materials. These were evaluated using a structured rubric that captured various aspects of TPACK-based learning design, including the selection and use of AI tools, alignment with pedagogical goals, and coherence between content, methods, and technology. Additionally, microteaching sessions were used to observe whether the integration of technology remained consistent in actual delivery and not

just in written planning. Figure 3 presents the descriptive statistics of pre-service teachers' actual TPACK performance scores.

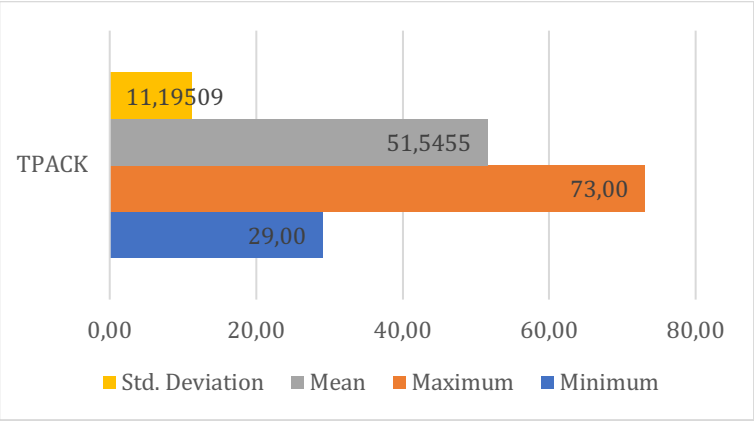


Figure 3. Pre-service EFL teachers' actual TPACK Performance

The descriptive statistics show that the actual TPACK performance scores of the 77 Pre-service EFL teachers ranged from 29 to 73 out of a possible 80 points. The mean score was 51.55, with a standard deviation of 11.20, indicating a moderate level of TPACK performance overall. When converted to a 100-point scale for clarity, the mean performance score equates to approximately 64.4%, reinforcing the notion that participants performed adequately but not yet at an advanced or expert level.

The distribution of scores shows substantial variability among participants. The relatively high standard deviation (11.20) indicates that some individuals performed well above average, demonstrating strong integration of AI tools with pedagogical intent and content accuracy. These participants were able to create lesson plans where technology enhanced learning rather than functioning as a decorative or disconnected add-on. Conversely, others struggled to incorporate technology in ways that aligned meaningfully with learning objectives. Some plans exhibited surface-level use of AI tools (e.g., inserting a ChatGPT activity without a clear learning purpose) or showed inconsistencies between intended outcomes and the learning strategies chosen.

The wide score range from 29 to 73 points illustrates the uneven distribution of digital-pedagogical competence within the sample. While some pre-service teachers approached the upper performance threshold—demonstrating near-full alignment across the TPACK components—others performed below the midpoint, signaling significant gaps in their ability to integrate AI in pedagogically sound and content-relevant ways. These findings provide a useful reference point for comparing actual teaching performance with self-perceived competence in the TPACK domains. They suggest that although many participants can meet a baseline level of TPACK integration, there is considerable room for improvement, especially in embedding AI in ways that support learning goals and learner engagement. These variations are explored further in the predictive analysis presented in the next section.

The third objective of this study was to investigate whether pre-service EFL teachers' perceived Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK) could significantly predict their actual TPACK performance in AI-enhanced learning design. Understanding this relationship is important for identifying whether self-reported knowledge can serve as a valid indicator of teaching competence in the context of educational technology integration. To explore this relationship, multiple linear regression analysis was conducted, with perceived PCK, TCK, and TPK as the independent variables and actual TPACK

performance as the dependent variable. Prior to conducting the regression analysis, a series of assumption tests were performed to ensure the appropriateness and statistical validity of the model. These included tests for normality, linearity, multicollinearity, and heteroscedasticity, with the results presented in Table 1.

Table 1. Prerequisite Test Results

Assumption	Test/Indicator	Value	Sig. (p-value)
Normality	Kolmogorov-Smirnov Test Statistic	0.088	0.200
Linearity	Linearity (ANOVA: Linearity)	F = 0.461	0.500
	Deviation from Linearity	F = 1.148	0.334
Multicollinearity	Tolerance (PCK / TCK / TPK)	.989 / .993 / .996	-
	VIF (PCK / TCK / TPK)	1.011 / 1.007 / 1.004	-
Heteroscedasticity	ANOVA (Test on Absolute Residuals)	F = 1.526	0.215

As shown in Table 1, all assumptions required for multiple regression analysis were satisfactorily met. The Kolmogorov–Smirnov test indicated that the residuals were normally distributed ($p = 0.200 > 0.05$), satisfying the assumption of normality. Regarding linearity, both the test of linearity ($F = 0.461$, $p = 0.500$) and the deviation from linearity ($F = 1.148$, $p = 0.334$) were non-significant, indicating a valid linear relationship between the independent and dependent variables. Tests for multicollinearity also confirmed that the independent variables were sufficiently independent. The tolerance values for PCK, TCK, and TPK ranged from 0.989 to 0.996, and all VIF values were very close to 1 (ranging from 1.004 to 1.011), far below the commonly accepted threshold of 10. This suggests that multicollinearity was not a concern in the regression model. Finally, the assumption of homoscedasticity was tested by performing an ANOVA on the absolute residuals. The result was non-significant ($F = 1.526$, $p = 0.215$), indicating that the residual variance was relatively constant across predicted values. With all assumptions satisfied, the data were deemed appropriate for further regression analysis to explore the predictive relationship between pre-service teachers' perceived PCK, TCK, and TPK and their actual TPACK performance. The results of this regression model are reported in Table 2.

Table 2. The Results of Multiple Linear Regression

Source	SS	df	MS	F	Sig.
Regression	715.677	3	238.559	1.977	0.125
Residual	8809.414	73	120.677		
Total	9525.091	76			

As shown in Table 2, the regression model yielded an F-value of 1.977 with 3 and 73 degrees of freedom, and a p-value of 0.125. Since the p-value exceeds the 0.05 significance level, the regression model as a whole was not statistically significant. This result indicates that the combined set of independent variables—perceived PCK, TCK, and TPK—did not significantly account for the variance in pre-service teachers' actual TPACK performance. In other words, the perceived knowledge in the three domains did not significantly predict how well pre-service teachers demonstrated their ability to integrate technology, pedagogy, and content in AI-enhanced learning tasks. While these domains are conceptually central to the TPACK framework, their self-reported levels may not reliably translate into observable teaching competence, particularly in real or simulated classroom settings.

The lack of predictive power suggests a possible misalignment between what participants believe they know and what they can apply in practice. Although pre-service teachers reported moderate to high confidence in their Pedagogical Content Knowledge (PCK), Technological Content

Knowledge (TCK), and Technological Pedagogical Knowledge (TPK), these self-assessments did not significantly account for their actual TPACK performance scores. This discrepancy suggests that perceived competence in individual knowledge domains may not accurately reflect participants' real-world ability to integrate technology, pedagogy, and content cohesively.

One possible explanation for this finding is that self-reported data often capture belief or confidence rather than proven capability. Participants may have formed favorable impressions of their own skills based on theoretical coursework or limited exposure to AI tools, but lacked the depth of experience necessary to enact those skills effectively during lesson planning or microteaching. This gap becomes evident when actual performance is measured using objective criteria, such as rubric-based evaluations of learning design, alignment between tools and objectives, and learning coherence. Furthermore, the wide variability in actual TPACK performance scores suggests an inconsistent ability to apply perceived knowledge in learning design. In comparison, some individuals demonstrated strong performance, while others with similar self-assessed knowledge performed considerably lower, further reinforcing the notion that self-perception alone does not reliably predict enacted competence. These results highlight the need to consider both self-perceptions and performance-based evidence when evaluating teacher preparedness for technology-integrated learning.

The findings of this study underscore a persistent gap between pre-service EFL teachers' perceived competence in integrating pedagogy, content, and technology, and their actual performance in designing AI-enhanced learning. While many participants rated themselves relatively high in PCK, their self-assessed TCK and TPK remained moderate, and importantly, none of these dimensions significantly predicted actual TPACK performance. This mismatch points to a well-documented issue in teacher education: self-perception does not always equate to classroom competence (Aumann et al., 2023; Max et al., 2022). Previous studies in both general and language teacher education have similarly reported that pre-service teachers tend to evaluate their abilities more positively than their actual classroom performance demonstrates, particularly in the area of technology integration. This pattern may be explained by individuals' tendency to overestimate their abilities in areas where they lack competence. According to Kruger and Dunning (1999), individuals who are less skilled not only make inaccurate judgments and decisions but also lack the metacognitive awareness to recognize their own shortcomings. This dual burden can lead to inflated self-assessments that are not aligned with actual performance. In teacher education, this means that novices may genuinely believe they are capable of integrating digital tools into pedagogy, even when their lesson plans or classroom enactments show otherwise. Such overestimation is especially problematic when technology is rapidly evolving because even basic familiarity may be mistaken for deeper pedagogical understanding.

In this context, pre-service teachers with limited exposure to practical technology integration, especially AI, might assume they are more competent than they actually are, as they lack sufficient experience to accurately assess their skill level. As highlighted by Hava and Babayiğit (2024), digital proficiency predicts AI-TPACK performance, but overestimation is especially common among less digitally competent individuals. This may be particularly true in EFL contexts where digital literacy varies widely and access to AI tools during training is uneven. Pre-service teachers may have surface-level interactions with tools like ChatGPT or Grammarly for personal tasks (e.g., grammar checking or summarizing), but without structured pedagogical framing, they may misjudge their ability to integrate these tools into formal learning.

Furthermore, this discrepancy is exacerbated by insufficient AI-focused training in teacher preparation programs, particularly in Indonesia (Rahman, 2021; Williyan et al., 2024). Many pre-service teachers may have learned about digital tools or even used them for personal academic tasks, but have not received guided, pedagogically grounded learning on how to embed them meaningfully

into their learning design. Often, digital technology learning in pre-service programs is generic, focusing on operational skills (e.g., how to use Canva or Google Classroom) rather than pedagogical decision-making (e.g., why and when to use these tools to support specific language skills). As a result, students may lack the analytical tools to select or adapt AI applications for EFL learning goals critically. According to Chai et al. (2010), true TPACK development requires not just isolated knowledge of pedagogy, content, or technology, but a transformative intersection of all three domains through hands-on, context-rich experiences. In AI-enhanced learning, this integration becomes even more complex, as teachers must evaluate not only a tool's technical affordances but also its pedagogical alignment and linguistic appropriateness. Without such evaluative practice, the TPACK domains remain compartmentalized rather than synergistic.

The fact that self-perceived PCK, TCK, and TPK did not significantly predict actual performance also raises important questions about the validity of assessments in teacher education. While self-assessments are widely used to measure teacher readiness, they may lack predictive power unless accompanied by performance-based assessments that reflect real-world learning challenges (Lyublinskaya & Kaplon-Schilis, 2022). In line with Redmond and Lock (2019), this study reinforces the argument that observed enactment of TPACK, rather than belief alone, is a more reliable indicator of future classroom effectiveness. Therefore, relying solely on self-report instruments may create a false sense of preparedness among pre-service EFL teachers, particularly in complex learning domains such as AI-enhanced language teaching. Teacher educators must be cautious not to conflate confidence with competence and should adopt multi-method assessments such as portfolio evaluations, microteaching simulations, and rubric-based performance tasks to obtain a fuller picture of learning readiness.

These findings also carry significant implications for the design of teacher education curricula. The integration of AI tools such as ChatGPT, Grammarly, and Canva is no longer optional; it is a pedagogical necessity in modern English language teaching (George, 2023; Ning et al., 2024). However, preparing teachers for AI-enhanced learning requires more than technical tutorials; it also involves fostering a deep understanding of when, how, and why to use specific tools to support pedagogical goals and language outcomes (Floris & Renandya, 2025; Hu & Yao, 2023; Rasheed et al., 2025). This kind of pedagogical fluency cannot be developed through isolated workshops or short-term training. It must be embedded across multiple courses and practice-based experiences, where AI tools are introduced not only as digital solutions but as integral parts of learning design thinking. Moreover, national education policies such as the Merdeka Belajar Kampus Merdeka (MBKM) and the Peta Jalan Pendidikan Indonesia 2020–2035 stress the importance of digital transformation in education (Kusumawati & Umam, 2025; Sudarto, 2023). However, these macro-level aspirations must translate into micro-level changes within teacher preparation programs. Without meaningful opportunities to authentically apply TPACK in AI-integrated tasks, pre-service teachers will continue to develop inflated self-perceptions without the practical capacity to put into practice what they believe they know. This means embedding performance-based tasks in curriculum design, such as requiring candidates to produce and teach AI-supported lesson plans, reflect on their effectiveness, and revise them based on real or simulated feedback.

In conclusion, the study highlights the importance of integrating authentic, performance-oriented evaluations of pre-service EFL teachers' TPACK in teacher training programs, particularly as digital and AI technologies become increasingly embedded in educational practice. This study not only confirms existing concerns about the limitations of self-assessment but also provides concrete evidence to guide the design of teacher education curricula aimed at producing AI-ready educators. Moving forward, the challenge lies in bridging the gap between theoretical knowledge and applied

expertise—ensuring that the next generation of teachers is not only digitally aware, but also pedagogically equipped to harness the full potential of AI in the language classroom.

CONCLUSION

This study aimed to examine whether pre-service EFL teachers' perceived Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK) could predict their actual TPACK performance in designing AI-enhanced learning. The findings reveal an apparent misalignment between what pre-service teachers believe they know and what they can demonstrate in practice, as none of the perceived knowledge domains significantly predicted their actual TPACK competence. Although participants reported relatively high confidence in pedagogy-related knowledge, their ability to integrate technology meaningfully into learning design varied widely, suggesting that self-assessment may not be a reliable indicator of classroom readiness. These results underscore the importance of performance-based evaluation in teacher education and call for more authentic, experience-driven learning opportunities to bridge the gap between theory and practice. Scientifically, this study contributes to the growing literature on TPACK and AI integration in teacher education by offering empirical evidence from an under-researched context—Indonesian Pre-service EFL teachers—and by highlighting the limitations of perception-based assessments in preparing teachers for the complexities of AI-enhanced learning. It reinforces the theoretical premise that integrated knowledge is best developed through contextualized practice, and it offers practical implications for designing teacher education programs that aim to produce digitally competent and pedagogically responsive educators.

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