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Student teachers' technological pedagogical content knowledge: assessment in a private school

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ABSTRACT

This study assessed the technological pedagogical content knowledge (TPACK) among student-teachers in a private school during the academic year 2025-2026. Additionally, it examined the differences in the level of TPACK among the student teachers when grouped by demographics. A quantitative descriptive-comparative research design was employed. The study was participated in by a total of 103 student-teachers. A 47-item adopted instrument was used to collect the data, utilizing a 5-point Likert scale. The descriptive and comparative analyses were employed. Mean, standard deviation, and the Mann-Whitney U test were used. The whole process of this study adhered to the ethical guidelines. Generally, the findings showed that the student teachers obtained high mean scores (M=4.10, SD=0.50) in TPACK. Notably, their technological pedagogical knowledge was rated very high (M=4.31, SD=0.50). Additionally, the results revealed no significant differences (U=380.000, p=0.340) between male and female across all components of TPACK. However, significant differences were observed in pedagogical knowledge (U=881.000, p=0.029) and pedagogical content knowledge (U=903.000, p=0.039) when grouped according to program. The findings imply that the Department of Teacher Education is encouraged to continue to strengthen the integration of technology in pedagogy and content instruction to sustain and further enhance student teachers' technological competence.

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1. INTRODUCTION

The technological pedagogical content knowledge (TPACK) is a framework that underscores how teachers integrate technology in teaching particular content and using appropriate pedagogy. It merges three relevant forms of knowledge, namely, technology, pedagogy, and content [1]. This framework helps teachers design meaningful lessons that integrate technology to enhance teaching and learning activities [2]. In the same manner, this framework is very essential among student teachers as it prepares them to respond to the increasing trend of using technology in education and meet the demand of the 21st-century skills [3]. Hence, assessing the TPACK level of student teachers provides pivotal data that may help the department or college to continuously improve their program activities and prepare them for the demands of their chosen field.

Many studies in Asian countries have examined and explored the TPACK. There is a study that focused on teacher educators' TPACK and identified it is one of the key elements in school teacher training across Asia [4]. In addition, Chen and Jang [5] explored the relationship between self-regulation and TPACK of Taiwanese secondary in-service teachers. Moreover, in Singapore, Lu and Chen [6] examined the contextualization of the TPACK in the classroom practice. They investigated the alignment between teachers' self-reported TPACK and their demonstration in designing lesson plans and how they enact it. Furthermore, in Indonesia, Habibi *et al.* [7] assessed the role of TPACK in affecting pre-service language teachers in the context of ICT integration during their practice teaching. Given these studies, it is worth noting the growing interest in TPACK in educational systems.

In the Philippines, the Commission on Higher Education (CHED) has recognized the vital role of technology in teaching pedagogy [8]. In fact, this agency has invested in information and communication technology (ICT) and included technology in the curriculum of the teaching program to respond to the immediate need and provide quality education [9]. Similarly, teacher education in the Philippines is now required to train future teachers or student teachers to use digital tools in their lesson planning and instructions. The primary goal is to help future Filipino teachers become more competent and confident in using technology in various learning competencies and outcomes [10]. However, there are still many challenges that student teachers face in achieving the demands of technology-based teaching. Some Filipino student teachers lack access to digital tools and training to enhance their technological skills [11]. Not to mention, schools also need to provide continuous support and resources to help these future educators become effective in digital classrooms [12]. Thus, these issues underscore the need to assess and enhance the TPACK of student teachers to prepare them for their chosen field.

Several studies have been conducted and published on TPACK among students or pre-service teachers. In fact, Tanak [13] examined the effect of TPACK and designed a course for student teachers in teaching science. Meanwhile, the gap of this study is its small sample size of only 15 student teachers, which limits the generalizability of the findings to a broader population. Similarly, Santos and Castro [14] evaluated the application of TPACK of pre-service teachers in different public schools around Bulacan. The identified gap in this study is that it focuses predominantly on public schools and does not include private schools. In addition, Nilsson and Karlsson [15] investigated how the use of content representations, combined with video and digital tools, can capture student teachers' professional knowledge and practice. This study focuses on T-Core design and science topics in secondary school. Additionally, Nilsson [2] examined how student teachers incorporate digital technologies into their science teaching. Notably, this study is limited to 24 science student teachers and does not encompass other programs, focusing solely on T-Core design. In fact, their study recommends conducting a larger sample. The study by Trevisan [16] provides empirical evidence for a better understanding of how student teachers incorporate technologies into their teaching practices.

However, given the studies in the literature, there is a need to employ a larger population to enhance the generalizability of the findings of the study. In addition, conducting the study in private schools is vital to consider because these schools may have different resources, teaching styles, and environments compared to public schools, which can influence student teachers' TPACK development differently. Moreover, including both Bachelor of Secondary Education (BSED) and Bachelor of Elementary Education (BEED) programs as demographic variables allows the study to compare how TPACK varies between future secondary and elementary educators. This may provide insights for more targeted teacher training programs to be initiated by the college or department. Furthermore, the descriptive-comparative research design is chosen because it provides a clear snapshot of differences in TPACK among groups without requiring complex or multiple methods. In contrast to mixed methods, qualitative, or T-Core designs, it focuses on measurable comparisons rather than causal explanations or thematic exploration, which suits the study's objective of identifying variations among student teachers.

This study theoretically assumed that the level of TPACK among student-teachers varies based on their gender and program of study. This assumption is grounded in the TPACK framework proposed by Schmidt *et al.* [1]. This framework outlines the relationships among the three fundamental components of knowledge: technology, pedagogy, and content. These three knowledge types encompass an instinctive conception of teaching content, utilizing appropriate pedagogical methods and technologies. Thus, using TPACK as a framework for this study significantly helped to measure the teaching knowledge of integrating technology among student-teachers, which later on could inform the type of responsive training experiences to be offered by the department for them. Figure 1 presents the researcher-developed conceptual model illustrating the causal relationship between the independent and dependent variables. The independent variables, specifically the demographic profile of the student teachers is examined in relation to their level of TPACK. The results of this study may serve as benchmark data for the Department of Teacher Education (DTE) to design a responsive capacity-building initiatives for student teachers.

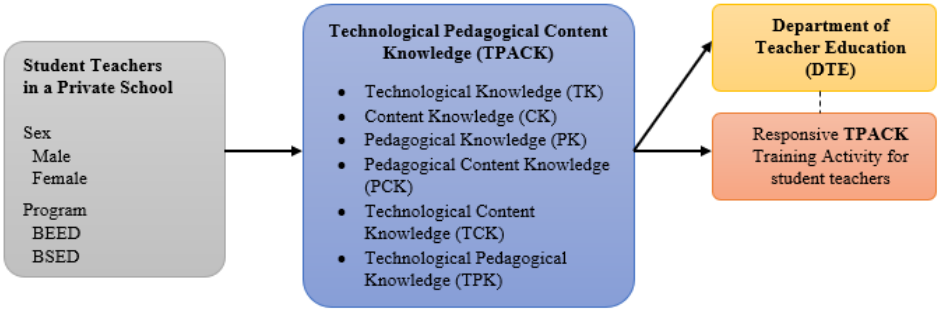

Figure 1. Conceptual model

This study aimed to assess the TPACK in the areas of technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), among the student teachers in a private school during the school year 2025-2026 when taken as a whole and grouped according to gender and program. Likewise, this study assessed the significant differences in the level of TPACK among student teachers when grouped by demographics. This study may inform the instructors in the DTE to craft a responsive learning activity to prepare student-teachers to integrate technology into their practice teaching effectively.

2. METHOD

This study utilized the descriptive-comparative research design to assess the level of TPACK among the student teachers. The chosen design statistically measured a set of variables to answer the theory-guided research questions and hypotheses [17]. On the one hand, the descriptive approach assessed the level of TPACK among student-teachers, considering them as a whole and grouped by gender and program. On the other hand, the comparative approach examined the significant differences in the level of TPACK among the respondents when grouped by demographics. The respondents were the total enumeration of 103 student-teachers in a private school in Western Visayas, Philippines. The study ensured that all student-teachers within the target population were represented. The list of student teachers was formally requested through a letter addressed to the dean of the DTE, along with the approval letter from the college president.

Table 1 presents the demographic profile of the respondents. The results showed that the majority were female (90.3%, n=93), while a small proportion were male (9.7%, n=10). This indicates that the teaching profession in the selected private school is predominantly composed of female student teachers. In terms of program, most respondents were enrolled in the BSED (66.0%, n=68), while 34.0% (n=35) were pursuing the BEED. This suggests that a greater number of student teachers are preparing to teach at the secondary level.

Table 1. Demographic profile of the respondents

Variable		n	Percentage (%)
Gender	Male	10	9.7
	Female	93	90.3
Program	BEED	35	34.0
	BSED	68	66.0
Whole		103	100.0

2.1. Data collection procedure

In gathering data, the study utilized a 47-item survey questionnaire adopted from Schmidt *et al.* [1]. Based on their research, the instrument was validated by three experts in TPACK using the content validity ratio. They reported that the mean ratings for items in the six knowledge domains were 5.14 (TK), 3.67 (PK), 8.50 (CK), 8.33 (TPK), 9.00 (PCK), and 7.88 (TPACK). In terms of the instrument's reliability, it was reported to have strong internal consistency, with a reliability range of .75 to .92 for the six subscales. Meanwhile, the study conducted a pilot test on 30 non-actual respondents to assess the reliability of the instrument based on the Filipino and geographical contexts. Hence, it yielded a reliable Cronbach's alpha result of 0.95. All the items were spread across the six subscales. The study used a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Lastly, the data were gathered using a Google Form that contained the informed consent form, the study's objective, demographic profile, and the TPACK scale.

2.2. Data analysis procedure

To analyze the data, descriptive and comparative statistical analyses were employed. Mean (M) and standard deviation (SD) were used to analyze the level of technological, pedagogical, and CK among the student-teachers. Additionally, this study utilized a mean range for interpretation of the descriptive results, spanning from 1.00-1.80 (very low) to 4.21-5.00 (very high), which are considered arbitrary cut-offs. To justify the use of this mean range in this study, the researchers referred to previous studies that also employed the same mean range [18], [19]. Meanwhile, before performing inferential analyses, the data were tested for normality using the Shapiro–Wilk test. The results revealed that the variables measuring TPACK were not normally distributed. This indicates a violation of the assumption of normality required for parametric tests. Consequently, nonparametric statistical tests, specifically the Mann-Whitney U test, were employed to determine significant differences in TPACK when the data were grouped by gender and program.

2.3. Ethical consideration

Lastly, the whole process of this study adhered to the Philippine Health Research Ethics Board (PHREB). The school administrators' permission was sought to conduct the study. In addition, the respondents were oriented about the goal of the research and their voluntary participation. Moreover, they were assured complete confidentiality of their data. The materials that contained raw information accessed from them were stored in password-protected files and disposed of by manual shredding within a given period.

3. RESULTS AND DISCUSSION

3.1. TPACK of student teachers

As shown in Table 2, the student teachers demonstrated a high level of TPACK. Overall, they obtained high mean scores in TK (M=3.97, SD=0.45), CK (M=3.78, SD=0.50), PK (M=4.04, SD=0.49), PCK (M=3.89, SD=0.52), TCK (M=3.95, SD=0.54), and TPACK (M=4.10, SD=0.50). Notably, their TPK (M=4.31, SD=0.50) was rated very high, indicating strong competence in integrating technology into pedagogical practices.

Table 2. Level of TPACK of student teachers

Variable		TK		CK		PK		PCK		TCK		TPK		TPACK	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Gender	Male	3.89	0.48	3.69	0.62	3.86	0.59	3.63	0.58	3.90	0.70	4.30	0.50	3.94	0.62
	Female	3.98	0.44	3.79	0.49	4.06	0.48	3.91	0.51	3.96	0.53	4.31	0.50	4.12	0.49
Program	BEED	4.08	0.45	3.88	0.51	4.19	0.45	4.06	0.49	4.06	0.50	4.37	0.45	4.16	0.46
	BSED	3.91	0.44	3.73	0.49	3.96	0.50	3.80	0.52	3.90	0.56	4.28	0.52	4.07	0.52
Whole		3.97	0.45	3.78	0.50	4.04	0.49	3.89	0.52	3.95	0.54	4.31	0.50	4.10	0.50

Mean range: 1.00-1.80=very low, 1.81-2.60=low, 2.61-3.40=moderate, 3.41-4.20=high, 4.21-5.00=very high

When grouped by gender, both male and female student teachers demonstrated a high level of TPACK across all domains. Female students consistently reported slightly higher mean scores than males, particularly in PK (M=4.06, SD=0.48 vs. M=3.86, SD=0.59) and TPACK (M=4.12, SD=0.49 vs. M=3.94, SD=0.62). This suggests that female student teachers perceive themselves as more adept at applying pedagogical and integrative technology practices.

Across programs, both BEED and BSED students demonstrated a high level of knowledge in all dimensions. BEED students obtained slightly higher mean scores overall, particularly in PK (M=4.19, SD=0.45) and PCK (M=4.06, SD=0.49), while BSED students scored marginally lower (M=3.96, SD=0.50; M=3.80, SD=0.52, respectively). This may indicate that BEED students, being trained in general education, are more confident in combining pedagogy with subject content.

Overall, the findings suggest that the student teachers possess a high level of TPACK. This indicates their strong ability to integrate technology effectively into their teaching practices. It means that they are capable of combining their understanding of content, pedagogy, and technology to create meaningful and engaging learning experiences for students. This could be because both the BEED and BSED programs include subjects that emphasize the integration of technology in education. This finding is consistent with the studies [20], [21], which found that subjects who have educational technology enhance students' ability to apply digital tools in instruction. It may also be attributed to the fact that student teachers are already equipped with technological skills since they frequently use digital tools when reporting topics or presenting content in class. This observation is supported by previous studies [22]–[24], who noted that the frequent use of technology in the classroom for academic tasks improves students' confidence and competence in integrating technology.

Furthermore, student teachers have demonstration classes where they apply technology in delivering lessons, enabling them to enhance their competence in integrating technology. This finding is consistent with several studies [14], [16], [25], which revealed that practical teaching experiences incorporating technology help pre-service teachers strengthen their TPACK and classroom readiness. The findings imply that the DTE may continue to improve the integration of technology in pedagogy and content instruction to sustain and further enhance student teachers' technological competence.

3.2. Differences in the TPACK of student teachers according to gender and program

As shown in Table 3, the results revealed no significant differences between male and female student teachers across all components of TPACK, including TK (U=398.000, p=0.452), CK (U=396.000, p=0.441), PK (U=358.000, p=0.228), PCK (U=318.500, p=0.092), TCK (U=423.500, p=0.630), TPK (U=445.500, p=0.825), and TPACK (U=380.000, p=0.340). These findings suggest that both male and female student teachers demonstrated comparable levels of TPACK, indicating that gender did not significantly influence their self-assessed knowledge and integration of technology, pedagogy, and content in teaching.

The findings suggest that both male and female student teachers possess comparable levels of TPACK. This means that gender identity does not play a determining role in how student teachers apply their TPACK skills. This could be because both male and female student teachers receive similar academic instruction, instructional support, and technological exposure within the private school. This finding is consistent with several studies [26]–[28], which emphasize that equitable training environments lead to similar levels of TPACK regardless of gender. However, the finding of this study is not consistent with the studies by Honra [29] and Yusuf [30], which find no significant gender differences in overall TPACK. Moreover, this could also be attributed to the increasing digital literacy and equal access to technology among student teachers, regardless of gender identity. This finding is consistent with previous studies [31], [32], who found that the free access of digital tools and online learning platforms has minimized gender gaps in technology use.

Furthermore, this could be because teacher education curricula are designed to provide uniform opportunities for all students to integrate technology into their practice teaching or demonstrations. This finding is consistent with the study of West *et al.* [33] and Falloon [34], who noted that structured and inclusive curriculum design promotes balanced technological competence among male and female student teachers. The findings suggest that the DTE may continue to promote inclusive and gender-neutral approaches in developing technological and pedagogical skills among all student teachers.

Table 3. Difference in the level of TPACK of student teachers according to gender

Variable	U	z	Effect size	p
TK	398.000	-0.752	-0.074	0.452
CK	396.000	-0.771	-0.076	0.441
PK	358.000	-1.206	-0.119	0.228
PCK	318.500	-1.687	-0.166	0.092
TCK	423.500	-0.481	-0.047	0.630
TPK	445.500	-0.222	-0.022	0.825
TPACK	380.000	-0.955	-0.094	0.340

Note: the difference in the means is significant when $p \leq 0.05$

Table 4 presents the differences in the levels of TPACK among student teachers, categorized by program. The results indicated no significant differences in TK (U=951.000, p=0.094), CK (U=1010.500, p=0.210), TCK (U=973.500, p=0.117), TPK (U=1077.500, p=0.424), and TPACK (U=1043.500, p=0.303). These findings suggest that BEED and BSED student teachers demonstrated comparable levels of knowledge in these areas.

However, significant differences were observed in PK (U=881.000, p=0.029) and PCK (U=903.000, p=0.039). In both domains, BEED students rated themselves significantly higher than BSED students, indicating that BEED student teachers perceive themselves as having stronger competencies in pedagogy and in integrating pedagogical strategies with subject content. This suggests that the BEED program may place greater emphasis on pedagogical preparation, enabling its students to feel more confident in their teaching approaches.

The findings suggest that BEED student teachers rated themselves significantly higher than BSED student teachers in both PK and PCK. This means that BEED student teachers perceive themselves as more competent in designing instructional strategies and connecting teaching methods with subject matter. This could be because BEED programs emphasize pedagogy more profoundly, focusing on classroom

management, differentiated instruction, and learner-centered approaches suitable for young learners or pupils. This finding is consistent with the studies [35], [36], who found that elementary education programs tend to prioritize pedagogical development over content specialization.

This could also be attributed to the broader and more integrative nature of the BEED program, which exposes student teachers to multiple subjects and holistic teaching methods that require PCK. It helped to strengthen their confidence in instructional design. This finding is consistent with several previous studies [37]–[39], who noted that exposure to diverse learning areas enhances self-perceived pedagogical competence among pre-service elementary teachers. The findings imply that the department may provide additional pedagogical enrichment for BSED student teachers to enhance their confidence and competence in linking instructional methods with their specific subject areas.

Table 4. Difference in the level of TPACK of student teachers according to program

Variable	U	z	Effect size	p
TK	951.000	-1.676	-0.165	0.094
CK	1010.500	-1.253	-0.123	0.210
PK	881.000*	-2.178	-0.215	0.029
PCK	903.000*	-2.066	-0.204	0.039
TCK	973.500	-1.569	-0.155	0.117
TPK	1077.500	-0.799	-0.079	0.424
TPACK	1043.500	-1.029	-0.101	0.303

Note: the difference in the means is significant when $p \leq 0.05$

3.3. Theoretical analysis

Grounded in the TPACK framework by Schmidt *et al.* [1], this study extends theoretical understanding by demonstrating how the integration of technology, pedagogy, and content knowledge varies not only by demographic factors, which this study finds non-significant by gender, but more importantly by program orientation as seen in the differences between BEED and BSED student teachers. The findings refine the TPACK framework by highlighting how distinct teacher education programs shape the development of PK and PCK differently. Additionally, it highlights the varied emphases on pedagogical adaptability versus content specialization within TPACK's intersecting domains. This suggests that TPACK is not universally uniform but contextually nuanced, influenced by curricular focus and training models. Hence, the findings encourage a reconceptualization of the framework to accommodate these differences in educational programs. Theoretical insights also emerge regarding the central pedagogical core in BEED students, reinforcing TPACK's premise that effective integration requires balancing these knowledge domains uniquely across teacher profiles, which warrants further research to model and optimize TPACK development tailored to different teacher education pathways.

3.4. Limitations of the finding

Meanwhile, this study is limited to student teachers from one private school in Western Visayas. This means the findings may not fully represent the TPACK levels of student teachers in other schools or regions. In addition, the population reflects a gender imbalance due to the limited number of male student teachers in the department where the study was conducted. The said imbalance restricts the generalizability of the findings. Hence, future studies are encouraged to utilize a more proportionate population to further strengthen and validate the results. Moreover, the use of self-reported competencies may also have influenced the results since respondents rated themselves higher or lower than their actual competencies. This means that high self-ratings may not reflect actual teaching performance. In addition, the study employed descriptive-comparative approaches and focused solely on two demographic variables, without considering other factors such as teaching experience, access to technology, or mentoring support that could also affect TPACK development. Hence, future research may include a larger and more diverse sample of student teachers from both private and public institutions. Future research may employ mixed methods, such as classroom observations or interviews, to investigate other potential factors that influence TPACK.

4. CONCLUSION

The findings imply that the DTE is encouraged to continue to strengthen the integration of technology in pedagogy and content instruction to sustain and further enhance student teachers' technological competence. In particular, the student teachers' TPK was rated very high, showing that they are highly capable of integrating technology into their teaching practices to make learning more engaging and effective.

In addition, findings suggest that the department may continue to promote inclusive and gender-neutral approaches in developing technological and pedagogical skills among all student teachers. Moreover, the findings imply that the department may provide additional pedagogical enrichment for BSED student teachers to enhance their confidence and competence in linking instructional methods with their specific subject areas. Furthermore, the DTE can strengthen technology integration by implementing targeted workshops like a digital pedagogy bootcamp that models the effective use of educational technology in subject-specific pedagogy. Also, establishing a technology facilitator to support both faculty and student teachers.

Pedagogical enrichment for BSED students may include specialized modules that link instructional strategies directly to their content areas, supplemented by teacher-student collaboration to build confidence and competence. These recommendations align with the priorities of CHED on enhancing ICT competencies and inclusive education frameworks to support all students. These interventions can help bridge resource gaps and technology-enhanced teaching practices that prepare student teachers for the demands of modern Philippine classrooms, including the adoption of asynchronous classes during natural calamities. Taken together, these findings emphasize that TPACK is a valuable lens for understanding how student teachers meaningfully connect technology, pedagogy, and subject content to strengthen their professional competence and classroom readiness.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

DATA AVAILABILITY

All the data included in the study can be accessed through Google Scholar, Crossref, Web of Science, and Scopus databases.

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