



Examining the TPACK of the pre-service teachers in the Philippines in the Post-Pandemic Era

VILLON, Joy Therese L.⁽¹⁾; NALDOZA, Niño D.⁽²⁾

⁽¹⁾  0000-0003-2255-8913; Doctor of Philosophy, Southern Luzon State University. Lucban, Quezon, Philippines. jvillon@slsu.edu.ph.

⁽²⁾  0009-0003-8323-0740; Philippine Normal University., Manila, Philippines. naldoza.nd@pnu.edu.ph

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ABSTRACT

Pre-service training determines the quality of new teachers. However, Southeast Asia Primary Learning Metrics (SEA-PLM) 2019 revealed that less than 10% of Grade 5 teachers had pre-service training in content knowledge and pedagogical skills. Hence, there should be comprehensive and systematic TPACK-based interventions. This study examines the TPACK of pre-service teachers in the post-pandemic era. Content knowledge (CK) and technological knowledge (TK) had statistically significant moderate positive effects on technological content knowledge (TCK). This research utilized structural equation modeling (SEM) to examine the TPACK constructs of the 964 pre-service teachers. Meanwhile, technological knowledge (TK) and pedagogical knowledge (PK) had statistically significant moderate and strong positive effects, respectively, on technological pedagogical knowledge (TPK). Also, pedagogical knowledge (PK) and content knowledge (CK) had statistically significant strong and moderate positive effects, respectively, on pedagogical content knowledge (PCK). Then, technological content knowledge (TCK), technological pedagogical knowledge (TPK), and pedagogical content knowledge (PCK) had statistically significant moderate positive effects on technological pedagogical content knowledge (TPACK). Thus, this study implies the importance of teachers' proficiency in integrating technology into teaching. This denotes the critical role of enhancing the TPACK of pre-service teachers. Hence, this study recommends a future study exploring the TPACK model implementation in different educational contexts and investigating the impact of TPACK on student learning outcomes.

RESUMO

A formação inicial determina a qualidade dos novos professores. No entanto, o relatório Southeast Asia Primary Learning Metrics (SEA-PLM) de 2019 revelou que menos de 10% dos professores do 5º ano tinham formação inicial em conhecimento de conteúdo e competências pedagógicas. Consequentemente, devem ser realizadas intervenções abrangentes e sistemáticas baseadas no TPACK. Este estudo examina o TPACK de futuros professores na era pós-pandemia. O conhecimento de conteúdo (CK) e o conhecimento tecnológico (TK) tiveram efeitos positivos moderados e estatisticamente significativos no conhecimento de conteúdo tecnológico (TCK). Esta pesquisa utilizou a modelagem de equações estruturais (SEM) para examinar os construtos do TPACK dos 964 futuros professores. Enquanto isso, o conhecimento tecnológico (TK) e o conhecimento pedagógico (PK) tiveram efeitos positivos moderados e fortes e estatisticamente significativos, respectivamente, no conhecimento pedagógico tecnológico (TPK). Além disso, o conhecimento pedagógico (PK) e o conhecimento de conteúdo (CK) teve efeitos positivos fortes e moderados estatisticamente significativos, respectivamente, no conhecimento pedagógico do conteúdo (PCK). Em seguida, o conhecimento tecnológico do conteúdo (TCK), o conhecimento pedagógico tecnológico (TPK) e o conhecimento pedagógico do conteúdo (PCK) tiveram efeitos positivos moderados estatisticamente significativos no conhecimento tecnológico do conteúdo pedagógico (TPACK). Assim, este estudo sugere a importância da proficiência dos professores na integração da tecnologia ao ensino. Isso denota o papel crítico de aprimorar o TPACK de futuros professores. Portanto, este estudo recomenda um estudo futuro explorando a implementação do modelo TPACK em diferentes contextos educacionais e investigando o impacto do TPACK nos resultados de aprendizagem dos alunos.

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Introduction

The widespread use of technology is one of the most notable aspects of the constantly developing educational system worldwide. Due to this widespread use of technology, students have access to current, uninterrupted, and virtually limitless information in a relatively short amount of time. Changes on a fundamental level need to be made in how elementary and secondary education is delivered before higher education expands to the global boundaries (McDiarmid & Zhao, 2023).

According to the International Society for Technology in Education, as cited by Crompton (2023), teachers utilize technology to facilitate learning, supporting student achievement and creating learning opportunities that challenge students to apply a design process and computational thinking to innovate and solve problems. In Southeast Asia, the Teaching Framework guides teachers to master subject matter, keep updated on education trends, use effective teaching strategies, and assess and provide feedback on student learning (SEAMEO INNOTECH, 2018).

In the Philippines, the Commission on Higher Education (CHED) released the policies, standards, and guidance for the Bachelor of Elementary Education. A graduate of this program should be able to demonstrate an in-depth understanding of the diversity of learners in various learning areas, manifest meaningful and comprehensive pedagogical content knowledge (PCK) of different subject areas, utilize appropriate assessment and evaluation tools to measure learning outcomes, manifest skills in communication, higher order thinking and use of tools and technology to accelerate learning and teaching, demonstrate positive attributes of a model teacher, both as an individual and as a professional (CMO No.74, S.2017).

These institutional reforms proposed to improve teacher quality were implemented. However, the expected changes were not generally observed (EDCOM II, 2023d). Based on the results of the Program for International Student Assessment (PISA) 2022 have highlighted the educational underachievement of 15-year-old Filipino students in mathematics, reading, and science when compared to their peers in over 80 countries. These findings require immediate national attention and should be regarded as a national emergency.

Likewise, the Southeast Asia Primary Learning Metrics (SEA-PLM) (2019) revealed that less than 10% of Grade 5 teachers had pre-service training in content knowledge and pedagogical skills. At the same time, a slightly larger share of early career teachers had been trained in these aspects before becoming teachers than senior teachers (Generelao et al., 2022).

The abovementioned findings support the idea of the need for the Philippine pre-service teaching curriculum to be responsive to meet the demands of the ever-changing world. The United Nations' Sustainable Development Goal 4 mentioned that there should be a

substantial increase in the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least-developed countries and small island developing states. Ensuring an inclusive and equitable quality education and promoting lifelong learning opportunities for all (Krabbe, 2023).

As also articulated in the Philippine Professional Standards for Teachers (Department of Education Order No. 42, s. 2017), it is expected that a beginning teacher should have a strong understanding of the subject in terms of content knowledge and pedagogy while demonstrating skills in the positive use of the information and communication technology (ICT) to facilitate the teaching and learning process.

This research explored the TPACK of pre-service teachers in the post-pandemic era to provide inputs for enhancing the TPACK of pre-service teachers in the Philippines.

The following are the objectives of the study: Determine the level of TPACK of the pre-service teachers in the Philippines and Examine the relationships of the TPACK constructs

Methodology

Descriptive correlational research is a methodological approach that seeks to identify relationships between variables without manipulating them. This type of research is particularly useful in fields such as education and health, where understanding the connections between several factors can inform practice and policy (Shiraishi & Yuine, 2024). Meanwhile, the respondents in this study comprised 964 pre-service teachers from teacher education institutions in the Philippines.

The number of pre-service teachers was determined based on the sample-to-item ratio guideline for determining a sample size based on the number of items in a study. The researchers sought approval from the university presidents and college presidents for the conduct of this study. Once the Office of the President approved the study, the questionnaires and consent form were sent via Google Forms or hard copy. Answering the three questionnaires lasted 5 to 25 minutes.

Snowball sampling, a widely used nonprobability method for identifying hidden populations, was employed to select the target respondents for this study. This approach relies on referrals from initial participants to others with relevant characteristics and offers a practical means of reaching respondents without their prior awareness. The success and efficiency of the snowball sampling approach, on the other hand, are almost contingent upon the personal or professional contacts of the researcher (Waters, 2018).

Meanwhile, the criteria for selecting the participants were as follows: 1. The pre-service teacher should be taking up a Bachelor of Elementary Education course. 2. The pre-service teacher has already taken up all professional education subjects required in the course. 3. The pre-service teacher is currently taking the teaching internship.

The validity of research results depends on selecting participants who meet specific criteria relevant to the research goals (Creswell & Creswell, 2017). Participant selection criteria should be closely aligned with the research focus, ensuring that selected participants can effectively address the research questions (Rasool, 2018).

This research also utilized the TPACK self-assessment questionnaire by Schmidt et al. (2009). The TPACK self-assessment questionnaire (Schmidt et al., 2009), a 47-item instrument, demonstrated internal consistency with $\alpha = 0.82$ for “Technological Knowledge” and $\alpha = 0.85$ for “Mathematics”, $\alpha = 0.94$ for “Social Studies”, $\alpha = 0.82$ for “Science”, and $\alpha = 0.75$ for “Literacy Content Knowledge”. Meanwhile, $\alpha = 0.84$ was obtained on “Pedagogical Knowledge”, $\alpha = 0.85$ on “Pedagogical Content Knowledge”, $\alpha = 0.80$ on “Technological Content Knowledge”, and $\alpha = 0.86$ on “Technological Pedagogical Content Knowledge”. These internal consistencies denote an excellent and acceptable research instrument (Clayson, 2020).

To analyze the data, this study also utilized median and inferential median to determine the level of TPACK of the preservice teachers. The median is preferred over the mean in datasets with outliers, as it is less sensitive to extreme values (Smida et al., 2022).

For non-normally distributed ordinal data, the inferential median estimates the population median rather than relying solely on the sample median. The “iomedian” function in R computes the inferential median by applying a series of one-sample Wilcoxon Rank tests to determine whether the population median is significantly different from a specified value at a confidence level (CF) of 0.95. Meanwhile, Structural Equation Modeling (SEM) examines the relationship among the TPACK variables. Structural equation modeling is used to test whether independent variables predict dependent variables. (Collier, 2020). The SEM analysis was done through the lavaan package in R.

To address ethical problems or issues concerning this study, permission to adopt and use the different assessment tools was sought from the respective authors (see Appendix A). Additionally, the researcher personally sent formal letters of request to the Office of the President of the teacher education institutions regarding the administration of Google survey questionnaires with informed consent for the participants. The study's true nature, protocol, and purpose, as well as the importance of their participation, were explained to them. Assurance of strict confidentiality was also given to the respondents. The researcher guaranteed that the names of the respondents would not appear or be reported in any way that would indicate their participation in the study. There were no known or anticipated risks for the respondents in this study.

Results and Discussion

This section discusses the significant results of the study about the level of the TPACK of pre-service teachers and the relationship among the TPACK constructs.

Table 1 below examines the level of TPACK constructs. The median represents the middle value of the observed responses for each item, while the inferential median provides a more robust estimate by incorporating statistical inference to adjust for variability in the sample and infer the population median.

In Technological Knowledge (TK), the inferential median for most items (except TK5 and TK7) is higher than the observed median (from 4 to 5). This suggests that when accounting for inferential statistics, there is evidence that the population median might be higher than the sample median.

In Content Knowledge (CK), most items retained the same median and inferential median (4), except for CK6, CK10, CK11, and CK12, where the inferential median increased to 5. In Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK), all inferential medians increased from 4 to 5. This suggests that at the 95% confidence level, the true population median is likely higher than the sample median for these constructs.

Table 1

Level of TPACK of Pre-Service Teachers in Teacher Education Institutions in Philippines

	Median	Inferential Median
Technological Knowledge		
TK1	4	5
TK2	4	5
TK3	4	5
TK4	4	5
TK5	4	4
TK6	4	5
TK7	4	4
Content Knowledge		
CK1	4	4
CK2	4	4
CK3	4	4
CK4	4	4
CK5	4	4
CK6	4	5
CK7	4	4
CK8	4	4
CK9	4	4
CK10	4	5
CK11	4	5
CK12	4	5

	Median	Inferential Median
Pedagogical Knowledge		
PK1	4	5
PK2	4	5
PK3	4	5
PK4	4	5
PK5	4	5
PK6	4	5
PK7	4	5
Pedagogical Content Knowledge		
PCK1	4	5
PCK2	4	5
PCK3	4	5
PCK4	4	5
Technological Content Knowledge		
TCK1	4	5
TCK2	4	5
TCK3	4	5
TCK4	4	5
Technological Pedagogical Knowledge		
TPK1	4	5
TPK2	4	5
TPK3	4	5
TPK4	4	5
TPK5	4	5
Technological Pedagogical Content Knowledge		
TPACK1	4	5
TPACK2	4	5
TPACK3	4	5
TPACK4	4	5
TPACK5	4	5
TPACK6	4	5
TPACK7	4	5
TPACK8	4	5

For determining the relationship of TPACK constructs, Table 2 shows the parameter estimates (regressions and covariances), and Figure 1 presents the path model (path coefficients, covariances, R^2 values, and error variances). Based on Table 1 and Figure 1, results showed that *content knowledge* (CK) ($\beta = .41, p < .001$) and *technological knowledge* (TK) ($\beta = .43, p < .001$) had statistically significant moderate positive effects on *technological content knowledge* (TCK) as well as explained a significant portion (62%) of its variance ($R^2 = .62$).

Technological knowledge (TK) ($\beta = .26, p < .001$) and *pedagogical knowledge* (PK) ($\beta = .60, p < .001$) had statistically significant moderate and strong positive effects, respectively, on *technological pedagogical knowledge* (TPK) as well as explained a significant portion (65%) of its variance ($R^2 = .65$). Also, PK ($\beta = .67, p < .001$) and CK ($\beta = .25, p < .001$) had statistically significant strong and moderate positive effects, respectively, on *pedagogical content knowledge* (PCK) as well as explained a significant portion (76%) of its variance ($R^2 = .76$).

TCK ($\beta = .34, p < .001$), TPK ($\beta = .24, p < .001$), and PCK ($\beta = .22, p < .001$) had statistically significant moderate positive effects on *technological pedagogical content knowledge* (TPACK).

Meanwhile, results also showed in table 3 that the statistical validity of the TPACK model is reinforced by several key indices, starting with a Chi-square ratio of 2.92; because this value falls below the standard 3.0 threshold, it suggests the model is not "strained" to fit the observed data. Supporting this are the incremental fit indices (CFI, TLI, and NFI) which range from 0.90 to 0.93, proving that this specific arrangement of PCK, TCK, and TPK explains the data far better than random chance and sits well within the accepted standards for educational research.

Finally, the RMSEA of 0.0 is arguably the most vital "badness-of-fit" measure which confirms a low error of approximation, rounding out a model that is statistically robust and provides a "good fit" for the data. The results confirms that Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK) successfully predict the more complex TPACK.

Table 2.

Model Parameters of the Structural Equation Model (No. of Iterations = 141)

				Estimate	β		SE
Regressions							
CK	→	TCK	.47	.41	***	.07	
TK	→	TCK	.42	.43	***	.06	
TK	→	TPK	.25	.26	***	.05	
PK	→	TPK	.69	.60	***	.06	
PK	→	PCK	.79	.67	***	.06	
CK	→	PCK	.27	.25	***	.05	
TCK	→	TPACK	.34	.34	***	.05	
TPK	→	TPACK	.26	.24	***	.06	
PCK	→	TPACK	.23	.22	***	.05	

Figure 1

Emerged model from the relationship of TPACK domains

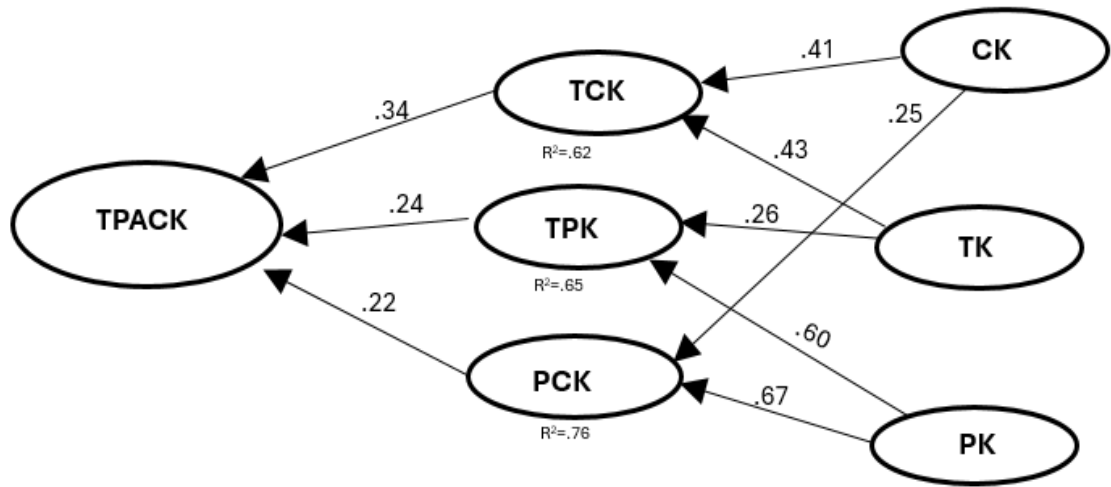


Table 3

Fit Statistics of the Structural Equation Model

Index	Value	Threshold
χ^2/df (Relative chi-square)	2.412	< 3.0 (Good) or < 5.0 (Acceptable)
CFI (Comparative Fit Index)	0.93	> 0.90 (Acceptable) or > 0.95 (Good)
TLI (Tucker-Lewis Index)	0.92	> 0.90 (Acceptable)
NFI (Normed Fit Index)	0.90	> 0.90 (Acceptable)
RMSEA (Root Mean Square Error of Approximation)	0.06	< 0.06 (Good) or < 0.08 (Acceptable)

Based on the results of the study, content knowledge (CK) and technological knowledge (TK) had statistically significant moderate positive effects on technological content knowledge (TCK). According to research findings, content knowledge (CK) and technological knowledge (TK) play crucial roles in honing technological content knowledge (TCK). In the study of Lestari and Rahayu (2023), CK and TK are integral components of TPACK, positively influencing TCK. Furthermore, Zulyusuri et al. (2022) stressed the importance of the technological pedagogical content knowledge (TPACK) model in developing and enhancing student learning outcomes and competencies, emphasizing the positive impact of CK and TK on TCK.

Similarly, technological knowledge (TK) and pedagogical knowledge (PK) had statistically significant moderate and strong positive effects, respectively, on technological pedagogical knowledge (TPK). Alegre and Galado (2023) emphasized a positive correlation between teachers' technological competence and pedagogical content knowledge practices, suggesting that while technological competence develops PCK practices, other factors also affect and influence effective teaching.

Apart from this, Adipat et al. (2023) pointed out the significance of professional development programs for teachers to incorporate novel approaches to content distribution, assessment, and documentation, highlighting the value of TPK in improving teaching quality. Christodoulou and Angeli (2022) concluded that personalized learning experiences through technology can effectively promote the development of teachers' TPACK, showcasing the advantages of technology-infused instructional design scenarios in improving TPK among educators. Generally, technological knowledge (TK) and pedagogical knowledge (PK) play critical roles in shaping the development of technological pedagogical knowledge (TPK) among teachers.

Furthermore, a strong correlation between TK and PK is crucial for the successful development of TPK, making sure that teachers are well-equipped to navigate the complexities of 21st-century education. Consistently, pedagogical knowledge (PK) and content knowledge (CK) had statistically significant strong and moderate positive effects, respectively, on pedagogical content knowledge (PCK).

Research findings denote that content knowledge (CK) and pedagogical knowledge (PK) have statistically significant effects on pedagogical content knowledge (PCK) (Behling et al., 2022; Usak et al., 2022). Respectively, CK has a strong positive effect on PCK, while PK has a moderate positive effect on PCK. These effects explain a significant portion of the variance in PCK, emphasizing the importance of both CK and PK in shaping teachers' total pedagogical content knowledge.

Also, technological content knowledge (TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), and SQD strategies have statistically significant moderate positive effects on technological pedagogical content knowledge (TPACK). Consistently, technological content knowledge (TCK), technological pedagogical knowledge (TPK), and pedagogical content knowledge (PCK) have significant effects on the development of technological pedagogical content knowledge (TPACK) among pre-service teachers and in-service educators.

From the studies of Dewi and Pahlevi (2023) as well as Alaguraja and Ponselvakumar (2023), it was shown that TCK, TPK, and PCK play important roles in enhancing the quality of future teachers by integrating technology, pedagogy, and content knowledge. Besides, a significant relationship among TCK, TPK, and PCK with the readiness to become teachers was

also noted by Lestari and Rahayu (2023), emphasizing the importance of these knowledge components in teacher preparation programs.

Additionally, findings in the study of Acikgoz and Akman (2023) suggest that both primary school and social studies teachers demonstrated high levels of TPACK, with TCK, TPK, and PCK contributing positively to their overall TPACK levels. Furthermore, the implementation of a technological pedagogical and content knowledge learning model has been shown to significantly influence elementary school students' cognition, pointing out the vital role of TCK, TPK, and PCK in schools (Witarsa & Siregar, 2023).

Briefly, the results imply that the pre-service teachers from Philippines have gained strong knowledge, competencies, and skills through educational training and experiences on how to appropriately apply technology in different lessons and align different subject concepts with their chosen pedagogies, the better their understanding of how to match technology and pedagogy for effective concept assimilation. Hence, it enables them to make direct connections between basic TPACK knowledge sources and TPACK when they experience the curriculum and teaching practices grow (Chai et al., 2013).

However, these results should not be the baseline for success in passing the licensure examination for teachers. From 2009-2023, the average passing rate in the licensure examination for elementary (33%) and secondary (40%) had depressing results compared to the passing rates in other professions (Second Congressional Commission on Education, 2024). Indeed, a comprehensive review and responsiveness of the pre-service teacher education curriculum is necessary (Second Congressional Commission on Education, 2024).

Final Considerations and Conclusion

This study determined the TPACK of pre-service teachers in different teacher education institutions in Philippines. The domains of TPACK, such as technological knowledge, content knowledge, pedagogical knowledge, technological content knowledge, pedagogical content knowledge, technological pedagogical knowledge, and technological content pedagogical knowledge of pre-service teachers in different teacher education institutions in Philippines showed a good level. This means that pre-service teacher respondents are competent in content, pedagogy, and technology.

This denotes the critical role of enhancing the TPACK of pre-service teachers. This also means that pre-service teacher respondents are competent in content, pedagogy, and technology. Hence, this study recommends a future study exploring the TPACK model implementation in different educational contexts and investigating the impact of TPACK on student learning outcomes. Future research can also utilize qualitative research to capture the subjective experiences of the respondents and to explore new ideas or unexpected findings.

Lastly, future studies should utilize longitudinal designs to examine how these relationships evolve and improve the emerging model from the TPACK, ICT Attitudes, and SQD Strategies.

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