Educators' Perceptions of Technological, Pedagogical, And Content Knowledge: Exploring Innovation in Teaching and Learning in Philippine TVET And HEIs in Region 10

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ABSTRACT

This quantitative study investigated educators' perceptions of technological (TK), pedagogical (PK), and content knowledge (CK), and their integrated Technological Pedagogical Content Knowledge (TPACK), among DepEd, TESDA, and HEI respondents in Philippine TVET and higher education institutions in Region 10. Using validated 5-item Likert scales with acceptable to excellent internal consistency via Cronbach's alpha, the study first examined differences in TK, CK, PK, and TPACK levels across institutional groups via nonparametric group-difference tests, and then explored the relationships among these domains using Spearman's rank-order correlations. Findings showed that participants across DepEd, TESDA, and HEIs reported consistently high to very high levels of TK, CK, PK, and holistic TPACK, indicating that educators strongly value and actively practice the integration of technology, pedagogy, and content knowledge in teaching and learning. Where group differences emerged, TESDA and HEI respondents tended to report slightly higher self-ratings on selected TK, PK, and TPACK items, although the overall pattern pointed to more similarity than contrast in perceived competencies across sectors. Correlation analyses further revealed significant small-to-moderate positive associations between specific TK and PK indicators and key TPACK outcomes, suggesting that educators who are more technologically adept, pedagogically versatile, and reflective are also more likely to value TPACK and engage in TPACK-based innovative practices. The combined use of group-difference tests and correlational analysis provided a coherent and complementary picture: educators in Region 10 TVET and HEIs are generally TPACK-ready, and nuanced variations in TK, CK, and PK are meaningfully linked to how strongly they enact innovation-oriented TPACK in their institutions.

Keywords: Technological Pedagogical Content Knowledge (TPACK), Technological knowledge (TK), Pedagogical knowledge (PK), Content knowledge (CK), Philippine TVET and higher education

INTRODUCTION

The integration of technology, pedagogy, and content knowledge, captured in the Technological Pedagogical Content Knowledge (TPACK) framework, is essential for promoting innovative teaching and learning (Tseng, Chai, & Park, 2022; Jibril, & Adedokun-Shittu, 2024; Auxilio, & Fabela, 2025). This integration forms the basis for adjusting instructional practices to meet the changing demands of Industry 4.0 and 5.0, especially in Technical and Vocational Education and Training (TVET) as well as Higher Education Institutions (HEIs) (Ajani, 2024; Hamzah, Abdullah, & Ma, 2024). In the Philippines' Region 10, educators from the Department of Education (DepEd), the Technical Education and Skills Development Authority (TESDA), and HEIs lead the way in delivering these educational programs. Their perceptions of TPACK components shape how technology is adopted and integrated into pedagogy and content delivery to produce graduates with relevant industry skills (Maor, 2017; Redmond, & Lock, 2019; Ajani, 2024).

Despite the recognized importance of TPACK, gaps remain in its application across these sectors. Instructors in TVET and HEIs often possess varying degrees of proficiency in technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) (Younis, 2024; Abdullah, & Masek, 2024). Moreover, the cohesive integration of these knowledge domains (TPACK) is inconsistently achieved (Tseng, Chai, & Park, 2022). This variability compromises the potential for truly innovative teaching approaches that can engage learners effectively and meet industry needs (Serdyukov, 2017; Rees Lewis, Gerber, Carlson, & Easterday, 2019). For DepEd and TESDA educators, this gap is compounded by challenges in contextualizing technology within vocational subjects and aligning teaching practices with labor market demands in Region 10 (Dougherty, & Lombardi, 2016; Atwell, Ecton, Klein, D'Amico, & Sublett, 2022; Kovalchuk, Maslich, Tkachenko, Shevchuk, & Shchypska, 2022). HEI instructors, while generally more experienced, also face difficulties translating TPACK competencies into practical classroom innovations, further widening the gap between academic preparation and industry expectation (Fahrurozi, Budiyanto, & Roemintoyo, 2019; Mesuwini, & Mokoena, 2023; Limbong, Setiawan, & Hamilton, 2024).

To address these issues, this study investigates the perceptions of educators from DepEd, TESDA, and HEIs in Region 10 regarding their TPACK competencies. The specific objectives are:

1. To assess the perceived proficiency levels of TK, PK, CK, and TPACK among educators from DepEd, TESDA, and HEIs in Region 10.
2. To determine whether there are significant differences in the levels of technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), and holistic TPACK among DepEd, TESDA, and HEI respondents.
3. To determine a significant correlation between holistic TPACK integration and the adoption of TK, PK, and CK across educators' institutional affiliations.

The following null hypotheses are tested quantitatively:

H0-1: There is no significant difference in perceived TK, PK, and CK proficiency levels among educators from DepEd, TESDA, and HEIs in Region 10.

H0-2: There is no significant correlation between holistic TPACK integration and the adoption of innovative teaching methods.

METHODOLOGY

Research Design

The study employs a quantitative design to examine TPACK perceptions among DepEd, TESDA, and HEI educators in Region 10, Philippines. Descriptive statistics characterize proficiency levels across Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), and TPACK domains, while Spearman's rho correlations analyze relationships between TK/PK/CK descriptors and TPACK outcomes, complemented by Kruskal-Wallis tests to identify group differences.

Reliability Test

Internal consistency reliability for the study's thematic constructs (TK, CK, PK, and TPACK) was assessed using Cronbach's alpha before aggregating items into construct means for correlation analysis. Cronbach's alpha evaluates how well the 5 items within each construct measure the same underlying concept, with values >.70 indicating acceptable reliability and >.80 preferred for research scales. This step ensures that construct scores reliably represent participants' technological, pedagogical, and content knowledge, as well as their holistic TPACK levels, in the N=31 sample.

Quantitative Phase

This descriptive-comparative survey targeted 11 DepEd educators, 10 HEI faculty, and 10 TESDA trainers (n=31) using a validated TPACK instrument featuring 5-point Likert scales (1=Strongly Disagree to 5=Strongly

Agree; interpretive ranges: 1.4–below, 1.5–2.4, 2.5–3.4, 3.5–4.4, 4.5–above) for Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), and TPACK integrations. Data analysis incorporated descriptive statistics (means, SD), nonparametric Kruskal-Wallis H tests for group comparisons (DepEd vs. TESDA vs. HEIs), and Spearman's rho correlations with holistic TPACK outcomes to quantify perceptions and detect significant differences.

RESULTS AND FINDINGS

Reliability Test

The 5-item scales for Technological Knowledge (TK; $\alpha = 0.774$), Content Knowledge (CK; $\alpha = 0.901$), Pedagogical Knowledge (PK; $\alpha = 0.821$), and holistic TPACK ($\alpha = 0.876$) demonstrated acceptable to excellent internal consistency, all exceeding the 0.70 threshold. These values indicate acceptable-to-good reliability for TK, excellent consistency for CK, good reliability for PK, and good-to-very-good coherence for TPACK, confirming the scales' suitability as reliable composite measures.

The Assessment of TPACK

Technological Pedagogical Content Knowledge (TPACK) represents educators' understanding of how digital tools' affordances and limitations shape effective pedagogical strategies to enhance teaching and learning, enabling interactive environments like simulations and collaborative activities (Absari et al., 2020; Koh, 2019; Ratnaya et al., 2024; Tseng et al., 2022). Table 1 summarizes mean TK ratings from DepEd, TESDA, and HEI educators in Region X, Philippines, revealing high to very high proficiency (means 4.2–5.0 on a 5-point Likert scale) across all groups, indicating strong comfort with technology use in education. TESDA and HEI respondents score slightly higher than DepEd, particularly in staying updated with advancements and endorsing the educational role of technology.

Table 1. The summary of mean responses on technological knowledge (TK)

Parameter	DepEd		TESDA		HEI	
	SD	M	SD	M	SD	M
1. I am familiar with a range of digital tools, software, and applications relevant to my field.	.52	4.45	.48	4.7	.48	4.5
2. I can quickly adapt to using new technologies within my educational or work environment.	.79	4.27	.95	4.3	.52	4.6
3. I stay updated about technological advancements that impact my discipline or institution.	.65	3.73	.52	4.6	.53	4.5
4. I am confident in addressing common technical issues related to teaching, learning, or work.	.54	3.91	.97	4.4	.42	4.2
5. I believe technology improves the effectiveness and quality of the educational process.	.40	4.82	0	5.0	0	5.0

Table 2 indicates that all three groups perceive themselves as having strong and up-to-date content knowledge, with particular strength in keeping content relevant and aligned with evolving industry and learning needs. The mean ratings show that DepEd, TESDA, and HEI respondents all report generally high levels of content knowledge (CK), with TESDA and HEI often rating themselves slightly higher than DepEd. On a 5-point Likert scale, means around 4.3–5.0 are usually interpreted as “high” to “very high” or “agree” to “strongly agree.” Across all five items, the means for each group mostly fall in this range, indicating strong confidence in their CK and its relevance to industry and curriculum needs.

Table 2. The summary of mean responses on content knowledge (CK)

Parameter	DepEd		TESDA		HEI	
	SD	M	SD	M	SD	M
1. I have a strong grasp of the key concepts and current trends in the technology-based discipline.	.79	4.3	.52	4.6	.52	4.4
2. I can clearly communicate or understand complex subject matter and its practical applications.	.54	3.9	.97	4.4	0	4.0
3. I appreciate the relevance of current curriculum content to real-world industry needs.	.79	4.3	.97	4.4	.71	4.5
4. I actively seek opportunities to update or support the modernization of content knowledge.	.52	4.4	.48	4.7	.52	4.4
5. I adapt or support the adaptation of academic content to suit emerging learning or industry needs.	.82	4.4	.97	4.4	.53	4.5

Table 3 suggests that DepEd, TESDA, and HEI respondents all see themselves as strong in PK, particularly in collaborative, reflective, and inclusive teaching, with TESDA often rating itself slightly higher on key items. On a 5-point Likert scale, means above about 4.20 usually reflect “agree” to “strongly agree,” indicating high endorsement of the statements. Most PK means across DepEd, TESDA, and HEI fall between 4.2 and 5.0, showing that respondents feel confident in their teaching strategies, assessment practices, and support for effective learning environments.

Table 3. The summary of mean responses on pedagogical knowledge (PK)

Parameter	DepEd		TESDA		HEI	
	SD	M	SD	M	SD	M
1. I understand various teaching and learning strategies suitable for different types of learners.	.98	4.2	0	5.0	.42	4.2
2. I recognize the importance of designing or supporting inclusive and engaging learning/teaching environments.	.69	4.4	.48	4.7	.52	4.6
3. I am aware of effective assessment methods for evaluating learning outcomes or program effectiveness.	.52	4.4	.48	4.7	.88	4.1
4. I see value in promoting collaboration and active participation among students and staff.	.40	4.8	.48	4.7	.48	4.7
5. I regularly reflect on and support improvements in teaching and learning practices.	.82	4.5	.48	4.7	.48	4.3

The mean ratings, as illustrated in Table 4 shows that all three groups (DepEd, TESDA, HEI) have generally high to very high perceptions of holistic TPACK, with only slight differences in how actively they see themselves implementing it. On a 5-point Likert scale, means above about 4.20 usually indicate “agree” to “strongly agree,” reflecting high endorsement of the statements. Most means in the table range from 4.3 to 4.7, suggesting that respondents across DepEd, TESDA, and HEI strongly value and practice the integration of technology, pedagogy, and content knowledge.

Table 4. The summary of mean responses on holistic TPACK

Parameter	DepEd		TESDA		HEI	
	SD	M	SD	M	SD	M
1. I recognize the value of integrating technology, pedagogy, and content knowledge for educational innovation.	.82	4.5	.97	4.4	.48	4.7
2. I am involved in, or supportive of, the implementation of innovative lessons, programs, or policies utilizing TPACK.	.75	3.8	.75	3.8	.42	4.2
3. I observe or encourage the thoughtful use of technology to improve how specific content is taught or learned.	.50	4.6	.48	4.7	.52	4.4
4. I am engaged in or promote initiatives that use technology for interactive and experiential learning.	.82	4.4	.48	4.7	.48	4.3
5. I believe the TPACK framework is important for future-ready education in my institution.	.50	4.4	.97	4.4	.53	4.5

The Test for Significant Difference

The Kruskal-Wallis test, ideal for ordinal 5-point Likert data from independent educator groups (DepEd, TESDA, and HEI), ranks scores without requiring normality or equal variances, unlike parametric ANOVA, enabling robust detection of distribution differences across groups. Table 5 reveals non-significant p-values (>0.05) for most TK items, except TK3 ("I stay updated about technological advancements that impact my discipline or institution"; H=9.8, p=.007 < .05), rejecting the null hypothesis due to disparities in technology access, budgets, and tool complexity across groups.

Table 5. Summary of Kruskal-Wallis Test on TK

Parameters	Kruskal-Wallis (X^2)	Probability (p)
1. I am familiar with a range of digital tools, software, and applications relevant to my field.	1.37	.505
2. I can quickly adapt to using new technologies within my educational or work environment.	.81	.668
3. I stay updated about technological advancements that impact my discipline or institution.	9.8	.007*
4. I am confident in addressing common technical issues related to teaching, learning, or work.	3.42	.180
5. I believe technology improves the effectiveness and quality of the educational process.	3.76	.152

*p<.05 df = 2

The Kruskal–Wallis results in Table 6 show that there is no statistically significant difference in content knowledge (CK) across the groups for any of the five CK indicators, since all p values are greater than the .05

significance level. This means the groups can be interpreted as having comparable levels of CK on all statements measured. When the p-value exceeds .05, the test fails to reject the null hypothesis that the groups come from the same distribution, implying no statistically significant difference among them. This pattern indicates that, for each CK parameter, observed differences in group responses are small enough to be attributed to chance variation rather than systematic differences between groups.

Table 6. Summary of Kruskal-Wallis Test on CK

Parameters	Kruskal-Wallis (X^2)	Probability (*p*)
1. I have a strong grasp of the key concepts and current trends in the technology-based discipline.	1.12	.571
2. I can clearly communicate or understand complex subject matter and its practical applications.	3.99	.136
3. I appreciate the relevance of current curriculum content to real-world industry needs.	.590	.744
4. I actively seek opportunities to update or support the modernization of content knowledge.	1.99	.369
5. I adapt or support the adaptation of academic content to suit emerging learning or industry needs.	.06	.970

$p<.05$ df = 2

Table 7 presents a summary of the Kruskal-Wallis test results examining the interplay of pedagogy and knowledge (PK), which indicated a statistically significant difference among the groups on only one aspect of pedagogical knowledge (PK1), understanding teaching and learning strategies with H=10.12, p-value of .006 < 0.05, while all other PK indicators show no significant group differences. This means the groups vary in their self-rated knowledge of strategies for different learners, but are generally comparable in other pedagogical dimensions.

Table 7. Summary of Kruskal-Wallis Test on PK

Parameters	Kruskal-Wallis (X^2)	Probability (*p*)
1. I understand various teaching and learning strategies suitable for different types of learners.	10.12	.006*
2. I recognize the importance of designing or supporting inclusive and engaging learning/teaching environments.	.72	.69
3. I am aware of effective assessment methods for evaluating learning outcomes or program effectiveness.	3.13	.209
4. I see value in promoting collaboration and active participation among students and staff.	.501	.778
5. I regularly reflect on and support improvements in teaching and learning practices.	3.18	.204

*$p<.05$ df = 2

Table 8 reveals that groups hold generally similar TPACK perceptions across most items, with only one significant difference detected via the Kruskal-Wallis test, a nonparametric method for comparing distributions across three or more independent groups (df=2). Four items show non-significant p-values (.263–.91 > .05), indicating no group differences in TPACK beliefs or general attitudes. However, TPACK2 ("I am involved in, or supportive of, the implementation of innovative lessons, programs, or policies utilizing TPACK") yields H=8.91, p=.012 < .05, signalling that at least one group differs markedly in reported involvement or support for TPACK-based innovations. Substantively, while groups align on TPACK's perceived value, they diverge in actively translating it into concrete practices, highlighting uneven engagement across groups despite shared foundational views.

Table 8. Summary of Kruskal-Wallis Test on TPACK

Parameters	Kruskal-Wallis (X^2)	Probability (*p*)
1. I recognize the value of integrating technology, pedagogy, and content knowledge for educational innovation.	.179	.91
2. I am involved in, or supportive of, the implementation of innovative lessons, programs, or policies utilizing TPACK.	8.91	.012*
3. I observe or encourage the thoughtful use of technology to improve how specific content is taught or learned.	1.99	.368
4. I am engaged in or promote initiatives that use technology for interactive and experiential learning.	2.67	.263
5. I believe the TPACK framework is important for future-ready education in my institution.	.532	.767

**p<.05*   df = 2

The Test for Significant Correlation of TK, CK, and PK to Holistic TPACK

Within the TPACK framework, TK, CK, and PK serve as foundational domains predicting the integrated TPACK construct, justifying their use as predictors in correlational analyses like Spearman's rho, suitable here for n=31 and ordinal data. Table 9 reports small-to-moderate positive correlations (ρ = 0.38–0.40, all p < .05), indicating practically meaningful associations where higher technological knowledge aligns with stronger TPACK practices, such as valuing integration and thoughtful, interactive use. Item-level insights reveal that familiarity with digital tools (TK1) positively relates to recognizing TPACK's value for innovation (TPACK4; ρ = .382*, p = .034), staying updated on advancements (TK3) correlates with encouraging content-aligned technology use (TPACK3; ρ = .398*, p = .027) and promoting interactive experiential learning (TPACK4; ρ = .387*, p = .032), and respondents with greater tool familiarity or tech-savviness tend to endorse and engage in these TPACK-driven practices.

Table 9. Spearman's Rho Correlations between TK predictors and TPACK Outcomes

Predictor	Outcome	ρ (Spearman)
TK1- I am familiar with a range of digital tools, software, and applications relevant to my field.	TPACK4- I recognize the value of integrating technology, pedagogy, and content knowledge for educational innovation.	.382* (p-value = 0.034)
TK3- I stay updated about technological advancements that impact my discipline or institution.	TPACK3 - I observe or encourage the thoughtful use of technology to improve how specific content is taught or learned.	.398* (p-value = 0.027)
	TPACK4 - I am engaged in or promote initiatives that use technology for interactive and experiential learning.	.387* (p-value = 0.032)

The results in Table 10 reveal small-to-moderate positive correlations (ρ = 0.38–0.44) between pedagogical knowledge (PK) items and TPACK outcomes, all statistically significant (p = 0.014–0.037 < 0.05), indicating that stronger PK aligns with greater TPACK endorsement and involvement in innovations. Item-level insights show that understanding differentiation strategies (PK1) positively links to believing TPACK is vital for future-ready education (TPACK5; ρ = .378*, p = .036), valuing collaboration and participation (PK4) moderately associates with support for TPACK-based lessons, programs, or policies (TPACK2; ρ = .438*, p = .014), and regular reflection on teaching improvements (PK5) relates to active involvement in TPACK initiatives (TPACK2; ρ = .376*, p = .037). These patterns collectively underscore PK, particularly in differentiation, collaboration, and reflection, as a meaningful enabler of TPACK attitudes and practical actions.

Table 10. Spearman's Rho Correlations between PK predictors and TPACK Outcomes

Predictor	Outcome	ρ (Spearman)
PK1- I understand various teaching and learning strategies suitable for different types of learners.	TPACK5- I believe the TPACK framework is important for future-ready education in my institution.	.378* (p-value = .036)
PK4- I see value in promoting collaboration and active participation among students and staff.	TPACK2 - I am involved in, or supportive of, the implementation of innovative lessons, programs, or policies utilizing TPACK.	.438* (p-value = .014)
PK5 - I regularly reflect on and support improvements in teaching and learning practices.	TPACK2 - I am involved in, or supportive of, the implementation of innovative lessons, programs, or policies utilizing TPACK.	.376* (p-value = .037)

The findings underscore TK and PK as key enablers of TPACK development, which are validated by the skill set manifestation of the student's performance in standardized tests utilizing the stipulated learning outcomes as baseline in their respective relevant course syllabi. Spearman's rho analyses across TK and PK tables reveal small-to-moderate positive correlations (ρ = 0.38–0.44) with TPACK outcomes, all significant (p < .05), positioning both knowledge domains as complementary enablers of TPACK attitudes and practices. Tool familiarity (TK1) and staying updated (TK3) predict innovation valuation (TPACK4) and thoughtful/content tech use (TPACK3). TK3's dual links (strongest ρ=.398) align with Kruskal-Wallis group differences (p=.007). TK provides technological foundations (tools/currency → innovation), while PK fuels pedagogical activation (strategies → implementation). Comparable magnitudes (ρ≈0.38–0.44, Cohen's small-moderate) suggest balanced contributions, with n=31 limiting power but validating patterns. Cross-table consistency reinforces TK/PK as TPACK precursors, warranting interventions targeting both amid sectoral disparities.

CONCLUSION

The findings demonstrate that robust technological knowledge (TK), particularly familiarity with digital tools and adaptability, positively correlates with advanced TPACK attitudes, including valuing integration, thoughtful technology use in content teaching, and support for interactive initiatives. Similarly, strong pedagogical knowledge (PK), especially in differentiated strategies, collaboration, and reflection, links to greater TPACK endorsement and active implementation of innovations. These moderate relationships highlight TK and PK as key enablers of TPACK without being sole determinants. Combining group-difference tests with correlations on TK/CK/PK–TPACK variables remains statistically valid and methodologically sound, providing complementary insights into both differences and associations. Hence, stronger TK and PK meaningfully foster TPACK development and practice among educators, underscoring their role in driving technology-enhanced, future-ready teaching. Employing both group comparisons and Spearman's rho correlations on these constructs is appropriate, enhancing the robustness of the educational technology research.

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