

## Investigating the Structural Relationship between TPACK, Technological Self-efficacy, and Constructivist Teaching Practice

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### Abstract

Teachers' technological knowledge and teaching pedagogies are continually challenged by the shift towards online learning. Recognizing this phenomenon, the study aimed to derive a model incorporating the teachers' TPACK (technological pedagogical and content knowledge), constructivist teaching practices (CTP), technological self-efficacy (TSE), teaching experience, frequency of educational-technology trainings attended, and type of subjects taught using structural equation modeling techniques. The study comprised 187 teachers from 16 teacher education institutions. Results indicated that the teachers' CTP loaded highly on their pedagogical knowledge (PK) while their TSE also loaded highly on their technological knowledge (TK). The respondents' years of teaching experience indicated a significant but negative loading on the teachers' TSE. In contrast, the type of subjects taught by the teachers was removed from the model due to non-significance. The number of trainings attended by the teachers did not significantly predict their TSE as well as the teachers' TPACK. Fit indexes indicated that the proposed model is marginally acceptable. Further scrutiny of the derived model implied that the hypothesis that all elementary constructs of TPACK directly predicting the teachers' TPACK is rejected, validating results from previous studies. The analysis of the different structural paths also suggested that CTP greatly influenced the teachers' TPACK due to the combined effects of its direct and indirect paths, indicating that TPACK is much rooted in the constructivist philosophy. However, the teachers' TPACK was mostly positively predicted by PCK (pedagogical content knowledge), CTP, and TPK (technological-pedagogical knowledge). Results of the derived model, however, challenged the veracity of the TPACK construct.

**Keywords:** constructivist teaching, technology in education, technological self-efficacy, TPACK, structural equation modeling

### Introduction

The "Education 2030 Framework for Action" by UNESCO is designed to address Sustainable Development Goal No. 4 (SDG4) on "ensuring inclusive and equitable quality education and promote lifelong learning opportunities for all" (UNESCO, 2016, p. 1). SDG4 implies that all educational institutions should be at par with global standards and ensure quality teaching to cultivate the millennial generation's 21st-century skills through competent and skilled educators and using appropriate pedagogical approaches supported by appropriate educational technologies. In the Philippines, local and international standards (i.e., the National Competency-Based Teacher Standards (NCBTS), Philippine Qualification Reference Framework (PQF), ASEAN Qualifications Reference Framework (AQR)), challenges of globalization and new developments in technology integration for teaching have placed judicious demands on Filipino teachers who must now learn to develop technology-integrated programs and lessons in order to cultivate the students' 21st-century skills.

Furthermore, the onset of the pandemic has disrupted the global educational systems and forced educational institutions to adopt online learning platforms. It also forced teachers to adopt online teaching modalities, taxing their technological and online competencies to the limit. Educa-

tional researchers worldwide clamored for the need to investigate the efficacy of such an abrupt shift in educational systems and its effect on the teachers and students (Kundu & Bej, 2021; Dolighan & Owen, 2021; Košir et al., 2020). One way of investigating this phenomenon is through the lens of the technological, pedagogical, and content knowledge framework or TPACK (Koehler, Shin, & Mishra, 2012; Mishra & Koehler, 2006).

Recognizing the need to study this phenomenon, the study aimed to measure the extent of practice of the teachers in constructivist teaching methods (CTP), their level of competence in using educational technologies (TSE), and their knowledge in integrating technology, pedagogy, and content (TPACK). It also investigated the construct validity of a proposed model incorporating the teachers' TPACK, CTP, TSE, teaching experience (Y), number of educational-technology trainings attended (T), and type of subjects taught (S) using structural equation modeling techniques.

### **Methodology**

The study determined the teacher's extent of knowledge in TPACK using a standard self-survey instrument by Sahin (2011) and their level of competence in their technological self-efficacy (TSE) using a developed instrument based on Christensen and Knezek (2016). The respondent's extent of practice of the constructivist teaching methods was also measured using a developed instrument (CTP). Content validity review of the instruments mentioned necessitated minimal revisions, while reliability and construct validity measures generated "good" to "excellent" Cronbach's alpha levels (0.75-0.97) indicative of valid and reliable instruments. School culture sensitivity analysis (private vs. public) deemed that the instruments were not school-type specific. The study comprised 187 teachers from 16 teacher education institutions (TEI) in the Philippines. Correlation of the different variables was measured using Pearson product-moment correlation coefficient. Confirmatory factor analysis (CFA) and structural equation modeling using maximum likelihood estimation was utilized to measure the feasibility of the proposed model. Evaluation of the proposed model employed CFA fit indexes via absolute fit measures, incremental fit measures, parsimonious fit measures, and measurement model fit (Hair et al., 2018; Hooper, Coughlan & Mullen, 2008).

### **Results and Discussions**

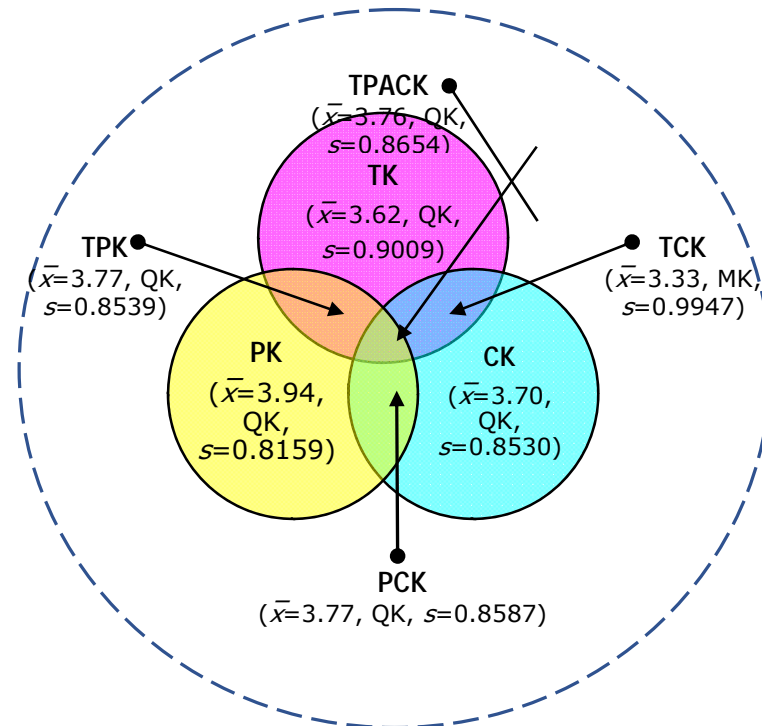
Results indicated that teachers of TEIs in Baguio and Benguet exhibited their highest extent of knowledge in teaching pedagogy (PK) (M=3.94, SD=0.8539) and their lowest in applying technology to their content areas (TCK) (M=3.33, SD=0.9947) (Figure 1). They perceive themselves to be most knowledgeable in "making class activities" (M=4.10, SD=0.9072), "managing class during class engagements" (M=4.10, SD=0.8709), and "developing class projects" (M=3.97, SD=0.9611). However, they exhibited a low extent of knowledge in TCK in "taking online courses (e.g., Massive Open Online Course (MOOC), paid online courses) to update my knowledge in my content area" (M=2.86, SD=1.2918), "using content-area specific computer applications" (M=3.27, SD=1.1157), and "using computer apps in delivering content to their subject areas" (M=3.40, SD=1.0943).

On the respondents' constructivist teaching practices (CTP), most teachers "often practice" cooperative learning (CL) (M=4.26, SD=0.6766), guided instruction (GI) (M=4.17, SD=0.6948) and project-based learning (PL) (M=4.15, SD=0.7107) but rarely practiced peer-tutoring (M=3.66, SD=1.0031) in their classes.

On the technological self-efficacy scale (TSE), the teachers exhibit much confidence (MC) in their TSE (M=3.64, SD=0.9195) with "using E-mails" (M=3.94, SD=1.0327), "integrated applications" (IA) (M=3.66, SD=1.0462) and "using recent technologies for student learning" (RT)

( $M=3.59$ ,  $SD=0.9639$ ) leading the list. However, they exhibited their lowest competency in “using technology for their professional development” (TPD) ( $M=3.51$ ,  $SD=0.9725$ ).

TK, CK, PK, TCK, TPK, PCK, TPACK, CTP, and TSE were all strongly and positively correlated (Table 1). However, TPACK is more positively correlated with PCK, PK, and TPK ( $r_{PCK-TPACK}=0.852$ ,  $p<0.01$ ;  $r_{PK-TPACK}=0.804$ ,  $p<0.01$ ;  $r_{TPK-TPACK}=0.792$ ,  $p<0.01$ ). Results implied that the teachers' TPACK correlates much with their knowledge in teaching pedagogy. This presupposes, among others, that mastery of teaching pedagogy is a “pre-requisite” for successfully integrating technology into their teaching.



**Figure 1. Teachers' Perceived Extent of Knowledge on their TPACK\* and its Constructs**  
Legend: \*TK-Technology Knowledge, PK-Pedagogical Knowledge, CK-Content Knowledge, TPK-

Technological Pedagogical Knowledge, TCK-Technological Content Knowledge, PCK-Pedagogical Content Knowledge, TPACK-Technological, Pedagogical and Content Knowledge

Assessing the effect of CTP, TSE, and other variables unto the teachers' TPACK yielded a simplified model (Figure 2). Results from Figure 2 proposed the following structural equations:

$$TPACK = 0.268TPK + 0.484PCK + 0.210CTP \quad (1)$$

$$PCK = 0.738PK + 0.131CK \quad (2)$$

$$TPK = 0.435PK + 0.284TK + 0.211CTP \quad (3)$$

$$TSE = -0.320Y \quad (4)$$

$$TK = 0.903TSE \quad (5)$$

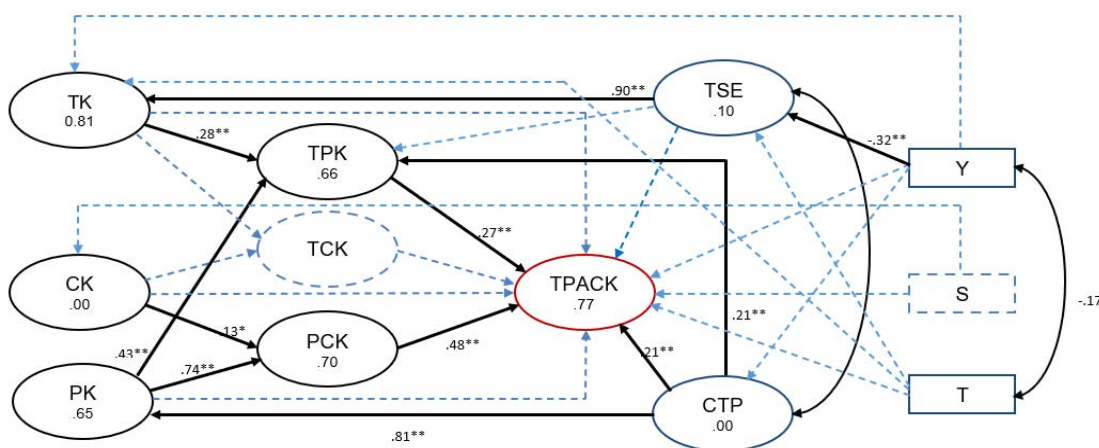
$$PK = 0.807CTP \quad (6)$$

**Table 1. Bivariate correlation between TK, CK, PK, TPK, TCK, PCK, TPACK, CTP, and TSE using Pearson correlation**

	TK	CK	PK	TPK	TCK	PCK	TPACK	CTP	TSE
TK	1.000	.698**	.556**	.668**	.779**	.515**	.536**	.402**	.835**
CK		1.000	.769**	.714**	.658**	.716**	.689**	.543**	.655**
PK			1.000	.767**	.564**	.851**	.804**	.652**	.517**
TPK				1.000	.798**	.773**	.792**	.654**	.657**
TCK					1.000	.673**	.653**	.468**	.779**
PCK						1.000	.852**	.626**	.542**
TPACK							1.000	.644**	.536**
CTP								1.000	.390**
TSE									1.000

\*Significant at the .01 level ( $p < .01$ )

The proposed model (Figure 2) indicated that the teachers' years of teaching experience (Y) was negatively correlated with their number of trainings (T) in educational technologies ( $r = -0.17, p < 0.05$ ) and was also a significant predictor of TSE, albeit, with a negative regression loading ( $\beta = -0.32, p < 0.01$ ). TSE did not significantly predict TPACK but positively predicted TK with a high regression loading ( $\beta = 0.903, p < 0.01$ ). This contradicts the results from Wang and Zhao (2021) and Dong et al. (2020). The number of trainings attended by the teachers (T) also did not significantly predict TSE and the teachers' TPACK. CTP significantly predicted PK, TPK, and TPACK with positive regression weights corroborating the belief that TPACK is much rooted in the constructivist philosophy (Polin & Moe, 2015; Darling-Aduana & Heinrich, 2018). However, the teachers' TPACK is mostly positively predicted by PCK ( $\beta = 0.484, p < 0.01$ ), CTP ( $\beta = 0.210, p < 0.01$ ), and TPK ( $\beta = 0.27, p < 0.01$ ) (Equation 1,  $R^2 = 0.77$ ) contradicting previous researchers' model on the topic (Rodríguez et al., 2019; Álvarez-Otero et al., 2018; Miguel-Revilla et al., 2020). CFA fit indexes indicated that the model was also a marginally acceptable model ( $\chi^2/df = 2.053$ , SRMR = 0.095, RMSEA = 0.076, AGFI = 0.828, TLI = 0.905, PNFI = 0.718, CFI = 0.921).



**Figure 2. Derived Structural Equation Model of the Teachers' TPACK, TSE, CTP and other Variables with the**

*Significant Path Coefficients and R-squared Values Note: \*Significant at the .05 level ( $p < .05$ )*

*\*\*Significant at the .01 level ( $p < .01$ )*

Further scrutiny of the derived model in Figure 2 implied that the hypothesis that all elementary constructs of TPACK (TK, CK, PK) directly predicting the teachers' TPACK is rejected, validating earlier findings by researchers in TPACK modeling (DeSantis, 2016; Wang et al., 2018; Backfisch et al., 2020; Castera et al., 2020). However, TK, CK, and PK may have an indirect influence on the teachers' TPACK via the structural paths  $PK \rightarrow PCK \rightarrow TPACK$ ,  $PK \rightarrow TPK \rightarrow TPACK$ ,  $CK \rightarrow PCK \rightarrow TPACK$ , and  $TK \rightarrow TPK \rightarrow TPACK$  (see Figure 2). Results of the analysis of the different structural paths suggested that the teachers' constructivist teaching practices (CTP) greatly influenced the teachers' TPACK due to the combined effects of its direct and indirect paths ( $CTP \rightarrow TPACK$  (.210) +  $CTP \rightarrow TPK \rightarrow TPACK$  (.210x.268) +  $CTP \rightarrow PK \rightarrow PCK \rightarrow TPACK$  (.807x.738x.484) +  $CTP \rightarrow PK \rightarrow TPK \rightarrow TPACK$  (.807x.435x.268) = .649). Moreover, CTP's influence on TPACK was seen to be mediated by PK, TPK, and PCK, suggesting the importance of teaching pedagogy in integrating technology into teaching. Evidence from research literature advocates the positive effects that a constructivist, student-oriented pedagogy has on using educational technologies for student motivation and self-efficacy (i.e., Mahasneh & Alwan, 2018; Tondeur et al., 2017). Additionally, Remegio, Simpao, and Cabang (2017) concluded that when teachers develop intermediate forms of technology-pedagogy-content knowledge, these contributed to their confidence in constructivist-oriented technology integration. However, the results of the derived model challenged the TPACK model's veracity for TEI teachers since the entire construct of the TPACK model was not conserved in the subsequent analysis of the model.

### Conclusion

The study indicated that most teachers "often practice" constructivist teaching practices and exhibit much confidence in using educational technologies for teaching. Results indicated that the teachers' TPACK and its elementary and secondary constructs are significantly and positively correlated with the teachers' CTP and TSE. CTP's influence on TPACK was seen to be mediated by the teachers' mastery of teaching pedagogy. TSE, however, did not significantly predict TPACK based on the model. Also, the number of trainings attended by the teachers (T) did not significantly predict their TSE as well as their TPACK. Evaluation of the proposed model indicated a marginally acceptable model which merits additional investigation by application to other fields and disciplines. Furthermore, the resulting model, which negated the effects of the TCK of the TPACK construct, necessitates additional investigation. The results of the study challenged the veracity of the TPACK construct.

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