TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE ON THE USE OF DIGITAL TECHNOLOGY IN TEACHING PRACTICE: A COMPARATIVE MODEL IN THE CONTEXT OF INDONESIAN AND MALAYSIA TEACHER PROSPECTIVE STUDENTS

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ABSTRACT

This study examined Indonesian and Malaysian pre-service teachers' digital technology integration. Technological pedagogical and content knowledge (TPACK) model was utilised to predict the use of digital technology. Three hundred and seventy-seven respondents from two higher education institutions completed a 37-item survey instruments based on the TPACK and digital technology implementation. The establishment of the instruments was conducted through content validity and face validity. The current study results analysed using partial least squares structural equation modelling (PLS-SEM) elaborated 10 significant relationships out of 12 proposed hypotheses. All TPACK domains are related and informed to be a statically valid in explaining digital technology use among the respondents. Policy recommendations and suggestions are offered for the betterment of Indonesian teachers' level of TPACK and digital technology integration

Keywords: Digital technology, implementation, PLS SEM, TPACK

1) INTRODUCTION

Technology in academic settings is becoming commonplace in today's classrooms, with many schools throughout the world adopting it as a standard. Digital technologies have been deemed mandatory not just for institutions of higher learning and K-12 schools. Many K-12 schools are competing to implement a 1:1 technology system in ensuring that all students and instructors have access to required technology. This position raises the prospect of a cultural shift in society, with technology-integrated education being viewed as a means of improving student learning. Indeed, one of the conditions for hiring new instructors, including language teachers, is the capacity to integrate technology into the classroom.

Adopting technology in the classroom necessitates a thorough understanding of technology, pedagogy, and content. In the context of using digital technology, TPACK can play a critical role in education (Koehler et al., 2011). The link between TPACK components has been the subject of numerous investigations. Furthermore, other research investigated the components of TPACK as they related to technological integration. A thorough TPACK interconnection and their consequences on digital technology integration, on the other hand, have not been well informed. As a result, the purpose of this study was to elucidate the connectivity and link between technology integration and teaching perceived by pre-service teachers. To meet the study's objectives, twelve hypotheses (Fig. 1) were developed, each involving eight constructs: Technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), technological and content knowledge (TCK), pedagogical content knowledge (PCK), technological content knowledge (TPK), technological pedagogical and content knowledge (TPACK), and digital technology use.

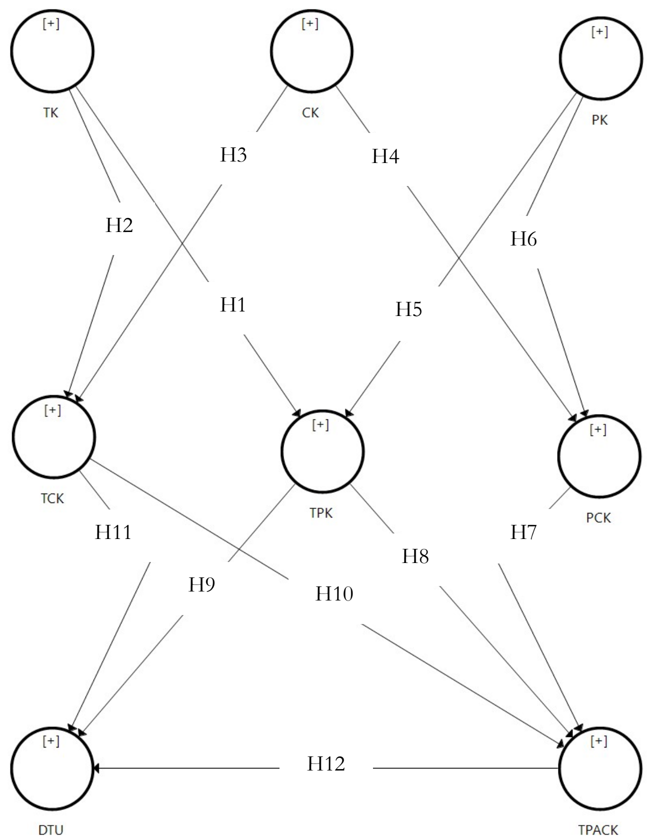

Figure 1. Path analysis: Hypotheses

Table 1 TPACK domains, definition

Domain	Definition and hypotheses	Prior studies
TK	Knowledge of various technologies H1: TK significantly affects TPK. H2: TK positively predicts TCK.	TK has significant relationships with TCK and TPK (Chai et al., 2012; Dong et al., 2015; Pamuk, 2015; Scherer et al., 2017)
CK	Knowledge of subject matter.	CK does not significantly predict

	H3: CK is a significant predictor of TCK. H4: CK predicts PCK.	for both TCK and PCK (Chai et al., 2012)(Chai et al., 2012) CK has significant relationships with only TCK and PCK (Dong et al., 2015; Pamuk, 2015)
PK	Understanding of aspects of classroom teaching strategies H5: PK predict TPK significantly. H6: PK positively predict PCK.	The relationship between PK and TPK emerges to be significant (Chai et al., 2012) PK is significant for TPK (Pamuk, 2015) PK is not a significant predictor of TPK (Dong et al., 2015)
PCK	Knowledge in representing content knowledge and adopting pedagogical strategies to make certain content/topics more understandable H7: PCK will positively and significantly predict TPACK.	PCK has a significant relationship with TPACK (Chai et al., 2012; Dong et al., 2015; Pamuk, 2015; Scherer et al., 2017)
TPK	Knowledge of the existence and specifications of various technologies to enable learning approaches and establishing new interactions in learning. H8: TPK significantly influences TPACK. H9: TPK predicts the use of digital technology positively.	Pamuk et al. (2015) mentioned TPK positively predicts TPACK (Scherer et al., 2017; Pamuk et al., 2015) TCK is not related to TPACK (Chai et al. 2012; Dong et al., 2015) Graham (2011) informed TPK predicts technology integration.
TCK	Knowledge of how to use technology to represent/research and create content in different ways regardless of teaching. H9: TCK significantly influences TPACK. H10: TCK predicts the use of digital technology.	TCK is a strong predictor for TPACK (Dong et al. 2015; Pamuk et al. 2015). Pamuk et al. (2015) exhibited that TCK and TPACK while Chai et al. (2012) found No correlation between TCK and TPACK emerged (Chai et al., 2012)
TPACK	Knowledge of the use of various technologies to teach/represent/facilitate the creation of knowledge from specific subject content. H11: TPACK significantly predicts TPACK.	TPACK is a good predictor of technology integration (Joo et al., 2018; Scherer et al., 2017)
Digital technology use	The use of digital technology such as the Internet, Computer, and smartphone in teaching	Purely dependent variable

The history of TPACK

TPACK was inspired by PCK (Shulman, 1987). PCK is primarily concerned with the creation of the most appropriate teaching approaches and components. Shulman (1986) addressed a discrepancy between classroom instruction using generic pedagogical techniques and teaching with content-specific pedagogy in his study of PCK. The debate was founded on the historical history of education, which contended that content and pedagogy should be considered "one indivisible body of knowledge" (p.6). Considering these important PCK principles, TPACK was developed as a model for articulating domains of efficient technology integration in education (Mishra & Koehler, 2006). Teachers must have a concept built by understanding the relationships among the elements; technology, content, and pedagogy" to integrate technology effectively within this framework (Angeli & Valanides, 2009). Even though TK, PK, and CK are likely to become representations of many knowledge foundations, the interactions and links between the main concepts form the framework's underlying essence. TPACK is made up of 7 different knowledge foundations; three of which are core: TK, PK, and CK. Meanwhile, the interconnections between the basic bases of TCK, PCK, TPK, and TPACK determine some other four parts.

2) METHODS

The sample for this research was gathered using a survey. Data collection procedures, a review of past was conducted, as well as an assessment of the instruments' validity and reliability. PLS-SEM was used to evaluate the model. Because the study procedure is not hampered by the assumption of dataset, this research used a predictive strategy to calculate the theory for causation.

Instrumentation

The examination of material assists a researcher in defining and analysing the concepts and theories that make up the research's theoretical basis, and other determining relevant methodologies and instruments to use to achieve the research's goals. We adapted previous related studies regarding TPACK and technology integration (Habibi et al., 2020; Schmidt et al., 2009). In this step, 37 indicators were created as a result. Afterwards, the instruments were tested for sociocultural and setting differences using face and content validity through discussions with experts and users. A group of five users (three pre-service teachers) discussed the revised instruments for face validity. The procedure was carried out in the form of an interactive group discussion. The instrument was discussed with five experts for content validity. Experts in educational technology field were among the specialists. Following the discussion, some questions were altered, and four were removed since they could not be used in the Indonesian educational environment, leaving 33 items for further verification.

Data collection

We gave the instruments to the respondents once we completed the face and content validity checks. The information was gathered from three Indonesian institutions with education schools. To date, each dean of each university's school of education has obtained and signed letters of authorization for data collecting. Google Form was used to distribute the information. The data was collected during a two-month period. Microsoft Excel and SPSS were used to compile all the responses. Meanwhile, the study's target group included all pre-service teachers in Indonesia and Malaysia. We separated the target population from their universities using random sampling. 400 instruments were provided, therefore. Only 377 responses, however, were measurable.

3) RESULTS

Measurement model

The measurement model was the method of deciding the concept measures' reliability and validity. This procedure looked at reflecting indicator loadings, internal consistency reliability, convergent validity, and discriminant validity. The reflecting indicator was reported using the PLS-SEM result format. Table 3 shows the detailed findings of the reflective measurement model evaluations for all eleven constructs. Several loadings were less than the suggested scores, according to the evaluation details and reflecting indicator results. Most indicators attained the desired value of >.700 because of the final PLS–SEM process. However, four have values below the cut-off; thus, they were dropped.

Internal consistency reliability

Cronbach's alpha and composite reliability were examined for this investigation using the PLS-SEM method. Internal consistency reliability values range from 0 to 1, with the greater the value, the more valid the data. Cronbach's alpha should be more than .700, as should composite reliability. Cronbach's alpha and composite reliability are presented in detail in Table 2. For most constructs, they were consistent, comparable, and had strong internal consistency dependability, exceeding the suggested value of .708 but falling short of the maximum value of .95. If HTMT (the major criteria for discriminant validity) are greater than the threshold, discriminant validity concerns arise. Because the items were conceptually identical, the threshold is less than .90 (an HTMT above .90 means less discriminant validity). Table 3 shows that all the results are less than .900. The HTMT was substantially different from 1, implying that the active constructs have discriminant validity. Following this procedure, twenty-nine items were added to the structural model's evaluation.

Table 2. Loading, alpha, rho_A and AVE

	Load	Alpha	rho_A	CR	AVE
CK1	.846	.759	.770	.861	.674
CK2	.794				
CK3	.822				
DTU1	.725	.851	.902	.898	.690
DTU2	.794				
DTU3	.914				
DTU4	.877				
PCK1	.945	.929	.948	.955	.875
PCK2	.921				
PCK3	.941				
PK2	.757	.841	.844	.887	.611
PK3	.766				
PK5	.768				
PK6	.826				
PK7	.790				
TCK1	.942	.923	.946	.951	.866
TCK2	.905				
TCK3	.944				
TK1	.859	.782	.790	.873	.696
TK2	.843				
TK3	.800				

TPACK1	.815	.837	.845	.884	.605
TPACK2	.803				
TPACK3	.766				
TPACK4	.702				
TPACK5	.798				
TPK2	.854	.818	.818	.892	.733
TPK3	.855				
TPK4	.859				

Table 4 HTMT values

HTMT								
	CK	DTU	PCK	PK	TCK	TK	TPACK	TPK
CK								
DTU	.155							
PCK	.561	.140						
PK	.838	.178	.555					
TCK	.472	.165	.505	.464				
TK	.482	.206	.319	.413	.475			
TPACK	.589	.189	.522	.653	.588	.595		
TPK	.587	.264	.540	.563	.614	.559	.831	

Structural model

We used bootstrap samples of 5000 to see if the correlations between independent and dependent variables in the latest research are significant. For the association between TCK and UICT, all relationships inferred in the structural model are significant at a 5% significance level. The findings support H1, H2, H3, H4, H5, H6, H7, H8, and H 1. Regarding the connectivity of TPACK foundations (PK, CK, and TK) and next tier bases of understanding (TPK, TCK, and PCK), the findings emphasize the positive significant associations which facilitate H1, H2, H3, H4, H5, H6, H7, H8, and H1.

TPK and TCK have been shown to be significantly affected by TK. TCK and PCK are also significantly predicted by CK. The final core foundation, PK, is thought to play a role in generating TPK and PCK. The strongest association arises between PK and PCK for this three basic base knowledge. TPK, TCK, and PCK are said to have a substantial impact on TPACK. As a result, statistical evidence supports the three hypotheses (H7, H8, and H10). TPK predicts TPACK the best, and it also has the greatest connection of all the hypotheses in this investigation. TCK is the least effective predictor of TPACK. TPK has also been shown to be a good predictor of TPACK.

This research is planned to elaborate TPACK components to affect Indonesian and Malaysian student teachers' usage of digital technology, in addition to the interconnection among TPACK components. Three of the predictors are claimed to statistically represent integration of technology using the PLS-SEM bootstrapping technique, whereas one of them, TCK, does not predict use of digital technology. TPACK is the strongest predictor of digital technology use, followed by TPK. Between PCK and UICT, the smallest meaningful association develops. H10, H11, and H13 are supported by the findings, however H8 is denied. Figure 2 and Table 8 provide the comprehensive display of the bootstrapping results.

Table 4. Significance of the relationships through the assessment of path coefficient, t value and p value.

		Path	Sample Mean (M)	SD	T value	P Values	Sig
H1	TK -> TPK	.328	.328	.050	6.626	.000	Yes
H2	TK -> TCK	.300	.305	.056	5.389	.000	Yes
H3	CK -> TCK	.297	.296	.059	5.049	.000	Yes
H4	CK -> PCK	.264	.267	.065	4.070	.000	Yes
H5	PK -> TPK	.358	.362	.051	6.965	.000	Yes
H6	PK -> PCK	.320	.324	.060	5.369	.000	Yes
H7	PCK -> TPACK	.127	.131	.045	2.811	.005	Yes
H8	TPK -> TPACK	.534	.536	.040	13.373	.000	Yes
H9	TPK -> DTU	.204	.203	.077	2.642	.009	Yes
H10	TCK -> TPACK	.181	.181	.049	3.679	.000	Yes
H11	TCK -> DTU	.048	.052	.066	.732	.465	No
H12	TPACK -> DTU	.000	.006	.088	.003	.998	No

4) DISCUSSION

The primary objective was to elaborate relationships among TPACK domains and examine the roles to affect digital technology use perceived by Indonesian and Malaysia respondents of student teachers. The research instruments were adapted to measure TPACK and digital technology use using face and content validity and measurement model. While developing and validating the instruments, recommendations of previous studies for TPACK and for digital technology use in the literature were considered. Through the processes, twenty-nine items were added for the structural model. The central elaboration is to inform the roles of TPACK in digital technology use among pre-service teachers. Before the process, TPACK components' interconnection was reported to examine TPACK's roles affecting digital technology use. TPACK was significantly affected by TPK that is significantly affected by PK. Similarly. Similarly, Pamuk et al. (2015) elaborated the different findings with TCK as the most significant predictor of TPACK. In addition, they reported PK strongly predicted TPK. Finally, digital technology use is only predicted by TPK; both TPACK and TCK are not significant predictor of digital technology use.

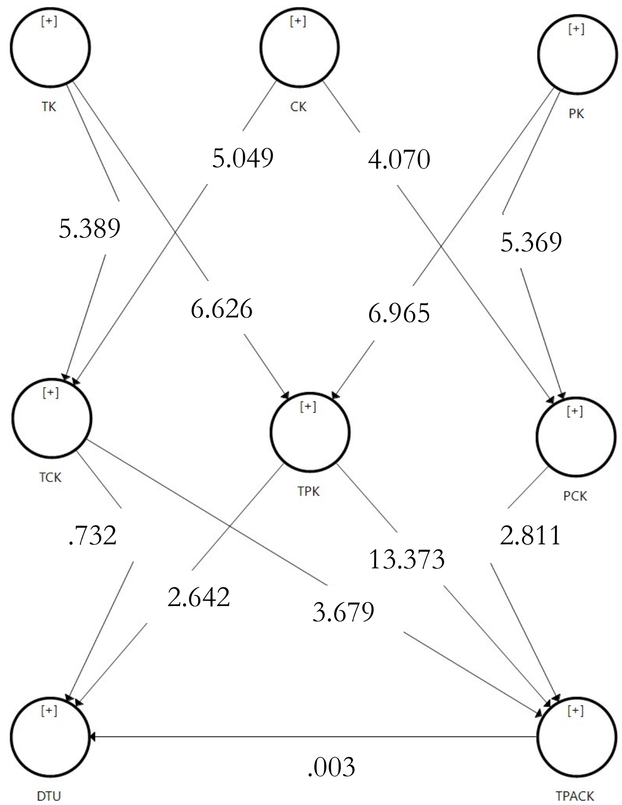

Figure 2. Final model; the t value

REFERENCES

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers and Education*, *52*(1), 154–168. https://doi.org/10.1016/j.compedu.2008.07.006

Chai, B. Y., Chai, C. S., Koh, J. H. L., Chua, M. J., Tan, B. T., & Looi, J. (2012). Facilitating development of design efficacy among singaporean in-service teachers through TPACK. *Workshop Proceedings of the 20th International Conference on Computers in Education, ICCE 2012*, 271–277.

Dong, Y., Chai, C. S., Sang, G. Y., Koh, J. H. L., & Tsai, C. C. (2015). Exploring the profiles and interplays of pre-service and in-service teachers' technological pedagogical content knowledge (TPACK) in China. *Educational Technology and Society*, *18*(1), 158–169. https://creativecommons.org/licenses/by-nc-nd/3.0/

Habibi, A., Yusop, F. D., & Razak, R. A. (2020). The role of TPACK in affecting pre-service language teachers' ICT integration during teaching practices: Indonesian context. *Education and Information Technologies*, *25*(3), 1929–1949. https://doi.org/10.1007/s10639-019-10040-2

Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing preservice teachers' intention to use technology: TPACK, teacher self-efficacy, and Technology Acceptance Model. *Educational Technology and Society*, *21*(3).

Koehler, M. J., Kereluki, K., & Mishra, P. (2011). On learning to subvert signs: technology and the TPACK framework. *The California Reader*, *44*(2), 12–18. http://punya.educ.msu.edu/publications/californiareader2010.pdf

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. In *Teachers College Record* (Vol. 108, Issue 6, pp. 1017–1054). https://doi.org/10.1111/j.1467-9620.2006.00684.x

Pamuk, S. (2015). TPACK AS A TECHNOLOGY INTEGRATION FRAMEWORK Understanding and Measurement of the TPACK Development Process. In *New Directions in Technological Pedagogical Content Knowledge Research: Multiple Perspectives*.

Scherer, R., Tondeur, J., & Siddiq, F. (2017). On the quest for validity: Testing the factor structure and measurement invariance of the technology-dimensions in the Technological, Pedagogical, and Content Knowledge (TPACK) model. *Computers and Education*, *112*, 1–17. https://doi.org/10.1016/j.compedu.2017.04.012

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (Track): The development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, *42*(2), 123–149. https://doi.org/10.1080/15391523.2009.10782544

Shulman, L. S. (1987). Shulman. 1987.Knowledge and teaching.pdf. In *Harvard Educational Review* (Vol. 57, Issue 1).