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Examining the Correlation among Technological Pedagogical and Content Knowledge (TPACK) subscales: A Study of Pre-service Teachers Training Program

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ABSTRACT
The study was intended to explore the correlation among different subscales of prospective teacher's Technological Pedagogical and Content Knowledge (TPACK). Six knowledge domains of the TPACK framework (TK, PK, CK, TPK, PCK, and TPK) were examined as latent variables in this study. B.Ed (Hons) Degree program in the Education Department of Karakoram International University was the targeted pre-service teachers training program. The sample was constituted of Eighty-five prospective educators who voluntarily contributed to the study. Schmidt et al.'s instrument was utilized for the collection of responses from the participants. The Pearson correlation with the two-tail test is applied to examine the findings. The result reported a positive correlation among all the six TPACK domains. The range of the Pearson correlation coefficient among the latent variables was from 0.174 (connecting TPACK and PK) to 0.547 (connecting PCKand CK). The results suggest that the validation of research instruments for measurement of teacher's TPACK knowledge in the context of Pakistan is a key need of the time.
Key Words: TPACK, Prospective Teachers, B.Ed (Hons)

Introduction

The influence of technology integration on teaching practices is changing in the resources, methods, content, and settings of teacher preparation programs (Zhang, Liu, & Cai, 2019). Modern teacher education degrees look for appropriate training and practices to progress teachers' capabilities in utilizing modern technologies into instructions (Muhaimin et al., 2019). It is mostly accepted that teaching with emerging, and new instructional technologies is a multifarious task. It is much more than just using IT equipment for teaching (Chang, Hsu, & Ciou, 2017). Technology integration into learning processes is an emerging trend. Teachers are struggling to employ technology effectively to upgrade the learning processes. Researchers are finding it difficult to apprehend the conception of technology incorporation in teaching and learning.

The emergence of the TPACK in 2006 offered a conceptual framework to investigate the instructor's knowledge with the interrelationship of content, pedagogy and technology (Lin, Tsai, Chai, & Lee, 2013). During the last decade, this framework has got wide attention from

the scholars of the developed world for the investigation of teacher's knowledge. Most of the TPACK literature comes from the context of China, the United States of America, Malaysia, Turkey and Australia (Bas & Senturk, 2018; Naaz & Khan, 2018).

The related literature reflects that the TPACK framework is popularly utilized for exploring instructor's skills in incorporating technology in the instruction process. This notion encourages teachers to gain technologically oriented knowledge and is used to investigate teachers' knowledge from multiple perspectives of technology, subject knowledge and pedagogy. The studies conducted in different contexts use not only diverse methods of investigations but also show diverse results about teachers' TPACK knowledge and skills. A huge research gap exists regarding the examination of prospective teachers' TPACK knowledge in Pakistan.

If we look at the teacher's training in Pakistan, the standardization of prospective teacher's training programs is not much old. A four years graduate degree program for pre-service teachers was initiated from Karakoram International University in 2008. Later this degree was properly launched from 15 public sector universities and 75 education colleges in 2009 (Ramzan, Iqbal, & Khan, 2013). It is the first teachers training program in the country where technological courses are integrated to support teacher's content and pedagogy. The technology incorporation in any prospective teacher's training scheme can be better viewed by the use of TPACK framework as TPACK is the most popular academic perspective to pursue technology incorporation in the learning process (Muhaimin et al., 2019). Hence a need arose to investigate the B.Ed (Hons) degree with the lens of the TPACK framework by examining the correlation among six different subscales of TPACK in the context of investigation prospective teachers training.

Literature Review

TPCK was presented in the area of teaching and learning as a theoretical model regarding investigating teacher' knowledge compulsory for active technology incorporation (Mishra and Koehler 2006). Teacher preparation programs started to progress technological-based curriculum for preparing teachers with the emergence of this theoretical framework for instructing with technology (Chai, Koh & Tsai, 2010; Jimoyiannis, 2010). The perfect investigation of TPACK is important for teachers' preparation programs (Young, Young, & Shaker, 2012). Numerous scholars utilized course designs and interventions to progress teachers' knowledge of TPACK (Bas & Senturk, 2018).

The TPACK model is regarded as a valuable framework for educators to consider the essential knowledge required for incorporating ICTs effectively in teaching and learning strategies (Naaz & Khan, 2018). The TPACK model offers a theoretical lens of unfolding whether an instructor can successfully conduct and design technology-based teaching (Mishra and Koehler 2006). TPACK is also possibly beneficial for appraising how teachers' training changes teachers' presentation in teaching with modern educational technologies (Lin, Tsai, Chai, & Lee, 2013). Only few researches have highlighted teachers' perspectives about the incorporation of technology from the perspective of TPACK (Zhang, Liu, & Cai, 2019).

Contemporary teacher training programs ought to offer a diverse range of innovative teaching methodologies for teachers (Martin, 2015). The design and environment of teacher training programs strongly influence the prospective trainer's understanding, perceptions, confidence level, consequently affecting their inclination towards utilizing contemporary ICTs in their instructions (Cacho, 2014; Gill and Dalgarno, 2008).

Most of the TPACK studies have concentrated on assessing the level of TPACK development of prospective teachers (Bas & Senturk, 2018). Somewhat recently, scholars widely implemented the TPACK framework to guide teacher preparation programs (Baran, Bilici, Sari, & Tondeur, 2019). In numerous studies, aspiring teachers have indicated that

technological usage requisite supplementary preparation and provision as they had no prior understanding and practice in employing ICT enhanced instructional practices (Baran, Bilici, Sari, & Tondeur, 2019)

TPACK model has been dynamically used since it was first presented in 2006 (Valtonen et al., 2017). Given the prominence of the TPACK model, a huge amount of quantitative researches have been dedicated to emerging numerous research tools to measure instructors' TPACK (Deng, Chai, So, Qian, & Chen, 2017). Educational researchers have lately been concerned with constructing valid and reliable instruments for evaluation of TPACK and its subscales (Schmidt, 2009; Martin, 2015).This could be due to the scarcity of prior conceptual frameworks of educational technology and teacher education as claimed by its developers (Koehler & Mishra, 2005; Makkawi, 2017).

The related literature reveals that numerous approaches, methods, and tools are accessible to explore the instructor's TPACK knowledge (Archambault, & Crippen, 2009; Mishra & Koehler, 2005; Young, Young, & Shaker, 2012). In literature interviews, self-report tools, and open-ended questionnaires are the frequently used techniques for measuring prospective teachers TPACK (Chai, Koh, & Tsai, 2013; Zhang, Liu, & Cai, 2019).

Building on a past of expanding survey methodology for evaluating teachers' levels of ICT integration, educational scholars have produced several survey tools that evaluate TPACK level of prospective (Baran, Chuang, & Thompson, 2011). The researchers aim to explore TPACK initiated with self-reported instruments for evaluating educators' level of TPACK (Schmidt, et al., 2009). scrutinization of three hundred and three TPACK based research studies indicated 141 TPACK measuring instruments (Koehler, Shin, and Mishra, 2012)

The TPACK literature is based on evaluating teacher's beliefs about the integration of ICTs in education (Gao, Choy, Wong, & Wu, 2009; Martin, 2015; Mayo, Kajs, & Tanguma, 2005). The development of the Schmidt et al. (2009) instrument is the major contribution in the field of TPACK for self-evaluation of TPACK and its subscales.

Many studies investigated the correlation among TPACK domains. Huang (2018) explored the TPACK knowledge of teachers and indicated strong associations among all the seven elements of TPACK. Koh & Sing (2011) showed that TPK and TCK have a substantial effect on TPACK perceptions of prospective instructors. Akman & Guven (2015) found a medium level of association linking CK and TK, a high level of association between TK and PK, weak association between CK and TPK, moderate level of association between TK and PCK.

Lehiste (2015) explored the significantly strong relationship among TPACK, TPK and TCK in the post-survey. Moreover, significant development of TCK and TPACK was found while there was limited development in CK and PK. Giannakos , et al., (2015) found a significant relation among sub-domains of TPACK with high scores.

Statement of the Problem

Traditional learning methods need to be advanced with the help of effective technology integration into instructional practices. The success of today's pre-service teacher training programs can gauge the effective instructions of future classrooms. In Pakistan, the teacher's training programs are striving to train the pre-service teachers for effective technology incorporation in their future classrooms. In this connection, many pre-service degrees are offered in higher educational institutes across the country. However, very little attention is given to examining the effectiveness of these degree programs in the light of the modern teacher education framework. In light of this, the current study is designed to explore the prospective teacher's knowledge by investigating the correlation among six major subscales of TPACK.

Objective

To explore the correlation among pre-service teachers' different domains of Technology Pedagogy and Content Knowledge (TPACK).

Research Question

Is there any significant association among the different prospective teacher's TPACK subscales?

Methodology

This quantitative investigation followed correlation analysis for reporting the relationship among different knowledge areas of TPACK. The six TPACK knowledge domains (TPACK, TK, PCK, CK, TPK, and PK) are considered latent variables, and five-point Likert scale statements were utilized to get the knowledge perception of teachers. using the SPSS package, the Pearson correlation with two-tail test is used to examine the findings.

Participants

The B.Ed (Hons) degree program of pre-service teachers training at Karakoram International University was the targeted program. The purposive sampling technique was applied to get a sample from 139 students enrolled in B.Ed (Hons) degree program. 85 teachers were part of the survey who completed one technological course, one TPK relevant course, 5 content courses, and five PCK related subjects.

Instrumentation

Schmidt et al. (2009) instrument was utilized to accumulate the survey data. The acquired instrument is exclusively designed for self-evaluation of prospective teachers, and it has been validated in different contexts (Fisser et al., 2015; Handal et al., 2013; Nordin, Faekah, & Ariffin, 2016; Chai, Koh, & Tsai, 2010; Valtonen et al., 2017). Pilot testing was also done on 16 % of the participants who fall in the criteria, and the piloted sample was excluded from the selection. The results of the pilot testing showed a low level of internal consistency for only one domain i.e., TCK whereas, an acceptable internal consistency was found for the remaining 6 TPACK knowledge domains. So, on the basis of pilot testing, the TCK domain was skipped from the questionnaire while all the six remaining domains of TPACK were included in the current study. Hofer & Harris (2012) also observed similar results; they specified that "most of the teachers TPACK experienced studies could not experience TCK". Valtonen, Leppänen, Hyypia, Sointu, Smits, & Tondeur (2020) also indicated that TCK is the most challenging area for pre-service teachers.

Data Collection and Analysis

The survey questionnaires were distributed in the hard copy among the participants and collected back with a 94 % response rate. The data was investigated through SPSS 28 software. The Likert Scale, comprising five intervals ranging from strongly agree to strongly disagree, were labeled from 1 to 5 respectively. The Pearson correlation with the two-tail test is applied to explore the results. The inter-correlation among latent variables was interpreted by using the general criteria suggested by Cohen (1988). That is correlation above 0.70 very strong, between 0.5 to 0.69 strong, between 0.30 to 0.49 medium, and between 0.10 to 0.29 very weak.

Research Ethics

The teachers were informed about the volunteer contribution and research purpose at the beginning of the questionnaire via consent statement. Participants' confidentiality was ensured throughout the research process. Approval was taken in writing from the chairperson of the Education Department of KIU prior to the collection of survey data.

Results

The current study examined the relationship among six subscales of TPACK with correlation analysis. The Six knowledge areas of TPACK are studied as imaginary variables for

exploring the correlations. The strength of correlation between the latent variables was measured by the Pearson correlation coefficient. The findings of the analysis are shown in Table 1. All six domains are statistically significant and positively correlated. The coefficient between latent variables varies from 0.174 (connecting TPACK & PK) to 0.547 (connecting PCK and CK).

Table 1.

Pearson Correlation among different knowledge domains

Latent Variables	TK	CK	PK	PCK	TPK	TPACK
TK	-					
CK	.500**	-				
PK	.326**	.542**	-			
PCK	.456**	.547**	.311**	-		
TPK	.197	.344**	.225*	.329**	-	
TPCK	.292**	.383**	.174	.279**	.297**	-

** Significant Correlation at the 0.01 level (2-tailed).
*Significant Correlation at the 0.05 level (2-tailed).

Technological Knowledge (TK) has a strong association with Content Knowledge (CK), $r(85)$=.50, p<.001. TK contains a moderate relationship with Pedagogical Knowledge (PK) $r(85)$=.32, p<.001. TK also has a moderate association with Pedagogical Content Knowledge (PCK) $r(85)$=.45, p<.001. TK has a very small relationship with TPACK $r(85)$=.19, p=.071. TK also has a very small association with TPK $r(85)$=.29, p=.007.

CK has a powerful association with PK and PCK (r=.54, p<.001). However, CK has a normal linkage with TPACK (r=.38, p<.001) and TPK (r=.34, p=.001).

PK has a medium association with PCK (r=.31, p=.004). However, PK has a very small correlation with TPACK(r=.17, p=.110) and TPK (r=.22, p=.038).

PCK has a medium association with TPK(r=.32, p=.002), while it has a very small correlation with TPACK(r=.27, p=.010).

TPK and TPACK have a small correlation with each other $r(85)$=.29, p=.006.

Discussion

Technology Pedagogy and Content Knowledge (TPACK) framework is an integrated model that exhibits the interrelationship of content technology and pedagogy for examination of teacher's knowledge required for effective adaptation of technology for their teaching practices. This research was designed to inspect the association among six TPACK subdomains of prospective teacher's knowledge. The findings of the current research show a statistically remarkable positive interconnection among six domains of TPACK. It is found that TPACK has a very small correlation with all the knowledge domains and a moderate correlation with CK. TPK has a very small correlation with TK and PK, a small correlation

with TPACK, and a moderate correlation with PCK and CK. In contrast to these results, Lehiste (2015) explored a significantly strong relationship between TPK and TPACK.

Furthermore, PCK has a large correlation with CK, a moderate correlation with TK, PK, and TPK, and a very small correlation with TPCK. PK has a large correlation with CK, moderate with TK and PCK, and very low with TPACK & TPK.

In contrast, Lin, Chai,Tsai, & Lee (2013) concluded that TPACK is extensively associated with all remaining knowledge domains.

Moreover, CK has a large correlation with TK, PK, and PCK; and a moderate correlation with TPK and TPCK. In contrast, Akman & Guven (2015) found low relation between CK and TPK.

Furthermore, TK has a large correlation with CK, moderate with PK and PCK, and a very small correlation with TPK and TPACK. In contrast, Akman & Guven (2015) reflected a medium association of TK with CK and PCK, high relation of TK with PK, and no relation of TK with TPCK. In contrast to the results of this research, Huang (2018) found a strong association between all the seven factors of TPACK.

Literature shows that implementing the TPACK framework into pre-service teacher's training results in developing technological-based effective teaching strategies. The literature also reflects that different subscales of TPACK are significantly correlated. So, pre-service teacher's training programs should concentrate on the appropriate implementation of the TPACK framework to better equip the 21st-century teachers for future classrooms.

Conclusion

The interrelation of content, technology and pedagogical knowledge is essential for incorporation of technology into instructional process. TPACK has been extensively used in literature to measure prospective teachers' knowledge, and many instruments are validated to evaluate TPACK proficiency. However, TPACK is the neglected field of study regarding prospective teachers in pakistan. The study examined the correlation among six domains of TPACK, and a positive association was found among six latent variables of TPACK. The Pearson correlation coefficient reflects strongest matches among latent variables ranging from 0.174 (linking PACK and PK) to 0.547 (allying PCK and CK).

Technological Content Knowledge (TCK) and TPACK are the most neglected subscales in terms of pre-service teachers training in Pakistan. In literature, the positive statistical correlation among different domains of TPACK subscales suggests that it is the need of the hour to give equal importance to all the knowledge domains of TPACK for effective teachers' training.

Recommendations

The context of the current study was a higher educational institute located in northern Pakistan. The targeted pre-service teacher’s preparation program was B.Ed (Hons). Replicating this study in different contexts and programs is significant for advancement in the field of ‘TPACK and teachers training’. It is suggested to construct and validate surveys for measuring TPACK knowledge of teachers within the Pakistani context. The available TPACK instruments should be validated in the context of Pakistan by applying Conformity and Exploratory Factor Analysis. Future studies should use Longitudinal and performance-based surveys for in-depth investigation of TPACK knowledge.

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