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TEACHER EDUCATORS' PERCEPTION OF TECHNOLOGICAL PEDAGOGICAL AND CONTENT KNOWLEDGE ON THEIR CLASSROOM TEACHING

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ABSTRACT

Students of present era, usually pronounced as "digital natives," enter schools with an expectation that they will be engaged in an information and communication technology (ICT) enriched learning experience under some ICT-expert teachers. To meet students' expectations, teachers strive to enhance their knowledge of modern technology and teaching techniques that demand integration of technology in classroom teaching. However, there is a consensus among all stakeholders, that also includes policymakers, that teachers (as well as teacher educators) in Pakistan are poorly prepared and thus cannot meet the expectations of the "digital natives." This study is based on the pedagogical content knowledge (PCK) and technological pedagogical content knowledge (TPACK) framework, which measures educators' knowledge of effective teaching with technology. The model attempts to describe the type of effective teaching knowledge required by educators to implement technology integration in learning environments. By adopting a quantitative approach, the study analyzed the impact of teacher educators' knowledge of three elements of TPACK, that include, technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK) on their classroom teaching. Using the survey method and two adopted questionnaires, data from all the teacher education institutes of public and private sector in Sindh, Pakistan were gathered. A total of 410 valid cases were used to analyze data through the SPSS and the

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Smart PLS. The findings of the study reveal that all three elements of TPACK have a significant positive impact on teacher educators' classroom teaching, this shows that it enhances students' achievement and the quality of education. The study recommends that administrators, policymakers and educational stakeholder, align teacher educators' continuing professional learning and development (CPLD) plans and curriculum of prospective teacher educators (pre-service teachers) with the specific factors that are known to improve a teacher's TPACK.

***Keywords**: Teacher Educators, Technological Pedagogical Content Knowledge and Classroom Teaching.*

INTRODUCTION

Technological advances require an entirely different workforce and countries must rapidly adapt themselves to these contests, otherwise, they will be left behind in the comprehensive competition. Pakistan faces challenge in addressing the basic issues of education access and suggestively improving the excellence of education to compete in the global arena (National Education Policy Framework [NEPF], 2018). There is consent amongst all stakeholders, including educationists and policymakers that the competence level of teachers in Pakistan is substandard. All education policies of Pakistan have proven that the quality of teachers prepared through different modes remains questionable. A large number of less qualified and professionally unqualified teachers are in the workforce of all the provinces of Pakistan and this pool is increasing constantly (National Education Policy [NEP], 2017). Numerous studies conducted during the last decades have jagged out the key concerns of the teacher education in Pakistan. The literature has cited a diversity of features and generally recognized that the quality of teachers in Pakistan is extremely truncated due to inappropriate professional development. (NPSTs, 2009). Socio-economic growth of a country is based upon the masses and quality of its human resource. The mechanism of providing this basic element for viable development of the society is either elevated or suppressed with the efficiency of its education system in which teacher is a universally predictable key factor. Teacher educators in most of the teacher education institutions in Sindh, mainly in the affiliated colleges and universities that are having insufficient professionally qualified teachers in their respective field (Mishra & Koehler, 2006), are at risk (NEP, 2017).

The National Education Policy 2009 ascertains the quality of teachers and acknowledges its importance as it is among the six basic pillars of overall quality of education, hence considers it the top primacy. Teacher education is a first and most important component for enlightening school effectiveness and student achievement (NEP, 2009). This is a technological modern globe where education reforms are necessary to improve teacher education programs and enhance teachers' knowledge and skills. Teacher education institutes in Pakistan, however are struggling to improve their programs as they have been facing innumerable challenges and lack of quality and professionally qualified teachers is one of them. In Sindh, many teacher educational institutes are engaged in preparing teachers at all levels. In Pakistan, like many other countries, teacher education institutions are the leading foundations for preparing teachers by their teachers' professional development courses. Qazi, Rawat and Thomas (2012) quoted Darling-Hammond who claimed that well prepared and qualified teachers generally perform better. Qazi et al. (2012) additionally established that Pakistani teacher education institutes do not meet the global standards and thus suggested preparing potential teachers for the certainties of classroom situations. The Government of Pakistan has been promoting the practice of teaching and learning through technologies in the schools, but technologies are not effectively used by the teachers in their classrooms (NEP, 2009). The strategic vision, as defined in the National Education Policy 2009, Pakistan identifies the need of teacher professional development in pedagogical aspects, communication, information and computer technology (ICT) skills at all levels (Munir & Khan, 2015). Zamir and Thomas (2019) recommended that teacher professional development in ICT needs instant attention for the development of teachers' competencies and confidence to integrate technologies in their teaching.

The moving objectives for learning, tied with changes in educational program noticeable quality and a more profound comprehension of educators' learning and thinking, have prompted new results about the effect of educators proficient advancement and how best to hone their aptitudes and information. What is important the most is that educators learn? Educators' professional advancement improves educators' information on instructing in the zone of content, teaching method and technological knowledge and at last it upgrades their teaching practices. Technology integration in education develops most important phenomenon in this new arena and this demands teachers to equip with the technological knowledge for their better teaching practices in the classrooms. Technology integration in classroom teaching enables teachers to meet the expectations of students who are already much capable with digital devices (Prensky, 2001). In instructional planning, technology plays a vital role to engage learners in the learning process (Günüç & Kuzu, 2014). Technology integration is an important model of teaching effectively in the classrooms. Many researchers have been motivated to explore different features of such technology integration (Anderson & Maninger, 2007; Wood & Ashfield, 2008). Technology integration allows learners to learn more in less time and allows schools to emphasize on universal learning atmospheres. Moreover, it could be an effective teaching tool when the requirement is to involve all students in the learning process. The use of technology advocates that the introduction of digital technologies into classrooms unlocks new avenues not only for curriculum development and improvements but also for school improvements (Halverson & Collins, 2009).

Teachers are striving to equip themselves with technological understanding and skills to improve their students' learning for academic achievement. Where in recent time, researchers have focused on the integration of technology in normal classrooms, there a need for more research studies with a focus on the effective classroom teaching in teacher education institutes is seen as important (Minshew & Anderson, 2015). For better understanding of how to support teacher educators in their implementation of technology, their knowledge of technology, pedagogy, and content must be implicit, as well as their methods and perceived barriers to technology integration must be understood. For effective teaching and learning, there must be an integration of technology. However, effective and proficient integration of technology cannot be achieved unless the teachers begin to change their approaches positively towards the use of technology in their daily educational activities (Chukwuemeka & Iscioglu, 2016).

Programs of teacher education are allied to the improvement of teacher's competency that would qualify the teachers to encounter the necessities of their profession (Abanobi & Abanobi, 2017). Though, instructional technologies have placed a demand on the necessity for technical knowledge, Abanobi and Abanobi (2017) stresses the prerequisite for pre-service teacher development to be adaptable to the various technological changes in teaching and learning. The teachers' role is producing the conducive environment for the students to learn. Teaching practices ought not to be executed through the routine strategies alone but instead educators should know about the capability of technologies to assist them with encouraging viably in the teaching. Classroom teaching is an unpredictable action that requires connecting various specific information. Koehler and Mishra (2009) perceived that educators practice their specialty in profoundly mind boggling, dynamic classroom settings that require them to change continually and advance their comprehension. Likewise, information from various spaces including information of learner's reasoning and learning, information on topic, and information on the utilization of instructing and learning are fundamental. The TPACK is a powerful tool of technology integration for classroom teaching (Koh et al., 2010; Koehler & Mishra, 2006). Educators' need to blend their study with technology for the higher achievement of students (Mishra & Koehler, 2006). Therefore, educators' should implement TPACK in their classrooms because it gives the huge establishment to technology integration, instructional methods and content information in teaching.

LITERATURE REVIEW

Technological Pedagogical and Content Knowledge (TPACK) was introduced for thought of educators' knowledge imperative for real integration of technology (Mishra & Koehler, 2006) which comprises of three overlying spaces of information including, Technological Knowledge, Pedagogical Knowledge and Content Knowledge. The idea of TPACK (Mishra & Koehler, 2006) is an extended work of Shulman's (1986) who gave a thought of (PCK). In his effort to express the information required by educators, Shulman recommended that educators' not just need to have content knowledge (CK) and general pedagogical knowledge (PK) about the methods of teaching and classroom management but they also need to possess an exceptional form of knowledge so that they can present content in a better way to their students. This form of knowledge, which is a blend of CK and PK and possibly other forms of knowledge such as the psychology of learners and so on, is known as PCK. With the development and proliferation of personal computers since the 1980s, it is clear now that teaching should be transformed by the ever more advanced (ICT). The lack of an inclusive theoretical framework to guide the formation of new practices associated with the integration of ICT is one of the key concerns that has been identified (Mishra & Koehler, 2006). The insertion of technological knowledge (TK) transformed the original framework, and the new TPACK framework is possibly more comprehensive and influential in explaining what should be done in today's classrooms. Table 1 designates the domains of TPACK.

Table 1: Components of the TPACK Model

TPACK components	**Definitions**
Technology knowledge (TK):	It refers to "the knowledge about numerous technologies extending from standard technologies like: pencil, paper to progressive technologies such as Internet, interactive whiteboards" (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009).
Content knowledge (CK):	It refers to the "teachers' knowledge of subject matter which means the knowledge of concrete subject matter that is to be learnt or taught (Mishra and Koehler, 2009, p. 397).
Pedagogical knowledge ():	It refers to "teachers' deep knowledge of the procedures and practices or methods of teaching and learning" (Koehler & Mishra, 2009, p. 64).
Pedagogical content knowledge (PCK):	It is "the knowledge of the teaching process" (Shulman, 1986). It is blended with teachers' knowledge and teaching skills.
Technological content knowledge (TCK):	It highlights that "how technology can produce new illustrations for specific content" (Koehler & Mishra, 2009, p. 125).
Technological pedagogical knowledge (TPK):	It describes "the ways technology can effect on the learning and teaching practices that are implemented during classroom instruction" (Koehler & Mishra, 2009).
Technological pedagogical content knowledge (TPACK):	It refers to "the knowledge, which is taught with good pedagogy by using appropriate technological tools" (Koehler & Mishra, 2006.

Adapted from: www.tpack.org

Educators have an instinctual comprehension of the mind perplexing interaction among the three fundamental parts of knowledge (CK, PK and TK) by encouraging teaching utilizing appropriate academic techniques and advanced technologies. Various researches add to the collection of information contiguous teaching and technologies mix impacts. Wang, Hsu, Campbell, Coster, and Longhurst (2014) examined technologies in schools by utilizing a blended techniques approach that included surveys, focus groups and observations of the teachers teaching practices. The nature of an educator's abilities is a basic factor that influences learners' outcomes (Magidin de Kramer, Masters, O'Dwyer, Dash, & Russell, 2012). Additionally, research has shown that teachers frequently require an impulsion from the school system to take on new technological skills (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). Kirikcilar and Yildiz (2018) studied teachers' TPACK and found that while all three types of knowledge were used to construct learning activities for students, teachers resisted most with integrating pedagogy and technology. Thus it is a prerequisite for teachers to grow in their understanding of how the knowledge of subject matter and the knowledge of technology interact. This includes understanding when and how technology will enhance the learning concepts. As the teacher's TPACK is established, the practices in the classrooms will more likely reflect the knowledge of the teacher.

Teacher Educator's Technological Knowledge and Classroom Teaching

The technological knowledge (TK) means knowledge of technologies which range from standard technologies such as pencil, paper to more innovative technologies and digital devices (Schmidt, et al., 2009a). Additionally, it includes the skills which require operational technologies, knowledge of how to install and remove additional devices and software programs (Mishra & Koehler, 2006). Cox (2008) described that TK is the capability of using computer technology, operating programs and hardware, and generating the anticipated results, but the ability of learning and adjusting new technologies into classroom teaching matters. Empirical studies on TPACK have primarily concentrated on technological knowledge. A study by Koh, Chai, and Tsai (2010) expressed that TK's effect was moderate to high on teachers' classroom teaching in Singapore. The results additionally indicated that technology courses that straight forwardly instructed technology apparatuses alongside instructional method, raised teachers' technological and pedagogical knowledge with moderate to high impact sizes. Technology integration into classrooms is resulted from the recommendations of many scholars (Hussain, Nawaz, Zaman, Dahar & Akhtar, 2010). The use of technology in the classrooms assists students' learning and it inspires students to participate in learning process. Lee, Tsai, Chai and Koh (2014) found that teachers who are reinforced by an educational technology established higher levels of TPACK in contrast to teachers who were not. Corry and Stella (2018) and

Cubeles and Riu (2018) claimed that experienced teachers while using technology had higher measures of self-efficacy during their classroom teaching. Thus the literature encouraged to postulate the following hypothesis (H_1).

H_1: Teacher educators' technological knowledge has a significant positive impact on their classroom teaching.

Teacher Educator's Content and Pedagogical Knowledge and Classroom Teaching

Pedagogical knowledge (PK) involves the procedures, processes, practices, strategies, and methods of teaching and learning (Koehler & Mishra, 2009). Educational goals and values, general classroom management skills, lesson planning, teaching and assessment strategies, and methods are included in this knowledge (Koehler & Mishra, 2009). Maor (2017) investigated two courses in Australia using merged learning for instructors. He discovered the effect of TPACK on digital pedagogies. Results stated that development in each domain of TPACK leading to in classroom teaching practices. Numerous studies specified that technology could offer teachers with facilities for online communication, feedback, and learning collaboration. Technology can help teachers to make them convenient, search abundant teaching materials on the internet, manage the virtual assessment, and allow them to monitor students having autonomous learning. Moreover, the use of technology in pedagogy has been revealed successfully to initiate students' learning motivation and grasp longer thoughtfulness (Hilton, 2016). Mouza et al. (2014) observed the first and second component jointly in a study. They stated that when the technology course is integrated with other skills and courses, pre-service teachers get benefits of putting on learning straight into teaching with technology. Hofer and Grandgenett (2012) studied teaching programs of teachers, results specified development in teachers TPACK during the program, but the major improvements occurred when pre-service teachers were simultaneously enrolled in the educational technology course, where they discoursed, instructional planning and technology integration.

Shulman (1986) indicated that content knowledge is positioned in the minds of teachers, and in the content knowledge, teachers should not only enlighten the truths of the fields, but they should also illuminate why the truths are required and worthy to know. Conferring to Jaikaran-doe and Doe (2017), CK covers knowledge of the subject area. Voithofer and

Cheng (2019) found that primary and secondary teachers establish that content knowledge of a subject has a significant effect on teaching. Harris and Hofer (2011) utilized content teaching method showing strategy for the advancement of instructors TPACK Participants arranged a unit by fusing an assortment of learning exercises into the content and pedagogical knowledge, participants distinguished that expansion specific exercises and technologies allowed them viably in their classroom teaching. The literature concerning the effect of the effect of content and pedagogical knowledge supported in postulating the following hypotheses (H_2 and H_3).

H_2: Teacher educators' pedagogical knowledge has a significant positive impact on their classroom teaching.

H_3: Teacher educators' content knowledge has a significant positive impact on their classroom teaching

CONCEPTUAL FRAMEWORK

The following conceptual framework for the current study was developed with the help of literature review.

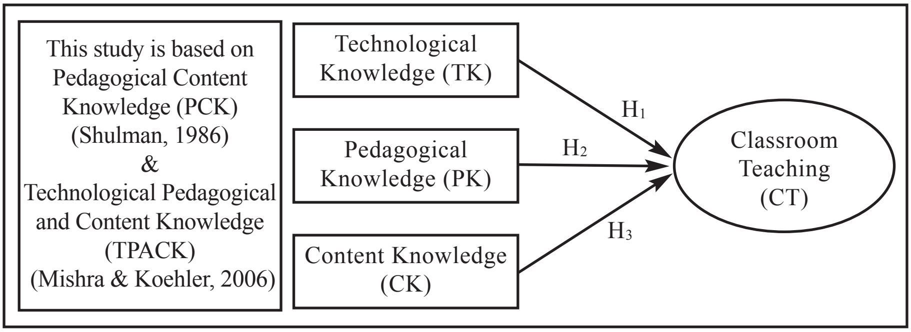

Figure 1. Conceptual Framework of the Study

The TPACK is a basic knowledge framework for effective combination of technology into the teaching process. (Figure 1) shows that teacher educators' technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK) are independent variables and classroom teaching (CT) is a dependent variable. They illustrate that TK, PK and CK effects on teacher educators' CT which supported in postulating three hypotheses namely, H_1, H_2 and H_3.

METHODOLOGY

This study employed quantitative (Creswell, 2014) approach to find out the impact of teacher educators' Technological Pedagogical and Content Knowledge (TPACK) on their classroom teaching.

Sample and data collection

The survey method was used to collect data for the current research. All the teacher educators of public and private sector teacher educational institutes were selected as the sample. Literature such as (Schmidt et al., 2009; Mishra & Koehler, 2006; Maor, 2017) provisions the selection of teacher educators as respondents for the study in the context of teacher educators' professional knowledge and their effective classroom teaching. Therefore, 450 survey questionnaires were circulated among the 43 public and private sector teacher education institutes. Altogether 423 questionnaires were collected which indicate that the response rate was 94 percent, but 13 questionnaires were rejected because they had incomplete responses. A total of 410 valid cases were used for data analysis.

Survey instrument and Procedure

Two questionnaires, including Survey of Pre-service Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009) and Self-assessment instrument for Teacher Evaluation scale (SITE) (Akram & Zepeda, 2015) were used to gather data for the present study. Every scale was determined through a 5 point Likert scale in which 1 determined strongly disagreed and 5 strongly agreed responses. In the study three TPACK constructs were used as independent variable that included: (1) Teacher educators' technological knowledge (TK) = 05 items; (2) Teacher educators' pedagogical knowledge (PK) = 07 items; (3) Teacher educators' content knowledge (CK) = 06 items and one contract from SITE, including, Teacher educators' classroom teaching (CT) that comprised two sub-constructs: (1) Teacher educators' instructional planning skills (IPS) = 05 items; and (2) Teacher educators' assessment skills (AS) = 04 items (See Appendix A). Concerning ethical issues, the lead researcher informed the participants about the realization of multiple and consent rules, secrecy, volunteer participation and confidentiality. The formal consent was obtained from the participants. Prior permission was obtained to use both the research instruments. The data were analyzed through (SPSS) version. 22.0, and Smart PLS version 3. Smart PLS (Ringle, Wende, & Becker, 2015) was used to confirm the validity and reliability and hypothesis.

Respondents' Profile

Table 2 reports the demographic details of the participants of the current study. It shows that 52 percent female and 48 percent male teacher educators participated in this study out of which 78 percent were from the public sector and 22 percent were from the private sector. Majority of the respondents were belonged to the age group of 36 to 45 years and 72 percent were married and 28 percent were unmarried. All the respondents of this study possessed Master's degree, 97 percent having professional degree and majority of them having more than 6 years' work experience as a teacher educator (Lecturer, Assistant Professor, Associate Professor and Professor). Demographic information also revealed that among the 410 respondents 118 had completed MS/M.Phil. degrees and 34 had earned PhD degrees.

Table 2: Demographic Information of the Respondents

Demographic variables (n= 410)		**Frequency (f)**	**Percentage (%)**
Gender	Female	214	52.2
	Male	196	47.8
	Total	410	100.0
Marital status	Married	297	72.4
	Unmarried	113	27.6
	Total	410	100.0
Age	25-35years	138	33.7
	36-45years	165	40.2
	46-55years	81	19.8
	Above than 55years	26	6.3
	Total	410	100.0
Experience	1-5years	81	19.8
	6-10years	125	30.5
	11-15years	90	22.0
	16-20years	64	15.6
	More than 20years	50	12.2
	Total	410	100.0
Institution	Public	319	77.8
	Private	91	22.2
	Total	410	100.0
Academic Qualification	Masters	253	61.7
	MS/M.Phil	118	28.8
	PhD	34	8.3
	Others	5	1.2
	Total	410	100.0
Professional Qualification	B.Ed	104	25.4
	M.Ed	295	72.0
	Others	11	2.7
	Total	410	100.0

DATA ANALYSIS AND RESULT

In the present study four constructs TK, PK, CK and CT with their 36 overall items were analyzed. As recommended by (Hair, Ringle & Sarstedt, 2013) the items with loadings above than 0.70 are acceptable, however the items with loadings between 0.40 and 0.70 can be retained on the basis of their acceptable validity and reliability. However, values below 0.40 will be removed. Thus TK=1, CK=6 and CT=2 items with loadings below the 0.70 were removed and all other items with their acceptable loadings value above than 0.70 were considered for further analysis (See Table 3).

The Measurement Model

To confirm adequate construct validity and reliability of the measurement model, the researchers assessed content validity, convergent validity and discriminant validity. The content validity of the present research was valid as factor loadings shown in Table 3 were greater than 0.7 (Hair, Hult, Ringle, & Sarstedt, 2013). Hair, Risher, Sarstedt and Ringle (2018) stated that Cronbach's alpha is the lower bound whereas the composite reliability (CR) is the upper bound for the internal consistency reliability of the research model. Table 4 indicates that the values of Cronbach's alpha are above the threshold value (minimum = 0.7) and the values of CR are above 0.7 but below 0.95. Thus where internal consistency is established there indicator redundancy is not present. Two measures in the current study confirmed that the group of items converged to measure the same concept or construct (Hair, Hult, Ringle, & Sarstedt 2013). Initially, as indicated in Table 3, all factors loadings were above 0.7, and later Table 4 indicates that the average variance extracted (AVE) was greater than 0.05 (Hair, Rishe, Sarsted, & Ringle (2018). To authenticate that a set of items can extricate a variable from other variables, three results were analyzed. Firstly, as indicated in Table 3, all items strongly loaded against their respective construct when compared with cross loadings, secondly, as indicated in Table 5, all diagonal bold values of the constructs, which are square roots of their respective AVE values, are greater than the values present in their respective rows and columns (Fornell & Larcker, 1981), and thirdly, as highlighted in Table 6, all the values for Heterotrait-Monotrait (HTMT) ratios are < 0.85 which depicts that the constructs in the current research discriminate from each other (Hair, Rishe, Sarsted, & Ringle (2018).

Table 3: Loadings and Cross Loadings

Construct items	CK	CT	PK	TK
Ck4	**0.719**	0.236	0.285	0.212
Ck5	**0.757**	0.322	0.292	0.277
Ck6	**0.752**	0.277	0.285	0.283
Ck10	**0.742**	0.247	0.354	0.267
Ck11	**0.776**	0.316	0.352	0.265
Ck12	**0.730**	0.255	0.389	0.294
CT_AS1	0.244	**0.735**	0.365	0.198
CT_AS2	0.243	**0.748**	0.386	0.206
CT_AS3	0.243	**0.737**	0.337	0.225
CT_AS4	0.285	**0.722**	0.359	0.287
CT_IPS1	0.272	**0.736**	0.401	0.223
CT_IPS2	0.302	**0.736**	0.404	0.189
CT_IPS3	0.280	**0.729**	0.387	0.282
CT_IPS5	0.297	**0.772**	0.439	0.184
CT_IPS6	0.302	**0.716**	0.371	0.263
Pk1	0.276	0.420	**0.722**	0.228
Pk2	0.327	0.325	**0.754**	0.240
Pk3	0.356	0.395	**0.803**	0.315
Pk4	0.326	0.389	**0.835**	0.253
Pk5	0.359	0.414	**0.778**	0.306
Pk6	0.337	0.419	**0.719**	0.254
Pk7	0.368	0.437	**0.794**	0.248
Tk2	0.214	0.250	0.235	**0.745**
Tk3	0.327	0.269	0.315	**0.821**
Tk4	0.275	0.267	0.294	**0.851**
Tk5	0.359	0.250	0.249	**0.823**
Tk6	0.227	0.169	0.258	**0.703**

Notes: TK= Technological Knowledge, PK=Pedagogical Knowledge, CK= Content Knowledge & CT= Classroom Teaching.

Table 4: Convergent Validity

Constructs	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Teacher Educators' Technological Knowledge (TK)	0.85	0.892	0.625
Teacher Educators' Pedagogical Knowledge (PK)	0.887	0.912	0.598
Teacher Educators' Content Knowledge (CK)	0.841	0.883	0.557
Teacher Educators' Classroom Teaching (CT)	0.895	0.915	0.543

Table 5: Correlations of Discriminant Validity (Fornell-Larcker Criterion)

Constructs	CK	CT	PK	TK
CK	**0.746**			
CT	0.374	**0.737**		
PK	0.435	0.522	**0.773**	
TK	0.358	0.310	0.342	**0.790**

Notes: TK= Technological Knowledge, PK=Pedagogical Knowledge, CK= Content Knowledge & CT= Classroom Teaching.

Table 6: Heterotrait-Monotrait Ratio (HTMT)

	CK	CT	PK	TK
CK				
CT	0.424			
PK	0.505	0.579		
TK	0.419	0.350	0.393	

Notes: TK= Technological Knowledge, PK=Pedagogical Knowledge, CK= Content Knowledge & CT= Classroom Teaching.

The Structural Model and Hypotheses Testing

After confirming the construct validity and reliability, suggested hypotheses of the study were tested through Partial Least Squares- Structural Equation Modeling (PLS-SEM) in Smart PLS (Ringle et al., 2015). The PLS-SEM approach provides better estimates over other covariance-based methods (Hair et al., 2013). Table 7 directs that all three elements of TPACK, namely, technological knowledge (TK) ($t = 2.186$, $p = 0.029$), pedagogical knowledge (PK) ($t = 7.801$, $p < 0.001$) and content knowledge (CK) ($t = 3.393$, $p < 0.001$) have significant positive effect on teacher educators' classroom teaching (CT). Thus the outcomes of the current research support all three hypotheses, that is, H_1, H_2 and H_3 (Refer to Table 7).

Table 7: Hypothesis Testing

No	Constructs	Original Sample (O)	Sample Mean (M)	Standard Deviation	T-Statistics	P-Values	f^2	Decision
H_1	TK -> CT	0.113	0.116	0.052	2.185	0.029	0.015	Supported
H_2	PK -> CT	0.417	0.415	0.053	7.801	0.000	0.194	Supported
H_3	CK -> CT	0.151	0.156	0.045	3.393	0.001	0.025	Supported

Notes: TK= Technological Knowledge, PK=Pedagogical Knowledge, CK= Content Knowledge & CT= Classroom Teaching.

Predictive Relevance of the Model

The predictive relevance of the different domains in the structural model was analyzed through R square (Hair et al., 2013) and Stone-

Geisser's Cross-Validated Redundancy (Q-square) (Geisser, 1974). Table 8 specifies that 30 percent (R-Square = 0.309) of classroom teaching is explained by the three constructs of TPACK, namely, TK, PK and CK which is larger than the threshold value (R-square = 0.10) recommended by Falk and Miller (1992). Besides, during the blindfolding method in Smart PLS, the value of Q-square was 0.163 which is > 0 (Geisser, 1974) hence, it reveals that the predictive relevance, though small (Hair, Risher, Sarstedt & Ringle, 2018), of the PLS-path model was established. Cohen (1988) claims that 0.02, 0.15 and 0.35 are three threshold three values of effect size (f^2) that represent small, medium and large effect size respectively. Table 7 presents effect size (f^2) of three predictors of teacher educators' classroom teaching. The values of effect size reveal that teacher educators' pedagogical knowledge has a medium effect (f^2 = 0.194), their content knowledge has a small effect (f^2 = 0.025) and technological knowledge has negligible effect (f^2 = 0.194) on their classroom teaching.

Table 8: Predictive relevance of the construct

	R Square	Q Square
CT	0.309	0.163

CT = Classroom Teaching

DISCUSSION

The present study has shown that three variables of TPACK namely, teacher educators' technological knowledge (TK), teacher educators' pedagogical knowledge (PK) and teacher educators' content knowledge (CK) have a significant and positive effect on their classroom teaching. All three hypotheses tested (H_1, H_2 & H_3) through the Smart PLS were supported which revealed that (1) teacher educators' technological knowledge has a significant positive impact on their classroom teaching; (2) teacher educators' pedagogical knowledge has a significant positive impact on their classroom teaching; and (3) teacher educators' content knowledge has a significant positive impact on their classroom teaching. The findings of this study are in accordance with numerous studies conducted in different parts of the world in a variety of contexts. Similar to the current research, the previous studies (Mishra & Koehler, 2006; Koehler & Mishra, 2009; Schmidt et al., 2009; Bruce & Chiu, 2015; Harris & Hofer, 2017; Kirikcilar & Yildiz, 2018; Patria, 2019; Hill & Uribe-Florez, 2019) revealed that technological knowledge, pedagogical knowledge and content knowledge highly impact on teachers' classroom teaching. However, none of these studies focused on the impact of technological, pedagogical and content knowledge on the classroom teaching of teacher educators' in Sindh Pakistan, so the present study has made a significant contribution by filling this gap in the literature as well. The t-statistics shown in Table 7 reveal that among the three predators, teacher educators' pedagogical knowledge has the highest significant positive effect (t = 7.801, p = .001) while their technological knowledge has the least significant positive effect (t = 2.185, p = .029) and their content knowledge has the medium significant positive effect (t = 3.393, p = .001) on teacher educators' teaching skills. However, the values of effect size shown in Table 7 reveal that out of three predictors, pedagogical knowledge has a significant positive yet a medium level effect (f^2 = 0.194), content knowledge has a significant but small effect (f^2 = 0.025) and technological knowledge has a negligible or no effect on teacher educators' classroom teaching (f^2 = 0.015). This encourages inferring that teacher educators in Sindh rely heavily on their content and pedagogical knowledge and they are unable to establish a connection between their technological knowledge and their classroom teaching. This result is consistent with Kirikcilar and Yildiz (2018) who found that found that while all three types of knowledge were used to construct learning activities for students, teachers resisted most with integrating pedagogy and technology. Zameer and Thomas (2019) found that the use of technology by teachers was associated with some external factors, including availability of equipment and supportive environment as well as applicability and relevance of the technology. They also found that the use of technology was associated with teachers' attitude toward technology and their computer competence. The Table 2 indicates that the majority of respondents of the current research were from public sector institutes (77.8 %). When contrasted with private sector teacher education institutes, the public sector teacher education institutes in Sindh lack technological facilities and thus teacher educators in public sector do not find the classroom environment conducive for teaching through technology. Most of the respondents of the current study were highly qualified (PhD = 8.3%, MS/MPhil = 28.8%, Master = 61.7%), majority of them were professionally qualified (MEd = 72%, BE = 25.4%) and most of them had more than five (5) years of experience (80.3%). These demographic characteristics of respondents encourage them to rely heavily on their experience as well as content and pedagogical knowledge and ignore technological knowledge. They find pedagogical knowledge irrelevant to teach the course content. On the contrary, Cubeles and Riu (2018) claimed that experienced teachers while using technology had higher measures of self-efficacy during their classroom teaching. This implies that if academically and professionally qualified experienced teachers educators of Sindh are provided with professional development opportunities to enhance their TPACK, their classroom teaching will be improved significantly and they will develop a high level of self-efficacy.

Implications of the research

This research has implications in many folds. Firstly, as the current study shows that TPACK has a significant impact on Teacher educators' classroom teaching, all teacher education institutes need to adopt and include TPACK in their teaching practices. Secondly, all the teacher educators need to be providing professional knowledge enhancement resources to help them teaching through technology integration. Thirdly, the findings of this study encourage inferring that administrators, policymakers and educational stakeholders can tailor individual development plans for teachers on explicit factors that are known to improve a teacher educators' TPACK. The administrators' role in implementing individual plans is to monitor and evaluate whether or not teacher educators acquiring necessary knowledge for teaching and technology integration and using technology effectively in their classroom practices. Finally, teacher education programs must not teach courses in isolation and should not teach technology as an *add-on* course rather integrate content, pedagogy and technology driven courses as proposed by Koehler and Mishra (2009). Teaching with technology has the potential to improve teacher educators' classroom teaching and classroom teaching in general therefore teacher education programs are recommended to introduce TPACK in their curriculum for prospective teachers and potential teacher educators.

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