THE ASSOCIATIONS BETWEEN LEARNING-TEACHING CONCEPTIONS AND TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE: A STRUCTURAL EQUATION MODELING STUDY

Abstract: Competency in technological pedagogical content knowledge is one of the fundamental standards to become a qualified teacher in 21. century. Teachers are expected to have TPACK with technology integration efficacies in their classroom. This research aims to explain the roles of TPACK and its components on behaviorist and constructivist learning – teaching conceptions. Designed as an explanatory research the current study employs hypotheses explaining cause – result connections amongst independent variables (knowledge of technology, knowledge of pedagogy and content knowledge), mediators (technological content knowledge, pedagogical content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge) and dependents (behaviorist and constructivist teacher conceptions). One of the structural equation modeling applications benefits from path analysis to uncover these associations. Mediation effects between them are tested through the Sobel tests and bias-corrected bootstrapping confidence interval. The path analyses point out that behaviorist teacher conception is just affected by technology knowledge. They show also that technology and pedagogy knowledge have indirect effects on constructivist teacher conceptions via technological content, pedagogical content, technological pedagogical knowledge, and TPACK. It is found that content knowledge is an agent directly affecting constructivist teacher conceptions. It is suggested that teachers should take part in workshops, projects etc. on TPACK or technology integration.

Keywords: TPACK, learning and teaching, technology integration, constructivist instruction, SEM.

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INTRODUCTION

Teaching new skills for students has changed teachers' roles from behaviourist theory to constructivist one in the 21st century. They also differ in missions, educational goals, learning – teaching understandings. On the one hand, in behaviourist theory, teachers transmit the content for students and ask them to memorize it through teacher-centered teaching strategies (Cleaver, 1975). Behaviourist teachers tend to prefer direct instruction as a teaching method. They always use basic technologies (e.g. PowerPoint) related to it in their classroom (Howard et al., 2000). On the other hand, in constructivist theory, teachers are expected to help them learn 21st century skills (e.g., problem-solving, critical thinking, decision-making) via student-centered strategies (Klieme & Clausen, 1999; Hoagland, 2000). Hasweh (1996) found that constructivist teachers help students more elaborate their ideas and concepts than behaviourists do. Constructivist teachers seek technologies (e.g. simulations, hypermedia with forums) that can engage students in problem-solving, conceptual understanding, critical thinking, and discussion outcomes (Entwistle, Skinner, Entwistle & Orr, 2000). For example, in case of hypermedia, it allows to understand the complexity of teaching, provide constructivist teaching methods and facilitate classroom discussions (Hughes, Packard & Pearson, 2000). Lampert, Heaton & Ball (1994) found that behaviourist approaches to teaching student teachers about constructivist approaches to mathematics instruction are effective in changing teachers' beliefs. Hypermedia environment by Lampert Heaton & Ball (1994) provided with several materials student teachers to experience real time math teaching apart from presenting them with behaviourist methods.

As been understood from the discussion above, Web-based applications like hypermedia are closely intertwined with constructivist pedagogical approaches. Concerning the role of novel technologies on knowledge acquisition, Tomei (2005) stated that teachers, educational institutions, and other stakeholders should reshape pedagogical and instructional approaches in addition to in-class resources to minimize the gap between contemporary instructional and learning methods and explicit instruction methods. He also expressed that the constructive process necessitates integrating technology into pedagogy and content knowledge. Some research show that constructivist pedagogy assisted technologies allowed to develop student teachers or teachers' TPACK (Schrum et al., 2005; Mishra & Koehler, 2006; Marreo et al., 2010; Pryor & Bitter, 2008; Harper & Cox, 2012; Meng & Sam, 2013; Yiğit, 2014; Durdu & Dağ, 2017; Karakuş, 2018; Atun & Usta, 2019). Henceforth, it is possible to say that TPACK has resulted from constructivist theory and approaches. TPACK term developed by Mishra & Koehler (2006), which is based on Shulman's pedagogical content knowledge (1986) concept and developed by Pierson's (2001) addition of technology knowledge, has become widespread with the use of constructivist theory and approaches in education (Mishra & Koehler, 2009; Harris, Mishra & Koehler, 2009; Schmidt et al. 2009).

In recent years, researchers (Koehler & Mishra, 2005; Mishra & Koehler, 2006) put forward technological pedagogical content knowledge (TPACK) to define teachers' knowledge about integrating technology efficiently into teaching and learning contexts (Yiğit, 2014). Harris, Mishra & Koehler (2009) considered TPACK as a way of thinking about technology integration. It is also regarded as an efficient teaching strategy that helps teachers develop sophisticated and dynamic knowledge (Lu, 2014). Liu (2013) defined it as a practical approach that allows teachers to integrate the technology into the classroom. Competency in TPACK is one of the fundamental standards to become a qualified teacher (Apau, 2017; Şahin, 2019; Şimşek & Sarsar, 2019; Alpaslan, Ulubey & Ata, 2021). Henceforth, teacher training curricula and teacher educators should not only focus on how to use the technology but also connect it with content and pedagogy (Sweeney & Drummond, 2013; Kraglund-Gauthier & Moseley, 2019; Yangın-Ersanlı, 2016; Uysal & Gündoğdu, 2019).

TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE

The foundations of TPACK lie in the concept' pedagogical content knowledge' that Shulman (1986) proposed as a combination of pedagogy and content knowledge. TPACK, which evolved by integrating the technology into PCK as a result of Pierson's (2001) study, was conceptualized and developed by Mishra & Koehler (2006) as a holistic competency framework or teaching approach regarding the development of teachers' knowledge of technology, pedagogy, and content. In this study of Mishra & Koehler (2006), while explaining the relationship between technology (TK), pedagogy (PK), and content knowledge (CK), they also explained the paired interactions in these fields of knowledge. As a result of these interactions, concepts related to pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogy knowledge (TPK), and technological pedagogical content knowledge (TPACK), which is a combination of TK, CK and PK, have evolved (Mishra & Koehler, 2006). Technological pedagogical content knowledge refers to teachers' knowledge to integrate the technology into their instruction in any content area (Mishra & Koehler, 2006, 2009; Schmidt et al. 2009). TPACK is an integrated knowledge enabling to incorporate technology consciously into the instruction in which teachers teach the subject using appropriate pedagogy and technology in a given content (Schmidt et al. 2009; Abbitt, 2011). Via TPACK, teachers may interpret associations among content, pedagogy, and technology knowledge. This interpretation enables teachers to use suitable pedagogical methods and technological tools (Schmidt, et al., 2009).

TECHNOLOGICAL KNOWLEDGE

Technology knowledge covers knowledge from simple tools such as books, chalk, blackboards to more advanced technologies such as the internet and digital video. Teachers with more comprehensive technological capabilities have the ability to use tools such as word processors, worksheets, browsers, and e-mail, knowledge of computer hardware and operating systems in the context of advanced technologies (Mishra & Koehler, 2006). They also know and have an ability to use instruments such as information and computer networks, digital content, e-books, internet sites, multimedia, Mobil technologies, multi-touchable cooperative software, virtual settings with multi-users (Qasem & Viswanathappa, 2016). Eventually, teachers equipping with technology knowledge accomplish a range of diverse tasks using information technology, and develop various ways of achieving a particular task (Mishra & Koehler, 2009).

PEDAGOGICAL KNOWLEDGE

Pedagogical knowledge encompasses knowledge about the methods, techniques, and processes of learning and teaching, students' nature (e.g., needs, interests, readiness), and strategies used to evaluate students' understandings (Mishra & Koehler, 2006). It also covers knowledge on instructional method and processes as well as dealing with classroom management, measurement and assessment, course design, and student assessment (Schmidt et al., 2009). Teachers with in-depth pedagogy knowledge understand how students learn, acquire skills and develop positive attitudes towards learning (Mishra & Koehler, 2006).

CONTENT KNOWLEDGE

It is concerned with knowledge about the themes or the subject matter in a given discipline. That is, teachers must grasp and understand the content they instruct. In terms of content knowledge, teachers should know basic facts, concepts, processes, and theories in their field. They should also understand the nature of knowledge and thinking in different disciplines as well as the deeper knowledge about components of the branch they study (Mishra & Koehler, 2006). For example, science lesson covers scientific facts and theories, the scientific method, and evidence-based logic. On the other hand, as for art lesson, it includes knowledge of art history, famous creations, sculptures, artisans and their historical contexts (Mishra & Koehler, 2009).

TECHNOLOGICAL CONTENT KNOWLEDGE

It explains the knowledge about which technologies to use to teach the subject matter or themes of a discipline. In technological content knowledge, teachers must know the subject matter well. They also understand that it can be taught and manipulated successfully by technology. For instance, a math teacher can employ Geometr's Sketchpad to teach subjects in Geometry. The software allows students to manipulate shapes and form, providing tangible illustrations of ideas, formulations, and concepts (Mishra & Koehler, 2006). In another instance, imagine Scratch software in disciplines such as science or physics. Teachers can use it to teach science subjects allowing students to create animations, games, and stories and be motivated to learn and understand them easily (Ouahbia et al., 2015).

PEDAGOGICAL CONTENT KNOWLEDGE

PCK was first described by Shulman (1986) as pedagogical knowledge that is applicable to teaching a particular content. Shulman's idea is consistent with the concept 'Pedagogical content knowledge' Mishra & Koehler (2006) proposed as a component of TPACK framework. PCK is concerned with the representation and formulation of notions, pedagogical methods, knowledge of conditions affecting student learning, and knowledge of students' prior knowledge. It also includes knowledge related to teaching strategies that incorporate appropriate conceptual illustrations to address student challenges and misunderstandings and promote meaningful learnings. Moreover, it also involves knowledge of what the students bring to the learning situation, which might be either facilitative or dysfunctional for the particular learning task (Mishra & Koehler, 2006).

TECHNOLOGICAL PEDAGOGICAL KNOWLEDGE

Technological pedagogy knowledge is knowledge about a repertoire of technological instruments used in learning and teaching. It also covers the ability to choose an instrument based on its suitability, strategies for employing its affordances, knowledge of pedagogical strategies, and the ability to apply those strategies to use technologies. Teachers understand that many instruments can be utilized for a particular task. Teachers know instruments necessary for keeping class records, lesson planning, assessment, student participation and motivation, and knowledge of generic technology-based applications such as WebQuests, discussion platforms, and chat rooms (Mishra & Koehler, 2006). Teachers can change and transform their instructions to an effective format using particular technologies. For example, Chen & Jang (2013) incorporated e-books into teaching processes, allowing students' learning and motivation, (b) their learning of complex and abstract concepts, (c) increasing interactions between teacher and students, and (d) directing teachers to think flexibly.

LEARNING – TEACHING CONCEPTIONS

BEHAVIORIST LEARNING CONCEPTIONS

As a psychological study area, behaviorist movement based on observing and analyzing how controlled environmental stimuli affect human behaviors. It has impacted learning and teaching processes as a result of Ivan Pavlov and Frederick Skinner's conditioning experiments. According to behaviorist tradition, learning means observable and measurable changes occurred in behaviors of a human being. The learner makes an association between stimulus and effect, and changes his/her behavior following this association. The teachers' role is to manipulate the environment to reinforce desirable behavioral changes (Brau, Fox & Robinson, 2020). By this tradition, a behaviorist teacher focuses just on transmitting knowledge to students (Richardson, 1996). Behaviorist instructional design comprises discrete and segmented knowledge and skills rather than the integration or structuring of knowledge and a holistic conceptual understanding.

CONSTRUCTIVIST LEARNING CONCEPTIONS

Constructivism opposes behaviorist approaches as well as some cognitive learning philosophies (Bhattacharjee, 2015). It is a philosophy based on the epistemological construction of knowledge instead of transmission and storage. According to constructivist conception, the learner's role is to build and transform knowledge (Applefield, Huber & Moallem, 2001). In this conception, students construct knowledge through activities since it is not wholly transmitted by the teacher (Cox, 2011). The teacher is considered as an agent mediating student and knowledge (Richardson, 1996). The constructivist teacher employs active learning strategies to scaffold activities and performances (so that students proceed from simple to complex), explore information and concepts, and construct knowledge and meanings (Hassad, 2011). They also create lessons for students to solve problems independently instead of direct instruction. Furthermore, they student-centered activities and cooperative learning projects based on students' basic curiosity about the world (Berube, 2001). They provide opportunities to collaborative study and problem-solving in classrooms (Cox, 2011). Accordingly, they utilize efficient instruments and strategies such as speaking, discussion, and inquiry to improve students' communication and thinking skills (Naeem & Basher &, 2014; Bay, Başaran & Döş, 2021). They also regulate the learning environment integrating the technology by considering students' needs and course content (Sang et al., 2010; Ertmer, 2005; Molebash, 2002).

THEORETICAL RELATIONSHIPS BETWEEN TPACK AND LEARNING – TEACHING CONCEPTIONS

Proposed as a framework on the inclusion of technology (Harris, Mishra & Koehler, 2009), TPACK is closely associated with technological skills (Kazu & Erten, 2011). Web 2 tools, excel, digital stories, communication technologies develop teachers' TPACK (Kul, Aksu & Birisci, 2019; Loong, 2014; Sancar-Tokmak, Sürmeli & Özgelen, 2014; Apeanti, 2016; Wright & Akgündüz, 2018). In fact, there are associations between TPACK and self-efficiency beliefs about technology or technology integration (Keser, Karaoğlan-Yılmaz & Yılmaz, 2015; Karakuş, 2018; Jaipal-Jamani et al, 2015; Kozikoğlu & Babacan, 2019). For example, it is founded that student teachers improve technology, pedagogy, and content knowledge in a digital story-assisted course (Sancar-Tokmak, Sürmeli & Özgelen, 2014; Kul, Aksu & Birisci, 2019). A study investigating the association between technological and pedagogical knowledge showed that teachers' use of technology helps them develop their pedagogical designs and stimulate information-seeking behaviors (Kraglund-Gauthier & Moseley, 2019). Piotrowski & Witte (2016) discovered that flipped classrooms and practices as a technological pedagogical method enhanced their technology expertise and TPACK. Şahin, Çelik, Aktürk & Aydın (2013) put forward that TPACK should be assessed holistically, and its' combinations (TK, PK, CK, TCK, TPK, TPACK) have an impact on another one. In other words, teachers' technological knowledge or content knowledge increases the development of theirs' TPACK.

Constructivist approaches increase TPACK while behaviorist instructional approaches present a low technological pedagogical content knowledge (Güneş & Bahçivan, 2016). Teachers are expected to use student-centered or constructivist learning methods with technology in their classroom. Technology usage in education improves cooperative learning; provides flexible learning; facilitates independent learning on time and setting (van Braak, 2001; Bauer, & Kenton, 2005; Jonassen, Howland, Moore, & Marra, 2003).

Based on binary theoretical associations amongst TK, PK, CK, TCK, PCK, TPK, TPACK and behaviorist, and constructivist learning – teaching conceptions in previous studies, a matrix of 30 hypotheses is created as shown in Table 1.

H0 hypothesis: any independent variable has no direct or indirect impact on a dependent variable

H1 hypothesis: any independent variable has direct or indirect impact on a dependent variable

For H1 hypothesis, a reference or references is/are presented to point out an association between two variables in Table 1.

For H0 hypothesis, a blank is left since there is not any association between two variables in Table 1.

30 hypotheses are divide into 6 sets of hypotheses by dependent variables as stated below.

H1, H2, and H3 hypotheses are created relating to direct effects on technological content knowledge.

H4, H5, H6 and H7 hypotheses are created relating to the direct, and indirect effects on pedagogical content knowledge.

H8, H9, H10, H11, and H12 are created relating to the direct, and indirect effects on technological pedagogical knowledge.

H13, H14, H15, H16, H17 and H18 are created relating to the direct and indirect effects on technological pedagogical content knowledge.

H19, H20, H21, H22, and H23 are created relating to the direct and indirect effects on behaviorist teacher style.

H24, H25, H26, H27, H28, H29, and H30 are created relating to the direct and indirect effects on constructivist teacher style.

6 hypotheses sets are tested and interpreted respectively in Table 3, 4, 7, 10, 13, and 14.

As stated previously, the present study aims to test theoretical associations amongst independent (TK, CK, PK), mediating (TCK, PCK, TPK, TPACK), and dependent (behaviorist and constructivist conceptions) variables via the survey data obtained for this study. It shows how technology integration and TPACK applications impact constructivist conceptions of the most valuable educational approaches in the 21st century. It is thought that the results of the current study will be beneficial for teacher educators to transform their practices from behaviorist approaches to constructivist ones.

Table 1. Studies showing theoretical associations between TPACK and its components and behaviorist – constructivist teachers conceptions

	Behaviorist	**Constructivist**	**TK**	**PK**	**CK**	**TCK**	**PCK**	**TPK**	**TPACK**
TK	**[H19]** Smith, Kim & McIntyre, 2015	**[H26]** van Braak, 2001; Smith, Kim & McIntyre, 2015; Bauer, & Kenton, 2005; Jonassen, Howland, Moore, & Marra, 2003	**X**	**[H6]** van Braak, 2001; Roschelle 2000; Lehtinen et al. 1998.	**[H7]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H3]** Sancar-Tokmak, Sürmeli & Özgelen, 2014; Şahin, Çelik, Aktürk & Aydın, 2013	**[H6]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H10]** Kraglund-Gauthier & Moseley, 2019; Şahin, Çelik, Özgün-Koca, Meagher & Edwards, 2010; Aktürk & Aydın, 2013; Piotrowski & Witte, 2016; Baturay & Gökçearslan & Şahin, 2017	**[H8]** Roschelle 2000; Lehtinen et al. 1998
PK	**[H20]** **X**	**[H25]**	**O**	**X**	**O**	**[H1]** Sancar-Tokmak, Sürmeli & Özgelen, 2014; Şahin, Çelik, Aktürk & Aydın, 2013	**[H4]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H9]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H14]** Şahin, Çelik, Aktürk & Aydın, 2013
CK	**[H21]** **X**	**[H24]**	**O**	**O**	**X**	**[H2]** Sancar-Tokmak, Sürmeli & Özgelen, 2014; Şahin, Çelik, Aktürk & Aydın, 2013	**[H5]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H8]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H13]** Şahin, Çelik, Aktürk & Aydın, 2013
TPK	**[H2]** **X**	**[H29]**	**[H10]** Kraglund-Gauthier & Moseley, 2019; Şahin, Çelik, Özgün-Koca, Meagher & Edwards, 2010; Aktürk & Aydın, 2013; Piotrowski & Witte, 2016; Baturay & Gökçearslan & Şahin, 2017	**[H9]** Şahin, Çelik, Aktürk & Aydın, 2013; Piotrowski & Witte, 2016	**[H8]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H12]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H16]** Şahin, Çelik, Aktürk & Aydın, 2013	**O**	**[H18]** Figgl, Gallagher, Scott & Ciampa, 2015; Piotrowski & Witte, 2016; Baturay & Gökçearslan & Şahin, 2017
PCK	**[H22]** **X**	**[H27]** Makgato, 2012	**[H6]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H4]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H5]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H7]** Şahin, Çelik, Aktürk & Aydın, 2013	**O**	**[H11]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H16]** Şahin, Çelik, Aktürk & Aydın, 2013
TCK	**[H23]** **X**	**[H28]**	**[H3]** Sancar-Tokmak, Sürmeli & Özgelen, 2014; Şahin, Çelik, Aktürk & Aydın, 2013	**[H1]** Sancar-Tokmak, Sürmeli & Özgelen, 2014; Şahin, Çelik, Aktürk & Aydın, 2013	**[H2]** Sancar-Tokmak, Sürmeli & Özgelen, 2014; Şahin, Çelik, Aktürk & Aydın, 2013	**X**	**[H11]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H12]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H17]** Şahin, Çelik, Aktürk & Aydın, 2013
TPACK	**[H5]** Güneş & Bahçivan, 2016; Smith, Kim & McIntyre, 2015	**[H30]** Güneş & Bahçivan, 2016; Niess, van Zee & Gillow-Wiles, 2011; Kafyulilo, 2010	**[H15]** Kazu & Erten, 2014; Kul, Aksu & Birisci, 2019; Keser, Karaoğlan-Yılmaz & Yılmaz, 2015; Loong, 2014; Karakuş, 2018; Kozikoğlu & Babacan, 2019; Apeanti, 2016; Wright & Akgündüz, 2018	**[H14]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H13]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H17]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H16]** Şahin, Çelik, Aktürk & Aydın, 2013	**[H18]** Figgl, Gallagher, Scott & Ciampa, 2015; Piotrowski & Witte, 2016; Baturay & Gökçearslan & Şahin, 2017	**X**

METHOD

THE RESEARCH MODEL

Aiming to investigate the effects of student teachers' technological pedagogical content knowledge (TPACK) on learning–teaching conceptions, the current study was designed as an explanatory (causal) research. The researchers employ the present model to establish causal–effect connections between independent and dependent variables (Cohen, Manion & Morrison, 2018). The study tried to explain the effects of technology, pedagogy, and content knowledge as independent variables on behaviorist and constructivist teacher conceptions as dependent variables by mediating technological content, pedagogical content, technological pedagogical knowledge, and technological pedagogical content knowledge. Assumptions like defining time order among variables, correlating them with another one, and eliminating alternative variables must be considered to establish such a causal–effect connection (Neuman, 2009).

Defining time order. Technology (TK), pedagogy (PK), and content knowledge (CK) are some of the primary components in TPACK. Technological content (TCK), pedagogical content (PCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) are derived from them. Technology, pedagogy, and content knowledge exist prior behaviorist (BLTC) and constructivist (CLTC) learning – teaching conceptions. So, TCK, PCK, TPK, and TPACK pre-exist with a behaviourist and constructivist conceptions.

Correlating them with another one. There are significant correlations among independent, mediators, and dependent variables. For this reason, correlational analysis was conducted to determine connections amongst TK, PK, CK, TCK, PCK, TPK, TPACK, and behaviorist and constructivist conceptions.

Eliminating alternative variables. The pre-requisite explains the effects of technology, pedagogy, content knowledge on behaviorist and constructivist conceptions mediating technological content, pedagogical content, technological pedagogical knowledge, and technological pedagogical content knowledge. It was benefited from path analysis and mediation analysis to test this pre-requisite.

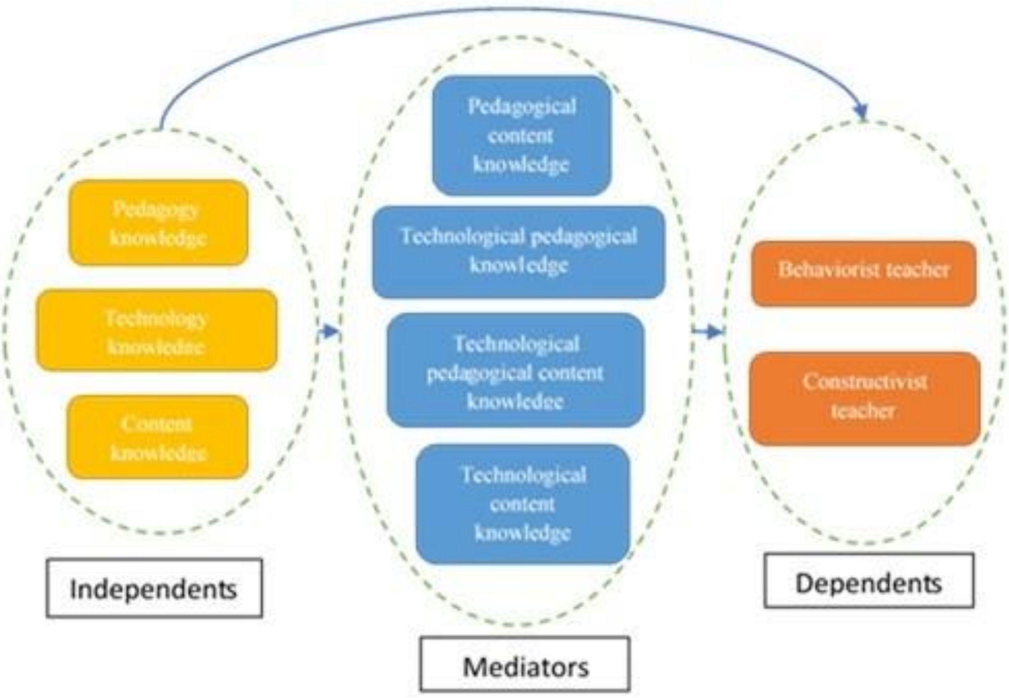

Figure 1. Hypothesis model

As shown in Figure 1, the hypothesis model is established following the cause – result associations amongst independents, mediators, and dependents.

THE UNIVERSE AND SAMPLE

The sample of the present research consisted of 362 university students at Faculty of Islamic Sciences at a public university in Turkey. Participants were included in study using convenient sampling method. Convenient sampling refers to selecting suitable or suitable persons, depending on circumstances such as time, cost, and location. A researcher, who conducts the research with the students in the classes he/she teaches, determines the sample by the convenience sampling method (Canbazoğlu-Bilici, 2019). For this reason, in this study, the researcher collected data only from students in this faculty, as he could easily reach his students in his classes, and it would be less costly to study. Specifically, the study focused specially student groups enrolled and completed pedagogical formation course at least since TPACK and learning – teaching conceptions are constructs explaining a qualified teacher (Apau, 2017). For this reason, not taking any pedagogical formation course, freshman students were excluded. Junior, sophomore and senior students participated in the study voluntarily. Table 1 presents frequencies and percentiles of students in study group.

Table 1. Frequencies and percentiles of student teachers in study group

Gender	(f)	(%)
Male	239	66
Female	123	34
Class degree		
Sophomore	131	36,2
Junior	88	24,3
Senior	143	39,5
Total	362	100

As seen in Table 1, 209 (%66) females, and 123 (%34) males of 362 students participated in the study. They are 131 sophomore (%36,2), 88 junior (%24,3), and 143 senior (%39,5) student teachers.

DATA COLLECTION INSTRUMENTS

Technological pedagogical content knowledge scale and learning – teaching conceptions scale were employed as data collection instruments.

TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE SCALE

The technological pedagogical content knowledge scale developed by Horzum, Akgün & Öztürk (2014) was used to measure student teachers' TPACK self-efficiency. It consists of 7 components and 51 items. The components are technology knowledge (6 items), pedagogy knowledge (7 items), content knowledge (8 items), technological content knowledge (6 items), pedagogical content knowledge (8 items), technological pedagogical knowledge (8 items) and technological pedagogical content knowledge (8 items). The inter-consistency coefficients calculated for the present study are in turn .870, .839, .892, .864, .905, .785, .905.

LEARNING – TEACHING CONCEPTIONS SCALE

Developed by Chan and Elliot (2004), and adapted by Aypay (2011) to Turkish language, the scale comprises 30 items, reducing two components. It includes behaviorist teacher conceptions (18 items) and constructivist teacher conceptions (12 items). Inter-consistency coefficients of two components are respectively calculated to be .832 and .750. in the current study.

DATA ANALYSIS

The data analysis of current study consists of three successive stages: Descriptive statistics, path analysis, and mediation analysis.

DESCRIPTIVE STATISTICS

Binary correlations amongst variables were calculated to test the effects of student teachers' TPACK on learning – teaching conceptions firstly since it is examined if variables are related with the others to explain the presence of the cause – result connections amongst variables (Neuman, 2009). For this reason, Pearson Moments Product Correlation Analysis and descriptive statistics were computed to deal with technological knowledge, pedagogical knowledge, content knowledge, technological content knowledge, pedagogical content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge and behaviourist and constructivist teachers conceptions.

PATH ANALYSIS

Path analysis was carried out using the maximum likelihood method to test the fit between the data and hypothesis model based on theoretical connections. The maximum likelihood method is used to estimate parameters of data stack with a normal distribution (Bryne, 2010). Some reference indices are checked to understand the fit between the data and the hypothesis model. That χ2/sd parameter is below 3 points out superior fit (Kline, 2011). As Goodness Fit Indices (GFI), Adjusted Goodness Fit Indices (AGFI), Comparative Fit Indices (CFI), and Incremental Fit Indices (IFI) reach 1 (one), the model indicates superior fit (Arbuckle, 2014). Root Mean Squared Errors Approximation (RMSEA) also should be less than .05 for model fit (Hu & Bentler, 1999). Technology, pedagogy, and content knowledge are independents; behaviourist and constructivist teacher conceptions are dependents.

MEDIATION ANALYSIS

Technological content knowledge, pedagogical content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge are considered as mediators. Mediation analysis is carried out to explain causality between independents and dependents (Hicks & Tingley, 2011). The Sobel test is performed to reinforce the significance of mediation effect in partial or full mediators (Preacher & Hayes, 2008). The mediation effect is also tested via the Bias-corrected Bootstrapping method. The method presents evidence about the mediation effect through bias-corrected confidence intervals (Shrout & Bolger, 2002). It creates confidence intervals for thousands of data sets resembling the available data via AMOS. The data with 2000 samples of % 95 likelihood are created. The estimation coefficient, confidence interval, and significance values for each parameter are calculated. The estimation coefficient is expected to be higher than 0 (zero) (Jung, Lee, Gupta & Cho, 2019).

There are more mediators in the present mediation analysis than one between an independent and dependent variable. These mediators create a multi serial mediation effect for causality. The purpose of multi serial mediation is to search for direct and indirect effects between independent and dependent variables where X (independents) affects M1 (first mediator), M1 has an impact on M2 (second mediator), and M2 affects Y (dependents) (Hayes, 2013).

RESULTS

In this section, uncovering the direct and indirect effects of TPACK and its components on behaviourist and constructivist learning – teaching conceptions, path analysis results are presented.

Figure 2 shows the direct and indirect effects of technology, pedagogy, content knowledge on behaviourist and constructivist teacher conceptions mediating technological content knowledge, pedagogical content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge. The results of these effects are presented in detail in separate topics.

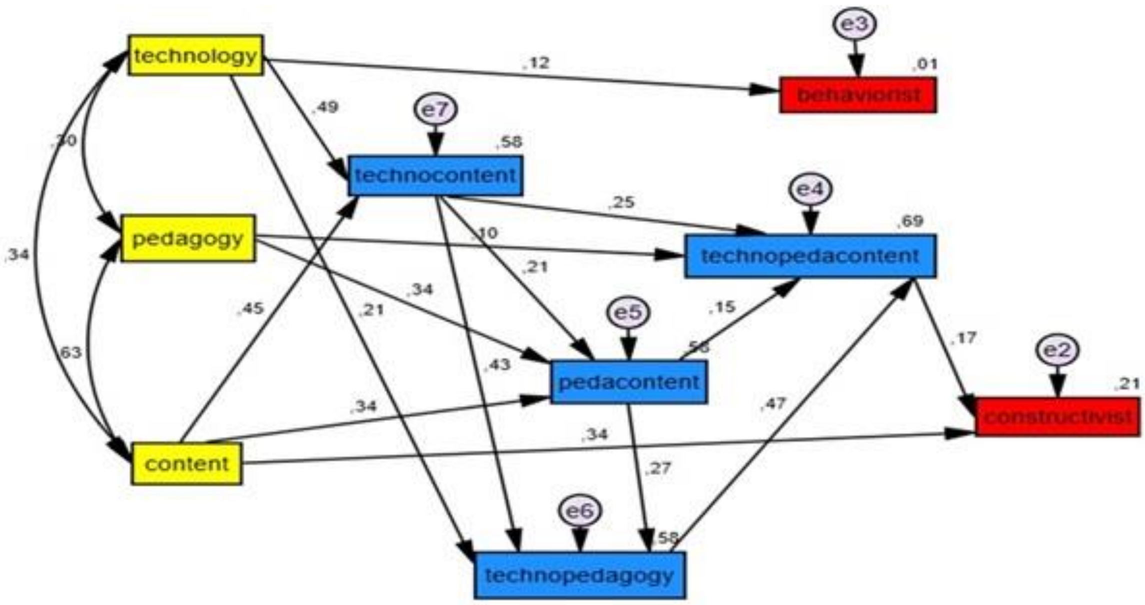

Figure 2. Path analysis diagram

Table 2 indicated that the chi-square value test (χ2/sd=2,41) is a superior fit according to the reference coefficients. It points out that IFI (Incremental Fit Indices), GFI (Goodness Fit Indices), and AGFI

(Adjusted Goodness Fit Indices) also have a superior fit while RMSEA (Root Mean Squared Error Approximate) has an acceptable fit (Blunch, 2008; Bryne, 2010).

Table 2. A comparison of values observed and goodness indices accepted

Parameter	Measurement values	Superior fit	Acceptable fit	Fit degree
CMIN/ sd	2,409	$0 \leq \chi 2$ /df≤2	$2 \leq \chi 2$ /df≤3	Superior
p		.05>		
GFI	,975	0,95≤GFI≤1,00	0,90≤GFI≤0,95	Superior
AGFI	,937	0,90≤AGFI≤1,00	0,85≤AGFI≤0,90	Superior
IFI	,985	0,95≤GFI≤1,00	0,90≤GFI≤0,95	Superior
CFI	,985	0,97≤CFI≤1,00	0,95≤ CFI ≤0,97	Superior
RMSEA	,062	0≤RMSEA≤0,05	0,05≤RMSEA≤0,08	Acceptable

THE DIRECT EFFECTS ON TECHNOLOGICAL CONTENT KNOWLEDGE

Table 3 shows that student teachers' PK has no impact on TCK (p>.05). H1 hypothesis is rejected based on this result. The H2 hypothesis is confirmed since there is a significant effect of CK on TCK (β=.45, p<.05). It is seen that TK affects TCK (β=.49, p<.05). It is possible to say that the H3 hypothesis is accepted. The results also indicate that TK and CK account for %58 of the variance on TCK. Table 3 shows path analysis results showing direct effects on technological content knowledge.

Table 3. Path analysis results showing direct effects on technological content knowledge

Hypothesis	Independent variables (IV)	Dependent variable (DV)	Direct effects	p	Total variance explained on (DV) by (IVs)	Accept/ reject
H1	PK	TCK	None	>.05		X
H2	CK		.45	.00	% 58	✓
H3	TK		.49	.00		✓

THE DIRECT AND INDIRECT EFFECTS ON PEDAGOGICAL CONTENT KNOWLEDGE

Path analysis results of the direct and indirect effects on pedagogical content knowledge are presented in Table 4.

Table 4. Path analysis results of the direct and indirect effects on pedagogical content knowledge

Hypothesis	Independent variables (IV)	Dependent variable (DV)	Direct effects (Beta)	p	Indirect effects (Beta)	p	Total variance explained on (DV) by (IVs)	Accept/ reject
H4	PK	PCK	.34	.00	None	>.05	%58	✓
H5	CK		.35	.00	.09	.00		✓
H6	TK		None	>.05	.10	.00		✓
H7	TCK		.21	.00	None	>.05		✓

Table 4 points out that PK directly impacts PCK (β=.34, p<.05). According to the results, PK is an independent variable affecting directly PCK (β=.35, p<.05). It also found that CK affects it by mediating TCK (β=.09, p<.05). Another result indicates that TK has no impact on PCK but mediates TCK (β=.10). This result explains that H4, H5, H6, and H7 hypotheses are accepted. Also, PK, CK, and TCK explain %85 of variance on PCK.

Table 5. Sobel test results of the effects of independents on one dependent via mediators

IV	R.C.	S.E.	MV	R.C.	S.E.	DV	Z value	p	Statue
TK	.434	.032	TCK	.181	.038	PCK	4.49	.00	Full
CK	.549	.044					4.45	.00	Partial

Path analysis shows us that it has a role as a partial mediator since CK directly impacts PCK and indirectly affects it through TCK. The mediator effect is tested with the Sobel test. The mediator effect of TCK is significant (Z=.4.49, p<.05). The results indicate that TC affects PCK only through TCK. Accordingly, it is seen that TCK has a mediator effect between CK and PCK. The Sobel tests confirm that the mediation effect is significant (Z=4.45, p<.05).

Table 6. Bootstrap analysis results

Parameter	Estimation	Lower bound	Upper bound	P
T→**TCK**→PCK	,079	,040	,123	.001
C → **TCK**→ PCK	,099	,052	,160	.001

Another method used to define the mediation effect is bias-corrected bootstrapping confidence interval as well as the Sobel test. The method presents robust evidence related to the significance of indirect effects (Shrout ve Bolger, 2002). The parameter value estimated for the mediation effect of TCK between TK and PCK is found as .079. The value is significant for the mediation effect of TCK. The coefficient tells us that the mediator effect of TCK is significant at the .001 level. Similarly, the estimation coefficient for the mediation effect of TCK between CK and PCK is computed as .099. It is found that the estimation coefficient (.052 - .160) confidence interval is significant.

THE DIRECT AND INDIRECT EFFECTS ON TECHNOLOGICAL PEDAGOGICAL KNOWLEDGE

Table 7 points out path analysis results of the direct, and indirect effects on technological pedagogical knowledge.

Table 7. Path analysis results of the direct, and indirect effects on technological pedagogical knowledge

Hypothesis	Independent variables (IV)	Dependent variable (DV)	Direct effects	p	Indirect effects	P	Total variance explained on (DV) by (IVs)	Accept/ reject
H8	CK	TPK	None	>.05	.31	.00	.579	✓
H9	PK		None	>.05	.09	.00		✓
H10	TK		.21	.00	.23	.00		✓
H11	PCK		.27	.00	none	>.05		✓
H12	TCK		.43	.00	.06	.00		✓

As seen in table 7, it is understood that CK affects TCK (p>.05). On the other hand, it is found that CK has an impact on TPK through TCK (β=.31, p<.05). As in CK, PK has no impact on although it affects TPK via TCK (β=.09, p<.05). It is also found that TK has direct and indirect effects on it through both TCK and PCK (β=.23, p<.05). Furthermore, TCK has a direct impact on TPK (β=.27, p<.05) as well as indirectly affecting it via PCK (β=.06, p<.05). It is possible to say that H8, H9, H10, H11, and H12 hypotheses are accepted on these results. Consequently, it is found that CK, PK, K, PCK, and TCK explain %58 of variance on TPK.

Table 8. Sobel test results of the effects of independents on one dependent via mediators

IVs	R.C.	S.E.	MV	R.C.	S.E.	DV	Z value	p	Statue
TK	.434	.032	TCK	.437	.051	TPK	7.24	.00	Partial
CK	.549	.044					7.06	.00	Full
PK	.339	.044	PCK	.317	.049		4.95	.00	Full
CK	.371	.054					4.71	.00	Full

As shown in Table 8, TK has both a direct and indirect via TCK impact on TPK. It can be stated that TCK plays a partial mediation role between TK and TPK. The Sobel test presents a shred of evidence about the significance of TCK's mediator role (Z=7.24, p<.05). Path analysis results indicate that CK can affect TPK just through TCK. It can be said that TCK is significantly a full mediator on this result (Z=7.06, p<.05). The results point out that PCK has a mediation effect on the cause – result connection between PK and TPACK. The Sobel test proves that PCK is a full mediator (Z=4.95, p<.05). Furthermore, an independent variable, CK is an independent variable of the effect on TPK via PCK. As a result of the Sobel Test, it can be said that the mediation effect role of PCK is significant (Z=4.71, p<.05).

Table 9. Bootstrap analysis results

	Estimation	Lower bound	Upper bound	p
T → TCK → TPK	,190	,143	,240	.001
T →TCK →PCK→TPK	,025	,013	,042	.000
C → TCK→ TPK	,240	,185	,309	.001
P → PCK→TPK	,107	,061	,166	.001
C→ PCK → TPK	,118	,076	,169	.01

Bias corrected bootstrapping analysis explains in Table 9 that the estimation value is calculated as .190 for the mediation role of TCK between TK and TPK. The value proves that the mediation role of TCK is significant in confidence interval (.143-.240). In multiple series mediator analysis, the estimated value is .025 in confidence interval (.013-.042) for TCK and PCK as mediators between TK and PK ($p<.05$). Bootstrapping analysis shows that the estimation value is .240 (.185-.309) for a mediator effect of TCK between CK and TPK. Furthermore, a conclusion is reached that PCK has a mediator effect between both PK-TPK (.107, .061-.166) and C-TPK (.118, .076-.169).

THE DIRECT AND INDIRECT EFFECTS ON TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE

Path analysis results of the direct and indirect effects on technological pedagogical content knowledge are shown in Table 10.

Table 10. Path analysis results of the direct and indirect effects on technological pedagogical content knowledge

Hypothesis	IVs	DVs	Direct effects	p	Indirect effects	p	Total variance explained on (DV) by (IVs)	Accept/ reject
H13	CK	TPACK	None	>.05	.32	.00	.579	✓
H14	PK		.10	.00	.09	.00		✓
H15	TK		None	>.05	.35	.00		✓
H16	PCK		.15	.00	.13	.00		✓
H17	TCK		.25	.00	.26	.00		✓
H18	TPK		.48	.00	-	-		✓

Path analysis results show that CK has no direct impact on TPK but affect indirectly it via TCK ($\beta=.32$, $p<.05$). It is also seen that PK, another independent variable, affect directly TPACK ($\beta=.10$, $p<.05$). In addition, via PCK, PK has an indirect effect on TPACK ($\beta=.09$, $p<.05$). On the other hand, TK has an indirect impact ($\beta=.35$, $p<.05$) on it through TCK, PCK, and TPK, although it does not directly affect TPACK ($p>.05$). Initially, PCK, TCK, and TPK are regarded as mediators; then, they are considered independents. PCK affects directly ($\beta=.15$, $p<.05$) and indirectly TPACK ($\beta=.13$, $p<.05$) via TPK. A TCK and TPK as independent variables directly impact TPACK ($\beta=.26$; $\beta=.48$; $p<.05$). The path analysis shows that H13-H18 hypotheses are approved. Eventually, it is concluded that CK, PK, TK, TCK, PCK, and TPK account for % 58 of the variance on TPACK.

Table 11. Sobel test results of the effects of independents on one dependent via mediators

IVs	R.C.	S.E.	MVs	R.C.	S.E.	DVs	Z value	p	Statue
TK	.434	.032	TCK	.236	.041	TPACK	5,30	.00	Full
CK	.549	.044					0.01	0.99	None
PK	.339	.044	PCK	.158	.047	TPACK	3.08	.00	Partial
CK	.371	.054					3.01	.00	Full
TK	.190	.041	TPK	.437	.040	TPACK	4.63	.00	Full
TCK	.181	.038	PCK	.158	.047		2.75	.00	Partial

As indicated in Table 11, TK indirectly affects TPACK via TCK. Accordingly, it is concluded that TCK has a full mediator effect. The Sobel test confirms the significance of TCK's mediator effect ($Z=5.30$, $p<.05$). TCK mediates wholly between CK and TPACK. However, the Sobel test proves us that the mediation effect of TCK is no significant between two ($p>.05$). On the other hand, PK has both direct and indirect impacts on TPACK via PCK. It can be said that it has a significant and partial mediation effect by looking at Sobel test results ($Z=3.08$, $p<.05$). It is also seen that PCK as a mediator has a significant effect between PK and TPK, according to Sobel test results ($Z=3.01$, $p<.05$). In addition, TK affects TPACK via just TPK. The Sobel test shows this effect as significant ($Z=4.63$, $p<.05$). Finally, TK affects, directly and indirectly, TCK through PCK. It is estimated as significant via The Sobel test ($Z=2.75$, $p<.05$).

As seen in Bias-corrected bootstrapping analysis (Table 12), the estimation value of mediation effect of TCK between TK and TPACK is .102 and significant at confidence interval (.039 - .169). In multiple serial mediation analyses, the estimation coefficient for an impact of TK on TPACK via TCK and PCK as mediators is .012, and the confidence interval is .005 - .027 ($p<.05$).

Table 12. Bootstrap analysis results

	Estimation	Lower bound	Upper bound	p
T→TCK→TPCK	,102	,039	,169	.002
T→TCK→PCK→TPCK	,012	,005	,027	.003
T→TPK→TPCK	,083	,043	,141	.002
T→TCK→PCK→TPK→TPCK	,011	,004	,023	.001
P→PCK → TPCK	,053	,018	,111	.006
P→ PCK → TPK → TPCK	,047	,020	,092	.002
C→ TCK → TPCK	,129	,046	,207	.002
C→ PCK → TPCK	,059	,026	,107	.003
C→TCK → PCK → TPCK	,016	,006	,035	.003
C→TCK→PCK → TPK → TPCK	,014	,005	,029	.001

THE DIRECT AND INDIRECT EFFECTS ON BEHAVIOURIST TEACHER CONCEPTIONS

Table 13 indicates the direct and indirect effects on behaviourist teacher conceptions.

Table 13. Path analysis results of the direct and indirect effects on behaviorist teacher style

Hypothesis	Independent variables (IVs)	Dependent variable (DV)	Direct effects	p	Indirect effects	p	Total variance explained on (DV) by (IVs)	Accept/ reject
H19	TK	Behaviorist teacher style (BTS)	.12	.00	None	>.05	1.4	✓
H20	PK		none	>.05	None	>.05		✓
H21	CK		none	>.05	None	>.05		✓
H22	PCK		none	>.05	None	>.05		✓
H23	TCK		none	>.05	None	>.05		✓

As shown in Table 13, it is seen that TK directly affects behaviourist teacher conceptions (BTC) (β=.12, p<.05). It can be said that TK explains % 4 of variance on BTC. H19-H23 hypotheses are accepted according to these results.

THE DIRECT AND INDIRECT EFFECTS ON CONSTRUCTIVIST TEACHER CONCEPTIONS

Path analysis results of the direct and indirect effects on constructivist teacher style are indicated in Table 14.

Table 14. Path analysis results of the direct and indirect effects on constructivist teacher style

Hypothesis	Independent variables (IVs)	Dependent variable (DVs)	Direct effects	p	Indirect effects	p	Total variance explained on (DV) by (IVs)	Accept/ reject
H24	CK	Constructivist teacher style (CTS)	.34	.00	.05	.00	21	✓
H25	PK		None	>.05	.03	.00		✓
H26	TK		None	>.05	.03	.00		✓
H27	PCK		None	>.05	.05	.00		✓
H28	TCK		None	>.05	.05	.00		✓
H29	TPK		None	>.05	.08	.00		✓
H30	TPACK		.17	.00	None	>.05		✓

Path analysis results point out that CK affects directly (β=.34, p<.05) and indirectly (β=.05, p<.05) constructivist teacher conceptions (CTC) via TCK, PCK, and TPACK. It is seen that PK (β=.03), TK (β=.03), PCK (β=.05), TCK (β=.05), and TPK (β=.08) as independents have indirect effects on CTC. Finally, TPACK has a direct impact on CTC (β=.17, p<.05). It is found that CK, PK, TK, TCK, PCK, TPK, and TPACK represent % 21 of variance on CTC.

Table 15. Sobel test results of the effects of independents on one dependent via mediators.

IVs	R.C.	S.E.	MVs	R.C.	S.E.	DV	Z value	p	Statue
PK	.108	.041	TPACK	.111	.037	(CTS)	1.98	.01	Full
TCK	.236	.041					2.66	.01	Full
PCK	.158	.047					2.23	.01	Full
TPK	.437	.040					2.89	.00	Full

As is shown in Table 15, PK, TCK, PCK, and TPK have the effects on CTC by mediating just TPACK. It is concluded in the Sobel test results that TPACK has significant mediation effect between a group of independents and dependent (p<.05).

Table 16. Bootstrap Analysis Results

	Estimation	Lower bound	Upper bound	p
T→TCK→TPCK→CTS	,011	,004	,025	.002
T→TCK→PCK→TPCK→CTS	,001	,000	,004	.003
T→TPS→TPCK→CTS	,009	,003	,019	.004
T→TCK→PCK→TPS→TPCK→CTS	,001	,000	,003	.002
P→PCK → TPCK→CTS	,006	,002	,016	.006
P→ PCK → TPS → TPCK→CTS	,005	,002	,012	.004
C→ TCK → TPCK→CTS	,014	,005	,032	.002
C→ PCK → TPCK→CTS	,006	,002	,016	.003
C→TCK → PCK → TPCK→CTS	,002	,001	,005	.003
C→TCK→PCK → TPS → TPCK→CTS	,002	,000	,004	.002

Bias corrected Bootstrapping analysis shows that estimation coefficient and confidence intervals of mediation effects of several mediators between TK, CK, and PK as independents and CTC as a dependent are found as expected.

DISCUSSION AND CONCLUSION

Aiming to uncover the relationships between technological pedagogical content knowledge and learning – teaching conceptions, the present study indeed tried to explain the roles of technological pedagogical content knowledge and its components on behaviourist and constructivist teacher conceptions. Hypotheses derived from theoretical associations in previous research was tested and assessed using this study's data.

The findings indicate that technology knowledge plays a role in behaviourist teaching conceptions. It possible to say that this result supports our hypothesis. Regardless of how technology is used, it represents a significant part of behavioural and constructivist learning and teaching processes. However, based on the results of path analysis, it can be said that technology in constructivist teaching has a much more influential role than behavioural teaching. Teachers in behavioural tradition utilize technologies like smart boards, PowerPoint, OER, etc., transferring the content to students as direct instruction is one of the methods that behaviourist teachers use frequently, (Hickman, 2017). This method makes the instruction inefficient and monotone without ICT support (Pardimin, Arcana & Supriadi, 2019). For this reason, direct instruction with no ICT causes a decrease in teacher efficiency on adapting teaching students' leaning at their own pace and differentiating the instruction considering students' development and context (Luke, 2014). Accordingly, behaviourist teachers often employ technological instruments in order to extend the restricted capacity of direct instruction on student learning and facilitate the instruction. In other words, it is possible to say that technology is an agent explaining behaviourist teacher competencies.

The findings show that technology knowledge indirectly affects constructivist conception mediating TCK, PCK, TPK and TPACK but no direct effect on it. With the inclusion of technology in education, teachers have used technological knowledge to design activities and lesson plans in the context of TPACK. However, technological pedagogical knowledge could not be developed when technology is not used in ways to provide inquiry-based experiences to increase students' learning (Özgün-Koca, Meagher & Edwards, 2010). So, teachers can have technological pedagogical knowledge only if they integrate it with given instructional method. The conclusion was confirmed by the results from the path analysis in the present study. Baturay, Gökçearslan & Şahin, (2017) found that there is any significant and positive association between outputs of technology integration like computer based instruction and TPACK. They understood that technology and technological pedagogy knowledge are considerably associated with computer-based instruction compared to other skills related to TPACK. The instruction has become constructivist when computer or technology is blended with pedagogical methods (Smith, Kim & McIntyre, 2015). Accordingly, teachers regard technology as effective tools to develop constructivist practices and stimulate students' curiosity. These constructivist methods enable to learn students independently as well as providing active and positive learning environments (Azizinezhad & Hashemi, 2011).

The findings point out that technological pedagogical content knowledge is closely related to constructivist teaching conceptions. It is concluded that TPACK and its components have direct and indirect effects on constructivist teacher conceptions. Teachers with higher TPACK are inclined to employ students centered strategies such as collaborative methods, allowing to students explore and solve problems (Niess, van Zee & Gillow-Wiles, 2011). The inclusion of technology with constructivist methods helps students learn rich and diverse knowledge, and deal with complex issues about students. It also provides experience in creating rich and unique outputs. The experience supports teachers - students' cooperation making meaningful discussion through technological instruments (Roschelle 2000; Lehtinen et al. 1998). It is possible to make an infer that our hypotheses are accepted based on the findings of studies mentioned.

Furthermore, several studies on relations between learning-teaching conceptions and TPACK are discussed above. It was concluded that the more constructivist student teachers are, the higher TPACK levels are. The conclusion was supported by the findings of these studies. For example, a study of Kafyulilo (2010) found that student teachers easily improved TPACK when they took part in microteaching, lesson design, and sharing ideas with peers. Another study also explained an association between behaviourist and constructivist teachers and TPACK. Behaviourist teachers have the low technological content knowledge and TPACK. The study asserted that teachers should employ student-centered learning and teaching conceptions to help them use technology efficiently. But the same study indicated that a teacher using student- centered strategies has a low TPACK. It can be said that a teacher with student-centered beliefs does not mean they can use the technology efficiently (Smith, Kim & McIntyre, 2015). For this reason, TPACK together with its components, is a teaching issue to be assessed holistically (Şahin, Çelik, Aktürk & Aydın, 2013). Harris & Hofer (2011) also sought two research questions 'How does TPACK affect teachers' instructional planning? and 'how TPACK can be improved? TPACK assisted teacher workshop in the current study uncovered that teachers' choice and use became conscious, differentiated, and strategic; the instructional planning transformed constructivist one. They also established quality standards for technology integration. Hence, it is possible to say that TPACK with other components transform learning – teaching processes into constructivist teaching.

The findings also show that content knowledge directly impacts on constructivist teacher conceptions. We make an inference that as student teachers learn concepts, ideas, and theories in discipline they are studying, they would have capacity to use effectively constructivist approaches throughout their instructions. Apart from technology and pedagogy knowledge, it is seen that content knowledge alone is an independent variable that affects directly the constructivist teaching approach. Besides, it is thought that they know where and how an instructional method or material is used or even how a technology is integrated when they know really content or subjects well at their disciplines. The integration process necessitates them comprehend the content in-depth. For this reason, it can be said that it is an influential factor in affecting immediately constructivist teacher conceptions and the hypothesis is accepted on inferences and discussions.

It is also concluded that technology has different roles in behaviourist and constructivist teaching conceptions. On the one hand, technology knowledge directly impacts behaviourist teaching conceptions. The hypothesis is accepted based on the result. Hickman (2017) expressed that behaviourist teachers always use it to present information, allowing students to understand quickly and effectively and they are the instructor and activator of technology. We have reached an inference that behaviourist teachers regard it as just an instrument based on both our study and Hickman's expressions (2017).

On the other hand, technology knowledge affects constructivist teacher understandings through TCK, TPK, PCK, and TPACK. The results prove to us that our hypotheses are accepted. There are complex and in-depth associations between technology knowledge and constructivist teacher understandings, as can be understood from these results. That is, it is concluded that constructivist teachers have the capacity to use the technology on purpose way intertwined with TCK, TPCK, PCK, and TPACK. Likewise, Hickman (2017) supported our conclusion stating that constructivist teachers reflect on technology usage. In a constructivist instruction, technology is used purposefully for instructional events such as technology integration, technology or computer-assisted instruction, TPACK based applications etc. As a result, it is stated that constructivist teachers' technology use differs in that students' higher-order development from that of behaviourist usage. Accordingly, they help students use independently it for practice, exploration, research, personalized learning, etc. (Hickman, 2017).

RECOMMENDATIONS

It is suggested that teachers should take part in workshops, projects, etc., on TPACK or technology integration. Since TPACK is closely related to technology integration, teachers must introduce and employ a variety of technological instruments in an instructional design. For this reason, they should be involved in technological material design projects where blending the technology with given pedagogical approaches and methods so that they can design constructivist instruction at their classrooms and provide students with opportunities of studying and learning with peers in collaborative groups.

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