Analysis of Relationships between Technological Pedagogical Content Knowledge and Educational Internet Use

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Abstract

This study analyzes the relationships between preservice teachers' technological pedagogical content knowledge (TPACK) and their self-efficacy beliefs in educational Internet use. Findings show statistically significant relationships among the knowledge domains in technology, pedagogy, content, and their intersections. Also, results from the canonical correlation analysis show that a statistically significant and strong relationship exists between the knowledge dimensions in the TPACK model and the self-efficacy beliefs in educational Internet use. Specifically, technology, content, and technological content knowledge domains are statistically significant predictors of preservice teachers' self-efficacy beliefs in educational Internet use. (Keywords: technological pedagogical and content knowledge, educational Internet use, self-efficacy)

The statement "Preparation for the teaching profession should be provided with training in general culture, special area education, and pedagogy knowledge" (Ozdemir, Yalın, & Sezgin, 2004) emphasizes the importance of the need for teachers to have a variety of competency areas. These skills are basic to the teaching profession. Teachers are expected to develop themselves in these competencies to be successful in their subject areas. To accomplish this, teachers and teacher candidates should use information and communication technologies better to follow developments in their content areas, transfer contemporary approaches and teaching methods to their practices, and increase their level of knowledge in general culture. In addition, self-efficacy is one of the most important factors that teachers should have to be able to effectively use computer and Internet technologies (Uzun, Ekici, & Sağlam, 2010). For teachers, technology is vital to develop their knowledge both in their areas of expertise and in pedagogy and general culture. For this reason, teachers should be able to integrate their knowledge in content, technology, and pedagogy successfully.

For several decades, computer and instructional technologies have been an integral part of our learning and communication activities. Starting at an early age, use of these technologies in our daily lives has become widespread (Orhan & Akkoyunlu, 2004). Education is one area where these technologies provide individuals with many benefits and opportunities. For example, digital video editing can provide students the opportunity to become instructional designers and active learners relating experiences of their own lives to school subjects (Miller, 2008). Also, computers and instructional technologies bring important improvements for teachers. Teachers can use instructional technologies to (a) provide multimedia learning, (b) meet students' individual needs, (c) gain attention, (d) make abstract contexts more concrete, and (e) save time for their teaching (Yalın, 2008). However, to take full advantage of these technologies, teachers should be able to (a) identify topics to learn with educational technology in ways that show the added value of educational technology applications, (b) create representations for conveying complex subject matter that is hard to teach through traditional methods in a comprehensible manner, (c) establish teaching strategies that meet learners' needs, (d) choose appropriate educational technology tools that support information transformation and teaching strategies, and (e) integrate educational technology activities into the classroom (Angeli & Valanides, 2005). When teachers integrate technology in education, students are more interested in the course (Schrum et al., 2007; Sweeder & Bednar, 2001). In addition, teachers who have a high level of experience in educational computer use have higher expectations for learning and teaching (Hicks, 2006), and teachers may help increase student performance by using computer technology (Margerum-Leys & Marx, 2002).

Related literature suggests teachers' use of instructional technology requires comprehensive and multidirectional knowledge (Lambert & Sanchez, 2007; Margerum-Leys & Marx, 2002). The goals of a modern education system is to train individuals to explore ways to access information, learn how and where to use the information gained, and develop critical thinking skills. These goals can be realized with qualified teachers who keep continually up to date on recent developments in science and technology (Yilmaz, 2007). For this reason, teachers should have the necessary skills and responsibilities to apply new technologies in their fields to achieve these goals (Hicks, 2006). For example, with the widespread use of the Internet and distance learning technologies, educators should discuss issues such as how to present content on the Internet, how to interact with students, and how to teach students how to interact professionally with other students (Peruski & Mishra, 2004).

An approach commonly encountered in the development of professional

teachers treating treat technology, pedagogy, and content as different and independent from each other. However, the trend of using appropriate computer and instructional technologies in teachers' academic training started to become important several years ago (Niess, 2005). In fact, teachers' professional development requires the consideration of different knowledge areas. Therefore, it is inevitable that teacher education programs should successfully demonstrate the associations between technology, pedagogy, and content.

Three basic components of successful teaching are content, pedagogy, and technology. In addition, the relationships among these three components form the basis of education (Koehler & Mishra, 2009). The Technological Pedagogical Content Knowledge (TPACK) framework is a concept that links technology to the other two approaches of the curriculum, content and pedagogy, and defines how the three knowledge areas (content, pedagogy, and technology) interact with each other. In their conceptual framework for teacher knowledge, Mishra and Koehler (2006) extend Shulman's (1986) pedagogical content knowledge model by involving technology knowledge. Each of the three components is dependent on the teacher's knowledge and compassion (Shin, Koehler, Mishra, Schmidt, Baran, & Thompson, 2009). TPACK includes learning how to use technology to build on existing knowledge to develop new epistemologies or strengthen old ones, how to constructively teach the subject with different pedagogical techniques, and how to take advantage of technology to restate some of the problems the students face (Mishra & Koehler, 2006).

As described by Yalın (2008), technology is a discipline that serves as a bridge between science and practice—a statement that emphasizes the relationships between technology, pedagogy, and content. As science knowledge refers to content and the practice describes pedagogical knowledge, technology can be seen as a bridge that joins these two disciplines.

Technology Integration and the Internet

Unlike other areas of technology, today the Internet includes many technologies, so it is necessary to configure the technological content knowledge differently (Horzum, 2011). These technologies have become quite important in teacher education (Lee, Tsai, & Chang, 2008). One of the developing information and communication technologies, the Internet, affects our lives and offers many benefits to its users (Beard & Wolf, 2001). The Internet has more functions than just advertising and an information distribution mechanism (Weiser, 2001). It offers access to different sources, such as libraries, museums, archives, and databases, to mention a few (Erdogan, Bayram, & Deniz, 2008). A majority of university students use the Internet daily (Demirer, Bozoglan, & Sahin, 2013). Akkoyunlu (2002) notes that teachers mostly use the Internet for communicative purposes (e-mail, chat, etc.). The Internet is also a communication tool where people socially interact, using Skype for example.

Related literature states that adults use the Internet for entertainment and communication (Bayraktar & Gun, 2007). In addition, individuals use the Internet to conduct research and play games (Tahiroglu, Celik, Uzel, Ozcan, & Avci, 2008). In fact, the Internet also affects and enriches the educational process by providing rich experiences for teachers and students (Akkoyunlu & Yilmaz, 2005). Using the Internet, students can obtain access to different forms of resources from anywhere at any time and can learn independently (Karatas, 2008). Thus, they develop themselves and enrich their knowledge by achieving significant educational benefits.

As highlighted in the related literature, computer technologies are not only used in learning and teaching, but they are also used as tools to seek information and share it with others (Akkoyunlu & Kurbanoglu, 2003). To employ information and communication technologies effectively, individuals must feel competent in the use of these technologies. Otherwise, individuals may not use these technologies efficiently or perhaps even at all. In fact, fulfillment of the professional competencies that teachers require is closely related to receiving good training and to the belief that they can complete their duties and responsibilities (Yilmaz, Koseoglu, Gercek & Soran, 2004).

Teachers' Self-Efficacy Beliefs

In recent years, self-efficacy is one of the variables used frequently in studies conducted in different areas (Akbulut, 2006; Vural & Hamurcu, 2008). In fact, beliefs about personal capabilities are the key determinants of behavior (Akgün, 2008). *Self-efficacy* is defined as the belief about the capacity of success in a particular event (Bandura, 1986). This concept is defined in different forms, such as *self-efficacy* (Akkoyunlu, Orhan & Umay, 2005; Deryakulu, Büyüköztürk, Karadeniz, & Olkun, 2009), *self-efficacy belief* (Akbulut, 2006; Akgun, 2008; Aşkar & Umay, 2001; Orhan & Akkoyunlu, 2003; Koseoglu, Yilmaz, Gerçek, & Soran, 2007), and *self-efficacy perception* (Akkoyunlu & Kurbanoglu, 2003). In this study, the term *self-efficacy beliefs* refers to teachers' perceptions about their competencies in educational Internet use.

Individuals with high self-efficacy beliefs are insistent and patient while accomplishing a job or task (Aşkar & Umay, 2001). For example, research shows that teachers with higher self-efficacy are more willing to instruct (Bıkmaz, 2004), as individuals who believe themselves competent in an activity have more tendency to participate in this event (Lent, Brown, & Hackett, 2002). Therefore, self-efficacy is an important factor for individuals to achieve their goals (Bıkmaz, 2006).

Although teachers' self-efficacy may not directly translate into their use of technology, it is a necessary condition for the adaptation of technology in education (Wang, Ertmer, & Newby, 2004). Teachers' self-efficacies in computer and Internet technologies affect their uses of these technologies and the quality of education using web technologies. The increase in teacher self-efficacies in Internet technologies has a positive effect

on their teaching and student learning (Lee & Tsai, 2010). In fact, it is important that teachers' perceptions that they are competent in educational Internet use will assist with the widespread use of this technology for educational purposes. In this study, we analyze the association between teachers' self-efficacy beliefs in educational Internet use and the perception levels of their TPACK.

Methods

This section describes the study group, research instruments, and data analysis methods.

Study Group and Procedures

In the current study, we use the TPACK model as the theoretical framework in the process of data collection and interpretation of the results. We conducted the study in a college of education at a large Turkish university in central Anatolia. The college has eight main departments: computer and instructional technologies education, social sciences, art education, primary education, science and mathematics education, educational leadership and policy studies, Turkish education, and foreign languages education. We distributed the survey to randomly selected students from these departments. Thus, the participants of this research study included 163 preservice teachers. Of these participants, 91 (56%) were female and 72 (44%) were male. As seniors, they were enrolled in a university class as part of their internship program. The participants received training on technology integration as part of their classes. We administered the surveys used for the study at the end of the internship program.

Instruments

In this study, we analyzed the relationships between preservice teachers' knowledge in technology pedagogy and content and their self-efficacy beliefs in educational Internet use. We used two research instruments. The first is a 28-item Survey of Self-efficacy in Educational Internet Use developed by Sahin (2009). This survey includes items such as: "I have the efficacy in searching the Internet resources," "I have the efficacy in sharing data with my friends through the Internet," and "I have the efficacy in locating and downloading e-books." In the educational Internet use self-efficacy survey, higher scores for the scale indicate higher perceived self-efficacy beliefs in use of the Internet for instructional purposes. The survey items consist of individual sentences and are answered by means of a 5-point Likert-type scale with five response choices (1 = not qualified, 2 = somewhat qualified, 3 = qualified, 4 = quite qualified, 5 = completely qualified).

The second research instrument, developed by Sahin (2011), is a 47-item Survey of Technological Pedagogical and Content Knowledge with seven subscales: technology knowledge (TK), pedagogy knowledge (PK), content knowledge (CK), technological pedagogy knowledge (TPK), technological content knowledge (TCK), pedagogical content knowledge (PCK), and technological pedagogical and content knowledge (TPACK). The TPACK subscale has items such as: "I have knowledge in integrating appropriate instructional methods and technologies into my content area," "I have knowledge in selecting contemporary strategies and technologies helping to teach my content effective," and "I have knowledge in taking a leadership role among my colleagues in the integration of content, pedagogy, and technology knowledge." In the Survey of Technological Pedagogical and Content Knowledge, higher scores for each subscale indicate a higher perceived acquaintance with applications of the knowledge base. The survey items are a 5-point Likert-type scale with five response choices (1 = no knowledge, 2 = little knowledge, 3 = moderate knowledge, 4 = a lot of knowledge, and 5 = complete knowledge).

In the development studies of these two instruments, we found Cronbach's alpha reliability coefficients between 0.86 and 0.96 for the subscales of the surveys. For scales used in research studies, the level of an acceptable Cronbach's alpha coefficient is suggested as 0.70 (Anastasi, 1982; Tavsancil, 2002; Tezbaşaran, 1997). Cronbach's alpha reliability coefficients for the surveys are as follow: 0.96 (for the educational Internet use self-efficacy survey), 0.93 (TK), 0.90 (PK), 0.86 (CK), 0.88 (TPK), 0.88 (TCK), 0.92 (PCK), and 0.92 (TPACK). Based on the findings of the survey development studies, the instruments are reliable measures.

Data Analysis

In the present study, we used descriptive statistics and correlation analysis to report relationships among the variables. Because each section of both surveys has a list of several items, we used the canonical correlation analysis method to determine the relationships between the level of knowledge for each domain of the TPACK model and the self-efficacy beliefs in educational Internet use. Canonical correlation (Rc) is a statistical method used to measure the relationship between two multidimensional variables (Saraçlı & Saraçlı, 2006; Tekin, 1993). We used Wilks' lambda, a multivariate statistic ranging between 0 and 1 (Mertler & Vannatta, 2002), to test the significance of the relationship between the sets of variables. Using multiple linear regression analysis, we tested the relationships between the dependent variable, educational Internet use, and the following seven predictor variables: TK, PK, CK, TPK, TCK, PCK, and TPACK.

Findings

Relationships among the TPACK Subscales

In this study, we examined the relationships between the seven TPACK domains with correlation analysis. Table 1 presents the findings of this analysis.

As seen in Table 1, all relationships between the variables included in the TPACK model are statistically significant and positive. Technology, pedagogy, content, and their interrelated knowledge dimensions are correlated. These results show that assessment of the TPACK level should be treated as a whole. These factors have a positive effect on each other. For example, increasing teachers' knowledge levels in technology or content has a positive effect on the enhancement of TPACK.

Table 1. Correlation Values among the TPACK Variables

Variable	1	2	3	4	5	6	7
TK	-						
PK	0.28**	-					
CK	0.36**	0.61**	-				
TPK	0.46**	0.67**	0.53**	-			
TCK	0.53**	0.60**	0.59**	0.79**	-		
PCK	0.29**	0.80**	0.63**	0.73**	0.69**	-	
TPACK	0.41**	0.66**	0.56**	0.72**	0.79**	0.72**	-

* $p < 0.05$

** $p < 0.01$

Table 2. Canonical Correlations between TPACK Domains and Educational Internet Use

	TK* (15 items)		PK* (6 items)		CK* (6 items)		TPK* (4 items)		TCK* (4 items)		PCK* (7 items)		TPACK* (5 items)	
	R_c (a)	R^2 (b)	R_c	R^2	R_c	R^2	R_c	R^2	R_c	R^2	R_c	R^2	R_c	R^2
1	0.80	0.30	0.49	0.14	0.57	0.18	0.58	0.25	0.65	0.31	0.54	0.18	0.58	0.25
2	0.50	0.01	0.39	0.01	0.45	0.03	0.36	0.01	0.41	0.02	0.42	0.01	0.41	0.02
3	0.47	0.01	0.32	0.01	0.35	0.01	0.32	0.01	0.24	0.01	0.38	0.01	0.39	0.01
4	0.40	0.01	0.29	0.01	0.30	0.01	0.25	0.01	0.20	0.00	0.37	0.01	0.31	0.01
5	0.39	<0.01	0.27	0.01	0.23	<0.01	-	-	-	-	0.34	0.01	0.24	<0.01
6	0.34	<0.01	0.18	<0.01	0.20	<0.01	-	-	-	-	0.30	0.01	-	-
7	0.33	<0.01	-	-	-	-	-	-	-	-	0.18	<0.01	-	-
8	0.30	<0.01	-	-	-	-	-	-	-	-	-	-	-	-
9	0.28	<0.01	-	-	-	-	-	-	-	-	-	-	-	-
10	0.26	<0.01	-	-	-	-	-	-	-	-	-	-	-	-
11	0.24	<0.01	-	-	-	-	-	-	-	-	-	-	-	-
12	0.21	<0.01	-	-	-	-	-	-	-	-	-	-	-	-
13	0.18	<0.01	-	-	-	-	-	-	-	-	-	-	-	-
14	0.16	<0.01	-	-	-	-	-	-	-	-	-	-	-	-
15	0.11	<0.01	-	-	-	-	-	-	-	-	-	-	-	-

* Correlated with self-efficacy beliefs in educational Internet use at significant level ($p < 0.05$ for Wilk's Lambda [Λ])

(a) Canonical correlation (R_c)

(b) R^2 for dependent variables

Relationships between Preservice Teachers' TPACK Levels and Educational Internet Use

Table 2 provides the canonical correlations between the variables in the TPACK model and the self-efficacy beliefs in the educational Internet use. The canonical correlation values range from 0.49 to 0.80. In this study, we determined statistically significant and strong relationships d between all knowledge domains contained in the TPACK model and the self-efficacy beliefs in the educational Internet use.

In addition, we analyzed predictive factors of teachers' self-efficacy beliefs in educational Internet use by regression analysis. Table 3 (p. 114) presents the results.

In the prediction of educational use of the Internet by preservice teachers, we determined that the technology, content, and technological content knowledge domains were statistically significant factors. We determined that preservice teachers, who have higher levels of knowledge in technology, content, and the integration of these two domains, have high self-efficacy beliefs in the educational use of the Internet.

Discussion

Findings from the current study show statistically significant relationships among the knowledge domains in technology, pedagogy, content, and their intersections. Also, results from the canonical correlation analysis show that statistically significant, strong relationships exist between the knowledge dimensions in the TPACK model and the self-efficacy beliefs in educational Internet use. Specifically, technology, content, and technological content knowledge domains are statistically significant predictors of preservice teachers' self-efficacy beliefs in educational Internet use. In fact, as the Survey of Self-efficacy in Educational Internet Use includes items regarding Internet use for educational purposes, it mainly measures self-efficacy beliefs in technology and content. Hence, the prediction of self-efficacy beliefs in educational Internet use by knowledge in technology, content, and technological

content domains shows the consistency of the two surveys with each other.

The findings from the current study show knowledge types in technology, pedagogy, content, and their connections are significantly correlated. These results and the relevant literature (Koehler, Mishra, & Yahya, 2007; Niess, 2006) suggest these three kinds of knowledge structures are not independent of each other, so they need to be addressed in an integrated manner. Also, the literature (Hughes, 2005; Kanuka, 2006) and the results of this study show the links between the three types of knowledge (technology, pedagogy, and content) should not be ignored. In fact, successful teaching with technology should help preservice teachers understand the closely interrelated and mutually supportive relationships between these three knowledge areas (Koehler et al., 2007). For this reason, the TPACK framework emphasizes the need for the integration of subject area knowledge and technology with appropriate pedagogical practice (Niess, 2005).

This study emphasizes the importance of TPACK. The TPACK model advocates that teachers, researchers, and faculty members should not simplify technology as an added tool to the curriculum, but should consider it as a fundamental part of the learning environment that contributes to pedagogy and content (Koehler & Mishra, 2009). The related literature (Hughes, 2004; Kanuka, 2006) suggests that TPACK is a significant phenomenon for preservice teachers to acquire in the field of their teaching subjects. To be able to develop and implement successful teaching, we must understand the relationship of technology with pedagogy and content (Koehler et al., 2007, Pierson, 2001) and emphasize the need for teachers to adapt technology effectively into their lessons and follow a more student-centered approach (Collier, Weinburgh, & Rivera, 2004; Pierson, 2001; Rowley, Dysard, & Arnold, 2005). If preservice teachers learn how to integrate technology into their subject areas, they are likely to use it to support learning in their professional lives and classrooms. However, if they learn it only as a skill, they may have difficulty using it for educational purposes (Hughes, 2005). To enhance learning and teaching, faculty members, who work in teacher education programs, should follow an approach that integrates technology, pedagogy, and content and model for their students the adoption of the TPACK framework (Dexter, Doering, & Riedel, 2006).

Table 3. Predictive Variables of Preservice Teachers' Educational Internet Use

Model	*R*	R^2	Std. err.	*F* change	Sig. *F* Change
1b	0.68	0.47	0.73	321.09	<0.01
2c	0.74	0.54	0.68	222.60	<0.01
3d	0.75	0.55	0.67	152.19	<0.01

a Dependent variable: Educational Internet use

b Predictors: (Constant), TK

c Predictors: (Constant), TK, TCK

d Predictors: (Constant), TK, TCK, CK

As awareness of the importance of the relationships between these three kinds of knowledge increases, educational institutions should provide environments and resources to realize interdisciplinary and multifaceted learning. Preservice teachers' teaching practica can be used effectively in terms of understanding and applying TPACK. Teachers who had TPACK in their college years are expected to use appropriate technological and pedagogical knowledge in their professional lives and classrooms to support learning.

In this study, we analyzed the relationships between preservice teachers' technological pedagogical content knowledge (TPACK) and their self-efficacy beliefs in educational Internet use. The findings show all knowledge types contained in the TPACK model are significantly and strongly related to the self-efficacy beliefs in educational Internet use. In the study, the findings indicate that teachers who understand TPACK will have higher self-efficacy toward Internet use and therefore better integration habits around using the Internet. The literature suggests that technology integration knowledge promotes the preservice teachers' self-efficacy in designing digital media (Lee & Tsai, 2010). By experiencing more technology-related pedagogy, teachers develop higher levels of self-efficacy beliefs in educational technology.

In addition, the results suggest it is important to investigate the areas of Internet use. Related literature states that students use the Internet more for social and emotional functions than academic or area-specific studies (Young, 1998). A study conducted regarding Internet use functions (Scherer, 1997) reported that a majority of students use the Internet on a regular basis for the purposes of e-mail (98.7%) and surfing the World Wide Web (85.2%). Related literature emphasizes that students do not use the Internet efficiently and effectively (Ersoy & Yasar, 2003). Yet another study states that healthy, efficient use of the Internet is related to psychological maturity and self-efficacy (Wang, 2001). In particular, teachers' information literacy and Internet use skills may be improved with preservice and inservice training, so the Internet can be an effective part of the teaching process (Akkoyunlu & Yilmaz, 2005).

In addition, the Internet can be used for tracking daily work, accessing information, searching and preparing assignments, eliminating emotional tensions, and spending free time activities. For these activities, the Internet should be used for its intended purpose and in a functional way. To accomplish this, teachers should share the educational applications of the Internet with their peers, since preservice teachers should have knowledge and experience in their subject matter to develop positive self-efficacy (Akkoyunlu & Kurbanoğlu, 2003). In fact, teachers, who have strong self-efficacy beliefs in their profession devote more effort to their students' learning and take their students' needs into consideration (Bıkmaz, 2004). To

strengthen students' self-efficacy beliefs, teachers should make instruction appropriate for the individual needs of students, make various activities suitable for the needs of each student, use collaborative learning approaches, and avoid assessment approaches that compare students to each other (Senemoğlu, 1997).

Conclusions

In this study, we found that technology, content, and technological content knowledge domains are statistically significant predictors of preservice teachers' self-efficacy beliefs in educational Internet use. The Survey of Self-efficacy in Educational Internet Use contains items regarding the use of the Internet for educational purposes and generally measures preservice teachers' self-efficacy beliefs in their knowledge about technology and content. In this respect, the prediction of self-efficacy beliefs in educational Internet use by only technology, content, and technological content knowledge shows that the two surveys we used in the present study are consistent with each other.

This study provides some research evidence that the subsections of the TPACK model are correlated, which lends credence to the point that teachers should not be teaching technology alone, but instead in the context of content and pedagogy. The results clearly show that better TPACK knowledge is correlated with higher self-efficacy in educational Internet use. It is clear that more research is needed into the educational uses of technology and the Internet, especially around TPACK. In the present study, the consistency of the two surveys shows that the two surveys meet the criterion-based validity. Hence, future research may use these surveys as valid and reliable data collection tools.

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