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Determining Turkish Senior Science Student Teachers' Technological Pedagogical Content Knowledge of 'Environmental Chemistry' Elective Course

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Abstract

Since effective technology integration requires interdependent content, technological, and pedagogical knowledge, Harris and Hofer (2006) suggest a logical approach to help teachers to better integrate technologies in their teaching. In this approach, students' content-related learning needs are directly linked with particular content-based learning activities and related educational technologies that will best support the activities' successful implementation. The aim of this study is to determine Turkish senior science student teachers' (SSSTs) Technological Pedagogical Content Knowledge (TPACK) of 'Environmental Chemistry' elective course and to examine relationships among the TPACK domains. Within the survey research methodology, the sample consisted of 165 senior science student teachers. The TPACK survey developed by Schmidt, Baran, Thompson, Koehler, Mishra, and Shin (2009) was initially translated and adapted from English into Turkish. Internal consistency for the adapted TPACK survey (a total of 32 likert-type items) with 7 different knowledge domains was found to be 0.91. After importing the data into SPSS 15.0^{TM}, one-way ANOVA was employed to compare the SSSTs' total scores of the TPACK domains. The results indicated that there was no significant difference among Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPCK). The senior SSSTs' PK domain outperformed those in TK and CK. Also, as compared TK with CK, their TK domain is better than CK one. Amongst PCK, TPK and TCK was no meaningful difference. TPACK scores of the SSSTs were higher than those in PCK, TPK and CK. Three principal domains of the TPACK, i.e. TK, CK, PK, influenced their intersection combinations, e.g. PCK, TPK and TCK. In fact, two out of the six domains, i.e. TK and PK, affected the TPACK performance.

Keywords: Technological Pedagogical Content Knowledge, Environmental Chemistry, Science Student Teachers

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Introduction

Since effective technology integration requires interdependent content, technological, and pedagogical knowledge, Harris and Hofer (2006) suggest a logical approach to help teachers to better integrate technologies in their teaching. In this approach, students' content-related learning needs are directly linked with particular content-based learning activities and related educational technologies that will best support the activities' successful implementation. Therein, Technological Pedagogical Content Knowledge (TPACK) provides a theoretical framework for teachers to grasp how to effectively integrate technology into real classroom instruction (Mishra & Koehler, 2006; Thompson & Mishra, 2007-2008).

The TPACK framework highlights complex relationships that exist between content, pedagogy and technology knowledge areas and is a helpful organizational structure for defining the question 'what is needed to integrate technology effectively' (Archambault & Crippen, 2009).

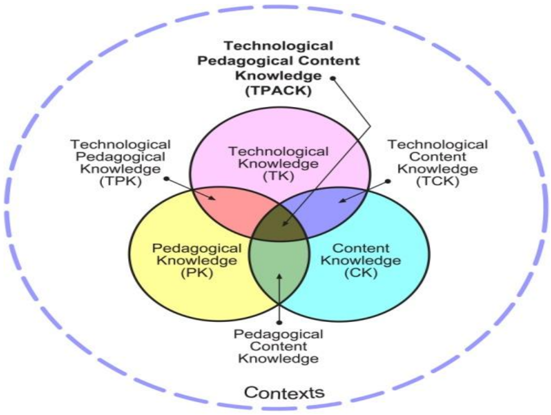
Heart of the TPACK framework contains the complex interplay of three primary forms of knowledge: Content Knowledge (CK), Pedagogy Knowledge (PK), and Technology Knowledge (TK). Integrating effectively technology into specific content or subject matter teaching requires to understand and negotiate the relationships between these three components. Likewise, the TPACK emphasizes the new kinds of intersectional knowledge: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK) and Technological Pedagogical Knowledge (TPK). Overall, the intersection of the three elements emerges Technological Pedagogical Content Knowledge (TPACK). Three out of seven domains in the TPACK framework (see Figure 1) are outlined as follows:

Technological Content Knowledge (TCK): *This intersection is relevant with how to apply technology to subject matter. Hence, the principal goal is to make it comprehensible for diverse populate learners and learning styles.*

Pedagogical Content Knowledge (PCK): *This intersection relates to how subject matter can be organized, adapted, facilitated, and presented.*

Technological Pedagogical Knowledge (TPK): *This intersection is about the knowledge of the existence of technologies and ability to apply them to change teaching and learning.*

Figure 1. Technological Pedagogical Content Knowledge (Koehler & Mishra 2008).



TPACK attempts to capture some of the essential qualities of knowledge that the teachers require for an integration of technology into their teaching. Further, it addresses the complex, multifaceted and situated nature of teacher knowledge (Koehler & Mishra 2005).

A few studies have been conducted on introducing and/or illustrating integration of technology into real classroom instruction. Also, some studies have argued theoretical scaffolds of such an integration process (e.g. Angeli & Valanides, 2005; Hughes, 2004; Irving, 2006; Niess, 2005; Mishra, & Koehler, 2006; Pierson, 2001). Because TPACK is quite new idea in scope of Turkish science education context, few studies have been carried out on Turkish senior science student teachers' (SSSTs) qualifications of TPACK knowledge domains and the relationships among them. Such a research study certainly will encourage the integration of technological knowledge into practical teaching strategies.

The aim of this study is to determine Turkish senior science student teachers' (SSSTs) Technological Pedagogical Content Knowledge (TPACK) of 'Environmental Chemistry' elective course and to examine relationships among the TPACK knowledge domains.

Methodology

Since the study attempted to identify an existing case of TPACK domains (technology knowledge--TK, content knowledge--CK, pedagogical knowledge--PK, pedagogical content knowledge--PCK, technological content knowledge--TCK, technological pedagogical knowledge--TPK, and technological pedagogical content knowledge--TPACK), the survey research methodology was employed.

Sample of the study

The sample consisted of 165 the senior science student teachers (SSSTs) enrolled in 'Environmental Chemistry' elective course.

Content of TPACK survey

The TPACK survey developed by Schmidt, Baran, Thompson, Koehler, Mishra, and Shin (2009) was initially translated and adapted from English into Turkish. Internal consistency for the adapted TPACK survey (a total of 32 likert-type items) with 7 different knowledge domains was found to be 0.91. In brief, the instrument which embraced seven TPACK domains and two types of models incorporated 6 TK items, 3 CK items, 7 PK items, 1 PCK items, 9 TCK items, 1 TPK items, and 5 TPACK items. Cronbach's alpha co-efficient for each TPACK knowledge domain was found 0.78 for TK, 0.70 for CK, 0.79 for PK, 0.70 for PCK, 0.71 for TPK, 0.82 for TCK, and 0.76 for TPACK.

Data analysis

The SSSTs' responses to each item were scored using five-level Likert scale, i.e. strongly disagree (1 point) to strongly agree (5 points). Because the

TPACK survey had nominal values, and was suitable for statistical analyses, the data were imported into SPSS 15.0^{TM}. later, one-way ANOVA was employed to compare the SSSTs' total scores of the TPACK domains.

Results and Discussion

As seen in Table 1, the SSSTs' means of TPACK domains ranged from 3.96 to 28.37. The highest standard deviation belonged to TK domain (3.73), whereas the lowest one was pertaining to PCK (0.64).

Table 1. Descriptive statistics

Domains	N	Mean	Std. Deviation	Std. Error
TK	165	22,16	3,73	0,29
CK		10,38	1,99	0,15
PK		28,37	3,44	0,27
PCK		3,94	0,64	0,05
TPK		3,86	0,74	0,06
TCK		3,96	0,66	0,05
TPACK		3,96	0,66	0,05

A one-way analysis of variance (ANOVA) was conducted to evaluate the relationships among SSSTs' total scores of the TPACK knowledge domains. As can be seen from Table 2, there was a significant difference amongst TPACK domains ($F(6,1148) = 2,42$, $p = .000$).

Table 2. ANOVA results

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	96011,775	6	16001,962	2,42	,000
Within Groups	7585,079	1148	6,607		
Total	103596,854	1154			

Because the variances (the standard deviations squared) among the seven domains were between 0.40 and 13.9, post hoc comparisons were conducted to evaluate pair-wise differences among the means with the Tukey HSD and presented in the Table 3.

The first knowledge domain, technology knowledge (TK), which refers to understanding how to use various technologies, indicated significant differences from CK, PCK, TPK, TCK, and TPACK in favour of TK. Also, there was a statistically significant difference between PK and TK in favour of PK.

The second knowledge domain, content knowledge (CK), which refers to the subject matter knowledge that teachers must have, showed significant differences from PCK, TPK, and TCK. Further, statistically meaningful differences between CK and PK and between CK and TPACK were found in favour of PK and TPACK.

Table 3. Post hoc comparisons with the using of the Tukey HSD

(I) Domains	(J) Domains	Mean Difference (I-J)	Sig.	(I) Domains	(J) domains	Mean Difference (I-J)	Sig.
TK	CK	11,78*	,000	PK	PCK	24,43*	,000
	PK	-6,21*	,000		TPK	24,51*	,000
	PCK	18,22*	,000		TCK	24,41*	,000
	TPK	18,30*	,000		TPACK	12,45*	,000
	TCK	18,19*	,000	PCK	TPK	0,08	1,000
	TPACK	6,24*	,000		TCK	-0,02	1,000
CK	PK	-17,99*	,000		TPACK	-11,76*	,000
	PCK	6,44*	,000	TPK	TCK	-0,10	1,000
	TPK	6,52*	,000		TPACK	-12,05*	,000
	TCK	6,42*	,000	TCK	TPACK	-11,95*	,000
	TPACK	-5,53*	,000				

* The mean difference is significant at the 0.05 level.

Pedagogical knowledge (PK), the third domain, which refers to the methods and processes of teaching such as classroom management, assessment, lesson plan development, and student learning, pointed out significant differences from PCK, TPK, TCK, and TPACK. Moreover, there were significant differences amongst three principal components of Technological Pedagogical Content Knowledge (TPCK), i.e. Technology Knowledge (TK), Content Knowledge (CK) and Pedagogy Knowledge (PK).

The fourth knowledge domain, pedagogical content knowledge (PCK), refers to the content knowledge that deals with the teaching process. There was only significant difference between PCK and TPACK in favour of TPACK.

The fifth knowledge domain, technological pedagogical knowledge (TPK), which refers to teachers' knowledge of how various technologies can be used in teaching and understanding, demonstrated a significant meaningful difference from TPACK.

The sixth knowledge domain, technological content knowledge (TCK), refers to teachers' understanding of how using a specific technology can change the way of student learning and practice concepts in a specific content area. There was a significant difference between TCK and TPACK in favour of TPACK.

The seventh knowledge domain, technological pedagogical content knowledge (TPACK), which refers to the knowledge teachers require for integrating technology into their teaching, showed significant differences from PCK, TPK, and TCK in favour of TPACK.

As seen from Table 3, there was no significant difference among Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK). In contrast, the remaining knowledge domains of the TPACK indicated statistically meaningful differences.

The SSSTs' PK domain outperformed those in TK and CK. Also, as compared TK with CK, the TK domain is better than CK one. Amongst PCK, TPK and TCK was no meaningful difference. TPACK scores of the SSSTs were higher than those in PCK, TPK and CK. Three principal domains of the TPACK, i.e. TK, CK, PK, influenced their intersection combinations, e.g. PCK, TPK and TCK. In fact, two out of the six domains, i.e. TK and PK, affected the TPACK performance.

Implications

TPACK framework maybe deployed for teaching practice and instructional technology as a reflective and intentional vehicle. Using the TPACK framework, science educators and instructional designers will be able to pedagogically relay content to course outcomes through the application of appropriate technologies**.** Given future potential of TPACK, it gives an opportunity for professional development and instructional technologists to transform teaching and learning thorough technology-integrated teaching. To keep up with current technological trend, use of TPACK survey will ultimately keep teacher educators informed on training pre-service teachers towards contemporary demands. Further, scopes of teacher education programs should be adapted to technological development and its needs.

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