Saltan & Arslan, *Cogent Education* (2017), 4: 1311501
http://dx.doi.org/10.1080/2331186X.2017.1311501

cogent education

INFORMATION & COMMUNICATIONS TECHNOLOGY IN EDUCATION | RESEARCH ARTICLE

A comparison of in-service and pre-service teachers' technological pedagogical content knowledge self-confidence

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Received: 07 February 2017
Accepted: 21 March 2017
Published: 13 April 2017

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Reviewing editor:
Shuyan Wang, The University of Southern Mississippi, USA

Additional information is available at the end of the article

Abstract: This study aimed to investigate and compare in-service and pre-service teachers' self confidence on technological pedagogical content knowledge (TPACK) in relation to their teaching experience, expertise, technology usage, and gender. To achieve this goal, survey method was conducted as part of a quantitative method design. Participants of the study consisted of 388 pre-service and 211 in-service teachers from four different concentrations: science, mathematics, information, and communications technology (ICT) and classroom teachers. The data were analyzed using paired Sample T-test and MANOVA statistical analysis. Results showed that both pre-service and in-service participants exhibit the highest self-confidence level in the technological content knowledge domain. While pre-service teachers had the lowest score in TPACK, in-service teachers had the lowest score in the technological knowledge domain. While pre-service mathematics teachers have significantly lower TPACK than pre-service science teachers, in-service ICT teachers' TPACK level is significantly higher than science, math, and classroom teachers' levels considering TPACK, pedagogical content knowledge (PCK) and technology knowledge (TK) domains.

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PUBLIC INTEREST STATEMENT

TPACK, technological pedagogical content knowledge, is a current teacher education framework and there have been a grooving interest since 2010. In this article, we aimed to investigate and compare in-service and pre-service teachers' self confidence in technological pedagogical and content knowledge in relation to their teaching experience, expertise, technology usage, and gender. Both pre-service and in-service participants exhibit the highest self-confidence level in the technological content knowledge domain. While pre-service teachers had the lowest score in TPACK, in-service teachers had the lowest score in the technological knowledge domain. Mathematics teachers have significantly lower TPACK than science teachers. This result may be because science teachers tend to use more technological tools and approaches in their classes than mathematics teachers. Further research is needed within teacher education programs and contexts in order to investigate how TPACK framework could enhance teacher education contribute technology integration, as well as students learning.

Subjects: Educational Research; Education Studies; Higher Education; Classroom Practice

Keywords: pedagogical issues; technology integration; teacher education; technological pedagogical content knowledge

1. Introduction

Every innovation brings along an integration process that takes a long time, especially in social disciplines. Supporting technology integration in schools has become an important issue on the agenda of countries worldwide over the past two decades (Chen & Jang, 2014). In particular, the introduction of more technology into everyday life has increased the pressure on teachers to use such technological tools and devices in line with instructional purposes. The use of instructional tools by teachers to facilitate teaching and learning processes is considered essential (Clements, 2002). Recent studies show that policy-makers and governments have been investing in instructional technologies, including computers, mobile devices, and Interactive boards, but both pre-service and in-service teachers are not sufficiently prepared to integrate these technologies into their classrooms (Agyei & Voogt, 2012). Even though pre-service teachers are regarded as digital natives, in most cases, they do not have a clear idea of how to integrate ICT into teaching and learning (Uygun, 2013). Instructional technologies are mostly perceived as a way of saving time and expanding classes rather than helping to "transform the nature of a subject at the most fundamental level" (McCormick & Scrimshaw, 2001, p. 47). It is clearly essential to have not only the current technologies and the knowledge to use them, but also the ability to integrate them into the given context (Pamuk, 2012). Different cultures and contexts generate variety in teachers' perspectives on technology integration (Alon & McIntyre, 2005; Correa, Perry, Sims, Miller, & Fang, 2008). Jang (2008) indicated that teachers become more successful when they work together to apply new technologies. In their study, Agyei and Voogt (2012) create design groups consisting of pre-service teachers to develop technology supported instructions. The aim is to utilize technology as "a tool for achieving instructional objectives, rather than considering it as an end in itself" (p. 550). Hsu, Tsai, Chang, and Liang (2017) compared technological pedagogical content knowledge (TPACK) of experienced teachers with novice teachers regarding game-based learning. Results showed that teaching experience did not significantly affect teachers' TPACK. In a recent study, Voogt and McKenney (2017) investigated how pre-service teachers can effectively use technology for development of early literacy regarding TPACK framework. The finding of the study offers several recommendations for police makers and practitioners. In their multiple case study, Tondeur, Roblin, van Braak, Fisser, and Voogt (2013) indicated that the whole curriculum should contain the positive effect of instructional technology so that "pre-service teachers have the opportunity to (a) understand the educational reasons for using ICT and (b) experience how ICT can support teaching and learning across different subject domains" (p. 242). In brief, technological pedagogical content knowledge is a current teacher education framework and there have been a grooving interest since 2010. In various contexts, several studies conducted to understand pre-service and in-service teachers' TPACK. However, we know little about teachers' technological pedagogical content knowledge self-confidence. The number of the studies is not enough which compares pre-service with in-service teachers regarding their knowledge of critical subdomains in TPACK framework.

1.1. Theoretical framework

Technological pedagogical content knowledge is a current framework in teacher education which focuses on the heart of technology integration by proposing an integration of pedagogical content knowledge (PCK) and technology knowledge (TK). PCK was first mentioned by Shulman (1986) who emphasized the integration of content and pedagogic knowledge in teacher certification programs. Pedagogical content knowledge means the ability of using pedagogical and content knowledge together instead knowing pedagogical and content of a subject separately. Not only Teachers should have pedagogical and content knowledge, but also they merge them in teaching. On the other hand, Shulman's framework does not ignore the importance of technology knowledge in teacher education; on the contrary, technological abilities that teachers should have fallen under "curricular knowledge" in PCK. Since the 1980s, technological improvement in the field of education has accelerated. After this, technology knowledge has become an important component of teaching and learning. Solely technological knowledge can be defined as the ability to use hard and soft technologies. Thus, the transformation of "Pedagogical Content Knowledge" into "Technological Pedagogical Content Knowledge" should be seen as an expected result. TPACK has been defined as integrative, innovative, contextual, and complex knowledge of pedagogy, content, and technology (Angeli & Valanides, 2009; Harris et al., 2010; Koehler & Mishra, 2009). This approach proposes three important component of teaching as pedagogy, content, and technology. Surely, the crucial point is to merge these components in teaching. Koehler and Mishra (2009) propose seven sub-domains under the TPACK framework: content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technology knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) (see Figure 1). TPACK is an interwoven model; an inadequacy in any domain of the model can cause an ultimate failure in the use of the intended technology (Pamuk, 2012). TPACK is a comprehensive model, but there are a limited number of studies that investigate the interaction between the domain areas. In their study, Chai, Koh, and Tsai (2010) indicated that the largest effect on pre-service teachers' TPACK level belongs to the pedagogical knowledge domain. More comprehensive studies were needed to investigate how knowledge domains affect each other and how the overall TPACK framework affects teachers' comprehension of the importance of meaningful technology integration in education (Bos, 2011; Tokmak, Yelken, & Konokman, 2013). In order to acquire technological pedagogical content knowledge, teacher educators follow different approaches. Some of the main approaches and implementation stages are summarized in Table 1 While some studies only focus

Figure 1. Technological pedagogical content knowledge.

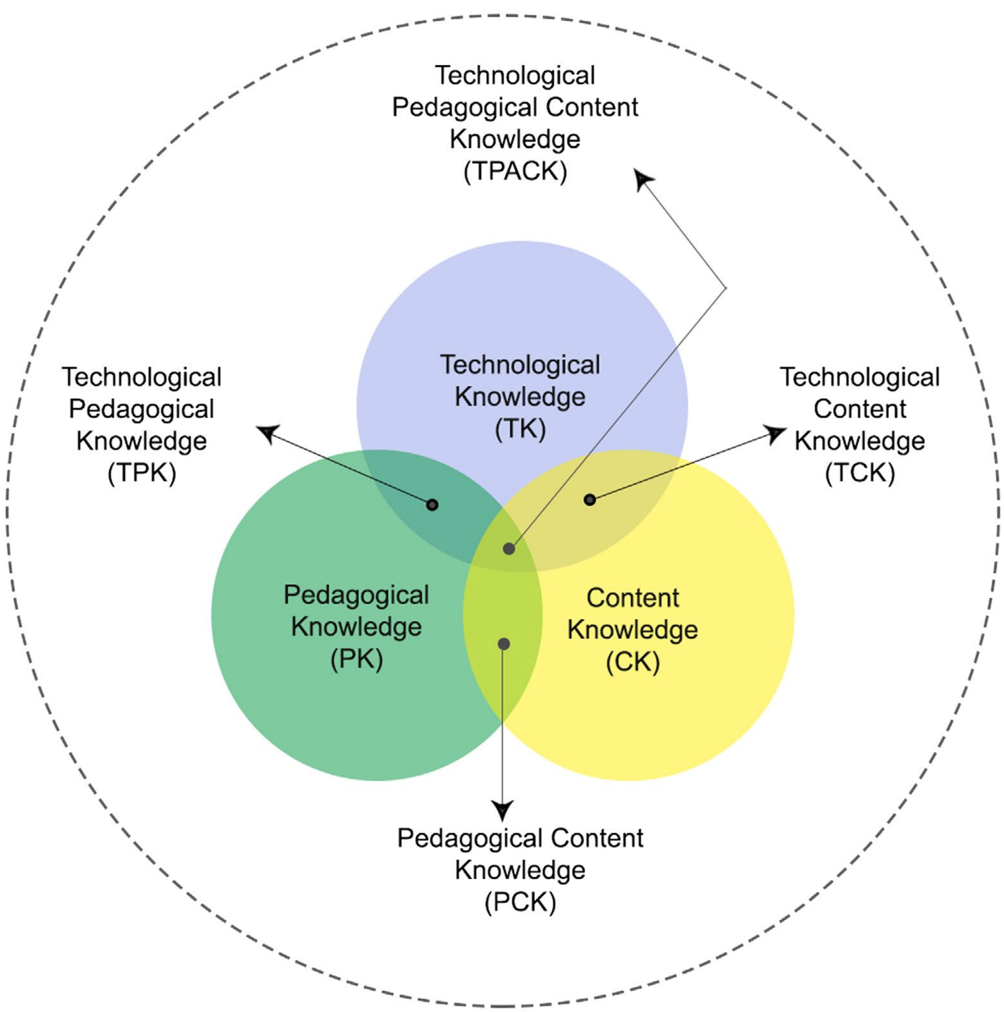

Table 1. TPACK development approaches

Activities in approach	Stage
Introduction of TPACK	Workshop
Demonstration of example lessons and discussion	Workshop/discussion
Micro-teaching	Workshop/implementation
Developed lesson plan and materials	Workshop/design/implementation

on TPACK in pre-service teacher preparation programs (e.g. Finger, Jamieson-Proctor, & Albion, 2010; Schmidt et al., 2009), others focus mainly on in-service teachers' TPACK development (e.g. McGrath, Karabas, & Willis, 2011) . It is necessary to gain a clearer view of both pre-service and in-service teachers' TPACK.

1.2. Purposes of the study

The purpose of this study is to investigate and compare in-service and pre-service teachers' self confidence regarding their technological pedagogical and content knowledge (TPACK). In this regard, the study aimed to examine how in-service and pre-service teachers' TPACK self confidence differs with respect to their teaching experience, technology usage, and subject matter. The following research questions were addressed:

(1) Are there any significant differences among pre-service teachers' TPACK self-confidence by department?

(2) Are there any significant differences among pre-service teachers' TPACK self-confidence by computer and internet usage?

(3) Are there any significant differences among in-service teachers' TPACK self-confidence by subject matter?

(4) Are there any significant differences among in-service teachers' TPACK self-confidence by computer and internet usage?

(5) Are there any significant differences among in-service teachers' TPACK self-confidence by teaching experience?

(6) Are there any significant differences among TPACK confidence of pre-service and in-service teachers of the same expertise?

2. Research design

The methodology of this study is based on survey research (Fraenkel & Wallen, 2006). According to Leedy and Ormrod (2005), this type of design is ideal for educational purposes and can be used to gather a lot of information from population groups to "learn about their characteristics, opinions, attitudes, and previous experiences" (p. 183). To meet the objectives of the research type, a structured questionnaire was used to collect data. The participants of this survey study consisted of 388 pre-service and 211 in-service teachers studying one of the well-established teacher training institutions in Turkey. They were from four subject matters, consisting of science, mathematics, ICT, and classroom teachers. Purposeful sampling, a widely used technique was employed. The number of participant was enough to represent current context. Characteristics of the participants are summarized in Table 2.

Data was collected through a questionnaire which consisted of two parts. The first part of the questionnaire contained seven questions to gather demographic information and the computer and internet usage habits of the participants. The second part of the questionnaire was the "Technological, Pedagogical, and Content Knowledge Self-Confidence" scale developed by Graham et al. (2009). Timur and Taşar (2011) translated the survey into Turkish and Cronbach Alpha was calculated as .92. The TPACK scale consists of 31 5-point likert-type questions under TK, TCK, TPK, and TPACK factors.

Table 2. Characteristics of pre-service and in-service teachers

	Pre-service teachers	In-service teachers
Gender		
Male	113	94
Female	275	117
Subject matters		
Science	132	48
Math	72	59
ICT	28	22
Classroom	156	82
Have a personal computer/cellphone		
Yes	310	143
No	78	68
Daily computer use		
Less than 2 h	179	86
Between 3 and 5 h	173	85
More than 5 h	36	40

Note: ICT, Information and communication technology teacher.

Data analysis included descriptive analysis for each of the dependant variables and subscales, an independent sample T-test for defining the effects of the dependant variables on scale scores, and multivariate analysis of variance (MANOVA) to examine the statistical differences between in-service and pre-service teachers' self confidence. The mean, standard deviation, and percentiles were gathered for the dependant variables and each of the sub-scales. Paired Sample T-Test and MANOVA were used. Based on the MANOVA test result (if there were any statistically significant effects), ANOVAs were conducted for each of the subscale scores to find individual group differences as follow-up tests. SPSS 2.0 for Windows was used for all of these statistical procedures. Impact ratios (effect sizes) were also calculated for the independent variables on the dependant variable and labeled based on Cohen's (1988) definitions: small, medium, and large.

3. Results

3.1. Descriptive analysis

Descriptive statistics (number of participants, mean, and standard deviation) for pre-service and in-service teachers' self confidence scores on four sub-scales of the instrument (their technological pedagogical and content knowledge) are given in Table 3. According to Table 3, when all participants' self-confidence scores are considered, it was observed that technological content knowledge, with 4.05 and 3.95 mean scores, respectively, is higher than other knowledge domains of TPACK framework for both the pre-service and in-service participants. Moreover, compared to the other

Table 3. Teachers' self confidence scores on their technological pedagogical content knowledge

	Pre-service			In-service		
	N	M	SD	*N*	M	SD
TPACK	388	3.54	.55	211	3.62	.77
TPK	388	3.67	.62	211	3.72	.82
TCK	388	4.05	1.03	211	3.95	1.22
TK	388	3.65	.66	211	3.58	.88

Notes: TPACK, technological pedagogical content knowledge; TPK, technological pedagogical knowledge; TCK, technological content knowledge; TK, technological knowledge.

Table 4. Post hoc ANOVA test result

Dependant variable	df	*f*	η^2	*p*-value
TPACK	3	3.94	.83	.00*
TPK	3	3.43	.73	.01*
TCK	3	.123	.07	.94
TK	3	2.75	.66	.04*

Notes: TPACK, technological pedagogical content knowledge; TPK, technological pedagogical knowledge; TCK, technological content knowledge; TK, technological knowledge.

*Significance level at $p < .05$.

knowledge domains, for TCK, both pre-service and in-service teachers agreed (agree or strongly agree) with the statement.

3.2. Research Question 1

Are there any significant differences among pre-service teachers' TPACK self-confidence by department?

One-way MANOVA was conducted to determine the effect of teachers' department on the teachers' self confidence on their technological pedagogical content knowledge (TPACK). Assumptions of MANOVA were checked for normality, linearity, homogeneity of variance matrices and the homogeneity test result showed that this assumption was violated (Box's M = 69.75, $p < .05$). For this reason a more robust statistic, Pillai's Trace, was used for reporting the result. As outlined in Table 4, no statistically significant difference was found in pre-service teachers' TPACK scores with respect to the department of the participants (Pillai's Trace = .51, $F(12, 1149) = 1.646$, $p > .05$). Univariate testing, ANOVA, was used to evaluate the independent variable's effect on each dependant variable. The result indicated the effect for TPACK scores of pre-service students ($F(3, 388) = 3.94$, $p < .05$), TPK scores ($F(3, 388) = 3.43$, $p < .05$), and also TK scores ($F(3, 388) = 2.75$, $p < .05$) to be statistically significant. Table 4 summarizes the univariate analysis result as follow-up tests to MANOVA.

When the detailed t-test results of *post hoc* ANOVA were examined, a statistically significant difference was found between math (M = 3.38, SD = .065) and both computer (M = 3.71, SD = .104, $p = .03$) and classroom teaching (M = 3.62, SD = .044, $p = .01$) under the domain of TPACK.

3.3. Research Question 2

Are there any significant differences among pre-service teachers' TPACK self-confidence by computer and internet usage?

A MANOVA was used to compare the computer and internet use of pre-service teachers for the four dimensions of the TPACK self confidence defined by the instrument. All assumptions of MANOVA for normality, linearity, homogeneity of variance-covariance matrices, and multicollinearity were checked before conducting the analysis and no serious violation was noted. The result showed that there was no statistically significant difference in the four dimensions of the TPACK scores of pre-service students based on their internet and computer use (Wilks' Lambda = .99, $F = .247$, df = (8, 764), $p = .982$). As a follow-up test, post hoc ANOVA was conducted, but no statistically significant effect was found for each independent variable on the dependant variables.

3.4. Research Questions 3–5

Are there any significant differences among in-service teachers' TPACK self-confidence by subject matter, computer and internet usage, and teaching experience?

Four separate multivariate tests were used to find the mean differences in TPACK scores of in-service teachers by department, computer and internet usage, and teaching experience. Before the analysis, assumptions of MANOVA (e.g. normality, linearity, multivariate homogeneity of variance-covariance) were tested and no significant violation of assumptions was found. Outlier analysis was also performed to ensure no extreme scores in the data-set and three outliers were removed from the analysis. As presented in Table 5, statistically significant differences were found between in-service teachers' TPACK scores with respect to subject matter ($F = 3.40$, $p < .001$), computer use ($F = 6.36$, $p < .001$), and teaching experience ($F = 2.73$, $p < .001$). Because all MANOVAs were significant based on Wilks' lambda values, univariate analysis of variance (ANOVA) was conducted for each independent variable.

Table 6 indicates the mean difference of the TPACK self confidence scores by in-service teachers' subject matter (Science, Math, ICT, and Classroom Teaching). The Multivariate test was significant and Univariate analysis was conducted for each dependant variable separately. As seen in Table 6, subject matter significantly affected the TPACK, TPK, and TK levels of the teachers. On the other hand, technological content knowledge was not significantly affected by the subject matter of the in-service teachers ($F(12, 540) = 1.609$, $p > .05$).

Further, Table 7 shows the mean difference of the TPACK self confidence scores by teachers' daily hours of computer use. The Multivariate result was significant for computer use by score of TPACK self confidence score. Univariate ANOVAs were conducted on each dependant variable separately to find the locus of the multivariate effect. As seen in Table 7, in-service teachers' daily computer use significantly affected each dimension of the TPACK self confidence scores (at the level of .00).

Finally, Table 8 shows ANOVA results to determine the effect of teaching experience of in-service teachers on the teachers' TPACK self confidence. The Multivariate result was significant for years of teaching experience by frequency of teachers' TPACK scores. However, the ANOVA results revealed that only the technological knowledge domain of the TPACK framework had a significant effect on the teaching experience ($F(4, 203) = 3.11$, $p < .05$).

Table 5. MANOVA results In-Service teachers' TPACK self confidence scores

Source	TPACK m	*F* score	*p*-value
Subject matter			
Science	3.62	3.40	.00*
Math	3.54		
ICT	4.43		
Classroom	3.64		
Computer use			
Lower than 2 h	3.40	6.36	.00*
3–4 h	3.75		
Higher than 5 h	4.20		
Teaching experience			
1–5	3.75	2.32	.00*
6–10	3.85		
11–15	3.80		
16–20	3.73		
Over 20	3.55		

*Significance level at $p < .05$.

Table 6. Post hoc ANOVA test result for teachers' department on dependant variable

TPACK self confidence	Department	Mean	SD	*f*	*p*-value
Technological pedagogical content knowledge (TPACK)	Science education	3.62	.62	7.4	.00*
	Math education	3.42	.70		
	Computer education	4.28	.58		
	Classroom teaching	3.58	.84		
Technological pedagogical knowledge (TPK)	Science education	3.74	.71	5.8	.00*
	Math education	3.54	.71		
	Computer education	4.35	.54		
	Classroom teaching	3.67	.93		
Technological content knowledge (TCK)	Science education	3.97	1.03	1.6	.18
	Math education	3.98	1.26		
	Computer education	4.43	1.08		
	Classroom teaching	3.79	1.32		
Technological knowledge (TK)	Science education	3.56	.72	9.5	.00*
	Math education	3.56	.70		
	Computer education	4.44	.71		
	Classroom teaching	3.37	.99		

*Science education (n = 48), Math education (n = 59), Computer education (n = 22), Classroom teaching (n = 82), df = 12, df (Error) = 540, SD = Standard deviation.

Table 7. Post hoc ANOVA test result for teachers' daily computer use

TPACK self confidence	Daily computer use	Mean	SD	*f*	*p*-value
Technological pedagogical content knowledge (TPACK)	Lower than 2 h	3.40	.81	9.91	.00*
	3–4 h	3.65	.68		
	Higher than 5 h	4.02	.68		
Technological pedagogical knowledge (TPK)	Lower than 2 h	3.43	.85	13.90	.00*
	3–4 h	3.80	.72		
	Higher than 5 h	4.19	.69		
Technological content knowledge (TCK)	Lower than 2 h	3.64	1.28	5.11	.00*
	3–4 h	4.14	1.20		
	Higher than 5 h	4.24	.99		
Technological knowledge (TK)	Lower than 2 h	3.32	.91	19.82	.00*
	3–4 h	3.50	.77		
	Higher than 5 h	4.29	.66		

*Lower than 2 h (n = 86), 3–4 h (n = 85), Higher than 5 h (n = 40), df = 8, df (Error) = 410, SD = Standard deviation.

3.5. Research Question 6

Are there any significant differences among the TPACK self confidence scores of pre-service and in-service teachers in the same subject?

An one-way MANOVA test was conducted to determine the effect of teacher status as pre-service and in-service on teachers' TPACK scores. Again, before conducting the analysis, all assumptions of MANOVA were checked and no significant violation of linearity, normality, or homogeneity were found. The result was not statistically significant, Wilks' λ = .98, F = 2.188, df = (4, 593), p = .069, indicating no multivariate effect.

Table 8. Post hoc ANOVA test result for teachers' experience of years

TPCK self confidence	Teaching experience	Mean	SD	*f*	*p*-value
Technological pedagogical content knowledge (TPACK)	1–5	3.42	.75	1.76	.13
	6–10	3.71	.67		
	11–15	3.74	.69		
	16–20	3.81	.77		
	Over 20	3.56	.95		
Technological pedagogical knowledge (TPK)	1–5	3.53	.87	1.38	.24
	6–10	3.87	.65		
	11–15	3.83	.72		
	16–20	3.77	.86		
	Over 20	3.70	.97		
Technological content knowledge (TCK)	1–5	4.10	1.19	1.40	.23
	6–10	4.11	1.29		
	11–15	3.99	1.26		
	16–20	3.96	1.18		
	Over 20	3.55	1.19		
Technological knowledge (TK)	1–5	3.57	.78	3.11	.01*
	6–10	3.80	.77		
	11–15	3.70	.93		
	16–20	3.67	.98		
	Over 20	3.17	.94		

*1–5 (n = 57), 6–10 (n = 44), 11–15 (n = 46), 16–20 (n = 23), Over 20 (n = 38), df = 4, df (Error) = 203, SD = Standard deviation.

4. Discussion and conclusion

This study aimed to investigate and compare in-service and pre-service teachers' self confidence in technological pedagogical and content knowledge (TPACK) in relation to their teaching experience, expertise, technology usage, and gender. The results showed that both pre-service and in-service participants exhibit the highest self-confidence level in the technological content knowledge domain. While pre-service teachers had the lowest score in TPACK, in-service teachers had the lowest score in the technological knowledge domain. This finding is similar to the findings of Fishman and Davis (2006). They indicated that improvement in TPACK takes a long time and pre-service teachers need to move beyond teacher preparation programs by having experience in the teaching profession to build TPACK. The effect of participants' subject matters on their TPACK self confidence was investigated. The results indicated that pre-service Math teachers' TPACK level was significantly lower than pre-service ICT and classroom teachers. In their study, Jang and Tsai (2012) investigated the differences between mathematics and science teachers' TPACK. Similarly, they found that mathematics teachers have significantly lower TPACK than science teachers. This result may be because science teachers tend to use more technological tools and approaches in their classes than mathematics teachers. The field of mathematics is one of the oldest sciences and has been taught since long before modern technologies were developed. Mathematics teachers may not feel the need to use technology for teaching math and this may explain their low TPACK levels. In a recent study, Tokmak, Incikabi, and Ozgelen (2013) explored the difference between science, mathematics, and literacy pre-service teachers' TPACK levels. They did not find a significant difference between pre-service teachers' TPACK levels depending on subject matter.

The effect of technology usage (computer use and internet use) on pre-service teachers' TPACK domains was also investigated. Findings showed that technology usage did not have a significant effect on pre-service teachers' TPACK domains. One might suppose that pre-service teachers who use technology would have a significantly higher TPACK score, especially on the TK domain. However, in contrast to the literature, the result did not indicate a significant effect of technology usage on pre-service teachers' TPACK domains. In their study, Jang and Tsai (2012) found a significant effect of IWB use on teachers' TPACK scores. Another recent study exposed that the TPACK scores of pre-service teachers who use ICT were significantly higher than those who did not use ICT (Kabakci Yurdakul & Coklar, 2014). Similar to pre-service teachers, statistically significant differences were found between in-service teachers' TPACK scores with respect to subject matter. The results indicated that ICT teachers' TPACK level was significantly higher than science, math, and classroom teachers' levels, considering the TPACK, TPK, and TK domains. However, participants' technological content knowledge (TCK) did not significantly differ depending on subject matter. A possible reason may be that ICT teachers' content knowledge covers the TK and TPK domains. One of the objectives of ICT teachers is appropriately integrating technology into schools. Therefore, it is understandable that they would get a higher score in the TPACK, TPK, and TK domains.

The results also showed that, contrary to pre-service teachers, technology usage had a significant effect on in-service teachers' TPACK scores. The scores of in-service teachers who use computers more than five hours a day was significantly higher in all domains of TPACK than teachers who use computers less than two hours a day. This result is not unpredictable, since the TK domain effects the total TPACK score (e.g. Jang, 2010). Moreover, it was found that the TK domain only significantly varied depending on experience. Teachers with 6–15 years of experience had higher TK scores than teachers with 20 years of experience. A teacher with five years of experience is generally considered an "experienced teacher". On the other hand, a teacher with more than 20 years of experience may not be sufficiently educated for using current technologies and instructional approaches. This result corresponds to the findings of previous studies in the literature. Several studies indicated that the TPACK scores of experienced teachers were higher than the scores of novice teachers (Jang & Tsai, 2012). In their study, Ozgun-Koca, Meagher, and Edwards (2010) found that lack of teaching experience cause inability to use technology in teaching. It is commonly held that experienced teachers use instructional methods and tools more efficiently. Surely, in order to use instructional technologies effectively teachers need more practicing, modeling, and understanding (Bell, Maeng, & Binns, 2013; Gill, Dalgarno, & Carlson, 2015).

It was found that the TPACK self confidence levels of pre-service and in-service teachers in the same subject did not vary. Considering the impact of experience, it could be supposed that the TPACK scores of Pre-service teachers would be lower than in-service teachers. However, the results did not show a significant difference. A possible reason may be that teacher training institutions provide students with well-planned classes to prepare them for the teaching profession. It was also assume that pre-service teachers are receiving up-to-date training. Also, in most of the case, teachers could be take adequate in-service training. However, the result of the study showed that both pre-service and in-service teachers need to improve their knowledge and skills to merge three subdomain of TPACK. This can only be achieved through proper training. On the other hand, further studies should be conducted to explore and compare the pre-service teachers' technological pedagogical and content knowledge who are studying in different institutions. Moreover, teaching programs of colleges could be examined in qualitative way.

Funding
The authors received no direct funding for this research.

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Citation information
Cite this article as: A comparison of in-service and pre-service teachers' technological pedagogical content knowledge self-confidence, Fatih Saltan & Kürşat Arslan, *Cogent Education* (2017), 4: 1311501.

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