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Investigating Pre-Service Early Childhood Education Teachers' Technological Pedagogical Content Knowledge (TPACK) Competencies Regarding Digital Literacy Skills and Their Technology Attitudes and Usage

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Abstract

The integration of technology into education is a substantial issue for supporting and updating teachers' professional development in today's world and bringing up digitally literate generations and well-educated human capital. Studies have shown that technology integration in education is a complex and multidimensional issue. TPACK transcends the triad of core knowledge types and comprises the basis for the effective integration of technology into teaching. Therefore, the present study sought to understand the contribution of the technology attitudes and usage, digital literacy skills, and online reading comprehension strategies in pre-service early childhood teachers' TPACK competencies. The participants in the study were 481 voluntary pre-service early childhood teachers (female=398, male=83). The data were collected as a cross-sectional survey. The study findings revealed that pre-service teachers' TPACK competencies are associated with their technology attitude and usage, digital literacy skills, and online reading comprehension strategies, as well as that the variables explained 38% of the variance. However, pre-service teachers' grade level and GPA are not related to their self-reported TPACK competencies. These findings can be seen as signals of the necessity for theoretical knowledge and practice to be developed in pre-service teachers' technology integration in education.

Keywords: TPACK, digital literacy skills, technology attitude, usage, pre-service, early childhood teachers

1. Introduction

Rapid advances in technology can change human lives dramatically. Individuals experience technology-driven environments not only in daily life but also in professional life in the digital age (Graham, 2011; Mishra & Koehler, 2006). The integration of technology into education is a substantial issue for supporting and updating teachers' professional development in today's world and bringing up digitally literate generations and well-educated human capital. Thus, technology-enriched education from preschool through higher education is a policy focus in countries such as Canada (Alberta Education, 2013; Milton, 2003), the USA (US Department of Education, 2018; Office of Educational Technology, 2017) and Japan (Ministry of Education, Culture, Sports & Technology, 2018; Nurutdinova & Dmitrieva, 2017). In this context, the Movement of Enhancing Opportunity and Improving Technology (FATIH) project has been administered in Turkey since 2010 to provide technology-enriched learning environments in public schools. The FATIH project aims to supply information communication technologies (ICTs) for each school, classroom, teacher and student to enhance accessibility, productivity, equality, e-measurability and quality among students to fill digital gaps (Ministry of Education, 2016). According to the FATIH project reports, 1.4 million tablets were distributed to students. In addition, 3,362 public schools were equipped with hardware and software infrastructure, and 84,000 smart boards were provided to classrooms. Although a total of 8 billion Turkish lira was invested in the project, the expected benefits did not appear (Dursun, Kirbas, & Yuksel, 2015; Oz, 2015; Yolcu & Bayram, 2016).

On the one hand, the availability of ICT devices and technical support are the external factors affecting technology integration in education. On the other hand, teachers' internal factors, such as competencies, attitudes and beliefs, are also essential to developing and designing appropriate technology-enriched learning experiences in classrooms (Anderson & Maninger, 2007; Baek, Jong, & Kim, 2008; Schmidt, Baran, Thompson, Mishra,

Koehler, & Shin, 2009; Teo & Noyes, 2011; Tondeur, Pareja Roblin, van Braak, Fisser, & Voogt, 2013). Studies have shown that technology integration in education is a complex and multidimensional issue and generally does not fit existing teacher education practices and programs (Olson, 2000; Kabakci-Yurdakul & Coklar, 2014; Voogt & McKenney, 2017; Voogt, Tilya, & van den Akker, 2009). Thus, Mishra and Koehler (2006) proposed the Technological Pedagogical Content Knowledge (TPACK) concept to provide a theoretical framework for elaborating teachers' complex roles and competencies in the technology integration process.

1.1 Technological Pedagogical Content Knowledge (TPACK)

Mishra and Koehler (2006) broadened out Shulman's (1986) Pedagogical Content Knowledge (PCK) conceptual framework and built a theoretical grounding for understanding the required teacher competencies for integrating technology into their teaching process. Mishra and Koehler (2006) articulated a key knowledge model based on a triad of content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK). There are transactional associations among these three key knowledge types. The framework advocates that the whole is greater than the sum of its parts, and dynamic interactions among the core knowledge types produce four additional knowledge types: pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPACK; Graham, 2011; Koehler & Mishra, 2009; Koehler, Mishra, Kereluik, Shin, & Graham, 2014; Mishra & Koehler, 2006). TPACK transcends the triad of core knowledge types and comprises the basis for the effective integration of technology into teaching, "requiring an understanding of the representation of concepts using technologies, and pedagogical techniques that use technologies in constructive ways to teach content" (Koehler & Mishra, 2009, p. 66).

In light of the TPACK framework, various TPACK instruments (e.g., Canbazoglu-Bilici, Yamak, Kavak, Guzey, 2013; Kabakci-Yurdakul, Odabasi, Kilicer, Coklar, Birinci, & Kurt, 2012; Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009) have been developed to investigate pre-service (Joo, Park, & Lim, 2018; Kabakci-Yurdakul & Coklar, 2014; Scherer, Tondeur, Siddiq, & Baran, 2018; Voogt & McKenney, 2017; Yerdelen-Damar, Boz, & Aydın-Gunbahar, 2017) and in-service teachers' (Dong, Chai, Sang, Koh, & Tsai, 2015; Jang, 2010; Liang, Chai, Koh, Yang, & Tsai, 2013; Lin, Tsai, Chai, & Lee, 2013; Niess et al., 2009) technology integration competencies in teaching to determine barriers to teaching effectively with technology and to bolster teachers' competencies. These studies showed that teachers' TPACK competencies are associated with their ICT usage (Kabakci-Yurdakul & Coklar, 2014; Karaca, Can, & Yildirim, 2013; Yerdelen-Damar et al., 2017), ownership (Inan & Lowther, 2009; Yerdelen-Damar et al., 2017), attitudes toward technology (Karaca et al., 2013; Scherer et al., 2018), and perceptions of the usefulness of teaching with technology (Alsofyani, Aris, Eynon, & Majid, 2012; Joo et al., 2018). However, digital literacy skills and online reading comprehension strategies are also essential components of constructing and producing knowledge from digital sources (Leu, Kinzer, Coiro, Castek, & Henry, 2017; Leu et al., 2011; Ng, 2012; Ustundag, Gunes, & Bahcivan, 2017) to develop technology-enriched learning experiences for children. There is a research gap in investigating the relationships among TPACK, digital literacy skills and online reading comprehension strategies. Therefore, the present study attempts to elaborate an understanding of TPACK competencies regarding digital literacy skills, online reading comprehension strategies and attitudes toward technology and technology usage.

1.2 Digital Literacy

Prensky (2001) first articulated the term "digital natives" in the literature to describe generations who live surrounded by digital technologies and who actively use these technologies to access, create and share information via online platforms. They are capable of processing multiple digital tasks simultaneously, such as blogging, downloading e-books and surfing social networks, in contrast to previous generations. However, Prensky identified digital natives in terms of their birth year—namely, people born after 1980—but studies have shown that age is not an actual indicator; the availability of ICTs and the breadth of technology usage, education and previous experiences are important for describing digital natives (Altun & Tantekin-Erden, 2018; Helsper & Eynon, 2010; Ng, 2012a). Ng (2012b) proposed a digital literacy model to clarify the competencies imputed to digital natives. According to Ng's (2012b) framework, digital literacy skills consist of technical, cognitive and socio-emotional dimensions and the intersections among these dimensions. The technical dimension covers the capability of operating ICTs adequately for learning and daily life activities, such as sending photos from smart phones via Bluetooth, downloading e-books and updating applications. The cognitive dimension related to the mental skills involved in processing digital information to operate ICTs also comprises ethical, legal and moral concerns related to trading online platforms and the use of digital sources (e.g., copyrights and plagiarism). Lastly, the socio-emotional dimension is associated with skills in navigating digital activities, such as communicating, learning, teaching and socializing, by obeying communication rules, protecting privacy, using

polite language, being aware of cyber bulling and reporting threats (Ng, 2012a). Studies have pointed out that these digital capabilities can be indicators of individuals' ability to be competent technology users, adopt new technologies comfortably, and transfer daily-life and professional operations to digital platforms (Gunes & Bahcivan, 2018; Ng, 2012a; Ustundag et al., 2017). Therefore, digital literacy skills are a possible predictor of TPACK competencies. The present study aims to investigate the relation between TPACK and digital literacy skills with and without attitudes toward technology, the breadth of ICT usage and online reading comprehension strategies.

1.3 Online Reading Comprehension Strategies

Reading is a basic receptive language skill and a way to access knowledge in academic tasks. The evolution of ICTs has gradually changed the nature of text and caused a textual shift from print-based text to hyper/multimodal texts, enriched visuals, sounds, animations and navigational pathways (Jewitt, 2012; Kitson, 2011; Leu et al., 2017; Walsh, 2006). The presence of technology-immersed texts has not decreased the importance of reading skills in the digital age; however, reading has become a more sophisticated skill requiring one to process multiple information types. Leu et al. (2017) have proposed the new literacies framework to examine the changing nature of literacy and emerging literacy skills in the digital age. They suggest that the nature of literacy has evolved with rapid advances in ICTs. A typical reader now faces a screen of hypertext with abundant visuals, sounds, links, and animations rather than simple text and visuals on a page. Therefore, a reader is required to process different types of information at the same time to make meaning from hypertexts. Furthermore, it is easy to access a vast amount of information about any topic of interest. Clearly, then, there is a need to develop strategies to recognize and avoid unreliable sources and to access accurate and reliable sources. New literacies encompass complex skills and strategies to handle digital sources and communicate, comprehend, and compose information in hypertexts. Leu et al. (2011) advocated that literacy is a deictic term (one that changes rapidly) in the digital age and that online reading comprehension requires a set of complex sub-skills. A reader can encounter accurate or misleading online information; therefore, the reader needs to follow these five major steps: a) identify important questions; b) locate information; c) evaluate information critically; d) synthesize information to answer questions; and e) communicate the answers to others (p. 7). Research has demonstrated that the majority of pre-service teachers tend to choose to read online sources (Altun & Tantekin-Erden, 2018; Ulusoy & Dedeoglu, 2015). Online reading strategies are essential for both meaning making from online sources to learn new information and for developing appropriate online materials for technology-integrated teaching, but no published study has investigated the association between TPACK and online reading comprehension skills, as far as this researcher can access. The current study attempts to investigate the potential association between TPACK and online reading comprehension and to provide empirical evidence.

1.4 Attitudes Toward Technology and Technology Usage

Attitude is an evaluative and affective attribution/disposition regarding favor or disfavor of a particular action, situation or subject (Eagly & Chaiken, 1993), and the linkage between psychological tendencies and behavior has been investigated in large body of research (Ajzen & Fishbein, 2000; Glasman & Albarracin, 2006; Kim & Hunter, 1993; Kraus, 1995; Maio, Haddock, & Verplanken, 2018). Davis, Bagozzi and Warshaw (1989) proposed the Technology Acceptance Model (TAM) to address the role of psychological factors in user acceptance of technology (Teo & Noyes, 2011). According to the model, individuals' attitudes toward technology are related to their intention to use technology and their acceptance status (Davis et al., 1989). Studies have provided evidence that attitude is a variable driving ICT usage (Bhattacherjee & Premkumar, 2004; Cavas, Cavas, Karaoglan, & Kisla, 2009; Teo & Noyes, 2011), and teachers who have more positive attitudes toward technology tend to integrate technology into their teaching (Galowich, 1999; Marangunic & Granic, 2015). Furthermore, recent research has revealed that attitude toward technology/ICT is associated with pre-service teachers' TPACK competencies and self-beliefs (Scherer et al., 2017; Yerdelen-Damar et al., 2017). The aforementioned studies discussed that different factors have roles in teachers' TPACK competencies. Based on these studies' findings, the present study aims to investigate the contributions of attitudes toward technology and usage, digital literacy skills and online reading comprehension strategies on pre-service early childhood teachers' TPACK competencies. This study attempts to answer the following research questions:

1) Is there a significant difference in pre-service teachers' TPACK scores according to gender?

2) Is there a significant difference in pre-service teachers' TPACK scores according to grade level?

3) Is there a significant difference in pre-service teachers' TPACK scores according to cumulative grade-point average (GPA)?

4) Is there a significant difference in pre-service teachers' TPACK scores according to household income?

5) Is there a significant difference in pre-service teachers' TPACK scores according to ownership of ICTs?

6) Is there a relationship between TPACK and attitudes toward technology and usage, digital literacy skills and online reading comprehension strategies?

7) How well do attitudes toward technology and usage, digital literacy skills and online reading comprehension strategies predict pre-service teachers' TPACK competencies?

2. Method

In this study, a correlational research design (Fraenkel & Wallen, 2006) was used to investigate the relationship between pre-service early childhood teachers' TPACK competencies and attitudes toward technology and usage, digital literacy skills and online reading comprehension strategies.

2.1 Sample

The participants in the study were 481 voluntary pre-service early childhood teachers (female=398, male=83) from two state universities in Central Anatolia, Turkey. The participants' age ranged from 18 to 30 years old (M=21.20, SD=2.71). The participants also comprised 114 freshmen, 117 sophomores, 129 juniors and 121 seniors. Detailed demographic information on the pre-service teachers is presented in Table 1.

Table 1. Demographic information of the participants

	f	%
Gender		
Female	398	82.7
Male	83	17.3
Total	481	100
Year		
Freshman	114	23.70
Sophomore	117	24.32
Junior	129	26.82
Senior	121	25.16
Total	481	100
GPA		
1.00–2.00	46	9.56
2.01–2.50	82	17.05
2.51–3.00	121	25.16
3.01–3.50	184	38.25
3.51–4.00	48	9.98
Total	481	100
*Household income groups**		
0–1.500 TRY	83	17.30
1.501–3.000 TRY	222	46.20
3.001–4.500 TRY	127	26.40
4.501–6.000 TRY	29	6.00
6.001+ TRY	16	3.30
Total	481	100

Note. *According to the Ministry of Labor, Social Services, and Family (2018), the net minimum wage in Turkey is 1,603 Turkish lira (TRY), the individual poverty threshold is set at 2.136 TRY and a living wage for a four-person family is 5.662 TRY (Confederation of Turkish Trade Unions, 2018).

2.2 Data Collection Procedures

The study data were collected in the spring semester of the 2017–2018 academic year. The pre-service teachers were selected using a convenience sampling method, a nonrandom sampling method that enables a researcher to study the available individuals (Fraenkel & Wallen, 2006). The data were collected as a cross-sectional survey. A total of 600 questionnaires were distributed to pre-service teachers at their courses, 86.83% of which (n=521) were returned. Among the 521 questionnaires, 40 had missing information, so they were excluded from the dataset.

2.3 Instruments

The data in the study were collected through the following scales: the technological pedagogical content knowledge scale (TPACK-Deep), digital literacy skills, online reading comprehension strategies and the

demographic information form.

2.3.1 Technological Pedagogical Content Knowledge Scale (TPACK-Deep)

A technological pedagogical content knowledge scale (TPACK-Deep) was developed by Kabakci-Yurdakul, Ferhan-Odabasi, Kilicer, Coklar, Birinci, and Kurt (2012) to measure pre-service teachers' TPACK competencies. The scale consisted of 33 items in a 5-point Likert-type scale. The pilot study of the scale was conducted with 995 pre-service teachers in Turkey. Regarding the internal consistency of the total scale, the Cronbach's alpha value was calculated as .95. The scale comprised four factors: design (10 items, α=.92), exertion (12 items, α=.91), ethics (6 items, α=.86) and proficiency (5 items, α= .85). The total variance explained by the four factors was 59.08.

2.3.2 Digital Literacy Skills

Ng (2012) developed the Digital Literacy Skills scale, and it was adapted into Turkish by Ustundag, Gunes and Bahcivan (2017). They performed an explanatory factor analysis with 979 pre-service teachers who were recruited from 13 state universities. The scale consisted of 10 items in a 5-point Likert-type scale. The explanatory factor analysis revealed a one-factor solution and explained that the total variance was 40. The Cronbach's alpha value was calculated as .86.

2.3.3 Online Reading Comprehension Strategies

The scale was developed by Ulusoy and Dedeoglu (2012) to assess pre-service teachers' self-reported online reading comprehension strategies. The initial pool of 97 items was generated by conceptual explanation in the New Literacies Framework (e.g., Coiro, 2003; Leu, Coiro, Castek, Hartman, Henry, & Reinking, 2008). After gaining expert opinions and conducting a pilot study, the final version of the scale included 46 items in a 5-point Likert-type scale. They administered the scale to 495 pre-service teachers in Turkey and reported that a Cronbach's alpha value of .93.

2.3.4 Attitudes Toward Technology Scale

Aydın and Karaa (2013) developed a way to measure pre-service teachers' attitudes toward technology. They prepared 22 items in a 5-point Likert-type scale, and they conducted a pilot study with 378 pre-service teachers. A confirmatory factor analysis yielded one factor structure, and five of the items were excluded from the scale due to lower factor loadings. The final version of the scale consisted of 17 items, and the Cronbach's alpha value was calculated as .87.

2.3.5 Demographic Information Form

The demographic information form was established to collect information from pre-service teachers regarding gender, age, GPA, grade level, household income, ICT ownership and daily ICT usage time.

2.4 Data Analysis

The research data were analyzed using the SPSS Statistics Ver. 22.00 software program. Descriptive and inferential statistical methods (independent samples t-test, one-way ANOVA, Pearson correlation, and multiple regressions) were performed to analyze the data.

3. Results

Before conducting inferential statistical analysis, the distribution of the scores was examined. As seen in Table 2, the skewness and kurtosis values of the scores were within a -2 to +2 range. Histogram graphs corroborated the normal distribution visually (Tabachnick & Fidell, 2007). Therefore, the data set met normal distribution.

Table 2. The descriptive statistics of the data set

	N	*Min*	*Max*	*M*	*SD*	*Skewness*	*Kurtosis*
Technology attitude	481	25.00	84.00	59.03	10.10	-0.50	0.76
Digital literacy	481	10.00	50.00	34.13	6.47	-0.51	0.73
Online reading comprehension	481	64.00	174.00	128.60	20.14	0.22	-0.20
TPACK.design	481	10.00	50.00	37.25	7.07	-0.79	1.14
TPACK.exertion	481	12.00	60.00	46.71	7.84	-1.18	1.77
TPACK.ethics	481	6.00	30.00	22.46	4.16	-0.76	1.31
TPACK.proficiency	481	5.00	25.00	18.97	3.44	-0.76	1.50
TPACK.total	481	33.00	165.00	125.41	16.43	-1.04	1.46

3.1 Pre-Service Teachers' TPACK Scores Regarding Gender

Independent samples t-tests were conducted to compare pre-service teachers' TPACK scores for females and males. As shown in Table 3, there was a significant difference in pre-service teachers total TPACK (t[479]=2.562, p<0.05, η^2=0.013), design (t[479]=2.593, p<0.05, η^2=0.013), and exertion sub-dimensions (t[479]=2.894, p<0.05, η^2=0.017) in favor of females. On the other hand, there was no significant difference in ethics (t[479]=1.498, p>0.05, η^2=0.004) or proficiency scores (t[479]=1.464, p>0.05, η^2=0.004) regarding gender.

Table 3. Independent samples t-tests results of pre-service teachers' TPACK scores regarding gender

		N	*M*	*SD*	*t*	*p*	η^2
TPACK.design	Female	398	37.63	6.98	2.593	0.010	0.013
	Male	83	35.43	7.26			
TPACK.exertion	Female	398	47.18	7.52	2.894	0.004	0.017
	Male	83	44.46	8.95			
TPACK.ethics	Female	398	22.59	4.02	1.498	0.135	0.004
	Male	83	21.84	4.75			
TPACK.proficiency	Female	398	19.07	3.49	1.464	0.144	0.004
	Male	83	18.46	3.16			
TPACK.total	Female	398	126.49	19.95	2.562	0.011	0.013
	Male	83	120.21	22.00			

3.2 Pre-Service Teachers' TPACK Scores Regarding Grade Level

One-way ANOVA analyses were performed to compare pre-service teachers' TPACK scores regarding grade level. As demonstrated in Table 4, the results revealed that there are no statistical significant differences among the pre-service teachers' design (F[3, 477]=0.413, p>0.05, η^2=0.002), exertion (F[3, 477]=1.555, p>0.05, η^2=0.009), ethics (F[3, 477]=1.581, p>0.05, η^2=0.009), proficiency (F[3, 477]=1.296, p>0.05, η^2=0.008), or total TPACK scores (F[3, 477]=1.192, p>0.05, η^2=0.007) with regard to their grade level.

Table 4. One-way ANOVA results for pre-service teachers' TPACK scores in terms of grade level

		Sum of Squares	*df*	*Mean Square*	*F*	*p*	η^2
TPACK.design	Between Groups	62.347	3	20.782	0.413	0.744	0.002
	Within Groups	23,993.199	477	50.300			
	Total	24,055.547	480				
TPACK.exertion	Between Groups	285.982	3	95.327	1.555	0.200	0.009
	Within Groups	29,251.128	477	61.323			
	Total	29,537.110	480				
TPACK.ethics	Between Groups	82.011	3	27.337	1.581	0.193	0.009
	Within Groups	8,245.673	477	17.287			
	Total	8,327.684	480				
TPACK.proficiency	Between Groups	46.050	3	15.350	1.296	0.275	0.008
	Within Groups	5,650.598	477	11.846			
	Total	5,696.649	480				
TPACK.total	Between Groups	1,491.123	3	497.041	1.192	0.312	0.007
	Within Groups	198,971.546	477	417.131			
	Total	200,462.669	480				

3.3 Pre-Service Teachers' TPACK Scores Regarding GPA

One-way ANOVA analyses were carried out to compare pre-service teachers' TPACK scores regarding GPA. As shown in Table 5, the results revealed that there are no statistical significant differences among the pre-service teachers' design (F[4, 476]=.1.271, p>0.05, η^2=0.010), exertion (F[4, 476]=0.844, p>0.05, η^2=0.007), ethics (F[4, 476]=0.470, p>0.05, η^2=0.003), proficiency (F[4, 476]=0.083, p>0.05, η^2=0.000), or total TPACK scores (F[4, 476]=0.406, p>0.05, η^2=0.003) with regard to their GPA.

Table 5. One-way ANOVA results for pre-service teachers' TPACK scores in terms of GPA

		Sum of Squares	*df*	*Mean Square*	*F*	*p*	η^2
TPACK.design	Between Groups	254.273	4	63.568	1.271	0.280	0.010
	Within Groups	23,801.274	476	50.003			
	Total	24,055.547	480				
TPACK.exertion	Between Groups	207.900	4	51.975	0.844	0.498	0.007
	Within Groups	29,329.211	476	61.616			
	Total	29,537.110	480				
TPACK.ethics	Between Groups	32.794	4	8.199	0.470	0.757	0.003
	Within Groups	8,294.890	476	17.426			
	Total	8,327.684	480				
TPACK.proficiency	Between Groups	3.966	4	.991	0.083	0.988	0.000
	Within Groups	5,692.683	476	11.959			
	Total	5,696.649	480				
TPACK.total	Between Groups	681.981	4	170.495	0.406	0.804	0.003
	Within Groups	199,780.689	476	419.707			
	Total	200,462.669	480				

3.4 Pre-Service Teachers' TPACK Scores Regarding Household Income

One-way ANOVA analyses were performed to determine if there is any statistical significant difference in pre-service teachers' TPACK scores in terms of household income. As shown in Table 6, results revealed that there are statistical significant differences in design (F[4, 476]=5.028, p<0.05, η^2=0.040) and total TPACK scores (F[4, 476]=2.576, p<0.05, η^2=0.021) with regard to their household income. In order to detect where the differences in scores occurred, the Scheffe test for post-hoc comparisons was used. Results showed that there are statistical differences between the pre-service teachers design scores for group 1(M=36.17, SD=6.47) and group 5 (M=42.50, SD=7.55). Furthermore, the total TPACK scores of group 5 (M=137.00, SD=21.84) was significantly different from group 1(M=123.02, SD=18.05).

Table 6. One-way ANOVA results for pre-service teachers' TPACK scores in terms of household income

		Sum of Squares	*df*	*Mean Square*	*F*	*p*	η^2
TPACK.design	Between Groups	977.497	4	244.374	5.028	0.001	0.040
	Within Groups	22942.419	476	48.607			
	Total	23919.916	480				
TPACK.exertion	Between Groups	348.601	4	87.150	1.422	0.225	0.011
	Within Groups	28917.706	476	61.266			
	Total	29266.306	480				
TPACK.ethics	Between Groups	94.159	4	23.540	1.363	0.246	0.011
	Within Groups	8152.973	476	17.273			
	Total	8247.132	480				
TPACK.proficiency	Between Groups	62.857	4	15.714	1.321	0.261	0.011
	Within Groups	5613.009	476	11.892			
	Total	5675.866	480				
TPACK.total	Between Groups	4246.736	4	1061.684	2.576	0.037	0.021
	Within Groups	194544.489	476	412.171			
	Total	198791.224	480				

3.5 Pre-Service Teachers' TPACK Scores Regarding ICTs Ownership

Independent samples t-tests were carried out to examine if there is any statistical significant difference among the pre-service teachers' TPACK scores with regard to their ICTs ownership. The majority of the pre-service teachers (97.7%) owned smartphones, thus, their TPACK scores were not examined regarding smartphone ownership. As seen in Table 7, the results imply that pre-service teachers' design (t[479]=2.880, p<0.05, η^2=0.017), exertion (t[479]=2.383, p<0.05, η^2=0.011), proficiency (t[479]=2.918, p<0.05, η^2=0.017), and total TPACK scores (t[479]=2.543, p<0.05, η^2=0.013) were differentiated statistically significantly in favor of PC ownership. However, ethic scores (t[479]=0.689, p>0.05, η^2=0.000) did not indicate any significant differences among pre-service teachers in terms of PC ownership.

A significant difference was found in design (t[479]=2.361, p<0.05, η^2=0.011) and total TPACK scores (t[479]=2.034, p<0.05, η^2=0.008) of pre-service teachers in terms of tablet ownership. As demonstrated in Table 7, the results revealed that the design (t[479]=5.341, p<0.05, η^2=0.056), exertion (t[479]=4.731, p<0.05, η^2=0.044), ethics (t[479]=5.358, p<0.05, η^2=0.056), proficiency (t[479]=4.628, p<0.05, η^2=0.042), and total TPACK scores (t[479]=5.568, p<0.05, η^2=0.060) were differentiated statistically significantly in favor of household Internet access.

Table 7. Independent samples t-tests results of pre-service teachers TPACK scores regarding ICTs ownership

ICTs ownership			*N*	*M*	*SD*	*t*	*p*	η^2
TPACK.design	PC	Yes	323	37.90	7.06	2.880	0.004	0.017
		No	158	35.93	6.94			
	Tablet	Yes	184	38.36	6.66	2.361	0.019	0.011
		No	297	36.78	7.63			
	Household Internet access	Yes	342	34.62	6.83	5.341	0.000	0.056
		No	139	38.32	6.90			
TPACK.exertion	PC	Yes	323	47.31	7.72	2.383	0.018	0.011
		No	158	45.50	7.97			
	Tablet	Yes	184	47.56	8.40	1.567	0.118	0.005
		No	297	46.39	7.46			
	Household Internet access	Yes	342	47.77	7.58	4.731	0.000	0.044
		No	139	44.12	7.90			
TPACK.ethics	PC	Yes	323	22.55	4.02	0.689	0.491	0.000
		No	158	22.27	4.23			
	Tablet	Yes	184	22.98	4.46	1.721	0.086	0.006
		No	297	22.27	3.92			
	Household Internet access	Yes	342	20.91	4.20	5.358	0.000	0.056
		No	139	23.09	3.98			
TPACK.proficiency	PC	Yes	323	19.29	3.38	2.918	0.004	0.017
		No	158	18.32	3.49			
	Tablet	Yes	184	19.33	3.58	1.535	0.125	0.004
		No	297	18.83	3.33			
	Household Internet access	Yes	342	19.42	3.37	4.628	0.000	0.042
		No	139	17.85	3.36			
TPACK.total	PC	Yes	323	127.06	20.26	2.543	0.011	0.013
		No	158	122.04	20.43			
	Tablet	Yes	184	128.23	19.12	2.034	0.042	0.008
		No	297	124.23	22.12			
	Household Internet access	Yes	342	128.62	19.60	5.568	0.000	0.060
		No	139	117.51	20.35			

3.6 Bivariate Relationship Between TPACK and Attitudes Toward Technology and Usage, Digital Literacy Skills, and Online Reading Comprehension Strategies

In order to determine if there are any significant relationships between TPACK and attitudes toward technology and usage, digital literacy skills, and online reading comprehension strategies, a Pearson correlation analysis was performed. Preliminary analyses revealed that there was no violation of the assumptions of normality and linearity.

Results indicated that there was a significantly high relationship between TPACK total and digital literacy skills scores (r=0.51, p<0.01). In addition, a moderately significant relationship was found between TPACK total and technology attitude (r=0.44, p<0.01) and online reading comprehension strategies (r=0.42, p<0.01). The detailed information regarding the Pearson correlation results is presented in Table 8.

Table 8. Bivariate correlations results

	1	2	3	4	5	6	7
1. Technology attitude	-						
2. Digital literacy	0.58**	-					
3. Online reading comprehension	0.31**	0.36**	-				
4. TPACK.design	0.45**	0.51**	0.40**	-			
5. TPACK.exertion	0.39**	0.44**	0.39**	0.77**	-		
6. TPACK.ethics	0.35**	0.39**	0.34**	0.65**	0.79**	-	
7. TPACK.proficiency	0.39**	0.46**	0.36**	0.69**	0.81**	0.77**	-
8. TPACK.total	0.44**	0.51**	0.42**	0.89**	0.95**	0.86**	0.88**

Note. **p<0.01.

3.7 Examination of TPACK Competencies' Predictors

Multiple regression analysis was performed to examine how the contributions of attitudes toward technology and usage, digital literacy skills, and online reading comprehension strategies can predict pre-service teachers' TPACK competencies. PC, tablet, and household Internet access entered the model as dummy variables. Pre-service teachers' daily ICTs-using time ranged between 150–549 minutes (M=278.50, SD=98.42, Skewness=0.802, and Kurtosis=-0.563).

Table 9. Multiple regression analysis results

Predictors	*B*	*β*	*t*	*p*	Tolerance	Variance inflation factor (VIF)
Constant	34.583		5.713	0.000		
PC	1.984	0.046	1.218	0.224	0.952	1.051
Tablet	1.568	0.038	1.031	0.303	0.970	1.031
Daily ICTs using time	0.004	0.093	2.535	0.012	0.988	1.012
Technology attitude	0.343	0.169	3.700	0.000	0.638	1.568
Digital literacy	0.941	0.298	6.408	0.000	0.616	1.622
Online reading comprehension strategies	0.158	0.232	5.781	0.000	0.832	1.203
Household internet access	7.059	0.157	4.204	0.000	0.961	1.040

Note. R^2=0.38, corrected R^2=0.38, F=40.804, p=0.000.

First, the assumptions of the test were checked. Preliminary analysis showed that the data set did not violated sample size (n>50+8m, m=predictors numbers), multicollinearity (correlations between independent and dependent variables is above 0.30, Tolerance>0.10, VIF<10), outliers (Mahalanobis distance is below 24.32), linearity, and homoscedasticity assumptions (Tabachnick & Fidell, 2007).

As shown in Table 9, results indicated that the model explained 38% of the total variance of pre-service teachers' TPACK competencies. According to the standardized beta (β) coefficients of the model, digital literacy skills (β=0.298, p<0.05) was a better predictor than online reading comprehension strategies (β=0.232, p<0.05), technology attitude (β=0.169, p<0.05), household Internet access (β=0.157, p<0.05), or daily ICTs usage (β=0.093, p<0.05). On the other hand, PC (β=0.046, p>0.05) and tablet ownership (β=0.038, p<0.05) were not significant predictors of the model.

4. Discussion

The present study sought to understand the contribution of the technology attitudes and usage, digital literacy skills, and online reading comprehension strategies in pre-service early childhood teachers' TPACK competencies. The study findings revealed that pre-service teachers' TPACK competencies are associated with their technology attitude and usage, digital literacy skills, and online reading comprehension strategies, as well as that the variables explained 38% of the variance. The multifaceted and complex nature of the TPACK (Dong et al., 2015; Graham, 2011; Koehler, Mishra, Kereluik, Shin, & Graham, 2014) and the linkage between TPACK competencies and technology attitude (Scherer et al., 2017; Yerdelen-Damar et al., 2017), ICTs usage, and ownership (Kabakci-Yurdakul & Coklar, 2014; Sad, Acikgul, & Delican, 2015; Yavuz-Konokman, Yanpar-Yelken, & Sancar-Tokmak, 2013) has been addressed and reported in the literature.

One of the contributions of this study is the provision of information about the strong relationship between TPACK and digital literacy skills, as well as the moderate relationship between TPACK and online reading comprehension skills. This strong association between TPACK competencies and digital literacy skills may be

due to the multidimensional conceptualization of the measurement constructs. Digital literacy skills are comprised of individuals' cognitive, technical, and socio-emotional capabilities to operate technological devices and programs (Ng, 2012a, 2012b). Therefore, it is expected that individuals' personal capabilities play a key role in technology integration in educational practices. However, the role of online reading comprehension in TPACK is a novel finding, and it is important to highlight that it falls within the scope of constructivist learning and teaching approach (Gordon, 2009; Koh, Chai, & Tsai, 2014; Windschitl, 2002). Reading is a constructivist meaning-making process from text. A reader decodes written or visual texts, uses comprehension strategies and prior knowledge, and accesses their own meaning. Thus, a reader's online reading comprehension strategies can bolster information processing from a digital environment for both personal learning and teaching with technology. These findings propose that reading skills are still one of the most important language skills in the Digital Age, but literacy skills is a deictic term and new literacies are emerging in tandem with rapid change in ICTs (Forzani & Leu, 2017; Leu, Forzani, Rhoads, Maykel, Kennedy, & Timbrell, 2015; Leu et al., 2017). Therefore, new literacy skills should be integrated in education programs to bring up new digitally-literate generations. This interpretation, however, requires further research to investigate the direct and mediated association between TPACK and online reading comprehension strategies in detail in order to present more clear evidence.

Furthermore, findings revealed that daily ICTs' use of time are a weak predictor regarding attitude toward technology, digital literacy skills, and online reading comprehension strategies. These findings can be interpreted in their cultural context. According to the We Are Social (2018) report, Turkish people's average time using social media was two hours, 48 minutes per dat. Altun and Tantekin-Erden (2018) investigated 1,015 pre-service preschool teachers' digital literacy profiles. They reported that pre-service teachers' daily screen time was 254.82 minutes (SD=177.15, range 15–900). They mostly spend time on social media (48%), communication (27%), playing games (10%) and shopping (9%). Only 2% of the pre-service teachers indicated that they spent time in digital environments for their professional development and academic tasks. These findings illuminated not only the ICT use of time but also the content of digital activities' possible role in pre-service teachers' TPACK competencies. Therefore, further studies should examine pre-service teachers' ICT experiences regarding time and content together.

Concerning gender, the analysis of the current study revealed that preservice teachers' design, exertion, and total TPACK total scores were significantly differentiated in favor of females. Previous studies yielded inconsistent findings regarding gender and TPACK; gender neutrality (Akgun, 2013; Sad, Acikgul, & Delican, 2015) in favor of males (Erdogan & Sahin, 2010; Jang & Tsai, 2013; Koh, Chai, & Tsai, 2010), and females (Karaca, 2015; Oz, 2015). These inconsistent findings can be related to participants' characteristics, such as ICT experience, attitude, department, and culture, rather than gender.

Another finding of this study was that pre-service teachers' grade level and GPA are not related to their self-reported TPACK competencies. Both of the state universities' education programs did not cover any compulsory courses regarding technology integration in education. Only one of the universities provides selected technology in early childhood education for two years. These findings can be seen as signals of the necessity for theoretical knowledge and practice to be developed in pre-service teachers' technology integration in education. Similarly, Voogt and McKenney (2017) found that pre-service early childhood teachers have barriers in teaching with technology; technology integration is a complex process and they often fail in this process (Voogt, Tilya, & vanden Akker, 2009). The gap in pre-service teachers' training programs regarding ICTs integration is also addressed in the literature (Agyei & Voogt, 2011; Tondeur et al., 2013). Pre-service teachers will teach digital natives, teacher education programs should prepare them for the circumstances that might face the teaching profession. Young children are exposed to enriched digital experiences at home (Edwards, Henderson, Gronn, Scott, & Mirkhil, 2017; Plowman, McPake, & Stephen, 2010; Stephen, Stevenson, & Adey, 2013). The American Academy of Pediatrics (2016) recommended one hour of screen time daily for children aged two to five for high-quality programs. Therefore, early childhood teachers should select, develop, and apply developmentally appropriate, qualified technology-enriched activities to support children's learning development. Therefore, pre-service teachers should have the opportunity to gain hands-on experiences to integrate technology education into their courses and teaching practices in preschools. The role of education and TPACK design-based intervention programs having an effect on fostering pre-service teachers' technology integration in education practices were reported in previous studies (Baran & Uygun, 2016; Lee & Kim, 2014; Lee & Lee, 2014; Sointu et al., 2016). These findings pointed out that TPACK should be integrated into pre-service education programs rather than remaining as isolated knowledge domains in technological and pedagogical content. These studies show that pre-service teachers foster their TPACK competencies when combining theory

and practice in their education. They need to transfer theoretical knowledge into practice with assignments and receive feedback to evaluate and revise their competencies. Furthermore, the pre-service teaching practicum in preschool classrooms can be an opportunity to conduct technology-integrated activities with children. Pre-service teachers can prepare blended lessons with digital activities alongside traditional classroom activities. These kinds of teaching practicum experiences can bolster pre-service teachers' integration of technology in real classroom environments, provide feedback from not only course instructors but also in-service teachers and preschool children and prepare them to be teachers of digitally native children. Future studies should consider design TPACK fostering instructional models based on the predictor skills, knowledges, and practices of technology integration in education.

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