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Physical education and sports teachers' technological pedagogical content knowledge (TPACK) competencies: mixed design research

Competencias del conocimiento tecnológico pedagógico del contenido (TPACK) de los profesores de educación física y deportes: una investigación de diseño mixto.

Nazlı Yanar Tunçel[1]*, Semiyha Tuncel[2]

[1]Karamanoğlu Mehmetbey University Faculty of Sport Sciences, Karaman, Türkiye

[2]Ankara University Faculty of Sport Sciences, Ankara, Türkiye

*Correspondence Author: Nazlı Yanar Tunçel nazliyanar@kmu.edu.tr

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Abstract
This study aimed to determine whether there was a difference between physical education and sport teachers' technological pedagogical content knowledge competences according to various variables. In this study, in which quantitative and qualitative data were used together, sequential explanatory design from mixed method research design was used. The research group of the study consisted of 712 teachers in the quantitative part and 26 teachers in the qualitative part. Personal information form, Technological Pedagogical Content Knowledge Competency Scale and structured interview form were used as data collection tools. The quantitative data obtained were analysed in Jamovi 2.0.0 programme. In the analysis of quantitative data, t-test, Mann Whitney U test, One Way ANOVA were used. The qualitative data obtained were analysed in MaxQda software. According to the quantitative data results of the study, statistically significant differences were found in gender, age, education level, institution type, access to technology, level of technology use, length of service and duty region in the sub-dimensions of TK, TCK, TPK and TPACK of physical education teachers ($p<0.05$). According to the qualitative data results, differences were found according to gender, age and length of service.

Keywords: technological knowledge, pedagogical knowledge, content knowledge, physical education teachers, physical education course

Resumen
El objetivo era determinar si existían diferencias en las competencias de conocimiento del contenido pedagógico tecnológico de los profesores de educación física y deporte en función de diversas variables. Para ello, se empleó un diseño explicativo secuencial de método mixto, en el que se combinaron datos cuantitativos y cualitativos. El grupo de investigación del estudio estaba formado por 712 profesores en la parte cuantitativa y 26 en la cualitativa. Los instrumentos de recogida de datos fueron el formulario de información personal, la Escala de Competencia en Conocimientos de Contenido Pedagógico Tecnológico y el formulario de entrevista estructurada. Los datos cuantitativos obtenidos se analizaron en el programa Jamovi 2.0.0. Para el análisis de los datos cuantitativos se utilizaron las pruebas t de Student, U de Mann-Whitney y ANOVA unidireccional. Los datos cualitativos obtenidos se analizaron en el programa MaxQda. Según los resultados del estudio, se encontraron diferencias estadísticamente significativas en cuanto al género, la edad, el nivel educativo, el tipo de institución, el acceso a la tecnología, el nivel de uso de la tecnología, la antigüedad y la región de destino en las subdimensiones de TK, TCK, TPK y TPACK de los profesores de educación física ($p < 0,05$). Según los resultados de los datos cualitativos, se encontraron diferencias en función del género, la edad y la antigüedad.

Palabras clave: conocimiento tecnológico, conocimiento pedagógico, conocimiento del contenido, profesores de educación física, cursos de educación física.

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Introduction

The fact that educational technology courses in faculties of education provide students with technical skills but do not show them how to integrate technology into teaching has led to discussions about the concept of 'qualified teacher' in teacher education and the development of models describing teachers' contextual knowledge (Cirit & Canbolat, 2020; Borko & Putnam, 1996). Technological Pedagogical Content Knowledge (TPACK), a new model that defines the concept of "Qualified Teacher", emerged in the study of Mishra and Koehler (2006) as a new paradigm with the integration of technology into Lee Shulman's Pedagogical Content Knowledge (PCK), which was developed in 1986. In this context, researches on the place of technology in education, why and how it should be used, teachers' competences related to their fields and technology at a higher level and their training in equipment that can enable the integration of educational technology are increasing day by day. This conceptual framework is based on three basic knowledge areas. These are explained as Pedagogical Knowledge (PK), Content Knowledge (CK) and Technological Knowledge (TK). At the intersection of technology, pedagogy and content knowledge, Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK) and Technological Content Knowledge (TCK) have emerged (Mishra & Koehler, 2007). TPACK provides a framework for teachers to incorporate technology into their programmes. When the international literature is examined, although there are many studies on TPACK (Lee et al., 2021; O'Neil & Krause, 2019), there are limited studies in the field of physical education and sports in our country (Çar & Aydos, 2020; Semiz & İnce, 2012), and it seems that it is not at the desired level compared to other branches. Aware of the availability of technology, its adoption and integration can be successful if it is combined with teachers' pedagogical goals and didactic knowledge. What is important for physical education and sport teachers to accept and use technology is knowing how to apply it among technological possibilities. The TPACK framework has emerged as a theoretical framework that aims to determine what knowledge is necessary for teaching in the digital age (Willermark, 2018).

The integration of technology in physical education offers important opportunities for monitoring student performance, providing effective feedback and individualising the

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learning process. This integration is thought to support contemporary teaching approaches by contributing to the development of both physical and digital literacies in students. In this context, the aim of this study is to investigate whether physical education and sport teachers' technological pedagogical content knowledge (TPACK) competencies differ in terms of various variables.

Method

In this study, sequential explanatory design from mixed method research design was used. This design is a two-stage design in which qualitative data are used to develop and explain quantitative results within a study (Ivankova et al., 2006). The quantitative part of the research, which constitutes the first stage, was designed as a relational survey design, and the qualitative part, which constitutes the second stage, was designed as phenomenology.

Study Group

In the quantitative phase of the study, the sample consisted of 720 physical education teachers working in different regions of Turkey. Participants were selected using a stratified sampling method based on demographic variables such as region, gender and school type to ensure representativeness of the population (Büyüköztürk, 2016). In the qualitative phase, participants were selected using maximum variation sampling, a purposive sampling strategy that includes individuals with different characteristics relevant to the purpose of the study (Creswell, 2020). The number of participants was determined based on the data saturation criterion, which resulted in the inclusion of 26 teachers (Yıldırım & Şimşek, 2013). Voluntary informed consent was obtained from participants. The demographic information of the individuals who contributed to the research is presented in Table 1 (Francis et al., 2010).

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Table 1. Descriptive Statistics of the Participants

		Quantitative		Qualitative
	Group	F	%	f
Gender	Female	290	40.7	12
	Male	422	59.3	14
Age	21-30	238	33.4	15
	31-40	257	36.1	10
	41-50	185	26.0	1
	51 and older	31	4.5	
Educational Status	Bachelor's Graduate (BSc)	571	80.2	
	Master's Graduate (MSc)	141	19.8	
Institution Type	State institution	616	86.5	
	Private institution	96	13.5	
Grade of teaching	Primary School	54	7.6	
	Middle School	428	60.1	
	High School	230	32.3	
Service experience	< 10 years	466	65.4	24
	11-21 years	123	17.3	2
	>21 years	123	17.3	
Region of Duty	Marmara Region	206	28.9	
	Southern Anatolia Region	150	21.1	
	Central Anatolia Region	129	18.1	
	Mediterranean Region	76	10.7	
	Black Sea Region	60	8.4	
	Eastern Anatolia Region	59	8.3	
	Aegean Region	32	4.5	
Access to technology in the institution	Yes	459	64.5	
	No	253	35.5	
Level of technology use	Sufficient	602	84.6	
	Insufficient	110	15.4	

Data Collection Tools

Quantitative data collection tool

TPACK, which was developed by Horzum et al. (2014) to measure teachers' technological pedagogical content knowledge competencies, was used. The scale consisted of 51 items and the items were graded on a five-point Likert scale. The scale consisted of 7 sub-dimensions: TK (6 items), CK (8 items), PK (7 items), PCK (8 items), TPK (8 items), TCK (6 items), TPACK (8 items). The Cronbach's alpha (α) coefficient of the scale was calculated as 0.97 and its sub-dimensions were calculated as TK α=0.85, PK α=0.82, CK α=0.85, TCK α=0.84, PCK α=0.87, TPK α=0.89, TPACK α = 0.88. As a result of the reliability analysis of the TPACK scale that we used in this study, Cronbach's α values were given in Table 2. A reliability coefficient of 70 and higher was generally considered sufficient for the reliability of test scores (Büyüköztürk, 2016).

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Table 2. Reliability Analysis Test Results of the TPACK Scale Subscales

Sub-dimensions	Cronbach's α
TK	.94
PK	.93
CK	.92
TCK	.92
PCK	.93
TPK	.92
TPACK	.92
SCALE	.94

In the qualitative data collection tool interview form, the qualitative phase of the research was performed with the participants who participated in the first phase and who voluntarily wanted to continue in the second phase. In the development of the draft questions in the interview form, the relevant literature (Njiku et al., 2021; Baek et al., 2018) was utilised. In order for quantitative and qualitative data to complement each other, the sub-dimensions of the "TPACK Scale" were considered in the creation of qualitative structured questions. In this context, an information form was created to learn the personal information of the researchers (gender, age, length of service) and 7 structured questions were created to learn the teachers' opinions about TPACK competences.

Data Analysis

The quantitative analyses of the participants' data were analysed in Jamovi 2.0.0 programme. In testing the normality of the data, the skewness value was first analysed as a result of the skewness test from the TPACK total scale factor scores used for physical education and sport teachers, it was seen that the skewness coefficient (0.126) was between (-1) and (+1). According to this result, it can be concluded that the data obtained from physical education and sports teachers were normally distributed (Büyüköztürk, 2016). It was found that only the data relating to the gender variable did not show a normal distribution. Based on this, sample t-test / Mann Whitney U Test was used for pairwise comparisons and One Way ANOVA test was used for more than two comparisons. The significance level was set as .05 in all analyses. The data obtained from the interviews were analysed using MaxQda analysis software. As a result, the sentences obtained from the interviews about TPACK were coded and categorised into sub-themes. As a result,

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the findings from the quantitative data were supported and explained in more detail by the qualitative data.

Research Ethics

Permission letters were obtained from Ankara University Scientific Research and Publication Ethics Committee (Document no: E-23757613-302.01.09-210985) on 26/04/2021 and from Ministry of National Education Strategy Development Presidency on 05/10/2021.

Findings

Quantitative Results of the Study

Table 3. Participants' Min, Max, Mean and Standard Deviation Scores of the Items of TPACK Scale Sub-dimensions

Sub-dimensions	Min	Max	$\bar{x}$	SS
TK	1	5	3.91	0.59
PK	1	5	4.22	0.47
CK	1	5	4.26	0.47
TCK	1	5	4.06	0.53
PCK	1	5	4.29	0.48
TPK	1	5	4.12	0.52
TPACK	1	5	4.11	0.54

Regarding the TPACK efficacy of the participants, it was determined that 1.00-1.80 was very low, 1.81-2.60 was low, 2.61-3.40 was medium, 3.41-4.20 was high and 4.21-5.00 was very high TPACK efficacy. When Table 4 was analysed it was seen that the teachers participating in the study had a high level of TK (3.91±0.59), a high level of PK (4.22±0.47), CK (4.26±0.47), TCK (4.06±0.53), PCK (4.29±0.48), TPK (4.12±0.52) and TPACK (4.11±0.54).

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Table 4. Mann Whitney U Test Results of Participants' TPACK Competences According to Gender

Sub-dimensions	Grups	N	$\bar{X}$	Ss	U	p	Eta Kare (η^2)
TK	Female	290	22.5	3.50	44805	0.000***	0.27
	Male	422	24.1	3.40			
PK	Female	290	29.5	3.16	60274	0.73	0.02
	Male	422	29.6	3.38			
CK	Female	290	33.8	3.71	57048	0.12	0.07
	Male	422	34.3	3.74			
TCK	Female	290	23.9	3.14	54125	0.00**	0.12
	Male	422	24.6	3.19			
PCK	Female	290	34.3	3.80	61101	0.97	0.00
	Male	422	34.3	3.80			
TPK	Female	290	32.4	4.04	53093	0.00**	0.13
	Male	422	33.4	4.25			
TPACK	Female	290	32.4	4.14	54717	0.01*	0.11
	Male	422	33.2	4.38			
SCALE	Female	290	186.4	18.99	56753	0.10	0.07
	Male	422	189.3	20.21			

*p<0.05, **p<0.01, ***p<0.001

When Table 4 was analysed, it was seen that the mean scores of males were statistically significantly higher than the mean scores of females in the TK (U=44805, p=0.000), TCK (U=54125, p=0.001), TPK (U=53093, p=0.002) and TPACK (U=54717, p=0.03) sub-dimensions of physical education and sport teachers.

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Table 5. ANOVA Test Results of Participants' TPACK Competences According to Age Groups

Sub-dimensions	Grups	N	$\bar{X}$	Ss	F	p	Fark (Tukey)
TK	(1) 21-30 age	238	23.7	3.62	2.765	0.04*	(1) > (4)
	(2) 31-40 age	257	23.6	3.34			
	(3) 41-50 age	185	23.1	3.53			
	(4) ≥ 51 age	32	22.0	3.93			
PK	(1) 21-30 age	238	29.3	3.75	1.201	0.31	
	(2) 31-40 age	257	29.7	2.98			
	(3) 41-50 age	185	29.8	3.02			
	(4) ≥ 51 age	32	28.9	3.43			
CK	(1) 21-30 age	238	34.0	3.98	0.623	0.60	
	(2) 31-40 age	257	33.9	3.48			
	(3) 41-50 age	185	34.3	3.76			
	(4) ≥ 51 age	32	34.6	3.67			
TCK	(1) 21-30 age	238	24.4	3.35	0.728	0.54	
	(2) 31-40 age	257	24.4	2.92			
	(3) 41-50 age	185	24.4	3.18			
	(4) ≥ 51 age	32	23.4	3.88			
PCK	(1) 21-30 age	238	34.1	4.23	2.718	0.05	
	(2) 31-40 age	257	34.0	3.47			
	(3) 41-50 age	185	34.9	3.61			
	(4) ≥ 51 age	32	34.7	3.75			
TPK	(1) 21-30 age	238	33.1	4.39	2.385	0.07	
	(2) 31-40 age	257	33.2	3.75			
	(3) 41-50 age	185	32.8	4.27			
	(4) ≥ 51 age	32	30.9	4.98			
TPACK	(1) 21-30 age	238	33.2	4.34	2.066	0.11	
	(2) 31-40 age	257	32.9	3.91			
	(3) 41-50 age	185	32.8	4.26			
	(4) ≥ 51 age	32	30.9	6.08			
SCALE	(1) 21-30 age	238	188.1	21.4	0.876	0.46	
	(2) 31-40 age	257	188.1	18.3			
	(3) 41-50 age	185	189.1	19.6			
	(4) ≥ 51 age	32	182.8	20.3			

*p<0.05

When Table 5 was examined, as a result of the analysis of TPACK competencies of physical education and sport teachers according to the age group variable, a statistically significant difference was found in the sub-dimension of TK ($F_{3\text{-}137}$=2.765, p=0.04) (p<0.05). This significance was in favour of those in the age range of 21-30 against those in the age group of 51 and above.

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Table 6. t-Test Results of TPACK Competences of the Participants According to Education Level

Sub-dimensions	Grups	N	$\bar{X}$	Ss	df	t	p	Cohen-d
TK	BSc	571	23.2	3.41	710	-3.42	<0.00***	0.32
	MSc	141	24.4	3.84				
PK	BSc	571	29.4	3.12	710	-1.62	0.11	0.15
	MSc	141	29.9	3.89				
CK	BSc	571	33.9	3.61	710	-1.99	0.05	0.19
	MSc	141	34.6	4.16				
TCK	BSc	571	24.2	3.16	710	-2.13	0.03*	0.20
	MSc	141	24.9	3.24				
PCK	BSc	571	34.2	3.78	710	-1.97	0.05	0.19
	MSc	141	34.9	3.84				
TPK	BSc	571	32.8	4.17	710	-2.38	0.02*	0.22
	MSc	141	33.7	4.16				
TPACK	BSc	571	32.7	4.27	710	-2.58	0.01*	0.24
	MSc	141	33.7	4.30				
SCALE	BSc	571	187.2	19.32	710	-2.43	0.02*	0.23
	MSc	141	191.7	21.12				

*p<0.05, **p<0.01, ***p<0.001

When Table 6 was analysed it can be seen that the mean scores of physical education teachers in the sub-dimensions of TK (t=-3.42, p=0.000), TCK (t=-2.13, p=0.03), TPK (t=-2.38, p=0.02) and TPACK (t=-2.58, p=0.01) and in the total scale (t=-2.43, p=0.02) of postgraduate graduates were statistically significantly higher than the mean scores of undergraduate graduates.

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Table 7. ANOVA Test Results of Participants' TPACK Competences According to Length of Service

Sub-dimensions	Grups	N	$\bar{X}$	Ss	F	p	Fark (Tukey)
TK	(1) ≤ 10 years	466	23.7	3.58	4.5218	0.01*	(1) > (3)
	(2)11-20 years	123	23.5	2.93			
	(3) ≥ 21 years	23	22.5	3.74			
PK	(1) ≤ 10 years	466	29.5	3.45	0.3766	0.67	
	(2)11-20 years	123	29.6	2.66			
	(3) ≥ 21 years	23	29.7	3.26			
CK	(1) ≤ 10 years	466	34.0	3.81	1.0937	0.34	
	(2)11-20 years	123	34.0	3.36			
	(3) ≥ 21 years	23	34.5	3.80			
TCK	(1) ≤ 10 years	466	24.4	3.17	0.2391	0.79	
	(2)11-20 years	123	24.5	3.09			
	(3) ≥ 21 years	23	24.2	3.35			
PCK	(1) ≤ 10 years	466	34.1	3.94	4.4640	0.01*	(3) > (1)
	(2)11-20 years	123	34.3	3.28			
	(3) ≥ 21 years	23	35.2	3.65			
TPK	(1) ≤ 10 years	466	33.1	4.15	1.0366	0.36	
	(2)11-20 years	123	32.9	3.95			
	(3) ≥ 21 years	23	32.5	4.55			
TPACK	(1) ≤ 10 years	466	33.0	4.19	0.8134	0.45	
	(2)11-20 years	123	33.0	3.94			
	(3) ≥ 21 years	23	32.4	4.96			
SCALE	(1) ≤ 10 years	466	188.0	20.21	0.0431	0.96	
	(2)11-20 years	123	188.3	17.73			
	(3) ≥ 21 years	23	188.6	20.10			

*p<0.05

When Table 7 was examined as a result of the analysis of TPACK competencies of physical education and sport teachers according to the length of service variable, a statistically significant difference was found in the sub-dimension of TK ($F_{2\text{-}242}$=4.5218, p=0.01) (p<0.05). This significance was in favour of those with 21 years of service experience or more versus those with 10 years of service experience or less. A statistically significant difference was found in the PCK sub-dimension ($F_{2\text{-}248}$=4.4640, p=0.01) (p<0.05). This significance was in favour of those with 21 years of service or more against those with 10 years of service or less.

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Table 8. t-Test Results of Participants' TPACK Competencies According to Institution Type

Sub-dimensions	Grups	N	$\bar{X}$	ss	df	t	p	Cohen-d
TK	State	616	23.4	3.51	710	-1.454	0.15	0.16
	Private	96	29.9	3.60				
PK	State	616	29.5	3.30	710	-1.183	0.24	0.13
	Private	96	29.9	3.18				
CK	State	616	34.0	3.71	710	-1.701	0.09	0.19
	Private	96	34.7	3.85				
TCK	State	616	24.3	3.22	710	-1.953	0.05	0.21
	Private	96	24.9	2.89				
PCK	State	616	34.3	3.81	710	-0.596	0.55	0.07
	Private	96	34.5	3.78				
TPK	State	616	32.9	4.21	710	-1.179	0.24	0.13
	Private	96	33.5	4.03				
TPACK	State	616	32.7	4.30	710	-2.027	0.04*	0.22
	Private	96	33.7	4.18				
SCALE	State	616	187.7	19.72	710	-1.637	0.10	0.18
	Private	96	191.2	19.83				

*p<0.05

When Table 8 was examined the mean scores of physical education and sport teachers working in private education institutions in TPACK sub-dimension were statistically significantly higher than the mean scores of those working in public institutions (t=-2.027, p=0.04).

Table 9. t Test Results of TPACK Competencies of the Participants According to the Variable of Access to Technology in the Institution

Sub-dimensions	Grups	N	X	Ss	df	t	p	Cohen-d
TK	Yes	459	23.6	3.46	710	1.56	0.12	0.12
	No	253	23.2	3.63				
PK	Yes	459	29.7	3.15	710	2.13	0.03*	0.17
	No	253	29.2	3.50				
CK	Yes	459	34.3	3.72	710	1.93	0.05	0.15
	No	253	33.7	3.73				
TCK	Yes	459	24.6	3.08	710	2.42	0.02*	0.19
	No	253	24.0	3.33				
PCK	Yes	459	34.5	3.86	710	1.52	0.13	0.12
	No	253	34.0	3.68				
TPK	Yes	459	33.1	4.18	710	1.04	0.30	0.08
	No	253	32.8	4.18				
TPACK	Yes	459	33.1	4.29	710	1.60	0.11	0.13
	No	253	32.5	4.28				
SCALE	Yes	459	189.2	19.82	710	1.97	0.05	0.15
	No	253	186.2	19.54				

*p<0.05

When Table 9 was analysed the mean scores of physical education and sport teachers who have access to technology in the institution where they work in PK (t=2.13,

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p=0.03) and TCK (t=2.42, p=0.02) sub-dimensions were statistically significantly higher than the mean scores of those who did not have access to technology.

Table 10. t-Test results of participants' TPACK competences according to technology level variable

Sub-dimensions	Grups	N	$\bar{X}$	Ss	df	t	P	Cohen-d
TK	Sufficient	602	24.0	3.15	710	10.68	0.00***	1.11
	Insufficient	110	20.4	3.89				
PK	Sufficient	602	29.7	3.21	710	4.27	0.00***	0.44
	Insufficient	110	28.3	3.44				
CK	Sufficient	602	34.4	3.62	710	4.72	0.00***	0.49
	Insufficient	110	32.6	3.99				
TCK	Sufficient	602	24.7	3.03	710	7.67	0.00***	0.80
	Insufficient	110	22.3	3.23				
PCK	Sufficient	602	34.5	3.72	710	3.74	0.00***	0.39
	Insufficient	110	33.1	4.04				
TPK	Sufficient	602	33.4	3.97	710	7.07	0.00***	0.73
	Insufficient	110	30.5	4.46				
TPACK	Sufficient	602	33.3	4.09	710	6.91	0.00***	0.72
	Insufficient	110	30.3	4.51				
SCALE	Sufficient	602	190.2	19.03	710	6.57	0.00***	0.68
	Insufficient	110	177.1	20.12				

***p<0.001

When Table 10 was analysed, it was found that the mean scores of physical education and sport teachers who had sufficient technology knowledge in the sub-dimensions of TK (t=10.68, p=0.000), PK (t=4.27, p=0.000), CK (t=4.72, p=0.000), TCK (t=7.67, p=0.000), PCK (t=3.74, p=0.000), TPK (t=7.07, p=0.000), TPACK (t=6.91, p=0.000) sub-dimensions and the total scale (t=6.57, p=0.000), the mean scores of those with sufficient technology knowledge were statistically significantly higher than the mean scores of those with insufficient technology knowledge.

Table 11. Participants' TPACK and Descriptive Variables Pearson's Correlation Test Result

		TK	PK	CK	TCK	PCK	TPK	TPACK
Service Experience	r	-0.133	0.024	0.033	-0.034	0.086	-0.084	-0.082
	P	0.00***	0.52	0.39	0.37	0.02*	0.02*	0.03*

*p<0.05, *** p<0.001

When Table 11 was analysed, a statistically significant negative low level relationship was found between the participants' length of service and TK sub-dimension (r=-0.133, p=0.00). It can be said that as the participants' length of service increased, their

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TK competences decreased. A statistically significant positive very low level relationship was found between the participants' length of service and PCK competences (r=0.086, p=0.02). It can be said that as the participants' length of service increased, their PCK competences also increased. A statistically significant negative very low level relationship was found between the participants' length of service and their TPK competences (r=-0.084, p=0.02). It can be said that as the participants' length of service increased, their TPACK competences decreased. A statistically significant negative very low level relationship was found between the participants' length of service and TPACK competences (r=-0.082, p=0.03). It can be said that TPACK competences of the participants decreased as the length of service increased.

Qualitative Results of the Study
Technology Knowledge

To provide a basis for teachers' technological knowledge and skills, teachers were asked about their level of technology use. In addition to the fact that the materials they use and their experiences with technology were not comprehensive, the teachers stated that they were capable of using technology whenever they needed it in their lessons.

P1: *I can benefit from technology programmes such as EBA and Zoom because it is both a theoretical and practical course due to my branch. Since such a model was developed this year due to the pandemic, EBA and Zoom have seriously benefited children and us. I am at a level to use them in lessons and when I need them myself.*

According to our teacher P1, it is important for PE and sport teachers to be able to use technology effectively to access, share and teach course resources in times of crisis.

Teachers stated that the facilities of the school were important in terms of improving their level of technology knowledge and access to technology in their lessons, as well as the knowledge of the use of in-service training was also effective.

P3: I see myself as an intermediate level and I am new to teaching. I have difficulties in terms of use, whether it is the school I am in or the level of the students. There is no technology infrastructure in the region we are in. We encountered a situation like the pandemic and I think there is more need after that. I am trying to improve myself as much as I can. As it is known, the field of technology is very wide and different technological

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tools are developing. I was attending in-service trainings, but with the pandemic, these trainings have increased even more. I also benefited from some training sites I researched myself.

The teachers of physical education and sports have stated that they consider themselves sufficient in terms of technology usage knowledge. However, they stated that they encountered obstacles to the use of technology, especially the insufficient school facilities during the teaching of the course.

Pedagogy Knowledge

The pedagogical knowledge of physical education and sport teachers was asked about what they pay attention to when teaching a knowledge or skill in their lessons. The teachers stated that they pay attention to the readiness of the students, class levels and the physical structure of the school during teaching.

P5: I pay attention to the physical structure of the classroom or school and the readiness of the students. I pay attention to whether I have enough materials. Apart from that, I try to attract the attention of the students. Then I teach the lesson with the necessary methods and techniques. I get feedback from the students in the last 5 minutes of the lesson.

P6: When teaching a knowledge or skill, of course, I pay attention to the perception level of the students. I use different teaching methods according to the grade levels. While I prefer to decorate what I teach with educational games at primary school level, this situation may change at secondary and high school level.

The statements of P7 and P8, who stated that there are the characteristics that students should exhibit at the end of the lesson and the achievements in the curriculum together with the students' readiness and grade levels, are as follows:

P7: There are gains, how can we be useful to reach that gain, how can we make students' learning easier, faster and more permanent, we provide our preparation for that. Besides, in the annual plans, I make preparations in a way that the student will learn according to the gains that the student should gain that week.

P8: I especially look at whether they gain the learning outcomes of our course. Especially skills should be gained at a certain age group. I pay a lot of attention to the level of the students. I measure their level of knowledge at first. I try to make students

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gain the activities according to their level of knowledge. I also pay attention to individual differences here. Some students have difficulty in learning, some have difficulties in applying skills, accordingly, I divide the class into groups and have activities that everyone can apply according to the level of that class in activities related to motor skills.

Content Knowledge

Physical education and sport teachers were asked about their level of field knowledge. They stated that physical education teachers have comprehensive subject knowledge related to their field and that they continuously improve themselves.

P9: When we look at both the health knowledge, training knowledge and educational sciences that a physical education teacher should know, I find myself sufficient. Of course, it is necessary to improve further. Especially teachers should constantly improve themselves.

P10: I took a master's degree to improve myself in terms of my level of knowledge. We learn something new every day in the profession. I add something new to myself. We also learn something while teaching something new to students. There are situations that we also learn from the students. The development is constantly open and I am trying to improve myself.

It can be said that physical education and sport teachers' content knowledge was at the desired level and they keep themselves updated by renewing themselves individually in a way to contribute to their skills and qualifications.

P13: My bachelor's degree was in teaching and then I received a master's degree in this field. Therefore, I consider myself sufficient. I am in constant communication with my professors at the university, so I also update myself. I am a member of some forum sites from social media accounts and I access different resources there.

Technological Content Knowledge

Physical education and sports teachers were asked what they pay attention to in terms of using technology while teaching in accordance with the course content. The statements of P11 and P12, who stated that the teachers could not use technology actively in their lessons and that they mostly used the smart board while transferring theoretical knowledge, are as follows;

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P11: *We use technology in our lessons to transfer rules and game information. I use smart boards and computers and such materials. I make use of these; I cannot say that I use technology in detail. I use it to transfer theoretical information in the room or when we cannot use the garden. I am a basketball referee and we use various applications there, but I have never used any application examples in my lessons. Since the program is already tight and our lesson hours are short, I cannot use it in practice much, and the class sizes are also high in a place like Istanbul. Of course, when I work in Batman, it is not that crowded.*

It is emphasized that the insufficient lesson hours are among the important reasons why teachers cannot use technology in their lessons. Setting up or dismantling technological equipment in a limited time may also mean that students will be less active.

P12: *First of all, we need to teach children theoretical information, in other words, I support the game rules with the use of smart boards by reflecting them on the board (projection). Apart from that, we learn by doing and experiencing. It cannot be said that we use technology much in my lessons.*

While most teachers associate technology in education with tools such as smart boards, phones and tablets, these technologies are not sufficient as the goal of physical education and sport is physical activity. Lack of school facilities and limited budgets hinder the use of technology, so teachers focus on the content of the lesson and go back to basics.

Technological Pedagogical Knowledge

Teachers were asked what they pay attention to when teaching a piece of information or skill in their lessons regarding pedagogical knowledge in the use of technological materials in their lessons.

P23: *So, if I am going to show something tactical according to the needs of the students, I use videos for that. Other than that, as I said, we don't have any other technological tools. I can only use the smart board or if I am going to do a team-related study from our WhatsApp groups, I can direct the videos I want them to watch from there. But I don't use any applications.*

Since physical education and sports lessons are taught in a gym or outdoors, it can be said that teachers should have the ability to teach technology in a way that supports

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the pedagogical strategies used in these environments. However, teachers also face difficulties and obstacles in integrating technology into physical education and sports lessons.

P25: *As I mentioned earlier, the material I can use as a technological tool in my school is smart boards. While teaching my lesson, I provide clues to the student through educational methods, allowing them to both have fun and learn. In this way, I think I guide the student in ensuring permanent learning.*

P26*: First of all, it should be suitable for the student. Apart from this, I try to choose content that is suitable for their age and if I have to use the internet during the lesson. I use whatever is suitable for the student. Pedagogical Field Knowledge It was asked what physical education and sports teachers' pay attention to when choosing the methods they use in the lesson, based on the way they relate their pedagogical knowledge (information about the teacher) to their own field knowledge (what they know about the ones they teach).*

Pedagogical Content Knowledge

P23*: I act according to the method that is suitable for the content of the lesson. I generally use the narration method when teaching theoretical lessons, since we do not have a gym in cold weather, we are in the classrooms. I teach theoretical lessons during those periods and use the narration method. If I am going to teach a practical lesson, I choose the appropriate method according to the subject I will teach, such as showing and doing, peer education, teaching each other.*

P24: *First of all, the method is of course according to the level of the student and their readiness. I prepare materials according to the students' grade level and the content of my lesson.*

In line with the opinions of our teachers coded as P23 and P24, they stated that the course content should be taught with appropriate teaching methods and techniques. However, it can be said that teachers with this knowledge can choose materials suitable for the subject area and that they have qualifications suitable for PCK features. Referring to the physical conditions of schools and insufficient lesson hours P26 touched on the insufficient lesson hours and deficiencies in the material:

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P26: *First of all, the curriculum and of course the gains. Time is very important and we try to use whatever we can during the 40-minute lesson. The grade level is also very important, the physical conditions of the school. We do not have a hall and we also have problems with materials at school.*

Technological Pedagogical Content Knowledge

Although physical education and sports teachers cannot use technology actively in their lessons, they are expected to know how computers and other technological materials work. It is important for them to show what they can do with technology while preparing course content. The statements of P4, who stated that mobile applications are used when designing learning experiences to attract students' attention and use different tools, are as follows;

P4: *There is actually more than one way to integrate these, but I see it very possible for this to be handled very adequately in the schools we work in. As I said here, we can solve this task simply and only with a smart board, phone or video. Or we can integrate it in this way, we are holding a volleyball tournament, there are applications from computers or phones, for example, the scoreboard application, I show this to the children. When it comes to nutrition, there are mobile applications for them to see and track how many calories foods have. I recommend that children who have phones download and use these applications.*

Discussion and Conclusion

It was found that the mean scores of males in the TK, TCK, TPK and TPACK sub-dimensions of physical education and sports teachers were statistically significantly higher than the mean scores of females. Despite the abundance of digital tools available in teachers' daily lives, gender differences can be observed in the use of digital tools. It was reported that male teachers' perception of technology was higher than female teachers (Görmüş & Semiz, 2023; Cekerol & Ozen, 2020). In the research conducted by Tou et al. (2020) on the use of ICT in physical education and sports lessons, it was seen that male teachers have more positive attitudes than their female colleagues. The qualitative results of our research also support our quantitative results. This result shows that male PE and

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sport teachers have a more positive view of technology integration, computer literacy and innovative teaching.

As a result of the analysis conducted on the TPACK competencies of PE and sports teachers according to the age group variable, a statistically significant difference emerged in favor of those between the ages of 21-30 in the TK sub-dimension. Barahona (2015) suggested that the inclusion of information tools in lessons depends on the teacher's technological knowledge and use of these tools. Therefore, it was thought that as teachers get older, their use in physical education and sports lessons decrease. Similar studies have suggested that younger teachers have a greater knowledge of, and interest in using, new technologies than older teachers (Çar & Aydos, 2022; Aznar-Díaz et al., 2019). Mahken (2024) also reported that as the age of physical education teachers increased, their use of email, web-based applications, integrated technologies and technology-assisted instruction decreased. In the study of Cekerol and Ozen (2020), it was reported that teachers under the age of 30 were more competent in the TK, CK, TCK, TPK and PCK sub-dimensions and teachers in the 30-39 age group were more competent in the PB sub-dimension. These results support the age-specific result of our study. It was revealed that the digital competencies of physical education and sports teachers have decreased over the years (Martínez-Rico et al., 2022). The results of this study were parallel to the results of our study. In addition, when we look at the qualitative result of our research, the fact that the TPACK views of teachers in the 21-30 age range were more intense supports our quantitative results. In this context, it can be said that the TPACK competencies of physical education and sports teachers differ between age groups and that young teachers were more prone to using technology.

The mean scores of master's degree graduates in the TK, TCK, TPK and TPACK sub-dimensions of physical education and sports teachers were statistically significantly higher than the mean scores of undergraduate graduates. Seldura et al. (2024) highlighted that personalised professional development programmes and higher education can play an important role in developing teachers' TPACK levels. Similarly, Li et al.'s (2022) study found a significant increase in teachers' technological pedagogical content knowledge as their education level increased. In Mahken's (2024) study, postgraduate PE teachers were found to have higher levels of competence in the TPACK sub-dimensions than

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undergraduate graduates. These results show that postgraduate education is an effective factor in the development of TPACK competences of teachers of physical education and sport.

According to the service period variable of PE and sports teachers, a statistically significant negative low-level relationship was found in the TK sub-dimension. It can be said that as the service period of teachers increases, their TK competencies decrease. The TK scores of teachers with 10 years or less were significantly higher than those with 21 years or more. A statistically significant positive very low relationship was found in the PCK sub-dimension. It can be said that as the service period of the participants increases, their PCK competencies also increase. It was observed that there were significantly more teachers with 21 years or more of service compared to those with 10 years or less. A statistically significant negative very low level relationship was found between the participants' service period and TPACK competencies. It can be said that as the participants' service period increased, their TPACK competencies decreased. A statistically significant negative very low level relationship was found between the participants' service period and TPACK competencies. It can be said that as the participants' service period increased, their TPACK competencies decreased. CK and PCK developed with teachers' teaching experiences (Mapulanga et al., 2022; Zhen, 2021; Çar & Aydos, 2020). Martínez-Rico et al. (2022) concluded in their study on the perceived digital competencies of PE and sports teachers that teachers with more experience perceived themselves as less competent in digital matters. When we look at the qualitative results of our research, it showed that the TPACK views of experienced teachers were more intense, which supports our quantitative results. Teaching experience, which was a variable closely related to age, can make us think about the role of teacher education and professional development.

The mean scores of PE and sports teachers working in private educational institutions in the TPACK sub-dimension were statistically significantly higher than the mean scores of those working in public institutions. The mean scores of those who have access to technology in the institution they work in the PK and TCK sub-dimension were statistically significantly higher than the mean scores of those who did not have access to technology. A statistically significant difference was found in the TK sub-dimension

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according to the duty region variable of physical education and sports teachers. It was stated that the technical support provided to teachers, as well as school administration, infrastructure and other stakeholders in the education process, was an important factor (Eickelmann et al., 2017). It was seen that it plays an important role in the positive change of the intention towards technology for educational purposes and that there was a significant relationship between the support provided (school administration, infrastructure, etc.) and the intention to use technology (Yüksel & Kızılaslan, 2020).

Martínez-Rico et al. (2022) reported in their study on the perceived digital competencies of physical education and sports teachers that teachers had high basic knowledge about the operation of hardware tools, but teachers' scores on improving work in a technological environment and applying different methodologies were low. The reasons for the failure to integrate educational technology in most developing countries were inadequate financial support and infrastructure, human capital, management support, and behavioral and environmental aspects (Dotong et al., 2016). The Luong et al (2021) showed that pre-service physical education and sport teachers were ready for mobile learning despite the lack of internet infrastructure and online training. As a result of the qualitative interviews, they stated that teachers had difficulty in accessing technology and almost all of them only had smart boards as technological education materials.

It was determined that the mean scores of physical education and sports teachers with sufficient technology knowledge in the total scale and sub-dimensions were statistically significantly higher than the mean scores of those with insufficient technology knowledge. Tseng et al. (2019) stated that solving the contextual problems that teachers encounter while using and designing instructional technology will have positive effects on TPACK development.

As a result, it was determined that physical education and sports teachers have high levels of TPACK competencies and sub-dimensions. Teachers' TPACK competencies are affected by variables such as gender, age, education level, service period, institution they work in and technology knowledge levels.

In this direction, WEB sites can be designed that physical education and sports teachers can refer to when they cannot use technology efficiently in their lessons. Student

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outcomes for using technology in physical education can be added to the physical Education and sports curriculum. Qualitative interviews can be conducted with students about the integration of technology for physical education and sports lessons. Multidisciplinary studies can be conducted between information technologies and physical education and sports teachers regarding the use of technology, and projects can be supported by the MEB R&D teams. European Union projects can be conducted and information can be provided on how technology is used in physical education and sports lessons abroad.

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