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An Examination of Classroom Teachers Candidates' Technological Pedagogical Content Knowledge (TPACK) Levels According to Various Variables

Derya Kıylık [a], Dr. Eylem Kılıç [b]*

[a] *Department of Educational Sciences, Van Yüzüncü Yıl University, Van 65080, Türkiye*

[b] *Department of Computer Education and Instructional Technology, Van Yüzüncü Yıl University, Van 65080, Turkiye Postcode, Country*

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A B S T R A C T

The purpose of this study is to investigate the levels of TPACK among classroom teacher candidates and whether these levels vary according to different variables. Additionally, the study aims to determine how the courses taken in the classroom-teaching program affect the required competencies and to identify educational challenges arising from technology-enhanced lessons through open-ended questions. Both quantitative and qualitative research methods were used and 217 teacher candidates participated to the study. The findings of the research indicate that classroom teacher candidates have high levels of TPACK, and their levels of Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK) are above the intermediate level. Furthermore, there is a statistically significant difference in TPACK levels among the variables of age, internet experience, and computer experience. It is observed that the courses in the classroom-teaching program are taught more theoretically than in a practical manner, and due to reasons such as the inadequacy of university professors, education, and technological tools, teacher candidates struggle to integrate technology into instruction effectively. The study also reveals that there is a lack of necessary education on how to integrate TPACK and those teacher candidates do not put effort into improving their TPACK levels.

Keywords: Technological Pedagogical Content Knowledge (TPACK); Computer experiences; Prospective classroom teachers

1. Introduction

One of the increasingly significant issues for societies today is the quality of education. Among the factors influencing the quality of education, teachers have played crucial roles in education from the past to the present. Mishra and Koehler (2008) have expressed that the roles of teachers are critical in this new century and for their success, they need to take responsibility for the entire curriculum. The quality and competence of teachers are of great importance in the success of educational activities (Bal and Karademir, 2013). The successful training of teachers who can effectively integrate technological advancements into the classroom environment and meet the criteria for their profession requires a solid pre-service education and continuous professional development (Bilgin, Tatar, and Ay, 2012). Consequently, one of the obligatory responsibilities of institutions that train teachers is to educate their students to a level where they can teach in the future classrooms. Demir, Özmantar, Bingölbalı, and Bozkurt (2011) state that teachers are expected to use technology effectively in the process of learning it, and they are also expected to use technology in their professional development and serve as models to students.

The widespread use of technology in the education process has led to changes in the curriculum of teacher education faculties, resulting in an increase in the number of courses and hours. The Higher Education Council (YÖK) introduced two new technology courses, Computer and Instructional Technologies and Material Development, into teacher education programs (YÖK, 1998). However, it is emphasized that these courses do not adequately equip teacher candidates with the ability to apply educational technologies to teaching strategies, methods, techniques, and assessment processes; furthermore, it is noted that in the early years of the teacher education program, general culture, subject area, and teaching profession knowledge courses are taught independently of each other (Bilgin, Tatar, and Ay, 2012).

The majority of educators and researchers generally agree that technology should be used in education as a tool rather than an end in itself. However, it can be said that technology education in education faculties often remains limited to knowledge and skills and is delivered as a separate technology course unrelated to other areas (Usta and Korkmaz, 2010). Arslan and Özpınar (2008) stress the importance of teacher training and the significant responsibilities that education faculties have. Therefore, for effective education in schools, curricula and teacher training practices must be parallel to each other. According to Toker (2005), one of the significant mistakes is to assume that courses aimed at teaching technology in the programs will change the anxieties, confidence, and attitudes of education faculty students towards technology. He explains that adding technology-focused courses to the program

is a general mistake made by universities and that these types of courses only produce teachers who are computer literate, but for a teacher, the ability to use technology in educational settings is more important than being computer literate. If the faculty members in teacher education institutions are not proficient in using technology, the technology courses added to teacher education programs will also be inadequate for providing technology education. Öksüz, Ak, and Uça (2009) state that in this case, teacher candidates are not sufficiently equipped with the skills to use technological tools related to their subject areas, and there is not enough understanding of where and how to use technology.

Learning environments organized by teachers and teacher candidates who are not computer literate, cannot use computers and other technologies adequately, are not aware of the necessity of using technology in their lessons, and avoid using complex and new technologies have reduced functionality and effectiveness (Yavuz-Konakman, Yanpar-Yelken, and Sancar-Tokmak, 2012). To address these issues and to equip teachers and teacher candidates with the competence to use technology and integrate it into their teaching, Schmidt, Baran, Thompson, Mishra, Koehler & Shin (2009) suggest that we need to rethink our pre-service practices in teacher education and find new strategies to effectively integrate technology into instruction. Srisawadi (2012) argues that the concept of Technological Pedagogical Content Knowledge (TPACK), built on Shulman's Pedagogical Content Knowledge (PCK) and proposed by Mishra and Koehler (2006), has become the subject of numerous studies as a framework to promote teachers' teaching competence in the 21st century.

"Within the TPACK framework, there are three components of knowledge presented in three overlapping circles: technology, pedagogy, and content. TPACK is the intersection of all these knowledge domains. Understanding this knowledge (TPACK) is beyond understanding just technology, pedagogy, and content. Rather, it is a new form that explains how these forms of knowledge interact with each other. Of course, these include an understanding of how concepts are presented through technology; they use pedagogical techniques to teach technology and content constructively. It includes an understanding of what makes concepts easy or difficult to learn, knowledge of the student's prior knowledge and epistemological theories; it includes knowledge of how technologies can enhance existing knowledge" (Mishra and Koehler, 2008, p. 10).

Schmidt et al. (2009) emphasized the need for teachers and teacher candidates to be professionals in using TPAB for moderate use in instruction; they must receive effective education and be equipped with professional development experience. Therefore, it is necessary to conduct a more reliable assessment to measure and understand TPAB and its components. In line with this perspective, the integration of technology into education has led to the need for teachers, who are the most important factor in using technology in education, to use technology for their purposes and to understand how to present concepts through technology in their lessons. Indeed, the training of teachers who will adopt and implement new technologies is as important as equipping educational institutions with technological facilities (Bilgin, Tatar, and Ay, 2012). It is not enough to introduce teacher candidates to technology only; rather, it is crucial to teach learning activities and skills using technology and new teaching methods, and to what extent they are gained by teacher candidates in pre-service education.

Studies also indicate that a large portion of teachers lack sufficient knowledge and skills in instructional technologies from their pre-service training, resulting in deficiencies in using technology in instructional processes (Uçar, 1999); they do not achieve the required level of competence in using technology (Toker, 2005); the presence of technology in classrooms is not sufficient to integrate technology into lessons (Demir et al., 2011).

1.1 Aim of the study

This study aims to examine the levels of Technological Pedagogical Content Knowledge (TPACK) of pre-service classroom teacher candidates in the context of a primary education program. The study also seeks to investigate whether the TPACK levels of pre-service classroom teacher candidates vary according to different variables and how the courses they take in the primary education program affect the competencies they should possess. To achieve this goal, the following questions were addressed:

- What are the levels of Technological Pedagogical Content Knowledge (TPACK) among classroom teacher candidates enrolled in the primary education program?
- Do the levels of Technological Pedagogical Content Knowledge (TPACK) among classroom teacher candidates vary according to different variables?
- How do the courses taken by classroom teacher candidates in the primary education program affect the competencies they should possess?

2. Research Method

In this study, both quantitative and qualitative research designs were employed concurrently. A mixed methods research approach was utilized to assess the Technological Pedagogical Content Knowledge (TPACK) levels of pre-service classroom teacher candidates and to evaluate these levels according to various demographic variables. According to Creswell (2012), a mixed methods approach goes beyond merely collecting data from two different types of research (qualitative and quantitative); it involves integrating, correlating, and embedding distinct research data into one another throughout the research process. Statistical methods were used for the analysis of quantitative data. Qualitative data consisting of five open-ended questions were analyzed using document analysis. Document analysis encompasses the analysis of written materials containing information about the phenomenon or phenomena under investigation. Documents are important sources of information that should be effectively utilized in qualitative research (Yıldırım and Şimşek, 2005).

2.1 Sample

The research was conducted with the participation of 217 classroom teacher candidates who were continuing their education in the 3rd and 4th years of the Department of Primary Education at Yüzüncü Yıl University. The frequency and percentage values of demographic data related to teacher candidates are presented in Table 1.

Among the classroom teacher candidates, it is observed that 82 (37.8 %) are female and 135 (62.2%) are male; 13 (6%) fall within the 17-20 age range, 187 (86.6%) are between 21-24 years old, and 16 (7.4%) fall within the 25-28 age range; 93 (43.7%) are in the 3rd year, and 120 (56.3%) are in the 4th year of their studies.

When examining the computer usage experience of the participating teacher candidates, it is seen that 15 (7%) are novices, 149 (70%) are at an intermediate level, 43 (20.2%) are advanced, and 6 (1.8%) are experts in using computers. Generally, the computer experience of the teacher candidates is at an intermediate level. Regarding internet experience, 10 (4.9%) are novices, 128 (62.7%) are at an intermediate level, 60 (29.4%) are advanced, and 6 (2.9%) are experts. Overall, the internet experience of the teacher candidates is at an intermediate level. From the participating pre-service classroom teacher candidates, 131 (60.4%) have internet access on their mobile devices, while 82 (37.8%) do not have internet access on their mobile devices; 93 (42.9%) have educational apps installed on their mobile devices, while 119 (54.8%) do not use such apps on their mobile devices.

Table 1: Demographic Characteristics of Classroom Teacher Candidate

Variable		**f**	**%**
Gender	Female	82	37.8
	Male	135	62.2
Age	17-20	13	6.0
	21-24	187	86.6
	25-28	16	7.4
	Missing Data	1	0.5
Grade	3.grade	93	43.7
	4. grade	120	56.3
	Missing Data	4	1.8
Computer Experiences	Novice	15	7.0
	Intermediate	149	70.0
	Advanced	43	20.2
	Expert	6	2.8
	Missing Data	4	1.8
Internet Experiences	Novice	10	4.9
	Intermediate	128	62.7
	Advanced	60	29.4
	Expert	6	2.9
	Missing Data	13	6
Internet Connection on Mobile Device	Yes	131	60.4
	No	82	37.8
	Missing Data	4	1.8
Educational Apps on your mobile device	Yes	93	42.9
	No	119	54.8

	Missing Data	5	2.3
Frequency of Internet use	5 hour	100	47.8
	6-10 hour	49	23.4
	11-15	32	15.3
	16-20	28	13.4
	Missing Data	8	3.7
	Total	217	100

2.2 Research Process and Data Collection Tools

After obtaining the necessary ethical permissions for the "Personal Information Form," the "Technological Pedagogical Content Knowledge (TPACK) Scale," and the "Open-ended Questions," the research process began by visiting the classes where the determined sample of classroom teacher candidates were studying. Initially, the researcher provided information to the pre-service classroom teacher candidates about the purpose of the study and what they should pay attention to. Then, the scales were administered. The scales and open-ended questions were filled out by the students on a voluntary basis. While a majority of the students completed the scales, it was observed that the number of students responding to the open-ended questions was lower.

2.2.1 Personal Information Form

The Personal Information Form includes 9 questions related to the gender, age, grade, computer experience and etc. The demographic questionnaire was developed by the researcher and reviewed by an expert before being administered.

2.2.2 Technological Pedagogical Content Knowledge (TPACK) Scale

The TPACK Scale, adapted into Turkish by [16] from the original scale developed by [11] consists of 46 Likert-type items. The scale does not contain negatively worded items. The scale includes seven dimensions: "Technological Knowledge" (TK) with 6 items (items 1-6), "Content Knowledge" (CK) with 11 items (items 7-18), "Pedagogical Knowledge" (PK) with 6 items (items 19-25), "Pedagogical Content Knowledge" (PCK) with 3 items (items 26-29), "Technological Content Knowledge" (TCK) with 3 items (items 30-33), "Technological Pedagogical Knowledge" (TPK) with 5 items (items 34-39), and "Technological Pedagogical Content Knowledge" (TPACK) with 6 items (items 40-46). The "Content Knowledge" dimension of the scale for classroom teachers includes four sub-dimensions: Mathematics, Social Studies, Science, and Literacy. In total, there are 10 dimensions, and a 10-factor structure was considered in the Confirmatory Factor Analysis (CFA). The total score from the items in each dimension represents the score for that dimension. The total score obtained from the scale ranges between 46 and 230. The original scale's Cronbach's alpha reliability coefficients for each dimension were calculated to be between 0.78 and 0.93 [11]. The internal consistency coefficient was calculated for the current study and was presented in Table 2.

The factor loadings for the dimensions are as follows: Technological Knowledge (TK): 0.799, Mathematics: 0.880, Social Studies: 0.704, Science: 0.762, Literacy: 0.731, Pedagogical Knowledge (PB): 0.890, Pedagogical Content Knowledge (PCK): 0.829, Technological Content Knowledge (TCK): 0.790, Technological Pedagogical Knowledge (TPK): 0.856, Technological Pedagogical Content Knowledge (TPCK): 0.840 These factor loadings indicate the strength of the relationships between the items and their respective latent dimensions. Four of these dimensions, Mathematics, Social Studies, Science, and Literacy, form the content dimension of the TPACK scale. The Cronbach's Alpha reliability coefficients for these dimensions are above 0.7, indicating sufficient reliability. In summary, the factor loadings and reliability coefficients indicate the validity and reliability of the scale's dimensions, supporting the soundness of the instrument used in the study.

Table 2: Technological Pedagogical Content Knowledge (TPACK) internal consistency coefficient

Scale Dimension	Item number	Internal consistency coefficient
Technological Knowledge	6	0.799
Content Knowledge		
Math	3	0.880
Social Sciences	3	0.704
Natural Sciences	3	0.762
Literacy	3	0.731

Pedagogical Knowledge	7	0.890
Pedagogical Content Knowledge	4	0.829
Technological Content Knowledge	4	0.790
Technological Pedagogical Knowledge	6	0.856
Technological Pedagogical Content Knowledge	7	0.840

2.2.3 Open-Ended Questions

In order to determine how the courses taken in the classroom-teaching program affect the competencies that should be possessed, a pool of questions was developed by the researcher. After being reviewed by a subject expert, five open-ended questions were selected for the current study.

3. Result

The findings obtained from the analysis of the research data are presented in a way that answers each research question. In order to determine the TPACK levels of prospective classroom teachers, scores were calculated from each sub-dimension and the total scale (Table 3).

When examining Table 3, it can be observed that the scores obtained by classroom teacher candidates from the TPCK scale range between 78 and 230. The high average score (M =166.49) of the classroom teacher candidates from the TPCK scale indicates that their levels of Technological Pedagogical Content Knowledge (TPCK) are high. Considering the moderate average scores for the factors of the scale, it can be noted that the average scores obtained by the classroom teacher candidates from the TPCK scale factors are above the possible moderate score that can be obtained from each sub-component. From these findings, it can be inferred that the levels of Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPCK) of classroom teacher candidates are above the moderate level.

Tablo 3: Levels of TPACK of Classroom Teachers Candidates

Dimensions	**N**	**Min.**	**Max.**	**M**	**S**
Technological Knowledge	217	6	30	20,18	4,65
Content Knowledge	217	3	15	11,27	2,72
Math	217	4	15	10,91	2,24
Social Sciences	217	2	15	9,14	2,63
Natural Sciences	215	3	15	11,67	2,35
Literacy	214	4	35	26,76	5,18
Pedagogical Knowledge	213	4	20	15,01	3,07
Pedagogical Content Knowledge	213	5	20	14,01	2,99
Technological Content Knowledge	213	4	30	22,03	4,68
Technological Pedagogical Content Knowledge	208	7	35	25,51	4,79
TPACK		78	230	166.49	35.30

3.1 Examination of prospective classroom teachers' TPACK levels in terms of different variables.

3.1.1 The relationship between TPACK and Gender

An independent t-test is employed to determine whether there is a significant difference between the genders of classroom teacher candidates and their TPACK levels (Table 4).

Table 4: The t-test analysis results of the TPACK levels in terms of their genders.

Gender	N	M	Ss	t	df	p
Female	81	26.04	4.93	1.276	206	0.204
Male	127	25.18	4.96			

According to the result, there is no statistically significant difference between the TPACK levels of female classroom teacher candidates (M=26.04) and male classroom teacher candidates (M=25.18), as evidenced by the t-test result t(276)= 1.27, 0.20>0.05.

3.1.2 Relationship between Age and TPACK

One-way ANOVA test is employed to determine whether there is a significant difference among age group of classroom teacher candidates and their TPACK levels (Table 5-6).

According to the age group variable, a statistically significant difference was found among the TPACK levels of classroom teacher candidates [F(2,205)=3.375, p=0.03]. LSD was used to compare groups and, it is found that there is a significant difference in TPACK levels among classroom teacher candidates aged 17-20 (M=28, SD=2.97), 21-24 (M=25.52, SD=4.67), and 25-28 (M=23.33, SD=6.44) years. The group with the highest TPACK level consists of prospective teachers in the youngest age group (Table 6).

Table 5: Descriptive results of the TPACK levels in terms of age

Age	N	M	Sd
17-20	13	28	2.97
21-24	180	25.52	4.67
25-28	15	23.33	6.44
Total	208	25.51	4.79

Table 6: ANOVA results of the TPACK levels in terms of age

Age	Sum of squares	Sd	Mean of Squares	F	P	Difference
Between Group	151.679	2	75.839	3.375	0.036	17-20 > 25-28 25-28< 21-24
Within group	4606.244	205	22.469			
Total	475.923	207				

3.1.3 Relationship between Classroom Level and TPACK

An independent t-test was used to determine whether there is a significant difference between the educational levels of classroom teacher candidates and their TPACK levels (Table 7).

Table 7: T-test analysis results of the TPACK in terms of class level

Grade	N	M	Sd	t	df	P
3. Grade	90	25.41	4.60	-0.395	202	0.693
4. Grade	114	25.67	4.85			

Accordingly, there is no statistically significant difference between the TPACK levels of classroom teacher candidates in the 3rd grade (M=25.41) and those in the 4th grade (M=25.67), as indicated by the t-test result t (202) = -0.39, 0.69>0.05.

3.1.4 Relationship between Computer Experiences and TPACK

One-way ANOVA test was employed to determine whether there is a significant difference between the computer experience of classroom teacher candidates and their TPACK levels (Table 8).

Table 8: ANOVA analysis results of the TPACK levels of in terms of computer experience

Computer Experiences	Sum of squares	sd	Mean of squares	F	P	Difference
Between Groups	225.161	3	75.054	3.402	0.019	Novice<Intermediate Intermediate< Advanced Advanced< Expert
Within Groups	4411.820	200	22.059			
Total	4636.980	203				

According to the computer experience variable, there was a statistically significant difference among the TPACK levels of classroom teacher candidates [F(3,200)=3.402, p=0.01]. LSD was used to compare groups and, there is a significant difference among the averages of classroom teacher candidates with novice computer experience (M=22.80, SD=6.09), those with intermediate computer experience (M=25.35, SD=4.59), those with advanced computer experience (M=26.57, SD=4.65), and expert computer experience (M=28.83, SD=3.18). In this case, it can be stated that as computer experience increases, TPACK levels also increase.

3.1.5 Relationship between Internet Experiences and TPACK

One-way ANOVA test was employed to determine whether there is a significant difference amng the internet experience of prospective classroom teacher candidates and their TPACK levels (Table 9).

Table 9: ANOVA analysis results of the TPACK levels of in terms of internet experience

Internet Experinces	Sum of squares	sd	Mean of squares	F	p	Difference
Between Groups	180.820	3	60.273	2.697	0.047	Novice< Advanced Advance< Expert
Within Groups	4290.134	192	22.344			
Total	4470.954	195				

According to the internet experience variable, there was found to be a statistically significant difference among the TPAB levels of prospective classroom teacher candidates [F(3,192)=2.697, p=0.04]. LSD was used to compare groups and there is a significant difference among the averages of prospective classroom teacher candidates with novice internet experience (M=22.50, SD=6.39), those with advanced internet experience (M=26.10, SD=4.59), and expert internet experience (M=28.83, SD=3.18). It can be stated that as internet experience increases, TPACK levels also increase.

3.1.6 Relationship between Internet connection on mobile device and TPACK

An independent t-test was used to determine whether there is a significant difference between the presence of internet on the mobile devices of classroom teacher candidates and their TPACK levels (Table 10).

Table 10: T-test analysis results of the TPACK levels in terms of mobile internet.

Having Internet on Mobile Device	N	M	Sd	t	df	P
Yes	124	25.62	4.90	0.481	202	0.631
No	80	25.28	4.72			

Accordingly, there is no significant difference between the TPACK levels of classroom teacher candidates who have internet on their mobile devices (M=25.62) and those who do not have internet on their mobile devices (M=25.28), as indicated by the t-test result t(202)= 0.48, 0.63>0.05.

3.1.7 Relationship between educational application on mobile device and TPACK

The independent t-test was employed to determine whether there is a significant difference in TPACK (Basic Skill Areas Score) levels among classroom teacher candidates using an educational application on their mobile devices (Table 11)

Table 11: The t-test analysis results of the TPACK levels in terms of mobile applications

Mobile Educational App	N	M	Ss	T	df	P
Yes	90	25.78	5.16	0.740	201	0.460
No	113	25.29	4.39			

Accordingly, it is found that there is no significant difference between the TPACK levels of classroom teacher candidates who have an educational application on their mobile device (M = 25.78) and those who do not have an educational application on their mobile device (M = 25.29). t (201) = 0.74, 0.46>0.05.

3.1.8 Perspectives on Assessing the Competencies of Teacher Candidates through Courses in the Classroom Teaching Program.

In the study, the question initially posed to classroom teacher candidates was, 'Do you think you have sufficient knowledge to integrate what you have learned in Computer I, Computer II, and Instructional Technology and Material Development Courses (ITMD) into technology-enhanced teaching? Why?' As seen in Table 12, out of the 217 classroom teacher candidates participating in the study, 45 (20.7%) indicated that Computer I, II, and ITMD courses provided sufficient knowledge for integrating technology into learning, while 124 (57.1%) stated that they did not provide sufficient knowledge. Additionally, 7 participants (3.2%) mentioned partial sufficiency, and 41 (18.8%) left the question blank. Overall, it can be concluded that Computer I, II, and Educational Technology courses did not contribute adequately by providing sufficient knowledge for integrating technology into learning.

Table 12: Contribution of Courses to the Integration of Technology in Learning.

	Thema	f	%
'Do you think you have sufficient knowledge to integrate what you have learned in Computer I, Computer II, and Instructional Technology and Material Development Courses (ITMD) into technology-enhanced teaching? Why?	Yes-Sufficient	45	20.7
	No-Insufficient	124	57.1
	Partly-Sufficient	7	3.2
	No response	41	18.8
Total		217	100

While looking at the contributing factor to the integration of technology into learning with regard to the initial question, out of the 45 individuals, 10 (22.2%) indicated that they have sufficient prior knowledge, 1 (2.2%) mentioned that their instructors were well-equipped and effective in teaching, and 13 (28.8%) expressed that they received good education through practical applications in the classes. However, 21 individuals (46.6%) did not specify any reason (Table 13).

Table 13. Factors Contributing to the Integration of Technology into Learning

	Thema	f	%
The courses were sufficient	Having sufficient prior knowledge	10	22.2
	The instructors were well-equipped and effective in teaching	1	2.2
	Receiving effective training through practical application	13	28.8
	Not stated	21	46.6
Total		45	100

On the other hand, the teachers indicated the reason for insufficient knowledge to integrate technology in learning. Among the, out of 124 individuals, 9 (7.2%) mentioned that instructors were insufficient and indifferent, 18 (14.5%) indicated that university education was inadequate, 11 (8.8%) pointed out the insufficiency of practical education, 15 (12%) perceived themselves as inadequate, 8 (6.4%) stated that classes were not conducted due to earthquakes, 6 (4.8%) reported an inability to use computers, 35 (16.3%) observed that courses were treated superficially and theoretically, 4 (3.8%) noted that only slide presentations were used in classes, 5 (4%) highlighted the inadequacy of technological tools in classrooms, 3 (2.4%) mentioned that exposure to courses was limited to the first year, 6 (4.8%) expressed that they solely relied on their own prior knowledge, and 2 (1.6%) admitted to a lack of interest in the course. Overall, it is evident that courses were generally treated superficially.

Secondly, the question asked to classroom teacher candidates was “Do you believe that the necessary training on how to integrate technological pedagogical content knowledge is provided in the courses you have taken in your department? Why?” As seen in Table 14, out of the 217 prospective primary school teachers participating in the study, 39 (17.9%) indicated that they received the necessary training on how to integrate technological pedagogical content knowledge in the courses they took, while 127 (58.5%) stated that they did not receive the required training. Additionally, 3 participants (1.3%) mentioned partial acquisition of the training, and 48 (22.1%) did not provide a response to this question. Generally, they believe that the required education on how to integrate technological pedagogical content knowledge was not provided in the courses they took in their department.”

Table 14: Receiving Necessary Training on How to Integrate TPACK

	Theme	**f**	**%**
Do you believe that the necessary training on how to integrate technological pedagogical content knowledge is provided in the courses you have taken in your department? Why?'	Yes	39	17.9
	No	127	58.5
	Partially	3	1.3
	No response	48	22.1
Total		217	100

As shown in Table 15, out of 39 individuals, 7 (17.9%) mentioned that the education and courses were efficient, 3 (7.6%) found the school experience courses to be effective, 7 (17.9%) stated that the instructors had sufficient knowledge and expertise, 1 (2.5%) believed they had sufficient prior knowledge, 2 (5.2%) mentioned that the courses were conducted practically, and 1 (2.5%) highlighted the presence of dedicated and sensitive teachers. On the other hand, 18 individuals (46.1%) did not specify any reasons regarding whether they received the necessary training on how to integrate TPACK.

When examining the reasons for teacher candidates not being able to receive training on how to integrate TPACK, out of 127 individuals, 5 (3.9%) stated that the application was insufficient, 26 (20.4%) indicated that the instructors were inadequate and indifferent to the courses, 15 (11.8%) mentioned the inadequacy of education at the university, 36 (28.3%) expressed that the courses were theoretical, superficial, and inadequate, 3 (2.3%) admitted to a lack of their own knowledge, 4 (3.1%) mentioned that classes were not conducted due to earthquakes, 6 (4.7%) reported the inadequacy of technological tools, 3 (2.3%) stated that exposure to courses was limited to the first year, 3 (2.3%) expressed that technology was not given enough importance, 3 (2.3%) mentioned attendance requirements, 3 (2.3%) indicated that courses were handled independently of each other, 1 (0.7%) noted that information was not updated, 1 (0.7%) mentioned that student levels were low, and 1 (0.7%) stated that there was insufficient time. Additionally, 17 individuals (13.3%) did not specify any reasons. Overall, it is observed that the courses are theoretical, superficial, and inadequate.

Table 15: Necessary Training on How to Integrate TPACK

	Thema	**f**	**%**
Yes	Effectiveness of education and courses	7	17.9
	Efficiency of school experience courses	3	7.6
	Instructors having sufficient knowledge and expertise	7	17.9
	Having sufficient prior knowledge	1	2.5
	Practical handling of courses	2	5.1
	Dedication and sensitivity	1	2.5
	Not specified	18	46.1
Total		39	100

When examining the reasons for teacher candidates not being able to receive training on how to integrate TPACK, out of 127 individuals, 5 (3.9%) stated that the application was insufficient, 26 (20.4%) indicated that the instructors were inadequate and indifferent to the courses, 15 (11.8%) mentioned the inadequacy of education at the university, 36 (28.3%) expressed that the courses were theoretical, superficial, and inadequate, 3 (2.3%) admitted to a lack of their own knowledge, 4 (3.1%) mentioned that classes were not conducted due to earthquakes, 6 (4.7%) reported the inadequacy of technological tools, 3 (2.3%) stated that exposure to courses was limited to the first year, 3 (2.3%) expressed that technology was not given enough importance, 3 (2.3%) mentioned attendance requirements, 3 (2.3%) indicated that courses were handled independently of each other, 1 (0.7%) noted that information was not updated, 1 (0.7%) mentioned that student levels were low, and 1 (0.7%) stated that there was insufficient time. Additionally, 17 individuals (13.3%) did not specify any reasons. Overall, it is observed that the courses are theoretical, superficial, and inadequate

Thirdly, the question asked to classroom teacher candidates was “Can you elaborate on the areas where you encounter difficulties in applying technology, pedagogy, and subject-area knowledge to the teaching-learning process?” As observed in Table 16, out of the 217 prospective primary school teachers participating in the study, 101 (46.5%) indicated that they encounter difficulties in applying technology, pedagogy, and subject-area knowledge to the teaching-learning process, 19 (8.7%) stated that they do not encounter difficulties in any area, 4 (1.8%) mentioned partial difficulties, and 93 (42.8%) did not provide a response to this question. In general, it can be stated that teacher candidates face difficulties in integrating TPACK into the teaching-learning process."

When examining the areas where teacher candidates encounter difficulties in integrating TPACK into the teaching-learning process, out of 101 individuals, 23 (22.7%) identified deficiencies in subject-area knowledge, 18 (17.8%) experienced challenges in using technological tools,12 (11.8%) expressed difficulties in teaching science and technology, 10 (9.9%) faced challenges in practical application due to the theoretical treatment of courses. In general, teacher candidates indicate a deficiency in subject-area knowledge for the TPAB learning-teaching process.

The following question were asked, 'How do you conduct studies to enhance your technological pedagogical content knowledge? Can you explain the reasons if you do or do not engage in such studies?' aimed to determine the efforts made by classroom teacher candidates to improve their technological pedagogical content knowledge.

Table 16: Areas Where They Encounter Difficulties

	Thema	**f**	**%**
Can you elaborate on the areas where you encounter difficulties in applying technology, pedagogy, and subject-area knowledge to the teaching-learning process?	Yes	101	46.5
	No	19	8.7
	Partially	4	1.8
	No response	93	42.8
Toplam		217	100

As seen in Table 17, out of the 217 classr00m teacher candidates participating in the study, 36 (16.5%) stated that they engage in studies to enhance their technological pedagogical content knowledge, 118 (54.3%) mentioned that they do not engage in such studies, and 63 individuals (29%) did not respond to this question. Generally, it can be said that teacher candidates do not conduct studies to enhance their technological pedagogical content knowledge.

Table 17 Studies Conducted to Improve TPACK

	Thema	**f**	**%**
How do you conduct studies to enhance your technological pedagogical content knowledge? Can you explain the reasons if you do or do not engage in such studies?	Yes	36	16.5
	No	118	54.3
	No response	63	29
Total		217	100

The teachers stated some studies to improve their TPACK levels. Among them, out of 36 individuals, 10 (26.3%) mentioned that they follow and research changes on the internet, 5 (13.1%) exchange information with expert instructors, 3 (7.8%) use technological tools, 8 (21%) apply what they learn during internships, 11 (28.9%) read articles and books, and 1 (2.6%) watch videos. On the other hand, out of 118 individuals, 14 (11.8%) mentioned that they do not have time to improve their TPAB levels, 11 (9.3%) mentioned the intensity of school courses 6 (5%) stated that the opportunities are not favorable, 6 (5%) expressed a lack of interest, 7 (5.9%) reported concerns. Sixty-three individuals (53.3%) did not specify reasons for not engaging in efforts to improve their TPACK

The following question were asked, “What courses do you think are effective in acquiring the knowledge and skills required to be a good classroom teacher?” As seen in Table 19, out of the 217 pre-service teachers participating in the study, 138 (63.5%) expressed that the courses they took at the university were effective in acquiring the knowledge and skills required to be a good classroom teacher, while 79 (36.4%) stated that the courses they took were not effective. Overall, it can be said that the courses taken at the university are effective in acquiring the knowledge and skills required to be a good classroom teacher.

Table 18: ***Which Courses They Believe Were Effective.***

	Thema	f	%
What courses do you think are effective in acquiring the knowledge and skills required to be a good classroom teacher	Yes	138	63.5
	No	79	36.4
Total		217	100

Among these teachers, out of 138 individuals, 3 (1.4%) mentioned ethics, 6 (2.8%) computer science, 2 (0.9%) communication, 3 (1.4%) education in inclusive classrooms, 19 (9.1%) life skills, 22 (10.5%) teaching methods and techniques, 4 (1.9%) material development, 25 (12%) mathematics, 16 (7.6%) social studies, 9 (4.3%) Turkish, 1 (0.4%) sociology, 17 (8.1%) school experience, 24 (11.5%) classroom management, 4 (1.9%) inclusion, 3 (1.4%) guidance, 12 (5.7%) early reading and writing, 7 (3.3%) science, 2 (0.9%) calligraphy, 4 (1.9%) developmental and learning psychology, 4 (1.9%) community service applications, 5 (2.4%) drama, 2 (0.9%) early childhood, 2 (0.9%) introduction to educational science, and 3 (1.4%) educational psychology were effective. 9 individuals (4.3%) did not specify any particular course that was effective.

1. Conclusion And Discussion References

According to the findings obtained from the research, the average scores of prospective classroom teacher candidates from the TPACK scale being high (M =166.49) indicate that their levels of Technological Pedagogical Content Knowledge (TPACK) are high. When considering the moderate average scores for the factors of the scale, it can be observed that the average scores obtained by prospective classroom teacher candidates from the TPACK scale factors are above the possible moderate score that can be obtained from each sub-component. Therefore, it can be concluded that the levels of Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK) of prospective classroom teacher candidates are above the moderate level.

In studies focused on TPACK, while they show that teachers have different levels of TPACK proficiency, they generally indicate that they use technology with a teacher-centered teaching approach (Tseng, Chai, Tan, and Park, 2022).The research revealed that the TPACK levels of the participating prospective classroom teacher candidates did not show statistically significant differences in terms of gender, grade levels, weekly internet usage frequency, presence of internet and educational applications on mobile devices. In the literature, it is seen that gender does not show a significant difference in terms of TPACK levels (Kaya et al., 2011; Timur and Taşar, 2011). However, in some studies, it is observed that gender creates a significant difference, indicating that male teacher candidates feel more competent compared to female teacher candidates (Bal and Karademir, 2013; Şahin and Erdoğan, 2010; Toker, 2005).

The research found a statistically significant difference between the TPACK levels of prospective classroom teacher candidates and the age variable. Teacher candidates in the youngest age group had higher TPACK levels. This can be attributed to the freshness of their knowledge. There was also a statistically significant difference between TPACK levels and the variables of internet and computer experience. In this case, it can be said that the increase in internet and computer experience of teacher candidates can contribute to the improvement of TPACK levels. Usta and Korkmaz (2010) concluded that classroom teachers perceive themselves as competent in terms of computer proficiency. Toker (2005) also stated that teacher candidates who own a computer feel more competent in using technology. Yavuz-Konakman et al. (2013) found that teacher candidates with higher levels of access to technology, interest in new technologies, and technology use have higher TPACK levels.

In their study, Kaya et al. (2011) examined the difference between the departments of teacher candidates (Department of Electronics and Computer Education in Technical Education Faculty, Department of Computer and Instructional Technologies in Education Faculty) and TPACK levels as a different variable. As a result, they stated that there was a significant difference in favor of the teacher candidates of the Technical Education Faculty in the sub-dimensions of TPACK. Bal and Karademir (2013) also found significant differences between TPACK self-assessment levels and different variables such as seniority, academic level, department of graduation, class entered, and in-service training status, in their study aiming to determine social studies teachers' self-assessment levels regarding TPACK.

In the research, when evaluating the views of prospective classroom teacher candidates on how the courses they took in the classroom teacher education program would affect their competencies, it was observed that they did not consider themselves sufficient in integrating technology into instruction with what they learned in Computer I, Computer II, and TPCG courses due to the inadequacy of university education, application, instructors, and technological tools. Especially the superficial and theoretical processing of courses, leading to the perception of teacher candidates being inadequate in using technological devices and reducing their interest in the course, was observed to play a role in this regard.

In various studies, it has also been shown that having technology in the classroom is not sufficient to integrate technology into instruction. It is emphasized that teacher candidates need to be informed about how to integrate technology into the classroom, and their experience needs to be increased. It is foreseen that they need technology education. (Demir et al., 2011; Bilgin et al., 2012; Bozkurt and Cilavdaroğlu, 2011). Mauza, Kaechmer-Klein, Nandakumar,

Ozden, and Hu (2014) aimed to see the practical impact of teacher candidates' pedagogical approaches and technology use status on their domain knowledge.

In the research, it was observed that prospective classroom teacher candidates had difficulty in applying technology, pedagogy, and content knowledge in the learning-teaching process due to the inadequacy of their domain knowledge and practical deficiencies in using technological materials. They mentioned that they did not receive the necessary education in their departments on how technological pedagogical content knowledge could be integrated due to the theoretical nature of the courses, lack of emphasis on the course by instructors, inadequacy of technological tools, etc. Wang, Schmidt-Crawford & Jin (2018) found in their literature review that teacher candidates tend to imitate the use of technology in their learning-teaching processes and integrate it into their professional lives in a way similar to the classroom environment. Therefore, they emphasized the importance of practical applications received during their education.

In general, it can be concluded that prospective classroom teacher candidates do not consider themselves competent enough in terms of TPACK due to the reasons mentioned. It is seen that they have the need to improve themselves in this regard, but they cannot make the necessary effort and the opportunities are not provided. However, in another study, Yavuz-Konakman et al. (2013) found in the analysis of data collected through metaphors that the majority of prospective classroom teacher candidates perceive their TPCK-related perceptions as high. As a result, teacher candidates expressed that the existing problems need to be resolved because the use of technological pedagogical content knowledge in education will contribute positively to education.

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