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Observing the technological pedagogical and content knowledge levels of science teacher candidates

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This study was planned to observe the technological pedagogical and content knowledge of teacher candidates. The study group consists of 4th grade students of Firat University Faculty of Education who were asked to describe any desired topic in the secondary school science curriculum, using the methods and techniques of their choosing. Teacher candidates talked about topics they had chosen in front of their peers with micro teaching technique. During this process, teacher candidates were evaluated by themselves, their peers and teachers using an observation form in terms of their ability to use methods and techniques, mastery of field knowledge and ability to integrate technology into the course. In the study, partially mixed concurrent equal status design was used. Technological pedagogical and content knowledge survey was used for the quantitative data and the qualitative data of the study were obtained from observation forms filled by the researchers of the study, teacher candidates and their peers. The results showed that the teacher candidates had a moderate level of technological pedagogical content knowledge. The fact that the pre- and post-study scores were significantly different in favor of the posttests suggests that it is important for teacher candidates to have the opportunity to make self-evaluations. It is very important for the teacher candidates to attend the courses where they can evaluate their technology, pedagogy, and content knowledge (TPACK) competencies especially in their teacher training programs and to make up for their deficiencies without starting to their professional life.

Key words: Technology, pedagogy, and content knowledge (TPACK), micro teaching, science teacher candidates.

INTRODUCTION

The rapid changes in information, communication and technology in the 21st century have made the use of technology in the learning and teaching process inevitable in order to increase productivity and quality in education (Selim et al., 2009; Ekici et al., 2012). As a result of the need for technology, information technologies have been integrated with learning environments, and it has become involved in the

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education system (Ekici et al., 2012, Tabach, 2011). The integration of technology into educational activities has gained importance, and teaching and learning opportunities have been offered in classrooms prepared for both teachers and students so that easy and quick access to technology and learning materials can be provided (Doğan, 2012). Effective use of technology offers students a deep comprehension of concepts in a different and meaningful way, increasing the learning levels of students and contributing to the efficiency and permanence of education (Doğan, 2012, Selim et al., 2009).

The development of technology has enabled new models and approaches to be developed. One of these is the technology, pedagogy, and content knowledge (TPACK) approach, which has been added to the literature by the addition of technology knowledge by Mishra and Koehler (2006). The TPACK framework builds on pedagogical content knowledge developed by Shulman (1986). TPACK is an approach that is integrated with knowledge of technology, content knowledge, and pedagogical methodology specific to content, where technology integration knowledge will not be confined to technology courses alone. Teachers should improve their content knowledge by incorporating technology, and to acquire teaching skills by including technology in the process (Kopcha et al., 2014; Aygün et al., 2016).

There are three types of knowledge which are technology knowledge (TK), pedagogy knowledge (PK), and content knowledge (CK) in the TPACK model. In addition, the model has three components of knowledge: technological pedagogical knowledge (TPK), technological content knowledge (TCK) and pedagogical content knowledge (PCK) (Koehler and Mishra, 2005; 2008; 2009; Mishra and Koehler 2006; Shin et al., 2009). The seven knowledge constructs are explained below (Mishra and Koehler 2006):

Technology knowledge (TK): This knowledge includes a variety of technologies used in learning environments from blackboard to advanced technologies.

Pedagogy knowledge (PK): This knowledge refers to procedure, practice, or methods necessary for teaching and learning like as general classroom management strategies, course planning, and student assessment.

Content knowledge (CK): Content knowledge is about the subject to be learned or taught. Teachers must know and understand the topics that are taught, including knowledge of facts, concepts, theories, and procedures that are specific to a particular area such as math, biology, and history.

Technological pedagogical knowledge (TPK): It is needed to understand general pedagogical strategies applied to the use of technology, and to understand how teaching and learning will change with use of certain technologies. Teachers need to exceed these technologies and associate them into instruction.

Technological content knowledge (TCK): In this knowledge it is important to integrate the technology into teaching. Content knowledge need to be supported using technological equipments.

Pedagogical content knowledge (PCK): PCK deal to teaching knowledge feasible to a certain subject area. Teachers need to adapt instructional materials to know the students'wants.

Technological pedagogical and content knowledge (TPCK)**:** TPCK is the intersection of the three knowledge bases.

The seven components of TPACK is shown in Figure 1. The studies about the use of TPACK in teacher education have increased in recent years to measure TPACK (Schmidt et al., 2009; Archambault and Barnett, 2010; Koh et al., 2010; Sahin, 2011; Fisser et al., 2015; Kartal and Afacan, 2017; Drummond and Sweeney, 2017), to examine the information communication technologies (ICT) and TPACK integration (Öztürk, 2012; Chai et al., 2014; Yurdakul and Çoklar, 2014; Tondeur et al., 2015; Gür and Karamete, 2015; Ersoy et al., 2016; Kihoza et al., 2016; Koh et al., 2017; Kontkanen et al., 2017), for exploring teachers' technological pedagogical content knowledge (Hsu et al., 2013; Delen et al., 2015; Dong et al., 2015; Boschman et al., 2015; Phillips, 2017; Turgut, 2017), to examine TPACK and teachers' self- efficacies (Kazu and Erten, 2014; Kenar et al., 2015; Saudelli and Ciampa, 2016; Blonder and Rap, 2017), to determine TPACK and needs of Twenty-First-Century Education (Mishra, Koehler and Henriksen, 2010; Koh et al, 2015; Cherner and Smith, 2017).

Studies on TPACK emphasize that in addition to field content knowledge, a good teacher should know how to transfer this knowledge to his or her students (Canbazoğlu et al., 2010, Bilici, 2012). Voogt et al. (2013) in their literature review found that student-teachers do get experience in the design of technology-enhanced lessons but lack experiences in enacting technology based lessons. When we consider that technology integration is also an integral part of effective and efficient education, it is expected that teachers should improve their technological knowledge related to their current field content knowledge and their ability to use technology adequately in the teaching process (Gencosman, 2015; Khine et al, 2017).

Work in the field of TPACK in Turkey started in 2010, and the studies carried out in this field have increased over the years. In the studies conducted, the samples consisted mostly of teacher candidates while the samples of few studies consisted of teachers. However, it has been reported that mixed groups consisting mainly of

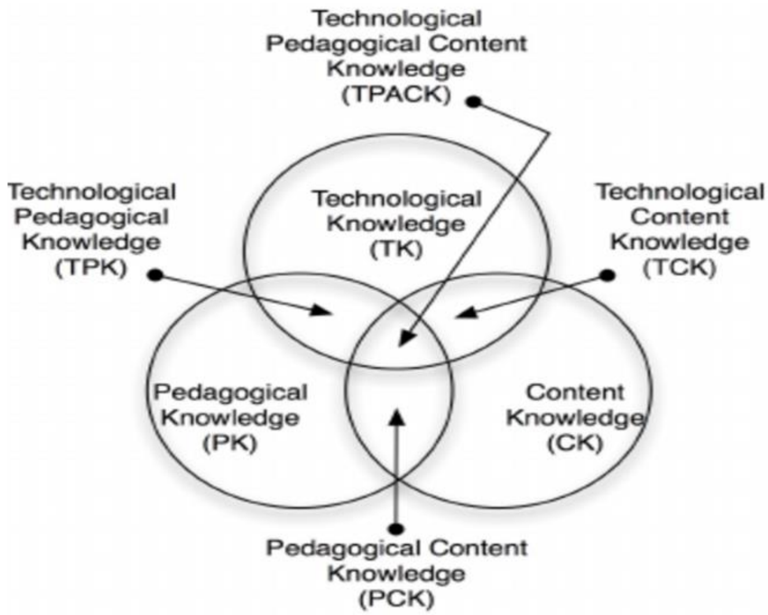

Figure 1. Technological pedagogical content knowledge (TPACK) (Mishra and Koehler, 2006).

more than one discipline were selected as the sample, and the most frequently studied fields after mixed groups would be listed as mathematics teachers, classroom teachers and science teachers (Baran and Bilici, 2015).

If we look at some of the recent studies conducted in the field of TPACK in Turkey; Aygün et al. (2016) in their study conducted on teacher candidates, found that the teacher candidates had a low level of competence in applying the teaching method and technique used in the teaching of the subject area through technology, and that the lectures were mostly made by presentations even though the activities prepared by the teacher candidates were intended to encourage discovery.

A total of 154 teacher candidates attending 2nd, 3rd and 4th years of college participated in a study aiming to determine the self-confidence of preschool teachers about their TPACK. The data were collected and analyzed using the TPACK self-confidence scale. According to the results of the study, it was found that the perceptions of the teacher candidates about their TPACK self-confidence were high, but there was no significant difference according to the gender and grade level of teacher candidates (Sancar et al., 2013).

In their study, Açıkgül and Aslaner (2015) aimed to determine the TPACK confidence levels of mathematics teacher candidates who were studying in different grades and to determine whether these confidence levels differed according to some variables. As a result of the TPACK confidence scale applied to 527 teacher candidates, it was found that candidates were highly confident of their TPACK. There was no significant difference in terms of computer ownership, frequency of use and level of use of technology, while there was also no significant difference according to gender and grade levels of candidates.

Kartal and Afacan (2017) in their study found pre-service science teachers' TPACK levels develop in direct proportion to their grade level. In many studies carried out with teacher candidates or teachers in the field of TPACK, many subjects such as self-evaluation levels of TPACK in the sample group, investigation of TPACK in terms of some variables, investigation of TPACK confidence perceptions, and TPCK self-efficacy are frequently encountered (Canbolat, 2011; Demir and Bozkurt, 2011; Bilici, 2012; Öztürk, 2013; Bal and Karademir, 2013; Akyüz, 2016; Aygün et al., 2016).

According to Mishra and Koehler (2008), while being an important part of the integration of technology in education, teachers need to be aware of technology, pedagogy and content knowledge about effectively and efficiently integrating technology into their lessons, as well as the knowledge structures generated as a result of the interaction of these with each other. Evaluations and discussions on education in Turkey have become more and more frequent in recent years, and they are among important current topics. Our ministry is undertaking breakthroughs and reforms in many fields in education in order to be able to raise young generations equipped for the constantly changing country and world conditions.

Undoubtedly, teachers are the most critical factor in these breakthrough and reform efforts. The most important role of change in the field of education belongs to teachers, no effort that teachers cannot embrace and internalize has been successful and these innovations are not reflected to the classroom environment. It is highly important to identify the TPACK levels of teacher candidates who will educate younger generations, and to eliminate existing shortcomings, enable them to graduate with a high TPACK, and to provide suitable environments for them to make use of information and communication technologies in their professional life. The prospect of teacher rearing emerges when a teacher candidate with a high self-sufficiency is considered to be more successful in his professional life and more willing and determined to solve it than a problem. When we consider that a teacher candidate with high self-efficacy has more success in professional life, is more willing and determined to solve an encountered problem, the importance of the responsibility of teacher training becomes evident.

Similarly, the successful integration of technology into the teaching process depends on the technology knowledge of teachers and their self-efficacy in using technology. This study was planned to observe the TPACK of teacher candidates. Teacher candidates were asked to describe any desired topic in the secondary school science curriculum, using the methods and techniques of their choosing. Teacher candidates talked about topics they had chosen in front of their peers with micro teaching technique. During this process, teacher candidates were evaluated by themselves, their peers, and teachers using an observation form in terms of their ability to use methods and techniques, mastery of field knowledge and ability to integrate technology into the course. The scores given are explained together with their reasons. The data obtained without this study is thought to be the answer to the following questions. The scores given were explained with their reasons. The data obtained in this study is thought to provide answers to the following questions.

Determining which methods and techniques teacher candidates choose will allow us to have an idea of what kind of strategy they will pursue in their future professional lives. In addition, knowing their mastery on the method they choose will give information about the proficiency of teachers in pedagogical terms. The topics that teacher candidates choose from the science curriculum, and identifying the grade level and discipline (physics, chemistry, and biology) that these topics belong to will provide us with an idea of the field competencies of the prospective teachers. We believe that this study will be useful in determining the reasons for the low level of success of the content knowledge examinations of teacher candidates, which is one of the teacher induction criteria in Turkey since 2013. We also believe that this study will answer the questions of whether teacher candidates use technology during the lecturing process, if so which technological tool do they use, the method they employ and how and at what level they integrate technology to their content knowledge. This study aims to observe the level of teacher candidates' technological pedagogical content knowledge according to components.

METHODOLOGY

In the study, Partially Mixed Concurrent Equal Status Design, where qualitative and quantitative data collection tools are used together was used. Leech and Onwuegbuzie (2009) have suggested that design should be used in concurrent applications with a two-stage design where the quantitative and qualitative components have equal weight. In the process of using the mixed method, all the characteristics of both quantitative and qualitative approaches must be known in depth and be actively used throughout this process (Çepni, 2014).

The study group consists of 4th grade students of Firat University Faculty of Education, 39 female and 7 male a total of 46 teacher candidates. TPACK survey was used for the quantitative data of the study. The qualitative data of the study were obtained from observation forms filled by the researchers of the study, teacher candidates and their peers. TPACK surveys are mostly preferred in the studies (Schmidt et al., 2009; Koh et al., 2010; Şad et al., 2015). In this study, TPACK survey was used, with a likert type of 5, from 47 items and 7 sub-dimensions, which was developed by Şahin (2011). The survey items are answered by means of a Likert-type scale with five response choices, including “1=not at all,” “2=little,” “3=moderate,” “4=quite,” and “5=complete.”

Observation form was formed by the researchers with the suggestion and participation of the teacher candidates. The observation form was examined by 5 science educators and decided to be suitable for use in the study. Teacher candidates are asked to evaluate their peers in terms of content knowledge, pedagogical knowledge and technological knowledge competencies and to score a maximum of ten points. Teacher candidates were asked to indicate the reasons of the points given.

FINDINGS

Qualitative and quantitative data of this study carried out with mixed pattern are given below.

Qualitative data

In this study, teacher candidates explained the topics they had chosen in front of their peers with the micro teaching technique. In this section, the data obtained from the observation forms were analyzed in terms of method and technical knowledge, content knowledge, and technology knowledge based on self, peer and teacher evaluations.

Observation form analysis of teacher candidates according to content knowledge

Teacher candidates have chosen the subjects they want from the science curriculum, and presented them with micro teaching method. Teacher candidates were scored while they were presenting their chosen topics by their peers, and five lecturers were present as observers. After the teacher candidates finished their presentation, they

Table 1. Teacher candidates' self-, peer- and teacher-assesstments in terms of content knowledge

Variable	Min score	Frequency (f)	Max score	Frequency (f)	Mean
Self-assesstments	5	1	10	28	9.37
Peer- assesstments	6.4	2	10	1	8.28
Teacher-assesstments	5	2	10	2	7.89

Table 2. Distribution of selected topics according to the information learning discipline.

The information learning discipline	5th grade	6th grade	7th grade	8th grade	Total	Percentage
Living creatures and life	12	3	4	3	22	47.9
Physical events	3	0	4	2	9	19.6
Matter and change	2	0	3	5	10	21.7
The world and the universe	3	0	1	1	5	10.8

watched their own videos and evaluated themselves. Tha data gotten from the scores of the prospective teachers' assessments, the topics selected, the class level in which these topics take place and the distribution of topics' learning discipline are presented in the tables below. Teacher candidates' self, peer and teacher assessments in terms of content knowledge are given in Table 1.

Teacher candidates' self-evaluation mean scores (9.37), peer evaluation mean scores (8.28) and teacher mean scores (7.89) are presented in Table 1. When the self-assessment scores are examined, it is found that a large rate of teacher candidates (61%) gave themselves the highest grade (max=10) that can be taken. It is shown that there is a significant difference between teacher assessment and self-assessment mean scores. The peer assesstment scores are between the self and teacher assesstment scores but they are closer to the teacher assesstment scores.

Table 2 shows the distribution of the topics selected by the teacher candidates in the micro-teaching practices according to the information learning discipline indicated in the Elementary Education Institutions Science Curriculum (2013). As shown in Table 2, "*living creatures and life*" learning discipline is the most selected learning discipline with 47.9% of the teacher candidates. The rate of preference for other learning disciplines is 21.7% in *matter and change*, 19.6% in *physical events* and 10.8% in *the world and the universe*. The topics selected by teacher candidates and the grade level in which these topics take place is indicated in Table 3.

According to Table 3, the teacher candidates mostly preferred the subjects at the 5 th grade level. The 6th grade subjects were least selected. The most selected units of living creatures and life learning disciplines were the units about human body subjects (n=15). Environmental subjects were also preferred by teacher candidates (n=7). The most preferred subject of the teacher candidates under the physical event learning discipline was the friction force (n=3). Under the matter and change learning discipline, the most preferred subject is the matter and change unit topics (n=10).

Observation form analysis of teacher candidates according to pedagogy knowledge

Teacher candidates presented their chosen topics with a method and technique they wanted with micro teaching method. Teacher candidates were graded in terms of their dominance of the methods and techniques by their peers and 5 teachers who participated in the lesson as observers. After the teacher candidates finished their presentation, they watched their own videos and evaluated themselves. The scores that teacher candidates receive from these evaluations are given in Table 4. Table 4 examined teacher candidates' self-assessment mean scores (9.34), peer assessment mean scores (8.46) and teacher assessment mean scores (7.89). When the self-assessment scores are examined, it is shown that a large rate of teacher candidates (61%) gave themselves the highest grade (max=10) that can be taken as content knowledge.

Observation form analysis of teacher candidates according to technology knowledge

Teacher candidates are required to integrate the selected topics, method and technique they desire with technology. Teacher candidates were evaluated by their peers and their teachers in terms of technology knowledge. Teacher candidates' self, peer and teacher assessments in terms of technology knowledge are given in Table 5. Table 5 shows teacher candidates' self-assessment mean scores (9.06), peer assessment mean scores (7.45) and teacher assessment mean scores

Table 3. The topics selected by teacher candidates and the grade level in which these topics take place.

Grade level	Unit	Subjects	Frequency	Total
5th grade	Let's solve the puzzle of our body	Digestion of nutrients	n=1	20
		Smoking and alcohol harm	n=1	
		Nutrients and their properties	n=4	
	Let's explore the world of living	Global warming	n=2	
		Human and environment relation	n=2	
		Let's recognize the living	n=2	
	Measuring the magnitude of force	Frictional force	n=3	
	Change of matter	Matter and characteristics	n=1	
		Heat-temperature	n=1	
	The mystery of the earth's crust	Environmental pollution	n=3	
6th grade	Systems in our body	Support and movement system	n=1	3
		The circulatory system	n=1	
		Respiratory system	n=1	
7th grade	Systems in our body	Sense organs	n=1	12
		Organ donation and organ transplantation	n=1	
		Controller and regulatory system	n=1	
		Digestive system	n=1	
	Reflection and absorption of light in the mirrors	Mirrors	n=1	
	Solar system and beyond	Solar system	n=1	
	Matter and properties of the matter	Domestic waste and recycling	n=1	
		Grain structure of the matter	n=2	
	Force and energy	Mass and weight	n=1	
		Pressure	n=2	
8th grade	Human growth and development	Mitosis and meiosis	n=1	11
		Genes	n=1	
	Living and energy relations	Biotechnology	n=1	
	Earthquake and weather events	Climate	n=1	
	Electricity in our lives	Electric loads	n=1	
	Simple machines	Simple machines	n=1	
	Structure of the matter	Matter and characteristics	n=3	
		Periodic table	n=1	
		Acids and bases	n=1	

Table 4. Teacher candidates' self-, peer- and teacher-assesstments in terms of pedagogy knowledge.

Variable	Min score	Frequency (f)	Max score	Frequency (f)	Mean
Self-assesstments	7	3	10	28	9.34
Peer- assesstments	6.4	1	10	1	8.46
Teacher-assesstments	4	3	10	5	7.89

Table 5. Teacher candidates' self-, peer- and teacher-assesstments in terms of technology knowledge.

Variable	Min score	Frequency (f)	Max score	Frequency (f)	Mean
Self-assesstment	5	3	10	28	9.06
Peer- assesstment	4.2	2	10	1	7.45
Teacher-assesstment	2	1	10	3	7.10

Table 6. Descriptive data of TPACK survey pretest and posttest scores.

Subscales	N	Pretest		Posttest	
		Mean	SD	Mean	SD
TK subscale	46	3.43	0.58127	3.59	0.58461
PK subscale	46	3.28	0.36493	3.47	0.61022
CK subscale	46	3.33	0.39277	3.72	0.43158
TPK subscale	46	3.39	0.38963	3.69	0.59204
TCK subscale	46	3.42	0.43420	3.78	0.50719
PCK subscale	46	3.35	0.46729	3.65	0.54606
TPACK subscale	46	3.35	0.48842	3.73	0.55250
TPACK scale	46	3.08	0.34630	3.72	0.46393

Table 7. t-test results of TK, PK, CK subscales and TPACK scale pretest-posttest scores.

Measurement	N	$\bar{X}$	SD	df	t	p
TK subscale pre-test	46	51.3913	8.71902	45	-2.413	0.020
TK subscale post-test	46	53.891	8.76921	45	-	-
PK subscale pre-test	46	19.6957	2.18957	45	-2.198	0.033
PK subscale post-test	46	20.8043	3.66133	45	-	-
CK subscale pre-test	46	20.0435	2.24060	45	-5.112	0.000
CK subscale post-test	46	22.3043	2.58946	45	-	-
TPACK scale pre-test	46	141.8696	15.92986	45	-11.493	0.000
TPACK scale post-test	46	170.9565	21.34058	45	-	-

(7.10). When the technology knowledge self-assessment scores are examined, it is found that 61% of teacher candidates gave themselves a full score just like content knowledge and pedagogy knowledge.

Quantitative data

In this section, the data of the scores obtained from the TPACK survey of the prospective teachers were analyzed. The TPACK survey consists of likert type 47 items and seven subscales including TK, PK, CK, TPK, TCK, PCK, and TPACK. It was examined whether the pre-test and post-test scores of the teacher candidates met the normality assumption. TK, PK, and CK subscales and pre-posttest scores of the TPACK scale fulfilled the normality assumption, and pre- and posttest scores of the TPK, TCK, PCK, TPACK subscales did not meet the normality assumption. Related sample t-test for scores meeting the normality hypothesis was analyzed, and using wilcoxon signed rank test for scores that did not meet normality hypothesis. Pretest and posttest mean scores and standard deviations showing the TPACK levels of teacher candidates are given in Table 6. When TPACK scale pre-test and post-test mean scores of teacher candidates are examined, it was found that post-test scores increase. However, it is indicated that the level of proficiency in the posttest mean scores is at the middle level as it is in the pretest scores. t-test results of TK, PK, CK subscales and TPACK scale pretest-posttest scores are given in Table 7. The results suggest that there are significant differences in the mean scores of technology knowledge subscale'pre-test and post-test scores ($t(45) = -2.413$, $p < 0.05$); pedagogy knowledge subscale subscale'pre-test and post-test scores ($t(45) = -2.198$, $p < 0.05$); content knowledge subscale subscale'pre-test and post-test scores ($t(45) = -5.112$, $p < 0.05$) and TPACK scale TPACK scale' pre-test and post-test total scores ($t(45) = -11.493$, $p < 0.05$). Pretest and posttest scores of TPK, TCK, PCK and TPACK were analyzed using the Wilcoxon signed rank test. The results are shown in Table 8. When Table 8 is examined, it is found that there is a significant difference between pretest and posttest scores of TPK, TCK, PCK and TPACK subscales of preservice teachers ($p<0.01$).

Conclusion

When TPACK scale pretest and posttest averages of teacher candidates are examined, it is found that there is an increase in post-test scores. This result shows that teacher candidates observing their peers like critics over the course of one term, and evaluating their peers and

Table 8. Wilcoxon signed rank test results of TPK, TCK, PCK and TPACK subscales' pretest and posttest scores

Variable	Posttest-pretest	N	Mean rank	Sum of ranks	z	p
TPK subscale	Negative ranks	7	10.86	76.00	-3.396*	0.001
	Positive ranks	24	17.50	420.00	-	-
	Ties	15	-	-	-	-
TCK subscale	Negative ranks	7	12.93	90.50	-3.839*	0.000
	Positive ranks	29	19.84	575.50	-	-
	Ties	10	-	-	-	-
PCK subscale	Negative ranks	5	15.10	75.50	-3.936*	0.000
	Positive ranks	30	18.48	554.50	-	-
	Ties	11	-	-	-	-
TPACK subscale	Negative ranks	7	9.79	68.50	-3.807*	0.000
	Positive ranks	26	18.94	492.50	-	-
	Ties	13	-	-	-	-

* Based on negative ranks.

themselves through the observation form have a positive effect on technological pedagogical content knowledge. The results of the paired sample t test and wilcoxon signed rank test showed that there was a significant difference in favor of the posttest scores in the TK, PK, CK, TPK, TCK, PCK, TPACK subscale scores and in the overall scores of the scale. However, it is found that the level of increase in the average of the posttest scores is at an intermediate level as it is in the pretest scores. When the relevant researches are examined, the results are in parallel with the general results of this research (Gömleksiz and Fidan, 2011; Sancar et al., 2013; Şad et al., 2015). The fact that teacher candidates more frequently being in learning environments where they are authentically evaluated as in this study will carry this level higher.

Teacher candidates were graded by themselves, their peers and their teachers in terms of their content knowledge, via the observation form. It was found that teacher candidates were not able to objectively evaluate themselves during self-evaluation. With an extremely high ratio of 61%, teacher candidates gave themselves a full score and expressed their content knowledge to be very good. This result is inconsistent with the results of teacher evaluation. Teacher candidates were left free on the topic selection, and thus they were given the opportunity to choose the topic they felt most competent in. Despite this, there were only two teacher candidates that received a full score in teacher evaluations, while this number was only one in peer evaluations.

Almost half of the teacher candidates chose the subject of "living creatures and life" learning domain. The rate of preference for other learning domains is below 25%. The reasons for the preference of living creatures and life learning domain may include teacher candidates having more content knowledge in this discipline, having a better attitude towards the discipline of biology, and seeing themselves to be more competent in this discipline. It is important to identify the reasons for this tendency of teacher candidates in terms of increasing their content competencies. We also believe that investigating the KPSS questions –a field examination where teacher candidates need to be successful before being inducted– that are answered correctly according to learning domains, and checked whether they are in accordance with the findings of this study, and taking the opinions of the candidates into consideration will contribute to the literature.

It is found that the teacher candidates prefer fifth grade topics with a frequency of 43.5% in topic selection. One of the reasons for teacher candidates to concentrate on 5th grade topics may be that candidates think fifth grade topics are easier to understand. Interestingly however, only 3 teacher candidates selected 6th grade topics, while other teacher candidates selected 7 and 8th grade topics. When the topics choices of the teacher candidates were examined, it was shown that the topics about the human body were selected the most. The second most selected topic was the ‘structure and change of matter’, which is under the ‘matter and change’ learning domain.

According to the results of the 2017 KPSS Teaching Content Knowledge Test (TCKT), the lowest average score of teacher candidates was found to be Science/Science and Technology with an average score of 11,777 (ÖSYM, 2017). In order to increase the content competencies of teacher candidates, we recommend determination of the topics that they do not feel competent in and making improvements in these areas.

Candidate teachers properly using the method they choose, and their communication with students was evaluated under the heading of pedagogical knowledge. The teacher candidates were objective in their self-evaluation forms with regard to pedagogical and technological knowledge, as this was the case for content knowledge, and they gave themselves the highest possible scores.

According to teacher evaluation, the average score of teacher candidates was 7.89, while the average score according to peer evaluation was 8.46. For technology knowledge, average scores of teacher evaluation was 7.10, while the average score of peer evaluation was 7.45. When we consider that teacher candidates prefer the method that they know best, it is thought provoking that the number of students who received the full score in pedagogical knowledge is n=5, and for technological knowledge is n=3. That is to say, while the teacher candidates felt competent, they were not found competent when they were evaluated by their teachers.

On the observation forms, scoring was done on a scale of ten points, and it was found that the scores were in proximity with the scores obtained from the TPACK scale when the teacher candidates were evaluated by their teachers on a scale of five (content knowledge=3.95, pedagogy knowledge=3.95, and technology knowledge=3.55). The quantitative and qualitative data obtained in the study showed that the teacher candidates had a moderate level of technological pedagogical content knowledge. The fact that the pre- and post-study scores were significantly different in favor of the posttests suggests that it is important for teacher candidates to have the opportunity to make self-evaluations. It is needed to develop the teacher candidates'effective specific level of TPACK in their subject area (Khine et al., 2017).

Teacher candidates do not have the opportunity to be in an implementation environment where they can evaluate their TPACK competencies until the school experience and teaching practice lessons in their final year. In this case they are too late to overcome the shortcomings in the fields and pedagogical topics that they find themselves to be incompetent.

Thomas et al. (2013) suggest TPACK into teacher education programs to measure implementation through evaluation and research. Teacher preparation programs is needed to transform into fully realized TPACK environments. The competencies of teacher candidates should be increased through micro teaching practices similar to those in this study. With an increase in the number of such studies, it can be ensured that teacher candidates evaluate themselves more objectively.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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