A Research on the Interaction Between Technological Pedagogical Content Knowledge and Content Knowledge for Teaching of Mathematics Teacher Candidates

Dr.Feriha Hande İdil
Dokuz Eylül University, İzmir
ORCID: 0000-0002-6205-7278
deuhande@gmail.com

Prof. Dr. Serkan Narlı
Dokuz Eylül University, İzmir
ORCID: 0000-0001-8629-8722
serkan.narli@deu.edu.tr

E-International Journal of Pedandragogy

Vol: 2, No:1, pp. 33-47

Research Article

Abstract:

This study aims to investigate the correlation between technological pedagogical content knowledge (TPACK) of primary education mathematics teacher candidates and their mathematical knowledge for teaching (MKT). This study uses non-empirical research approach for quantitative research. In total, 141 teacher candidates who are being trained in elementary level mathematics teacher education program have participated in the study. Research data is classified into 3 categories. Namely, TPACKscores of students, their multiple choice test scores and their demographical characteristics. Data was obtained using TPACKScale and the multiple choice test developed within the scope of Learning Mathematics for Teaching (LMT) project launched in the University of Michigan and went through the pilot study stage. It is found that the correlation between the components of MKTwas low while the correlation between the components of TPACK was high when the results of this research are examined. The necessity for a teacher to have all the MKT components simultaneously in order to conduct the effective teaching process was the most important finding of the study and it supported the theoretical structure. It was seen that content knowledge, alone, was not enough for a teacher to be a good instructorwith regards to the MKT theoretical framework. Additionally, it was seen that pedagogigal knowledge showed the highest effect while technological knowledgeshowed the lowest effect on predictions made in technological pedagogigal knowledge, technological content knowledge, pedagogigal content knowledge, and TPACK domains which were obtained from the interaction of basic domains (Pedagogical knowledge, technological knowledge and content knowledge). As a result, the correlation between MKT and TPACK scores were found to be insignificant.

Keywords: *Technological Pedagogical Content Knowledge, Content Knowledge for Teaching, Teacher Candidates, Mathematics.*

Received: 21.03.2022
Accepted: 26.04.2022

Suggested Citation

İdil, F. H. & Narlı, S. (2022). A Research on the interaction between technological pedagogical content knowledge and content knowledge for teaching of mathematics teacher candidates, *E-International Journal of Pedandragogy (e-ijpa),* 2(1), 33-47. Doi: https://trdoi.org/10.27579808/e-ijpa.86

INTRODUCTION

Technology today has penetrated almost every sphere of our lives and becomes even more widespread every other day. Technology is utilized in every field of science and is ever developing. Technological tools have been shaping practices, research methods and even research questions adopted by mathematicians directly as a result of advances in technology (Artigue, 2002). Therefore, technology with its widespread effect in our lives has a significant impact on mathematics teaching and several technological tools have been commonly used in mathematics teaching particularly in the last three decades. Mathematics teaching programs applied in many countries stress the necessity and importance of technology in mathematics teaching (NCTM, 2000). Because, technology is the bridge between what people know and what they can do (Şumuer and Yıldırım, 2018). Thus, knowing how to use technological tools such as computer software, scientific and graphical calculators, etc., comes to mean using these tools effectively for teaching. Therefore, teaching teachers how to use these technological tools alone both during their pre-service and in-service teaching training will not be enough (Akkoç, Özmantar and Bingölbali, 2008). The teacher element is considered one of the fundamental factors in the education system (Çelikten, Sanal and Yeni, 2005). The teacher element referred to here is a person who assists students in order for them to be successful whatever their needs, skills or conditions are. In other words, it refers to a guiding role in education with regards to individual needs considering individual differences of students. It is obvious that teachers who are specialized, open to innovation and technology, aware of his/her own skills, and open to self-development in a way to assist the mathematics learning process which involves abstract and cumulative concepts that can only be reached by intellectual processes, mathematical facts rather than empiric means (MEB, 2017). Teaching process management, one of the features of teachers, is considered among the factors affecting the success of students (Dursun and Dede, 2004; Dursun and Peker, 2003).The purpose of mathematical education is to bring up individuals who knows the meaning of mathematics, who has the mathematical knowledge meeting the needs of advancing world and who are specialized in the application of advanced technology (Ersoy, 2003). There is no doubt that these desired skills must be present in teachers who are to train these individuals. The sense of education dominated by traditional approaches fails to raise the knowledge in individuals within the scope of modern needs (Yiğit and Akdeniz, 2003). As a result, change in education approaches and teaching methods has become a necessity. Advances in science and technology have been prominent also in the education field as education has a dynamic structure requiring continued innovation (Kutluca and Birgin, 2007). The inclusion of new technologies in the learning environment resulted in increased usage of sense organs and increased student interest which helps utilizing the education and making learning fun (Özdemir and Tabuk, 2004). Technology integration in education is very important (Lai and Bower, 2019). Utilization of technological tools must be incorporated with the training of teachers and teacher candidates accordingly. This information is referred to as "Technological Pedagogical Content Knowledge (TPACK)" in the literature (Pierson, 1999; Niess, 2005).

TPACK was created with the inclusion of technological content knowledge into Shulman's model (Pedagogical Content Knowledge) (Cox, 2008). TPACK framework stresses the importance of correlations, interactions and restrictions between content, pedagogy and technology while introducing these notions as fundamentals of a good teacher development (Mishra and Kohler, 2006). TPACK framework defines the interaction between the sense of technology, pedagogy and content adopted by teachers in order to bring out an efficient teaching involving teaching technologies and discipline (Harris, Mishra and Koehler, 2007). TPACK is shaped influencing from each component it is in interaction with and their intersections. Components of TPACK are shown below (Figure 1).

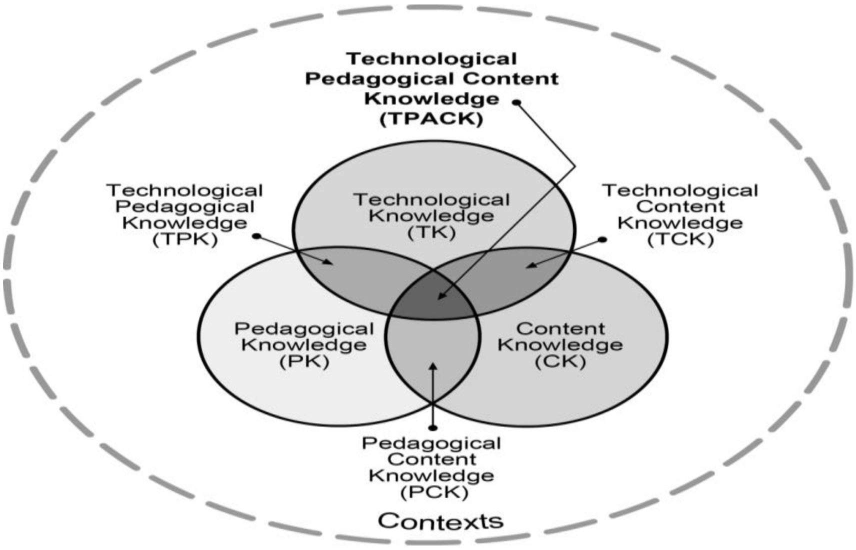

Figure 1: *Technological Pedagogical Content Knowledge(*TPACK*) Model*

TPACK model is based on three main knowledge domains namely technology, pedagogy and content (Koehler and Mishra, 2005):

- Technology includes tools such as computers, internet, videos, interactive whiteboards, and books.
- Pedagogy includes methods, strategies and processes involved in learning and teaching,
- Content includes the knowledge of the content to be taught.

Mishra and Koehler (2006) define the seven knowledge domains generated in line with the intersections of three main knowledge domains as follows: *Technological Knowledge (TK)***:** Technological knowledge involves educational tools such as whiteboards and computers and advance technology. *Pedagogical Knowledge (PK):* Pedagogical knowledge involves the knowledge about methods and techniques of learning and teaching with regards to detailed educational purposes, values and goals. *Content Knowledge (CK):* It is the knowledge contemplated over and the actual subject learned. *Pedagogical Content Knowledge (PCK):* It involves the knowledge of suitable approaches to teach the content and how and which elements to plan in order to provide a good education. *Technological Content Knowledge (TCK):* It is the knowledge of the interaction between technology and content. *Technological Pedagogical Knowledge (TPK):* Knowledge about components, use, and restrictions of several technologies used teaching and learning regulations. *Technological Pedagogical Content Knowledge (TPACK):* It is the knowledge which requires the use of the concepts involving technology applications and the comprehension of their presentations.

TPACK requires consideration of the knowledge with regards to several domains rather than unidirectional. Therefore, teacher candidates need a well-developed knowledge base as stated by Niess (2005). This issue, in other words, knowledge as the focus of individual learning, has been stressed by many in the recent years. Innovations in technology and the knowledge accumulation in content may be integrated with their development of technological knowledge in some disciplines. Teachers need to have a comprehensive sense of TPACK in order to be ready for mathematics teaching. Mathematics teachers need to contemplate about teaching with technology and how to teach mathematical concepts using notions, concepts, hypotheses, and generalizations (Richardson, 2009). Therefore, an effective teaching environment can be created when the mathematical knowledge teachers used in the teaching process and the technological knowledge used when conveying this knowledge are addressed as a whole.

Types of knowledge which is necessary to be found in teachers were first presented by Shulman and his detailed researches. The common belief that accepts a mathematics teacher will be the best person to teach mathematics if he/she is good at it (Begle, 1979, Gülden, 2009) has been changing with Shulman's pedagogical content knowledge (Shulman, 1986), a sub-component of content knowledge (Cox, 2008) and definition of this type of knowledge as one of the seven knowledge domains a teacher should possess. The conclusion reached was, teaching profession should involve authentic knowledge domains just like engineering and medicine and these domains should involve different features for each discipline as a result of Shulman's and other researchers' studies on teaching knowledge (Ball, Hill and Bass, 2005; Ball, Lubienski and Mewborn, 2001; Shulman, 1986 and Shulman, 1987). Teaching knowledge, with its overall meaning, is being attempted to be defined with knowledge domains which teachers must possess as distinct from any other individual possessing knowledge about the subject. One of the fundamental elements of the teaching knowledge defined for mathematics teaching is the specialized mathematics content knowledge (Ball, Hill and Bass, 2005) and it has been stressed that the mathematical knowledge possessed by teachers must involve a structure both individual and profound (Ball and Bass, 2003; Ball, Lubienski and Mewborn, 2001; Hill, Rowan and Ball, 2005; Even, 1993; Ponte and Chapman, 2006). In this contect, Ball, Thames and Phelps (2008) have developed the theoretical framework of Mathematical Knowledge for Teaching (MKT).Theoretical framework of Mathematical Knowledge for Teaching (MKT) allows for combined evaluation of content knowledge and pedagogical knowledge within studies involving mathematics teachers since 2008 while attempting to define the knowledge being used by teachers in the mathematics teaching processes. Theoretical framework of MKT consists of two fundamental categories namely Subject Matter Knowledge and Pedagogical Content Knowledge (Figure 2-Ball, Thames, and Phelps, 2008, p. 403).

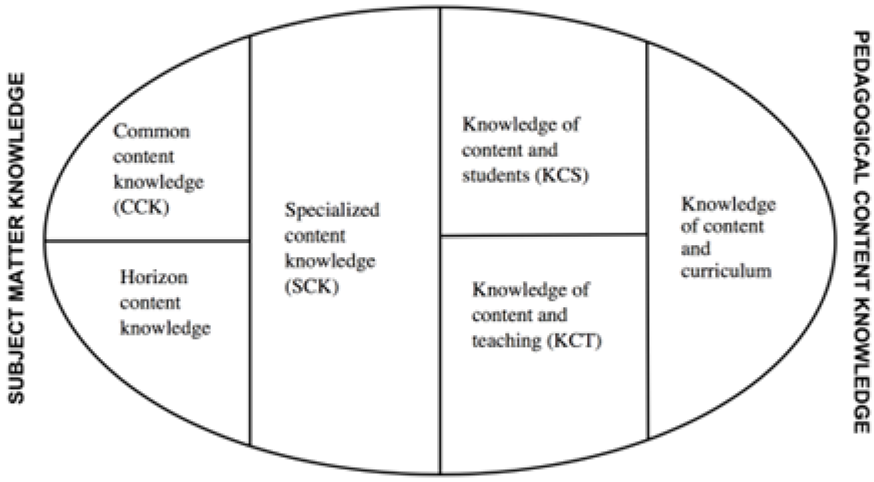

Figure 2: *The common representation of Mathematical Knowledge for Teaching (MKT)*

Content Knowledge consists of two categories namely *Common Content Knowledge* and *Specialized Content Knowledge*. *Common Content Knowledge* can be defined as the knowledge needed to solve a mathematical problem properly. This knowledge involves the knowledge and skills required in order to solve the questions given to students. It plays an important role in understanding, planning and learning the mathematics course. *Specialized Content Knowledge,* on the other hand, involves the knowledge and skills required by teaching mathematics. It includes tasks and responsibilities required for teaching mathematics. Knowledge and skills required to be possessed by teacher candidates in order to be able to teach mathematics courses are addressed in this context. Thus, it allows us to reveal teacher candidates' ideas about the solutions provided by students to the questions delivered to the teacher candidates.

Pedagogical Content Knowledge consists of two fundamental categories namely *Knowledge of Content and Students* and *Knowledge of Content and Teaching. Knowledge of Content and Students* focuses on the knowledge about mathematics and the student. Knowing the most commonly made student mistakes and their frequency of occurrence are within the scope of *Knowledge of Content and Students.* In this context, how candidates address solutions for different mathematics subjects, student mistakes and if they were able to identify the reason behind these mistakes were investigated. *Knowledge of Content and Teaching* focuses on identifying the suitable method and evaluating the advantages and disadvantages of alternative methods in order to define the proper teaching method to be used in teaching of a subject.

Purpose of this study:

Theoretical framework of MKT tries to define the professional knowledge which teachers should possess in an effective teaching process. However, teachers also need to possess sufficient technological knowledge related to their profession as a result of technological means commonly used in educational environments. Use of technology concerning the domain has become important along with the knowledge required for an efficient teaching process. Nevertheless, some criticism has been directed at the model and its restrictions along with the increasing attention and popularity TPACK attracts. Particularly, criticism made by Cox (2008), Graham (2011), Angeli and Valanides (2009) is notable. The issues of the correlations of the structures within this framework, their interactions and limitations were mentioned. In this context this study analyses the effects of pedagogical knowledge (PK), content knowledge (CK)and technological knowledge (TK) on pedagogical content knowledge (PCK), technological content knowledge (TCK) and technological pedagogical knowledge (TPK)and the effects of PCK, TCK, and TPK on TPACK and the relationship between content knowledge for teaching and technological pedagogical content knowledge of teacher candidates. The following questions probed for this purpose:

1. Are pedagogical knowledge (PK) and Technological knowledge (TK) as components of TPACK of mathematics teacher candidates predict technological pedagogical knowledge component?
2. Are content knowledge (CK) and technological knowledge (TK) as components of TPACK of mathematics teacher candidates predict technological content knowledge component?
3. Are pedagogical knowledge (PK) and content knowledge (CK) as components of TPACK of mathematics teacher candidates predict pedagogical content knowledge component?
4. Are content, pedagogical and technological knowledge of mathematics teacher candidates predict technological pedagogical content knowledge (TPACK) component?
5. Is there a correlation between MKT components of mathematics teacher candidates?
6. Is there a correlation between TPACK levels and MKT components of mathematics teacher candidates?
7. Does MKT scores of mathematics teacher candidates predict their TPACK scores?

METHOD

This study uses non-empirical review method, one of the approaches used for quantitative research (McMillan and Schumacher, 2010). A review is a research involving a larger sample when compared to other studies in the literature which identifies the characteristic of participants such as their ideas, interests, skills and behaviours about a subject or an event (Büyüköztürk, Çakmak, Akgün, Karadeniz ve Demirel, 2010).

Data Collection Process and Participants

This study is conducted with the participation of elementary level mathematics teacher candidates who are being trained in a University located in Turkey. The sample of this research involving 141 teacher candidates was identified using random sampling method. A personal information form consisting of demographical questions such as the program and grade the teacher candidates are attending, their gender and computer usage was delivered and "Technological Pedagogical Content Knowledge (TPACK) Scale" was used in order to identify the TPACK level participants use in mathematics courses. TPACK is a 5 point Likert scale which involves 47 items. Which are technology knowledge; pedagogy knowledge; content knowledge; technological pedagogy knowledge; technological content knowledge; pedagogical content knowledge; and technological pedagogical content knowledge. Perception of basic concepts and procedures of elementary level mathematics teachers, their usage of mathematical definitions and the way they are communicated to the students, common mistakes made by students, misconceptions, and determining solution methods and the way they evaluate different solution methods were analysed using a multiple choice test. The test used in this study is the test developed as part of the Learning Mathematics for Teaching (LMT) project launched in the University of Michigan and went through the pilot study stage.

Research Instrument

In this study, a scale regarding mathematics teacher candidates' perceptions in technological pedagogical and content knowledge (TPACK) domains, originally developed by Şahin (2011), is used.In the measurement tool, TPACK-Technological Pedagogical Content Knowledge (5 items; eg, integrating course content with appropriate technology and teaching principles/methods...) and sub-knowledge areas [TK-Technological knowledge (15 items; eg, solving a technical problem on the computer...), PK-Pedagogical knowledge (6 items; eg, Evaluating student performance...), CK-Content knowledge (6 items; eg, basic topics in field...), TPK Technological pedagogical knowledge (4 items; eg, assessing the suitability the education-training of a new technology ...), TCK-Technological content knowledge (4 items; eg, technologies for the field (computer applications)...) and PCK-Pedagogical content knowledge (7 items; eg, being able to easily prepare a lesson plan that includes classroom/in-school activities...)] related there are 47 items in total.In the Survey of TPACK, higher scores for each subscale indicate higher perceived acquaintance with the applications of the knowledge base.

The Validity and the Reliability of the Survey

The validity and reliability studies of the subscales were conducted by Şahin (2011) using data obtained from 348 pre-service teachers. According to the results of independent factor analyzes related to TPACK and sub-knowledge areas, the factor loads of the items in the subscales were found to be between 0.599 and 0.903. The total variance rates explained by the subscales were 51.87% for TK-Technological knowledge; 69.09% for PK-Pedagogical knowledge; 59.3% for CK-Content Knowledge; 74.48% for TPK-Technological pedagogical knowledge; 74.77% for TCK-Technological content knowledge; 69.02% for PCK-pedagogical content knowledge and 76.1% for TPACK-Technological Pedagogical Content Knowledge. In the development study of the instrument, the Cronbach alpha reliability coefficients are found between 0.86 and 0.96 for the subscales of the survey indicating that the instrument is a reliable measure. As a result of test-retest analyzes regarding the reliability of the scales in terms of stability, positive, significant and high-level correlations were found ranging between $r= 0.77$ and $r= 0.86$. The Cronbach Alpha internal consistency coefficients of the subscales were $\alpha=0.93$ for TK, $\alpha=0.90$ for PK, $\alpha=0.86$ for CK, $\alpha= 0.88$ for TPK, $\alpha=0.88$ for TCK, $\alpha=0.92$ for PCK, and It was calculated as $\alpha =0.92$ for TPACK. In this study, internal consistency alpha coefficient was found to be 0.96 as a result of the application of data collection tool to the study sample.

Data Analysis

Data collected from 141 teacher candidates were used in data analysis. TPACK scale scoring which involves a range of five answers ("I don't know", "I know a little about", "I have average knowledge about", "I have good knowledge about", and "I have perfect knowledge about") within a range of 1 (I don't know) to 5 (I have perfect knowledge about) was computerized. Nevertheless, the answers of the multiple choice test which aims to define teacher candidates' content teaching knowledge were coded as 0 (false) and 1 (true) and transferred into electronic environment. SPSS 15.0 software package was used in the analysis of the data obtained from TPACK and multiple choice test. A normality test was conducted in order to define the test to be used before data analysis. Frequency (%), independent t test, Pearson correlation coefficient and multiple regression techniques were used in data analysis. Data was first tested in order to see if it corresponds to the assumptions for the parametric analyses used. p=.01 and p=.05 significance levels were selected.

FINDINGS

Finding obtained from the data collected and scales used in order to measure content knowledge with regards to mathematics teaching and TPACK of the elementary level mathematics teachers and to investigate the correlation between these variables are presented in this chapter as per sub problems. Analyses conducted are as follows:

1. Findings Related with the 1st Sub Problem

It was aimed to answer the question of "Are pedagogical knowledge (PK) and Technological knowledge (TK) as components of TPACK of mathematics teacher candidates predict technological pedagogical knowledge (TPK) component?" in the 1st sub problem. Multiple regression technique was used in order to answer this question.

Table 1. *Multiple Regression Analysis Results for Prediction of TPK*

Model[a]	R	R^2	StdErr	F	T	P
1	,727[a]	,529	1,087	77,502	0,581	0,000

[a]: dependent variable: Technological Pedagogical Knowledge (TPK) [b]: predictor: Technological Knowledge (TK), Pedagogical Knowledge (PK)

There is a strong and significant correlation between technological pedagogical knowledge and technological and pedagogical knowledge; R=0,727, R2=0,529, F=77,502. Technological and pedagogical knowledge in combination predict technological pedagogical knowledge by .52. Technological and pedagogical knowledge explains the 52% of the variance of technological pedagogical knowledge. In addition, it is seen that pedagogical information contributed more to the prediction of TPK.

2. Findings Related with the 2nd Sub Problem

It was aimed to answer the question of "Are content knowledge (CK) and technological knowledge (TK) as components of TPACK of mathematics teacher candidates predict technological pedagogical knowledge (TCK) component?" in the 2nd sub problem. Multiple regression technique was used in order to answer this question.

Table 2. *Multiple Regression Analysis Results for Prediction of TCK*

Model[a]	R	R^2	Std Err	F	T	P
1	,816[a]	,665	0,969	137,233	-2,921	0,000

[a]: dependent variable: Technological Pedagogical Knowledge (TCK) [b]: predictor: Technological Knowledge (TK), Content Knowledge (CK)

There is a strong and significant correlation between technological content knowledge and technological and content knowledge; R=0,816, R2=0,665 F=137,233. Technological and content knowledge in combination predict technological content knowledge by 0.66. Technological and content knowledge explains the 66% of the variance of technological content knowledge. In addition, it is seen that CK has played a more active role in predicting TCK.

3. Findings Related with the 3rd Sub Problem

It was aimed to answer the question of "Are content knowledge (CK) and pedagogical knowledge (PK) as components of TPACK of mathematics teacher candidates predict pedagogical content knowledge (PCK) component?" in the 3rd sub problem. Multiple regression technique was used in order to answer this question.

Table 3. *Multiple Regression Analysis Results for Prediction of PCK*

Model[a]	R	R^2	Std Err	F	T	P
1	,800[a]	,641	1,331	122,941	2,491	0,000

[a]: dependent variable: Pedagogical Content Knowledge (PCK) [b]: predictor: Content Knowledge (CK), Pedagogical Knowledge (PK)

There is a strong and significant correlation between pedagogical content knowledge and pedagogical and content knowledge; R=0,800, R2=0,641 F=122,941. Pedagogical and content knowledge in combination predict pedagogical content knowledge by 0.64. Pedagogical and content knowledge explains the 64% of the variance of pedagogical content knowledge. PK is found to be more effective on predicting PCK.

4. Findings Related with the 4th Sub Problem<0}

It was aimed to answer the question of "Are pedagogical, content, and technological knowledge of mathematics teacher candidates predict technological pedagogical content knowledge (TPACK) component?" in the 4th sub problem. Multiple regression technique was used in order to answer this question.

Table 4. *Multiple Regression Analysis Results for Prediction of TPACK*

Model[a]	R	R^2	Std.Err	F	T	P
1	,735[a]	,540	1,304	53,569	1,037	0,000

[a]: dependent variable: Technological Pedagogical Content Knowledge (TPCK) [b]: predictor: Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK)

There is a strong and significant correlation between technological pedagogical content knowledge and technological, pedagogical and content knowledge; R=0,735 R2=0,540 F=53,569. Technological, content and pedagogical knowledge in combination predict technological pedagogical content knowledge by 0.54. Pedagogical, technological and content knowledge explains the 64% of the variance of technological pedagogical content knowledge. Additionally, PK's contribution on TPACK was found to be the highest while TK's contribution was insignificant.

5. Findings Related with the 5th Sub Problem

It was aimed to answer the question of "Is there a correlation between MKT components of mathematics teacher candidates?" in the 5th sub problem. Correlations between MKT components of the teacher candidates participated in the research were investigated. The correlation values obtained is shown in Table 5. When Table 5 is examined it is seen that the correlations between MKT scale components are low.

Table 5. *Correlation Values for the Relationship between MKT Components*

	1.	2.	3.	4.
SCK	-	,092	-,173*	,854**
KCS	,092	-	,040	,496**
KCT	-,173*	,040	-	,178**
MKT	-,854**	,496**	,178*	-

*: p<. 05 **: p<. 01 Specialised Content Knowledge (SCK), Knowledge of Content and Students (KCS), Knowledge of Content and Teaching (KCT), Mathematical Knowledge for Teaching (MKT)

Here, there is a significant and reverse correlation between SCK and KCT. Other correlations are not statistically significant.

6. Findings Related with the 6th Sub Problem

It was aimed to answer the question of "Is there a correlation between TPACK levels and MKT components of mathematics teacher candidates?" in the 6th sub problem. Correlations between TPACK levels and MKT components of the teacher candidates participated in the research were investigated. The correlation values obtained is shown in Table 6.

When Table 6 is examined it is seen that the intra-correlations of the sub-dimensions of the TPACK scale are high. On the other hand, intra-correlations of the MKT components are generally low. On the other hand, there is a reverse and statistically insignificant correlation between SCK, one of the MKT components, and all sub dimensions of TPACK.

Table 6. *Correlation Values for the Relationship between TPACK and MKT Components*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	1O.
1. TK	-	,387**	,379**	,313**	,459**	,547**	,356**	-,087	,076	,045
2. CK	,387**	-	,617**	,681**	,656**	,770**	,629**	-,072	,070	,043
3. PK	,379**	,617**	-	,751**	,696**	,680**	,685**	-,119	,151	,138
4. PCK	,313**	,618**	,751**	-	,738**	,740**	,734**	-,100	,105	,119
5.TPK	,459**	,656**	,696**	,738**	-	,755**	,690**	-,146	,053	,104
6.TCK	,547**	,770**	,680**	,740**	,755**	-	,659**	-,077	,099	,071
7. TPACK	,356**	,629**	,685**	,734**	,690**	,659**	-	-,127	,122	,081
8. SCK	-,087	-,072	-,119	-,100	-,146	-,077	-,127	-	,092	-,173*
9. KCS	,076	,070	,151	,105	,053	,099	,122	,092	-	,040
1O. KCT	,045	,138	,043	,119	,104	,071	,081	-,173*	,040	-

*: $p < .05$ **: $p < .01$ Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Technological Pedagogical Content Knowledge(TPACK), Specialised Content Knowledge (SCK), Knowledge of Content and Students (KCS), Knowledge of Content and Teaching (KCT).

7. Findings Related with the 7th Sub Problem

It was aimed to answer the question of "Does MKT scores of mathematics teacher candidates predict their TPACK scores?" in the 7th sub problem. Multiple regression technique was used in order to answer this question.<0}

Table 7. *Multiple Regression Analysis Results for Prediction of TPACK Scores*

Model[a]	R	R^2	Std. Err	F	T	P
1	,031[a]	,001	,843	,130	-,361	,719

[a]: dependent variable: Technological Pedagogical Content Knowledge (TPACK) total [b]: predictor: Mathematical Knowledge for Teaching (MKT) total

It is seen that there is no significant correlation between the total TPACK and MKT scores of the mathematics teacher candidates; R=0.031, R2= 0,001, F=0,130. Thus, it can be said that scores obtained from MKT scale do not contribute to the prediction of scores obtained from TPACK scale.

DISCUSSION AND CONCLUSION

Effective integration of technology into teaching-learning environment is gaining importance increasingly in order to allow children to develop life skills required in the 21st century such as perceptive and permanent learning, entrepreneurship, creativeness and impressive communication (Aydın ve Soyer, 2020). In this context, education system is needed to be shaped according to a basic conception and then to be updated according to new advancements. At this point, basics of education should be reconfigured starting from the institutions training teachers and they need to be open to changes and developments. As a result of this study, a significant and reverse correlation was detected between specialised content knowledge (SCK) and knowledge of content and teaching (KCT). It is clear that content knowledge alone is not enough for teacher candidates to conduct an effective teaching and the misconceptions and difficulties that students have must be known in parallel with the theoretical framework of MKT. However, another aspect of the education process which can be important today is the need to integrate technology into the teaching practice (Oldknow, 2006). This study proved that MKT scores of the mathematics teacher candidates alone are insufficient to predict TPACK scores obtained. The reason behind this finding may be the lack of a strong technological knowledge defined among MKT components. In the light of these findings, it can be said that a teacher who possess professional technological knowledge and strong MKT can conduct an effective teaching process. One of Today's desired teacher features can be achieved if professional technology usage is integrated with the studies conducted in order to develop pedagogical knowledge as part of the Teacher training programs. Thus, an effect in the desired direction in MKT components and teaching knowledge would be possible. Because, a teacher who knows how to facilitate learning using technology would also be aware of effective teaching methods related with his/her field. The existence of technology will not make sense without well-equipped teachers who will successfully apply technology in their classrooms (Çakıroğlu ve Çetinkaya-Aydın, 2019).

Another important finding of this study is that the predictions made in TPK, TCK, PCK, and TPACK domains which were obtained from the interaction of basic domains (PK, TK, CK) were also complying with the theoretical structure. These are provided by the strong and statistically significant correlation between the components which is identified with multiple regression analyses. Similar findings are available in the study conducted by Chai, Koh and Tsai (2010) and this study has defined PK as the most effective component. Our study also identified PK as the most effective component of TPACK. Therefore, it can be said that the order of importance in TPACK model must be PK, CK and TK as PK showed the highest effect on predicting TPACK in all cases while TK showed the lowest effect. In this context, it will be fair to say that a study involving teachers' TPACK development should not focus on a single domain yet must stress the development of both technology knowledge and content and pedagogy knowledge simultaneously.

Another important finding of this study is that the low level of correlation found between MKT components. This finding can be interpreted as 'a teacher possessing a strong content knowledge would not possess the knowledge about students and teaching methods'. In other words, it cannot be said that a teacher who is specialized in one component would master mathematical knowledge for teaching fully.

Therefore, it is critical to readdress how to structure the mathematics training of the teacher candidates (MKT), Special Teaching Methods they are taught, Classroom Experience and content, duration and setting of Teaching Practice lessons with regards to TPACK. The first thing to do in a faculty of educational sciences is to provide with the necessary infrastructure with specific and general technologies in mind. It is known that faculties of educational sciences have important issues with regards to PCK (Kaya, 2010; Kılıç, 2011). Therefore, instructors must synthesize curriculum of the course in question, subjects and concepts students find hard to learn, modern learning strategies and methods, and student oriented evaluation approaches and tools and possess the knowledge necessary for integrating technology with MKTs and PCK simultaneously and be role models for teacher candidates by applying this knowledge in the classroom.

REFERENCES

Akkoç, H., Özmantar, F. ve Bingolbali, E. (2008). Matematik Öğretmen AdaylarınaTeknolojik Pedagojik Alan Bilgisi Kazandırma Amaclı bir Program Geliştirme, *107K531 no'luTUBITAK Projesi, 1. dönem gelişme raporu.*

Angeli, C., and Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers and Education*, 52 (1), 154–168

Artigue, M. (2002). Learning mathematics in a CAS environment: Thegenesis of a reflection about instrumentation and the dialectics between technical and conceptual work. *International Journal of Computersfor Mathematical Learning*, 7(3), 245–274.

Aydın, M. ve Soyer, I. (2020). Teknoloji okuryazarlığı ve fen öğretimi. Artun, Aydın-Günbatar ve Günbatar (Ed.) *Fen öğretiminde teknoloji eğilimleri*. Ankara: Pegem Akademi.

Ball, D., and Bass, H. (2003). Interweaving Content andPedagogy in Teachingand Learning toTeach: Knowing and Using Mathematics. In J. Boaler (ed.) *Multiple Perspectives on Mathematics Teaching and Learning*, Wesport, CT: Ablex.

Ball, D. L.,Lubienski, S., andMewborn, D. (2001). Research on teachingmathematics: Theunsolved problem of teachers' mathematicalknowledge. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed.). New York: Macmillan.

Ball, D. L. Hill, H. H., and Bass, H. (2005). Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *American Educator*, pp. 14-46.

Ball, D. L., Thames, M. H., and Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389-407.

Begle, E. G. (1979). Critical Variables in Mathematics Education. Washington, DC: The Mathematics Association of Amerika and The National Council of Teachers of Mathematics.

Büyüköztürk, Ş., Çakmak, E., K., Akgün, Ö., E., Karadeniz, Ş. ve Demirel, F. (2010). *Bilimsel araştırma yöntemleri.* Ankara: Pegem Yayınları.

Çakıroğlu, J. ve Çetinkaya-Aydın, G. (2019). Fen bilimleri öğretiminde teknoloji kullanımı. Akgündüz, D. (Ed.), *Fen ve matematik eğitiminde teknolojik yaklaşımlar*. (57-73). Ankara: Anı yayıncılık.

Çelikten, M., Sanal, M. ve Yeni, Y. (2005). Ögretmenlikmeslegi ve özellikleri. *Sosyal Bilimler Enstitüsü Dergisi, 19*(2), 207–237.

Chai, C. S., Koh, J. H. L., and Tsai, C. C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Journal of Educational Technology & Society*, 13(4), 63-73.

Cox, S. (2008). *A Conceptual Analysis of Technological Pedagogical Content Knowledg*. Unpublished Dissertation. Bringham Young University, Provo, UT.

Dursun, S. ve Dede, Y. (2004). Ögrencilerin matematikte basarısını etkileyen faktörler: matematik ögretmenlerinin görüsleri bakımından. *Gazi Egitim Fakültesi Dergisi, 24*(2), 217–230.

Dursun, S. ve Peker, M. (2003). İkögretim altıncı sınıf ögrencilerinin matematik dersinde karşılaştıkları sorunlar. *Cumhuriyet Üniversitesi Sosyal BilimlerDergisi, 27*(1), 135–142.

Ersoy, Y. (2003). Teknoloji Destekli Matematik Eğitimi-I: *Gelişmeler, Politikalar ve Stratejiler*. İlköğretim-online. 2(1), 18-27.

Even, R. (1993). Subject Matter Knowledge andPedagogical Content Knowledge; Prospective Secondary Teachers and the Function Concept. Journal for Research in Mathematics Education. 24 (2), 94-116.

Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). *Computers & Education*, 57, 1953–1960.

Gülden, D. (2009). *Matematik öğretmen adaylarının limit ve süreklilik kavramlarına ilişkin pedagojik alan bilgilerinin değerlendirilmesi* (Yüksek lisans tezi). Marmara Üniversitesi Eğitim Bilimleri Enstitüsü, İstanbul.

Harris, J.B.,Mishra, P., andKoehler, M.J. (2007). Teachers' Technological Pedagogical Content Knowledge: Curriculum-basedTechnology Integration Reframed. *Paperpresented at the 2007 Annual Meeting of the American Educational Research Association,* Chicago.

Hill, H. C., Rowan, B., and Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American educational research journal*, *42*(2), 371-406.

Kaya, Z. (2010). *Fen ve teknoloji öğretmen adaylarının fotosentez ve hücresel solunum konusundaki teknolojide pedagojik alan bilgisinin (TPAB) araştırılması*. Yayımlanmamış yüksek lisans tezi, Fırat Üniversitesi, Elazığ.

Kılıç, A. (2011*). Fen ve teknoloji öğretmen adaylarının elektrik akımı konusundaki teknolojik pedagojik alan bilgilerinin ve sınıf içi uygulamalarının araştırılması.* Yayımlanmamış yüksek lisans tezi, Fırat Üniversitesi, Elazığ.

Koehler, M.J. and Mishra, P. (2005). What happens when teachers designed ucational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research*, 32(2), 131-152.

Kutluca, T. ve Birgin, O. (2007). Doğru denklemi konusunda geliştirilen bilgisayar destekli öğretim materyali hakkında matematik öğretmeni adaylarının görüşlerinin değerlendirilmesi. Gazi Eğitim FakültesiDergisi, Cilt 27, 81-97.

Lai, J. W., and Bower, M. (2019). How is the use of technology in education evaluated? A systematic review. *Computers & Education*, 133, 27-42.

McMillan, J. H.,andSchumacher, S. (2010). *Research in education: Evidence-basedinquiry*(7th ed.). Boston: Pearson.

MEB (Milli Egitim Bakanlığı) (2017). Matematik dersi öğretim programı (ilkokul ve ortaokul 1, 2, 3, 4, 5, 6, 7 ve 8. sınıflar). http://mufredat.meb.gov.tr (Erişim Tarihi: 28 Temmuz 2017).

Mishra, P. and Koehler, M.J. (2006). Technological Pedagogical Content Knowledge: A Framework forTeacher Knowledge. Teachers College Record, 108(6),1017–1054.

NCTM (National Council of Teachers of Mathematics) (2000). Principles and Standards for School Mathematics. Reston, Va. NCTM.

Niess, M. L. (2005) Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education*, 21, 509–523.

Oldknow, A. (2006). Let'sGetthe Show on the Road! *MathematicTeaching Incorporating Micromath*, 196, 16-21.

Özdemir, A. S., ve Tabuk, M. (2004). Matematik dersinde bilgisayar destekli öğretimin öğrenci başarı ve tutumlarına etkisi. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, 3 (5), 142-152.

Pierson, M. (1999). *Technology practice as a function of pedagogical expertise*. (Doctoral dissertation, Arizona State University). Retrieved from UMI Dissertation Service, 9924200.

Ponte, J. P. and Chapman, O. (2006). Mathematics Teachers' Knowledge and Practices. In Gutierrez and Boero (Eds.), *Handbook of Research on the Psychology of Mathematics Education: Past, Present and Future*. Sense Publishers: pp. 461-494

Richardson, S. (2009). Mathematics teachers' development, exploration, and advancement of technological pedagogical content knowledge in the teaching and learning of algebra. *Contemporary Issues in Technology and Teacher Education,* 9(2), 117-130.

Shulman, L.S. (1986).Paradigms and research programs in thestudy of teaching: A contemporary perspective. In M.C. Wittrock (Ed.), *Handbook of research on teaching(3rd Ed.)*. NewYork: Macmillan.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of thenew reform. *Harvard Educational Review*, 57, 122.

Şahin, İ. (2011). Development of survey of technological pedagogical and content knowledge (tpack). TOJET-The Turkish Online Journal of Educational Technology,10(1), 97–105.

Şumuer, E., and Yıldırım, S. (2018). Öğretim Teknolojisinin Tarihsel Gelişimi. In A. A. Kurt (Ed.), *Öğretim Teknolojilerinin Temelleri* (pp. 17-42). Ankara: Nobel Akademik Yayıncılık.

Yiğit, N. ve Akdeniz, A. R. (2003). Fizik Öğretiminde Bilgisayar Destekli Etkinliklerin Öğrenci Kazanımları Üzerine Etkisi: Elektrik Devreleri Örneği. *Gazi Eğitim Fakültesi Dergisi*, 23(3), 99-113.

Matematik Öğretmen Adaylarının Teknolojik Pedagojik Alan Bilgileri İle Öğretime Yönelik Alan Bilgileri Arasındaki İlişkilerin İncelenmesi

Dr.Feriha Hande İdil
Milli Eğitim Bakanlığı İzmir-Türkiye
ORCID: 0000-0002-6205-7278
deuhande@gmail.com

Prof. Dr. Serkan Narlı
Dokuz Eylül Üniversitesi - Türkiye
ORCID: 0000-0001-8629-8722
serkan.narli@deu.edu.tr

Özet

Bu araştırmanın amacı, ilköğretim matematik öğretmen adaylarının teknolojik pedagojik alan bilgileri (TPAB) ile öğretmek için matematik bilgileri (ÖMB) arasındaki ilişkiyi incelemektir. Araştırmada nicel araştırma yöntemlerinden biri olan deneysel olmayan tarama yöntemi kullanılmıştır. Çalışma, ilköğretim matematik öğretmenliği programında öğrenim gören 141 öğretmen adayının katılımı ile gerçekleştirilmiştir. Araştırmanın verileri üç grup halindedir. Bunlar; öğrencilerinTPABpuanları, çoktan seçmeli test puanları ve demografik özellikleridir. Veriler TPABÖlçeği ve Michigan Üniversitesinde yürütülen Öğretim İçin Matematik Öğrenme Projesi kapsamında geliştirilmiş ve pilot çalışmaları yapılmış çoktan seçmeli test kullanılarak elde edilmiştir. Araştırmanın sonuçları incelendiğinde, ÖMB bileşenleri arasındaki ilişkinin düşük TPAB bileşenlerinin kendi içindeki ilişkilerinin ise yüksek olduğu görülmüştür. Bir öğretmenin etkili öğretim sürecini gerçekleştirebilmesi için ÖMB bileşenlerine bir arada sahip olması gerektiği çalışmanın en önemli bulgularındandır ve kuramsal yapıyı desteklemektedir. ÖMB kuramsal çerçevesi doğrultusunda, bir öğretmenin iyi bir öğretici olabilmesi için alan bilgisinin tek başına yeterli olmadığı görülmüştür. Ayrıca, temel bilgi alanlarının (Pedagojik bilgi, teknolojik bilgi ve alan bilgisi.) etkileşimiyle ortaya çıkan teknolojik pedagojik bilgi, teknolojik alan bilgisi, pedagojik alan bilgisi ve TPABbilgi alanlarının yordanmasında en yüksek etkiyi pedagojik bilginin en düşük etkiyi de teknolojik bilginin yaptığı görülmüştür. Sonuç olarak, ÖMB ile TPAB puanları arasındaki ilişkinin istatiksel olarak anlamlı olmadığı sonucuna ulaşılmıştır.

Anahtar Kelimeler: *Teknolojik pedagojik alan bilgisi, Öğretime yönelik alan bilgisi, Öğretmen adayları, Matematik.*

E-Uluslararası Pedandragoji Dergisi

Cilt: 2, Sayı:1, ss. 33-47

Araştırma Makalesi

Gönderim Tarihi: 21.03.2022
Kabul Tarihi: 26.04.2022

Önerilen atıf şekli

İdil, F.H. ve Narlı, S. (2022). Matematik öğretmen adaylarinin teknolojik pedagojik alan bilgileri ile öğretime yönelik alan bilgileri arasindaki ilişkilerin incelenmesi, *E-Uluslararası Pedandragoji Dergisi (e-upad),* 2(1), 33-47. Doi: https://trdoi.org/10.27579808/e-ijpa.86

Genişletilmiş Özet

Problem: *Öğretmek İçin Matematik Bilgisi (ÖMB) kuramsal çerçevesi matematik öğretmenlerinin öğretim süreçlerinde kullandıkları bilgileri tanımlamaya çalışmaktadır. ÖMB ile yapılan çalışmalarda alan bilgisi ve pedagojik alan bilgisinin birlikte değerlendirilmesi vegeliştirilmesi amaçlanmaktadır. Son yıllarda öğretmenlerin etkili bir öğretim süreci için gerekli alan bilgilerinin yanı sıra alana yönelik teknoloji kullanımı da önemli hale gelmiştir. Gittikçe yaygınlaşan teknoloji kullanımıyla beraber öğretmenlerin alana yönelik teknoloji bilgilerinin de yeterli olması gerekmektedir. Matematik öğretmenleri alan ve teknoloji bilgilerini birarada kullanarak, matematiksel kavramların nasıl öğretilebileceği üzerinde düşünmelidir (Richardson, 2009). Dolayısıyla, öğretmenlerin öğretim süreçlerinde kullandıkları matematiksel bilgileriyle bunları aktarırken faydalandıkları teknolojik bilgi bir bütün olarak ele alınırsa etkili bir öğretim ortamı oluşturulabilir. Bu bağlamda çalışmada, pedagojik bilgi (PB), alan bilgisi (AB) ve teknolojik bilgi (TB)bileşenlerinin pedagojik alan bilgisi (PAB), teknolojik alan bilgisi (TAB) ve teknolojik pedagojik bilgi(TPB) bileşenlerineetkileri ile teknolojik pedagojik alan bilgileri (TPAB)üzerindeki etkilerideğerlendirilmiştir. Ayrıca, öğretmen adaylarının öğretime yönelik alan bilgileriyle TPAB arasındaki ilişkiler incelenmiştir.*

Yöntem: *Araştırmada nicel araştırma yaklaşımlarından biri olan deneysel olmayan tarama yöntemi kullanılmıştır (McMillan ve Schumacher, 2010). Araştırma Türkiye'de bulunan bir üniversitenin eğitim fakültesinde öğrenim gören ilköğretim matematik öğretmen adayları ile gerçekleştirilmiştir. Toplam 141 öğretmen adayı ile yürütülen araştırmada, örneklem basit seçkisiz örnekleme yöntemi ile belirlenmiştir. Araştırmada öğrenim görülen lisans programı, cinsiyet, sınıf ve bilgisayar kullanımı ile ilgili demografik bilgileri içeren sorulardan oluşan kişisel bilgi formu ve öğretmen adaylarının matematik dersinde teknolojik pedagojik alan bilgi düzeyini belirlemek için "TPAB Ölçeği" kullanılmıştır. İlköğretim matematik öğretmen adaylarının temel kavram ve işlemlere yönelik anlayışları, matematiksel tanımlarını kullanışları ve bunları öğrencilere sunuşları, öğrencilerin yaygın hatalarını, kavram yanılgılarını ve çözüm yöntemlerini belirleyişleri ve değişik çözüm yöntemlerini değerlendirme şekilleri çoktan seçmeli bir test yardımıyla incelenmiştir. Bu çalışmada kullanılan test, Michigan Üniversitesi'nde yürütülen Öğretmek İçin Matematik Öğrenme Projesi kapsamında geliştirilmiş ve pilot çalışmaları yapılmıştır. TPAB ölçeğinden ve çoktan seçmeli testten elde edilen verilerin analizleri için SPSS 15.0 paket programı kullanılmıştır.*

Bulgular: *Çalışma sonucunda, uzmanlık alan bilgisi (UAB) ile alan ve öğretme bilgisi (AÖtB)arasında anlamlı ve ters yönde bir ilişki bulunmuştur. Buradan öğretmen adaylarının etkili bir öğretim gerçekleştirebilmesi için alan bilgisinin tek başına yeterli olmadığı, çeşitli öğretim yöntemleri ve öğrencilerin hangi noktalarda kavram yanılgılarına, zorluklarına sahip olduklarını bilmesi gerektiği söylenebilir. Bu sonuç ÖMB kuramsal çerçevesi ile aynı doğrultudadır. Çalışmada ayrıca matematik öğretmen adaylarının ÖMBpuanlarının tek başına TPAB ölçeğinden alınan puanları yordamada yetersiz kaldığı sonucuna ulaşılmıştır. ÖMB bileşenleri içerisinde alana dönük güçlü bir teknolojik bilginin belirtilmemiş olması söz konusu sonucun elde edilmesinde etkili olmuştur. Buradan hareketle, alana yönelik teknolojik bilgi ve güçlü ÖMB'ne sahip olan bir öğretmenin etkili öğrenim süreçlerini gerçekleştirebileceği söylenebilir. Ayrıca çalışma sonucunda, öğretmen adaylarının TPAB'lerine ait temel bilgi alanlarının (PB, TB, AB) etkileşimiyle ortaya çıkan TPB, TAB, PAB ve TPAB bilgi alanlarının yordanması amacıyla gerçekleştirilen çoklu regresyon analizleri neticesinde güçlü ve istatistiksel olarak anlamlı ilişkiler bulunmuştur.*

Öneriler: *Eğitim fakültelerinde öğretmen adaylarının matematik eğitimi hakkında detaylı bilgiler edindikleri Özel Öğretim Yöntemleri, Okul Deneyimi ve Öğretmenlik Uygulaması derslerinin kapsam, süre ve öğretiminin; TPAB bakımındandeğerlendirilmesi oldukça önemlidir. Bu sebeple, eğitim fakültelerinde alan derslerinin öğretiminde kullanılabilecek genel teknolojiler hakkında gerekli alt yapı çalışmalarının tamamlanması gerekmektedir. Ayrıca, PAB kavramı bakımından da çeşitli problemlerin* *olduğu bilinmektedir (Kaya, 2010; Kılıç, 2011). Dolayısıyla öğretmen adaylarının, matematik öğretim programı, öğrencilerin zorlandıkları ve kavram yanılgılarının olduğu konular, çağdaş öğrenme stratejileri ve yöntemlerihakkında donanımlı olmaları gerekmektedir. Öğretmen adayları ayrıca, ders kazanımlarına uygun olarak matematik öğretim sürecine teknoloji entegrasyonunun nasıl yapılması gerektiği hakkında da yeterli olmalıdırlar. Bu bağlamda, öğretim elemanlarının söz konusu bilgiler açısından yeterli olmaları ve bu yeterlilikleri derslerinde sergileyerek öğretmen adaylarına model olmaları önem arz etmektedir.*