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| Research Article / Araştırma Makalesi |

Thematic Content Analysis of Postgraduate Dissertations on Technological Pedagogical Content Knowledge: The Case of Turkey

Teknolojik Pedagojik Alan Bilgisi Üzerine Lisansüstü Tezlerin Tematik İçerik Analizi: Türkiye Örneği

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Keywords

1. Technological pedagogical content knowledge
2. Teacher education
3. Thematıc content analysıs

Anahtar Kelimeler

1. Teknolojik pedagojik alan bilgisi
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Abstract

Purpose: The aim of this study is to carry out an in-depth analysis on postgraduate dissertations in Turkey addressing Technological Pedagogical Content Knowledge (TPACK).

Design/Methodology/Approach: It was conducted with thematic content analysis method. The data were obtained from the postgraduate dissertations published between 2009 and 2019 through a review of the National Thesis Center website of Higher Education Board (YÖK). The review yielded a total of 101 postgraduate dissertations on TPACK, 26 of which are doctoral and 75 of which are at master's level. The dissertations were analyzed using a matrix. Descriptive and content analysis methods were applied to reveal the aim, subject area, method, sample, data collection tools, results and recommendations in each of the dissertations.

Findings: The findings obtained from the analyses were translated into percentage and frequency values given in tables for comprehensibility. It was found out that most of the dissertations deal with the definition of TPACK competencies of teachers and teacher candidates and the relationship between TPACK and a number of variables including gender/grade level/ seniority year, and so forth. On the other hand, only few were intended to figure out the impact of the lessons or courses developed within the framework of TPACK. Lastly, most of the publications were conducted with screening model, and a considerable number of them used embedded design and multiple case designs

Highlights: The conclusion of the research is that there are many potential gaps to guide deeper change in education within the framework of TPACK, and in particular, further development and exploration of specific domain-based technological environments are needed.

Öz

Çalışmanın amacı: Bu çalışmanın amacı Türkiye'deki teknolojik pedagojik alan bilgisi (TPAB) konusunda yapılan lisansüstü tezleri kapsamlı bir şekilde incelemektir.

Materyal ve Yöntem: Araştırmada tematik içerik analizi yöntemi kullanılmıştır. Veriler, YÖK Ulusal Tez Merkezi incelenerek 2009-2019 yılları arasında yayımlanan lisansüstü tezlerinden elde edilmiştir. Taramalar sonucunda TPAB konusunda 26'sı doktora ve 75'i yüksek lisans tezi olmak üzere toplamda 101 lisansüstü teze ulaşılmıştır. Araştırmada yer alan lisansüstü tezleri matris kullanılarak analiz edilmiştir. Çalışmaların her biri, betimsel ve içerik analizi yöntemi kullanılarak çalışmanın amacı, konu alanı, yöntemi, örneklemi, veri toplama araçları, elde edilen sonuçlar ve öneriler bağlamında incelenmiştir..

Bulgular: Elde edilen bulgular anlaşılır şekilde düzenlenerek yüzde ve frekans değerleriyle birlikte tablo haline dönüştürülmüştür. Araştırmadan elde edilen bulgularda, tez çalışmalarının büyük bir çoğunluğunun öğretmen ve öğretmen adaylarının TPAB yeterliliklerinin tanımlanması ve TPAB ile cinsiyet/sınıf düzeyi/kıdem yılı vb. değişkenler arasındaki ilişkinin belirlenmesi üzerine olduğu görülürken, TPAB çerçevesinde geliştirilen ders veya kursların etkisi ile ilgili çalışmalar ise az sayıdadır. Çalışmaların çoğunluğunda yöntem olarak tarama modelinin kullanıldığı, ayrıca dikkate değer sayıda gömülü desen ve çoklu durum desenlerine başvurulduğu ortaya çıkmıştır.

Önemli Vurgular: Araştırmanın sonucunda TPACK çerçevesinde eğitimde daha derin değişime rehberlik etmek için birçok potansiyel boşluk olduğunu ve özellikle de spesifik alana dayalı teknolojik ortamların daha fazla geliştirilmesi ve araştırılması gerekmektedir.

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INTRODUCTION

With the advancement of technology, TPACK has become the focus of study for teacher educators and researchers in many countries in recent years (American Association of Colleges for Teacher Education [AACTE], 2008). TPACK is defined as a teacher's knowledge of integrating technology with pedagogical techniques in teaching a topic and knowing the effectiveness of presentations made with technological tools on students' learning (Graham, Burgoyne, Cantrell, Smith, St. Clair & Harris, 2009). The TPACK framework was defined by Koehler and Mishra (2005) and expanded with the incorporation of Technological Knowledge (TK) into the concept of Pedagogical Content Knowledge (PCK) referred by Schulman (1987) in teacher competencies (Kaya, Kaya and 2013). PACK is considered to be a unique feature that characterizes the teaching profession. Teachers can integrate appropriate pedagogical approaches into their content knowledge, and students can better understand the topic in question (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). Shulman (1987) stated that teacher competencies should include the titles of "content knowledge, pedagogical knowledge, pedagogical content knowledge, curriculum knowledge, learner characteristics knowledge, educational context knowledge, educational outcomes, goals, values, philosophical and historical foundations". Koehler (2012) argued that Shulman could not emphasize technology in his PACK model and could not associate technology with content knowledge (CK) and pedagogical knowledge (PK) because of the limited technological materials in classrooms such as blackboards, overhead projectors, typewriters, models and periodic tables, but the integration of technology into classrooms is a natural process now thanks to equipment such as computers, projectors, large digital screens and software in today's classrooms (Wang, Schmidt-Crawford & Jin, 2018).

As far as the existing literature is concerned, Kohler and Mishra (2005) cannot be said to be the first to use the term TPACK. Rather, it was first used by Pierson (2001) to describe the integration of technology into a teacher's classroom. Other researchers also used similar terms such as "PCK-related to Information and Communication Technology (ICT) (Angeli & Valanides, 2005)" or "Technology-Enhanced PCK (Niess, 2005)" (Voogt et al., 2013; Yigit, 2014). In addition, these researchers examined the development of technological, pedagogical and content knowledge of teachers and teacher candidates in both in-service and pre-service education, using a similar framework to the TPACK framework (Yiğit, 2014).

TPACK is a model that embraces both the relationships and interactions of content knowledge, pedagogical knowledge and technological knowledge that teachers are supposed to have (Abitt, 2011). TPACK and the types of knowledge it interacts with are shown in Figure 1.

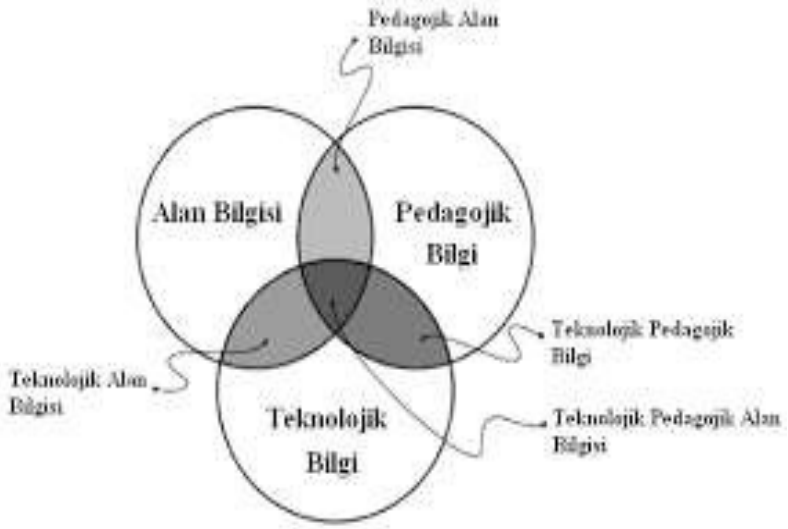

Figure 1. TPACK components

As seen in Figure 1, TPACK is the presentation of new concepts with different teaching styles thanks to technology rather than simply adding it to the teaching field in perspective. In respect to the teacher, it can be defined as having technological knowledge, using educational technologies and integrating these technologies into the classroom environment (Koehler & Mishra, 2008).

As can be understood from the explanations above, teachers must first have an effective TPACK in order to be able to integrate technology into their lessons. Due to this necessity, it can be said that the studies carried out within the framework of TPACK have gained significant momentum in recent years. In Table 1, studies related to TPACK are briefly summarized.

Table 1. Summary of studies on TPACK

Scope of the Studies	Studies in the Literature
Studies on teacher candidates' TPACK	Ayvaz, 2019; Bulut, 2012; Canbolat, 2011; Gündüz, 2018; Janssen & Lazonder, 2015; Kabakçı, 2011, Karakaya, 2012; Kaya, 2010; Keser, Karaoğlan Yılmaz & Yılmaz, 2015; Kılıç, 2011; Kılıç, 2015; Kocakaya, 2015; Öztürk, 2013; Tokmak, Yelken, & Konakman 2013; Savaş, 2011
Studies on teachers' TPACK	Ay, 2015; Archambault & Crippen, 2009; Kılıçkeser, 2019
Studies on instructors' TPACK	Şimşek, Demir, Bağçeci & Kinay, 2013
Studies on the impact of experimental applications on TPACK development	Baran, Canbazoğlu Bilici, Albayrak Sarı & Tondeur, (2019); Chai, Koh & Tsai, 2011; Çelik, Hebebci & Şahin, 2014; Ersoy, Yurdakul & Ceylan, 2016; Koh & Chai, 2014; Niess, 2005;
Content analysis studies	Abbit, 2011; Baran & Bilici, 2015; Chai, Koh & Tsai, 2013; Gür & Karamete, 2015; Kaleli-Yılmaz,2015; Korucu, Usta & Atun, 2017; Dikmen & Demirer, 2016; Rahmawatib, Budiyantoa & Basori, 2019; Setiawan, Phillipson, Sudarmin & Isnaeni, 2019; Yigit, 2014; Voogt, Fisser, Pareja Roblin, Tondeur & van Braak, 2013; Wang, Schmidt-Crawford & Jin, 2018; Willermark, 2018

As can be seen from Table 1, many studies have been conducted on the contribution of TPACK to teacher competencies for integration of technology into teaching, and analysis studies examining those studies also exist. In particular, exploring different dimensions of data revealed by scientific studies and performing content analyses help educators to identify potential areas of development. What is more, content analyses are considered important for a holistic look at the matter under consideration, to make sense of the trend about the matter and to understand various aspects of the studies (Göktaş et al., 2014). From this point of view, the data obtained from the content analysis studies on TPACK in Turkey seem quite useful as they hint at the types and disciplines of further studies in the relevant literature by providing a broad perspective on the matter. In other words, it is predicted that such documents indicate the missing parts in the TPACK literature and topic to be dealt by related researchers, consequently providing a more holistic picture. Content studies on TPACK in Turkey are presented in Table 2.

Table 2. Summary of content analysis studies on TPACK

Researcher(s)	Year	Data sources	Studies analyzed	Criteria of analysis	Results
Kaleli-Yılmaz (2014)	2000-2014	Google search engine, DergiPark, YÖK National Thesis Center, SPRINGER and EBSCOhost-ERIC	37 articles, 15 dissertations, 7 proceedings	Aim, subject area, method, sample, data collection tools, instructional practices used, results.	The majority of the studies were carried out on scale development and examination of TPACK competencies and improvement; the most common methods were quantitative research methods employing data collection tools like scales; the most frequent sample group contained teacher candidates and the participants often had high levels of TPACK competencies; and TPACK training improved the participants' TPACK competencies.
Baran & Bilici (2015)	2005-2013	EBSCOHost, ERIC, ISI Web of Science, Scholar Google search engine	30 articles	Aim, TPACK approaches, method, sample, data collection tools, data analysis methods, discipline/subject area.	The majority of the studies were carried out with qualitative research methods employing measurement tools like scales; the most common sample group contained teacher candidates; deficiencies were determined in portraying the TPACK context; the most common disciplines under consideration were science and mathematics.
Dikmen & Demirer (2016)	2009-2013	Databases containing SSCI journals, ULAKBİM database, YÖK thesis database	32 articles, 17 dissertations	Year and type, aim, areas of implementation, participants, methods, data collection tools and analysis methods.	The number of studies increased gradually over the years; the most common study aim targeted the relationship between various variables and TPACK; the most common research methods and data collection tools were quantitative methods and questionnaire, respectively; the most common sample group contained convenient teacher candidates; the most common implementation areas of TPACK were science and mathematics.

Researcher(s)	Year	Data sources	Studies analyzed	Criteria of analysis	Results
Korucu, Usta & Atun (2017)	2010-2016	Science Direct and Scholar Google databases	71 articles	Journal and year of publication, aim, research method, data collection tools and participants.	The most popular journal was Computers & Education; the number published papers increased by year; the aim of the studies was technology integration; the most common methods and tools were quantitative methods and questionnaires, respectively; the most common sample group contained teacher candidates and teachers.

Table 2 shows that the studies on TPACK in Turkey increased yearly, the studies often looked into the TPACK developments of teachers/teacher candidates and the integration of technology into education, the most frequenly used research methods included qualitative methods such as survey and experimental, and the most common data collection tools were scales/questionnaires. Besides, sampling targeted teacher candidates with the highest frequency. In short, it can be said that certain types of studies on TPACK have been replicated in the context of Turkey for a while.

It is thought that analyzing the popular and frequently studied topics, especially TPACK, will contribute exceptionally to the literature. Therefore, studies carried out on this subject are valuable for the literature. On the other hand, the current result might have appeared because only the TPACK studies published in journals (a total of 175 papers, see Table 2) were included and postgraduate dissertations are included in such publications at a lesser extent. Performing content analysis on more than one specific field may hinder analyzing the subject thoroughly. It is seen that TPACK tendencies were not clearly revealed separately in the available papers or dissertations. The thesis center database of the Higher Education Board (YÖK) shows that TPACK was the research topic of 25 postgraduate dissertations, 20 of which are master's and 5 doctoral dissertations, between 2009 and 2013. However, the number has shown a significant increase lately. The same topic was studied in 76 postgraduate dissertations, 55 being at master's and 21 at doctoral level, from 2013 to 2019 (YÖK, 2013; YÖK, 2019). Apart from these, the most recent content analysis study was carried out by Korucu, Usta, and Atun (2017) analyzing the studies carried out between the years 2010 and 2016. Another motive for the current study is that nearly 58 postgraduate dissertations were posted on the National Thesis Center database of YÖK in a short period between 2016 and 2019. Departing from these facts, this study was planned with a broader scope attempting to discuss postgraduate dissertations on TPACK written between 2009 and 2019 in Turkey against a set of variables. Answer was sought to the following questions:

1. How are the postgraduate dissertations on TPACK distributed by type, university and department of implementation, and year of publication?
2. What theme was discussed most frequently as the aim of the published postgraduate dissertations about TPACK?
3. How are the postgraduate dissertations on TPACK distributed by research method, sample type and data collection tools?
4. What subjects/fields did the postgraduate dissertations on TPACK target?
5. What theme was implied most frequently in the results of the published postgraduate dissertations about TPACK?
6. What themes were implied mostly in the recommendations of the published postgraduate dissertations about TPACK?

Significance and Value of the Study for the Literature

The main purpose of this content analysis study is to interpret the postgraduate studies on "Technological Pedagogical Content Knowledge (TPACK)" implemented by educational researchers so far in relation to selected criteria. In this scope, the studies were examined in terms of research pattern (qualitative, quantitative, etc.), participants (teacher candidates, senior teachers, etc.), data collection tools (interview, scale, multiple-choice test, observation, etc.), field of implementation and educational background (science, mathematics, classroom teaching, preschool teaching, etc.), results and recommendations put forth. The study is also intended to provide a different perspective to the postgraduate studies on TPACK in Turkey and to figure out studies needed in the future in consideration of the current literature. In other terms, it will provide a more holistic picture by showing the missing parts of the TPACK literature to the researchers who will do a postgraduate dissertation in this field and give them advice for well-directed new researches in this area. It would not too harsh to say that Turkish researchers of TPACK from various disciplines have been repetitive for a while ending up with no authentic products. Therefore, this study is needed in order to determine the lagging sides of the related literature (how TPACK develops, the impact of pre-service/in-service training on the development of TPACK, devising a teacher training TPACK model unique to the Turkish culture, etc.) so that future postgraduate studies can be directed to close this gap. Lastly, recommendations will be brought to increase the quality of new postgraduate dissertations on TPACK.

Limitations of the Study

This study intends to analyze postgraduate dissertations on TPACK. The majority of the existing analysis studies in the literature are aimed at revealing the trends in research papers. Unlike those, the current study included theses at postgraduate level to scrutinize a sufficient number of dissertations on TPACK and to reach reliable results in this segment. However, an exhaustive analysis of the subject and discipline content might be impeded by the thematic content analysis of more than one field. With this

concern, the scope of this study was narrowed down to postgraduate studies on TPACK. The inclusion of only theses at postgraduate level can be seen as a limitation of this study. Since this study was aimed to reveal the latest research trends, the studies published from 2009 to 2019 were taken into consideration. The range of publication years can be considered as another limitation of the study. As the final limitation, some master's and doctoral dissertations on TPACK may have been overlooked or not uploaded to the system despite careful screening.

METHOD

In this study, "thematic content analysis" was chosen from content analysis techniques as it is about critical examination of the themes and templates created to expose the trends and results of studies in a selected field (Çalık & Sözbilir, 2014). In this way, this technique provides a comprehensive resource to researchers with limited access to adequate researches in their (Ültay & Çalık, 2012). In general, content analysis method is the summarizing, classifying, comparing and presenting of the research content in numerical terms with the aid of scientific applications (Cohen, Monion & Morrison, 2007). There are applicable techniques such as content analysis to perform frequency analysis, relationship analysis, categorical analysis, evaluative analysis, closure indicator, vocabulary richness, readability indicator, thematic content analysis, descriptive content analysis, structural content analysis, emotional analysis, semantic content analysis (semantic analysis) and intent-motive inferences. The current study aims at interpreting the study data based on certain concepts and themes besides summarizing, classifying and comparing the contents and implications in the postgraduate dissertations. Thematic content analysis technique was preferred here since it was aimed to examine postgraduate level TPACK studies in Turkey in order to identify the common tendencies.

Data Collection

In this study, YÖK National Thesis Center database was scanned by using certain keywords in both Turkish and English to be able to access to all postgraduate dissertations on TPACK across Turkey and to be able to describe TPACK in Turkey and the world. The following Turkish and English key phrases were used for the search:

- “Teknolojik Pedagojik Alan Bilgisi,’’ or “TPAB”
- ‘’Teknolojik Pedagojik İçerik Bilgsi’’ or ‘’TPİB’’
- “Technological Pedagogical Content Knowledge” or “TPACK” - “Technological Pedagogical Content Knowledge” or “TPCK”.

As a result of the search, 75 master's and 26 doctoral dissertations were found to address TPACK and they all were included in the study. The other inclusion criterion was the deadline of April 2020 for publication of the dissertations.

Document Analysis

The theses collected were subjected to thematic review analysis by using the thematic analysis matrix developed by Ormancı Çepni, Deveci and Aydın (2015). The matrix consists of two sections as general features and content features. The general features investigate the type of publication, the university and department of implementation, and the year of publication whereas the other part deals with the aim and method of the studies, population-sample/study group type and size, grade level of the participants, data collection tools, subjects/fields, and results and recommendations (Table 3).

Table 3. Publication Classification Matrix

Theme	Code	Explanation
General features	Type of publication	Degree of study (master’s and doctorate)
	University of implementation	The university where the study was carried out
	Department of implementation	The departments where the study was carried out
	Publication year	The year when the study was published
Content features	Aims	Aim of the study
	Methods	Qualitative (case study, phenomenology, etc.) Quantitative (questionnaire, experimental, etc.)
	Data collection tools	Instruments used for collecting study data (observation, interview, scale, etc.)
	Population-sample	Size and educational background of the study participants

Theme	Code	Explanation
	Subjects/Fields	Science, mathematics, social studies, physics, chemistry, biology, physical education…
	Results and recommendations	Findings obtained from the study and recommendations brought accordingly

Data Analysis

The matrix above 3 was used for reviewing the dissertation studies reached through the YÖK's thesis database. As the first step, codes relevant to each category were elicited. To exemplify, each study was divided into categories according to the year it was published and the university and the department it was implemented in. Then, codes concerning the study aims were extracted and the studies sharing the same aims were put under the same code. Studies with a similar goal were clustered under relevant codes and synthesized under a representative theme. The same procedure was followed for grouping other codes and themes.

As mentioned earlier, the second part of the matrix used in this study exhibit content-related data about the reviewed items, such as aim, method, size and grade level of population-sample/study group, data collection tools, subjects/fields, results and recommendation. To analyze the data about the method and subject area of the dissertations, descriptive analysis was performed while the other type of data (i.e. aim, results and recommendations) was analyzed with the content analysis method. During the content analysis, first, the research data were converted to codes and then connected codes were brought together to generate themes. Lastly, frequency and percentage values were calculated for the derived codes and themes, and they were tabulated as can be seen in the following section.

Validity and Reliability: In the first stage of the classification, the researcher titled the common elements in the reviewed studies with a common theme. In the following stage, the themes and other elements used were compared with the coding made by a researcher of TPACK who is an expert in science teaching, and the disagreements were determined. For this purpose, prior to the classification of the publications, a consistency check was performed on the themes derived by the researcher and the expert. Coders' agreement was checked by using the formula "(reliability=agreement)/(agreement+disagreement)" (Miles & Huberman, 1994). There was a high level (93%) of agreement between the two coders. The rest of the codes and themes, which were the subject of disagreement, were rechecked by the researcher. Finally, the researcher's codes and themes were verified by the expert. As a result, internal and external validity and reliability of the study was ensured.

FINDINGS

The findings obtained through the data collection tools developed in the study are presented under 6 separate headings in parallel to the sub-problems of the study.

Distribution of Postgraduate Dissertations on TPACK by Type, University of Implementation, Department of Implementation, and Publication Year

The distribution of the postgraduate dissertations by level is given in Table 4.

Table 4. Distribution of postgraduate dissertations on TPACK by type

Theme	Code	f	%
Dissertation type	Master's	75	75
	Doctorate	26	25
	Total	101	100

Table 4 shows that 75% of the studies is composed of master's theses and 25% are doctoral theses.

The distribution of the postgraduate dissertations on TPACK by implementing university is given in Table 5.

Table 5. Distribution of postgraduate dissertations on TPACK by university of implementation

Theme	Code	f	%
University of implementation	Middle East Technical University	11	11
	Gazi University	10	10
	Fırat University	8	8
	Necmettin Erbakan University	8	8
	Marmara University	5	5
	Sakarya University	5	5
	Atatürk University	4	4
	Anadolu University	3	3
	Karadeniz Teknik University	3	3
	Amasya University	2	2
	Balıkesir University	2	2
	Bolu Abant İzzet Baysal University	2	2
	Celal Bayar University	2	2
	Cumhuriyet University	2	2
	Çanakkale Onsekiz Mart University	2	2
	Dicle University	2	2
	Dokuz Eylül University	2	2
	Dumlupınar University	2	2
	İnönü University	2	2
	Kastamonu University	2	2
	Mustafa Kemal University	2	2
	Muğla Sıtkı Koçman University	2	2
	Selçuk University	2	2
	Aksaray University	1	1
	Bahçeşehir University	1	1
	Boğaziçi University	1	1
	Bülent Ecevit University	1	1
	Erzincan University	1	1
	Eskişehir Osmangazi University	1	1
	Hacettepe University	1	1
	İstanbul University	1	1
	İstanbul Aydın University	1	1
	İstanbul Gelişim University	1	1
	Mersin University	1	1
	Mevlâna University	1	1
	Ondokuz Mayıs University	1	1
	Süleyman Demirel University	1	1
	Trabzon University	1	1
	Yüzüncü Yıl University	1	1
	Total	101	100

According to Table 5; 11% of the dissertations were conducted at Middle East Technical University, 10% at Gazi University, 8% at Fırat and Necmettin Erbakan University. Another 5% of the dissertations were found to be take place at Marmara and Sakarya Universities, and 4% at Atatürk University. There are two universities with 3% of the theses, 14 universities with 2% and 16 universities with 1%.

The distribution of postgraduate dissertations on TPACK by implementing department is shown in Table 6.

Table 6. Distribution of postgraduate dissertations on TPACK by department of implementation

Theme	Code	f	%
Department of implementation	Science Teaching	28	27
	Physical Education and Sports	1	1
	Physics Teaching	1	1
	Business Administration	1	1
	Chemistry Teaching	1	1

Theme	Code	f	%
	Pre-school Teaching	1	1
	Basic Education	1	1
	Turkish Language and Literature Teaching	1	1
	Total	101	100

Table 6 displays that 27% of the dissertations were implemented in Science Teaching Department and 23% in Mathematics Teaching. Another 12% of the dissertations were related to Computer and Instructional Technologies Teaching and 8% were about Arts in Teaching. The smallest portion, 1%, of the studies were found to belong to the departments of Turkish Language and Literature Teaching, Physics Teaching, Chemistry Teaching, Pre-school Teaching, Basic Education, Physical Education and Sports and Business Administration.

The distribution of the dissertations on TPACK by the year they were published is shown in Table 7.

Table 7. Distribution of postgraduate dissertations on TPACK by publication year

Theme	**Code**	**f**	**%**
Year	2009	2	2
	2010	1	1
	2011	7	7
	2012	6	6
	2013	5	5
	2014	10	10
	2015	12	12
	2016	14	13
	2017	16	16
	2018	15	15
	2019	13	13
	Total	101	100

Table 7 shows that 2 of the dissertations were published in 2009, 12 in 2015, and 13 in year 2019. The highest number of publications was recorded during 2017 (16 studies). It can be said that the number of dissertations saw a gradual increase over the years.

Aims of Reviewed Postgraduate Dissertations on TPACK

The distribution of the dissertations studies on TPACK by study aim is given in Table 8.

Table 8. Distribution of postgraduate theses on TPACK by aim

Theme	Code	Unit f	Unit %	Total f	Total %
TPACK competenncies	Examination of teacher candidates' TPACK competencies	57	20.2	109	38.6
	Examination of teachers' TPACK competencies	50	17.7		
	Examination of instructors' TPACK competencies	2	0.7		
TPACK and variables relationship	Examining the relationship between teacher candidates' TPACK knowledge and specific variables (gender, grade level, age, high school type)	46	16.3	161	57.0
	Examining the relationship between teachers' TPACK knowledge and specific variables (gender, seniority year, major, type of school worked)	42	14.9		
	Examining the relationship between teachers' TPACK knowledge and their instructional strategies/classroom management/teaching self-perception/technology attitude/owning technology/technology use levels	39	13.8		

Theme	Code	Unit f	Unit %	Total f	Total %
Impact of developed implementations on TPACK	Examining the relationship between teacher candidates' TPACK knowledge and their learning strategies/instructional strategies/thinking styles/teacher self-efficacy/technology attitude/technology use levels	32	11.3		
	Examining the relationship between instructors' TPACK knowledge and their teaching styles	2	0.7		
	The effect of IST/Course/Workshop training on the development of TPACK of teachers.	6	2.1	10	3.5
	The effect of IST/Course/Workshop training on the TPACK development of teacher candidates.	4	1.4		
TPACK scale adaptation	Developing and adapting a scale on TPACK	1	0.3	1	0.3
	Total	281*	100	281	100

*The number is different because some studies have more than one purpose.

As can be seen in the table above; 38.6% of the studies were conducted to measure TPACK competency levels of teachers/ teacher candidates/instructors, 57.0% researched the relationship between TPACK and gender/grade level/seniority year, etc, leaving the last portion for examinint the impact of the developed classes/training courses on TPACK development of teachers/teacher candidates (3.5%) and scale development (0.3%). As a note, it is seen that TPACK knowledge of teachers/teacher candidates was addressed frequently (f=107) whereas the impact of training courses/classes on TPACK development of teachers/teacher candidates (f=10) and TPACK scale development (f=1) was not studied so often.

Research Methods, Sample Sizes and Data Collection Tools of Reviewed Postgraduate Dissertations on TPACK

The research approaches and methods adopted in the reviewed postgraduate dissertations about TPACK are listed in Table 9 below.

Table 9. Distribution of postgraduate dissertations on TPACK by research approach and method

Theme	Code	Unit f	Unit %	Total f	Total %
Quantitative Research Meethod	Screening Model	46	45.5	57	56.4
	Experimental Design	8	7.9		
	Correlational Research Model	3	2.9		
Mixed Research Method	Embedded/Integrated Pattern	16	15.8	22	21.8
	Multiple Case Design	2	1.9		
	Convergent Parallel Design	2	1.9		
	Explanatory Design	1	0.9		
	Exploratory Sequential Design	1	0.9		
Qualitative Research Method	Multiple Case Study	14	13.8	22	21.8
	Case Study	8	7.9		
Total		101	100	101	100

Table 9 proves that 56.4% of the studies used quantitative research methods, 21.8% used qualitative research methods and another 21.8% used mixed methods. Also, the most widespread quantitative method was screening model (45,5%), and experimental design (7,9%) and correlational research model (2,9%) were employed relatively less frequently. The other most popular research patterns were seen to be embedded pattern (15,8%) and multiple case study (13,8%).

The distribution of postgraduate dissertations on TPACK by sample/study group type is displayed in Table 10.

Table 10. Distribution of postgraduate dissertations on TPACK by sample type

Theme	Code	Unit f	Unit %	Total f	Total %
Teacher candidates	Science Teacher Candidates	24	22.4	57	53.3
	Elementary School Mathematics Teacher Candidates	9	8.4		
	Secondary Mathematics Teacher Candidates	7	6.5		
	Social Studies Teacher Candidates	6	5.6		
	Classroom Teacher Candidates	3	2.8		
	English Language Teacher Candidates	3	2.8		
	Biology Teacher Candidates	2	1.8		
	Physical Education Teacher Candidates	1	0.9		
	Pre-school Teacher Candidates	1	0.9		
	Physics Teacher Candidates	1	0.9		
Teachers	Elementary School Mathematics Teachers	14	13.8	50	46.7
	Science Teachers	13	12.1		
	English Language Teachers	7	6.5		
	Classroom Teachers	3	2.8		
	Secondary Mathematics Teachers	2	1.8		
	Instructors	2	1.8		
	High School Teachers	2	1.8		
	Secondary Chemistry Teachers	1	0.9		
	Pre-school Teachers	1	0.9		
	Social Studies Teachers	1	0.9		
	French Language Teachers	1	0.9		
	German Language Teachers	1	0.9		
	Geography Teachers	1	0.9		
	Turkish Language and Literature Teachers	1	0.9		
Total		107	100	107	100

Table 10 shows that 53.3% of the dissertations about TPACK were carried out on teacher candidates while 46.7% were on teachers. Within the group of teachers itself, the most frequent sub-group was composed of science teacher candidates (f=24) followed by elementary school mathematics teacher candidates (f=9), secondary school mathematics teacher candidates (f=7) and social studies teacher candidates (f=6), respectively. Going back to the teachers, elementary school mathematics teachers (f=14) constituted the most frequent study group of all the dissertatons. The second most addressed sample was of science teachers (f=13) and the third one composed of English language teachers (f=7).

The distribution of postgraduate dissertations about TPACK by sample/study group size is shown in Table 11 below.

Table 11. Distribution of postgraduate dissertations on TPACK by sample size

Theme	Code	f	%
Sample Size	0 – 10	15	14.8
	11 - 30	4	3.7
	31 - 50	9	8.9
	51 – 70	6	5.9
	71 – 100	3	3.7
	101 – 200	20	19.8

Theme	Code	f	%
	201 ve üstü	44	43.6
Total		101	100

Table 11 shows that 43.6% of the postgraduate dissertations on TPACK were conducted with more than 201 participants and 19.8% were implemented with 101-200 people. A smaller percentage, 14.8% of the studies, was conducted with 0-10 people and 8.9% with 31-50 people.

Another criterion of review of the current study, an analysis was performed on the measurement tools, and the results are exhibited in Table 12.

Table 12. Distribution of postgraduate dissertations on TPACK by data collection tools used

Theme	Code	Unit f	Unit %	Total f	Total %
Scale	Placement Scale	58	21.3		
	Self-Efficacy Scale	36	13.1	119	43.4
	Perception/Belief/Attitude/Interest Scale	13	4.7		
	Scale of Teaching Styles	4	1.4		
	Tendency Determination Scale	3	1.0		
	Scale of Thinking Styles	3	1.0		
	Implementation Scale	1	0.3		
	Burnout Scale	1	0.3		
Observation	Observation	32	11.7	47	17.2
	Video footages	15	5.4		
Interview	Semi-formal interview	38	13.9	45	16.4
	Focus group interview	7	2.5		
Document analysis	Lesson plans	20	7.2	25	9.1
	Diary	2	0.7		
	Mind map	2	0.7		
	Drawing	1	0.3		
Questionnaire/Form/Inventory	Placement Questionnaire	11	4.1	24	8.7
	Lesson Evaluation Form	9	3.2		
	Pre-service training questionnaire	3	1.0		
	Perception Inventory	1	0.3		
Testler	Conceptual Knowledge Test	11	4.1		
	Word Association Test	2	0.7	14	5.1
	Kolmogorov - Smirnov Test	1	0.3		
Total		274	100	274	100

* The figure differs because multiple data collection tools were employed in some of the studies.

It can be understood from Table 12 that a large variety of data collection tools such as scale, observation, interview, document analysis, tests and questionnaire were used in the postgraduate dissertations on TPACK examined here. The breakdown of the tools was as following: Scales account for 43,4%, observation accounts for 17,1%, document analysis 9,1%, questionnaires/forms 8,7% and tests account for 5,1% of the all data collection tools used. Additionally, it was seen that a considerable number of studies were completed by using more than one single tool.

Subjects/Fields of Reviewed Postgraduate Dissertations on TPACK

The postgraduate dissertations related to TPACK are exhibited by theirv study subjects/fields in Table 13 below.

Table 13. Distribution of postgraduate dissertations on TPACK by subject of study

Theme	Code	Unit f	Unit %	Total f	Total %
Science	Photosynthesis and Cellular Respiration	2	7.2	17	60.7
	Electricity	2	7.2		
	Electrical current	1	3.6		
	Basic Astronomy	1	3.6		
	Electrostatics	1	3.6		
	Mixtures	1	3.6		
	Acid rains	1	3.6		
	Global Environmental Issues	1	3.6		
	Structure of Matter	1	3.6		
	Protein Synthesis	1	3.6		
	Refraction of Light	1	3.6		
	Light and Sound	1	3.6		
	Heat and temperature	1	3.6		
	Force and Motion	1	3.6		
	Genetics	1	3.6		
Mathematics	Derivatives	3	10.7	9	32.1
	Polygones	2	7.2		
	Geometry	2	7.2		
	Trigonometry	1	3.6		
	Second-Degree Functions	1	3.6		
Social Studies	Life on Earth	1	3.6	2	7.1
	Geography Information System	1	3.6		
Total		28	100	28	100

It was found out that only 28 of the studies were focused on a specific subject area while the others were conducted to figure out opinions/perceptions/competencies etc. related to TPACK as a generic matter of consideration. Interestingly, 60.7% of the subjects covered in the studies fall under sciences, 32.1% under mathematics and the last 7.1% relate to sub-fields of social sciences.

Results of Reviewed Postgraduate Dissertations on TPACK

As regards the results obtained in the postgraduate dissertations on TPACK, the findings are given in Table 14.

Table 14. Distribution of postgraduate dissertations on TPACK by their results

Theme	Code	Unit f	Level	Level f	Level %	Total f	Total %
			Good	19	42.2		

Theme	Code	Unit f	Level	Level f	Level %	Total f	Total %
TPACK knowledge levels	TPACK knowledge of teacher candidates	46	Medium	5	11.1	114	38.26
			Poor	21	46.7		
			Good	16	47.0		
	TPACK knowledge of teachers	34	Medium	6	17.6		
			Poor	12	35.2		
			Good	-	-		
	TK of teachers	18	Medium	8	44.4		
			Poor	10	55.6		
			Good	-	-		
	TK of teacher candidates	12	Medium	3	25.0		
			Poor	9	75.0		
			Good	-	-		
	TPACK knowledge of instructors	2	Medium	-	-		
			Poor	2	100		
			Good	-	-		
	TK of instructors	2	Medium	-	-		
			Poor	2	100		
TPACK relationship with variables	Relationship of teacher candidates' gender and TPACK	28	Significant	18	55.6	135	45.30
			Non-significant	10	43.4		
	Relationship of teachers' seniority year and TPACK	23	Significant	19	82.6		
			Non-significant	4	17.3		
	Relationship of teachers' gender and TPACK	17	Significant	16	94.1		
			Non-significant	1	5.9		
	Relationship of teacher candidates' TPACK level and technology owning/using level	12	Significant	12	100		
			Non-significant	-	-		
	Relationship of teachers' TPACK and their students' success	9	Significant	9	100		
			Non-significant	-	-		
	Relationship of teacher candidates' TPACK and grade level	7	Significant	6	85.7		
			Non-significant	1	14.3		
	Relationship of teachers' self-efficacy and TPACK level	6	Significant	6	100		
			Non-significant	-	-		
	Relationship of teacher candidates' TPACK level and thinking styles	5	Significant	5	100		
			Non-significant	-	-		
	Relationship of teacher candidates' PCK and TPACK	5	Significant	5	100		
			Non-significant	-	-		
	Relationship of teachers' owning technology/technology use level and TPACK	5	Significant	5	100		
			Non-significant	-	-		
	Relationship of teachers' TPACK level and the school they work	5	Significant	2	40		
			Non-	3	60		
	Relationship of teachers' major and TPACK level	4	Significant	1	25		
			Non-significant	3	75		
	Relationship of teachers'technology attitude and TPACK	3	Significant	3	100		
			Bo difference	-	-		

Theme	Code	Unit f	Level	Level f	Level %	Total f	Total %
TPACK effect of developed applications	Relationship of teacher candidates' TK and their high school type of graduation	3	Significant	3	100		
			Non-significant	-	-		
	Relationship of teacher candidates' TPACK and Technopedagogical Education Competencies	1	Significant	1	100		
			Non-significant	-	-		
	Relationship of instructors' TPACK level and academic title	1	Significant	1	100		
			Non-significant	-	-		
	Relationship of instructors' gender and TPACK	1	Significant	-	-		
			Non-significant	1	100		
	Impact of training courses/workshops on pre-service teachers' TPACK development	20	Positive	20	100		
			Neutral	-	-		
	Impact of pre-service/in-service training on teachers' TPACK development	13	Positive	9	69.23	33	11.07
			Neutral	4	30.77		
Necessity of TPACK	Instructors' purpose of using the TPACK in teaching topics Instructors' need for training on technology integration	16	Too abstract concepts	6	40	16	5.37
			Diffcult to understand concepts	6	40		
			Interest/entertainment	3	20		
			Necessary	1	100		
			Unnecesary	-	-		
Total		298	Total	298	100	298*	100

* The figure differs in some studies due to reaching multiple results.

Table 14 shows that 38.26% of the dissertations obtained results related to TPACK and TK levels of teachers/teacher candidates/instructors, 45.3% reached findings about the relationship between the TPACK knowledge of teachers/teacher candidates/instructors and several variables and % 11.07 of them obtained results on the impact of the developed training courses on the TPACK level of teachers/teacher candidates. Moreover, it was found that there is a visible weight on the results about TPACK and TK levels of teachers/teacher candidates/instructors (f=114), the relationship of teachers/teacher candidates and gender (f=45) and the relationship of TPAB levels of teachers and their seniority year (f=23).

Basic Recommendations Brought in Reviewed Postgraduate Dissertations on TPACK

As the last components of this review study, the recommendations offered in the postgraduate dissertations on TPACK were analyzed and summarized in Table 15 below.

Table 15. Distribution of postgraduate dissertations on TPACK by the theme of recommendations made

Theme	Code	Unit f	Unit %	Total f	Total %
Restructuring of education faculties	Content of lesson plans should be based on TPACK	27	18.37		
	Teaching Practice and School Experience should be replanned by considering TPACK	20	13.61		
	Technology-aided implementations and activities should be used to for subject field teaching in lessons	19	12.93		
	Teacher candidates should be taught how to develop and use technological software specific to subject field education	16	10.88		
	TPACK components should be covered gradually in lessons	13	8.84		

Theme	Code	Unit f	Unit %	Total f	Total %
Restructuring in-service training on TPACK	Teacher candidates should be provided opportunities to acquire and use new technologies	12	8.17	147	57
	Instructional environments should be created to incorporate gamified TPACK Activities into lessons	8	5.44		
	TPACK levels of faculty members should be measured	8	5.44		
	New teaching approaches should be included in lessons considering TPACK and thinking styles	6	4.08		
	TPACK knowledge of practice teachers should be improved	5	3.40		
	Practice teachers should be selected among those with high levels of TPACK	5	3.40		
	Simulation programs should be provided and enabled for use as a part of subject area education	5	3.40		
	TPACK knowledge of faculty members should be developed and in-service training should be given as a part of subject field education	2	1.36		
	Studies should be carried out to increase the technology knowledge of female teacher candidates	1	0.68		
	In-service trainings should be restructured according to teachers' areas of expertise	13	20	65	25.2
	Teachers with more seniority years should be given priority for in-service trainings	9	13.85		
	In-service training groups should be formed based on teachers' branches and seniority year	8	12.31		
	Teachers should be given opportunities to acquire and use new technologies	7	10.76		
	Courses should be run by specialized staff	6	9.23		
	TPACK components should be handled one by one during in-service courses	6	9.23		
	Continuous in-service training should be available on TPACK	6	9.23		
	In-service trainings should simulations specific to subject field education	4	6.15		
	TPACK courses should be in applied mode	2	3.08		
	(Such hardware) should be arranged so as to increase technological knowledge of female teachers	2	3.08		
	Technology standards and performance indicators should be developed for students and administrators	1	1.54		
	Professional development programs should be run during the regular semi-annual "seminar" period in schools	1	1.54		
Offering technological hardware	Technological infrastructure should be built in classrooms	26	56.52	46	17.8
	Faculties should provide teacher candidates with technology-based teaching materials	6	13.04		
	Schools should provide teachers with technology-based teaching materials	6	13.04		
	A technician should be employed in each school to take care of technology infrastructure	4	8.70		
	Software specific to teachers' branches should be diversified	4	8.70		

Theme	Code	Unit f	Unit %	Total f	Total %
Total		258	100	258	100

According to the table above, 57% of the recommendations in the postgraduate dissertations targeted restructuring of education faculties for TPACK development of teacher candidates and a 25.2% were mainly about restructuring in-service trainings to improve teachers' TPACK levels. Additionally, some dissertations recommended provision of technological hardware for restructuring the learning environments (%17.8). Other prominent recommendations included building the curricula of education faculties on TPACK for TPACK development of teacher candidates (f=27), running in-service training courses specific to teachers' branches and seniority years for their TPACK development (f=13) and giving senior teachers the priority to participate in such trainings (f=9).

DISCUSSION AND CONCLUSIONS

This part of the paper is devoted to associating the study findings with each other, comparing them with findings in similar domestic and international researches, and discussing the extent at which the sub-problems could be resolved. The findings elaborated in the foregoing part will be discussed under relevant headings in compliance with the sub-problems.

Aims of Reviewed Postgraduate Dissertations on TPACK

According to our findings, the majority of the postgraduate dissertation on TPACK aimed at describing TPACK competencies and examining the relationship between TPACK and certain variables such as gender/grade level/seniority etc. (Table 8). There are few studies handling the impact of special training courses or classes on TPACK. Similar findings were also resported by other content analysis studies in the literature (Baran & Canbazoğlu Bilici, 2015; Dikmen & Demirer, 2016; Kaleli-Yılmaz, 2015; Setiawan et al., 2019; Voogt et al. 2013; Willermark, 2018). In their content analysis study on TPACK in science education, Setiawan et al. (2019) found out that the largest part of such studies were aimed at determining TPACK competencies of pre-service/in-service science teachers while the rest of them were concerning the relationship between TPACK and other elements of technology integration, teacher candidates' TPACK development strategies, how teachers apply TPACK and developing a tool for TPACK. Researching the TPACK of teachers or teacher candidates and measuring their levels is an important topic. In addition to that, ways of helping teacher candidates and teachers to improve their technology knowledge and integrate technology into their lessons should be sought. Rahmawati, Budiyanto and Basori (2019) also conducted a content analysis study of researches on blended learning within the framework of TPACK. They found out that the teachers lag behind the TPACK levels required for successfully integrating educational technology, and they recommended that training courses or classes should be organized where diverse models are applied in order to elevate their TPACK levels and the outcomes should be announced. As one takes a look at the in-service trainings carried out within the framework of the FATIH project implemented in Turkey, it can be said that such initiatives seem to have an important effect on teachers' technology knowledge development and TPACK awareness, but it is not the case with integration of technology into teaching, to TPACK skills namely (Sezer, 2015). Chai et al. (2013) argued that since TPACK is a practice-dependent research area, training courses based on certain models (*Situated Technology Integration (SiTI) Model*, *TPACK-Comprehension, Observation, Practice and Reflection (TPACK-COPR) Model*, *Technology Mapping (TM) Model, etc*.) could increase the capacity of teachers to integrate ICT into the lesson and suggested that such learning environments should be further developed and researched in consideration of TPACK. On top of these, increasing the number of longitudinal pre-service/in-service studies designed within the framework of TPACK would be quite beneficial for clearly depicting what should be done to improve TPACK of both teachers and teacher candidates, which models should be preferred and how the course contents should be designed in our country (Kaleli-Yılmaz, 2015). For instance, when there is a technology-based course where concrete life is provided for individuals to acquire the necessary TK knowledge and experience within the framework of the Du-TE model, similar training is offered in the TPACK-COPR and TM models through in-class activities. In the TPACK-COPR model, the learning setting or context is attached more importance compared to the other models for TPACK development (Kaya & Yılayaz, 2013). In this context, the fact that long-term postgraduate studies to be carried out in the field of course development within the framework of TPACK are high in terms of quality and quantity will shed light on teacher education as to which model is effective.

Research Methods, Sample Sizes and Data Collection Tools of Reviewed Postgraduate Dissertations on TPACK

In this study, examination of the dissertation studies from the perspective of research approach demonstrates that quantitative approach was used more frequently than other research conceptions, and mixed method studies and qualitative studies were in equal numbers (Table 9). In a similar vein, other researchers concluded that the majority of TPACK studies (Baran & Canbazoğlu Bilici, 2015; Dikmen & Demirer, 2016; Kaleli-Yılmaz, 2015; Korucu, Usta & Atun, 2017) were carried out with quantitative research approach. This finding is in congruence with the results of Sözbilir, Kutu, Yaşar, and Arpacik (2010), which looked into the general trends in chemistry education research in Turkey and in the world and found a large number of studies based on quantitative research approach. Ekiz (2013) explained this with superiority of quantitative research approach thanks to fast, easy and convenience sampling as well as easier and faster data collection and interpretation. It must be said that there is a greater need for mixed method studies on TPACK in which quantitative and qualitative approaches are blended. Such studies are likely to not only offer more sound results about TPACK levels of the participants but also pave the way for other studies on TPACK. Researchers (Koehler et al., 2012; Tondeur et al., 2012) stated that the use of mixed research ideas using qualitative data to

support quantitative data in TPACK research will promote understanding and evaluation of the theoretical structure of TPACK and thus eliminate much of the concern in this regard. Researchers should take these recommendations into consideration in the context of Turkey like other countries. International TPACK review studies did not report standardized results. For example, the review of Chai et al. (2013) found out that qualitative research methods and practical studies were heavily employed. Willermark (2018) found that quantitative and mixed research methods were the most preferred approaches in TPACK studies. The TPACK review study by Wang, Schmidt-Crawford and Jin (2018) found that mixed method was the most broadly used methodology for the sake of data triangulation, validity and reliability. The dispute between the national and international findings on this aspect might be attributed to the fact that the examples in our country are still far from being longitudinal qualitative applications because TPACK researches have gained momentum in Turkey after 2014 (Table 7).

When the studies in the present review were checked regarding research methods, it was seen that screening model was in the lead, yet embedded design and multiple case designs showed considerable occurance (Korucu, Usta & Atun, 2017). On the other hand, Chai et al. (2013) reported a far higher number of case studies in similar studies. The disagreement between the local and international literature might be due to the fact that quantitative research approaches are more popular in Turkey whereas qualitative and mixed research methods are adopted much more in researches carried out in other countries. The point of screening model is to describe the person with their surrounding conditions without intervention (Karasar, 2010). Most of the studies carried out in Turkey are of quantitative type designed for scale development/application or appraisal of a given situation. Screening model might have been applied so often in the context of Turkey because of the abovementioned reason. To go into further details, half a dozen of reasons can be counted for lower popularity of other research methods compared to screening model: experimental studies are usually implemented with experimental and control groups, data collection and analysis process is more complex and laborious for the researcher than non-experimental studies, those methods require a longer period of time; likewise, case studies, correlational studies, descriptive studies are also extended over a long period of time.

When it comes to the participants of the TPACK theses in Turkey, the samples of the studies were largely composed of education faculty students or teachers, but only a small number of academic staff was picked for such studies (Table 10). By the same token, content analysis studies on TPACK researches indicated similar characteristics of sample groups in Turkey (Baran & Canbazoğlu Bilici, 2015; Dikmen & Demirer, 2016; Kaleli-Yılmaz, 2015; Korucu, Usta & Atun, 2017) and other countries (Wu, 2013; Setiawan et al.,2019; Wang, Schmidt-Crawford 2018; Willermark, 2018). It could be explained with the position of teachers and teacher candidates as focus group groups in education field and researchers' preference of easily accessible participants. Further examination into the study participants shows that teacher candidates appeared in more studies than teachers. To give an example, Setiawan et al. (2019) stated that most of the TPACK researches were implemented with teacher candidates, only one third of the studies were conducted with teachers, and the remaining was done with mixed study participants seeking to compare the TPACK of teachers and teacher candidates. In another example, Dikmen and Demirer (2016) pointed out that the majority of the TPAB study participants were comprised of teacher candidates, some were teachers and a very small number corresponded to academic staff. Kaleli-Yılmaz (2015) claim that teachers in our country generally abstain from volunteering in academic researches thinking that it will put extra time and burden onto them with no benefit in return and their weaknesses will be disclosed. They add that the majority of the participating teachers feel pushed to fill out questionnaires or scales and they pretend to be knowledgeable and well-trained; therefore, the researcher has to put so much effort to convince the teachers to take part and be truthful while responding to questions.

As for the branchs of the participant teacher candidates in the studies, they predominantly come from the fields of science, primary school mathematics, secondary school mathematics and social studies whereas the teachers often teach primary school mathematics, science and English (Table 10). Although the number of studies carried out with teachers other than mathematics, science and English language teaching is low, it was seen that studies were conducted with teachers and teacher candidates from almost every branch including physics, chemistry, biology, geography, and physical education (Baran & Canbazoğlu Bilici, 2015; Dikmen & Demirer, 2016; Kaleli-Yılmaz, 2015; Korucu, Usta and Atun, 2017). Also, the scanned studies were substantially done with teachers/teacher candidates at secondary school education while primary and high school levels did not get the same level of attention. In other words, no attempt has been undertaken yet to discover TPACK levels of teachers from various branches working in primary and secondary schools and what they do to better teach the subjects/topics to their students. Likewise, TPACK analysis studies in our country (Dikmen & Demirer, 2016; Kaleli-Yılmaz, 2015; Korucu, Usta & Atun, 2017) revealed that there exist no TPACK studies with branch teachers at secondary education. However, equivalent foreign studies (Chai et al. 2013; Setiawan et al. 2019; Willermark, 2018) show that nearly all branches have been touched upon in the scope of TPACK studies. This difference might arise from the fact that most of the researchers working on TPACK in our country specialize in science and mathematics.

It can be seen that a wide range of data collection tools such as scale, observation, interview, document analysis, test and questionnaire were used in the postgraduate dissertations on TPACK (Table 12). It should be added that use of more than one single tool was not an exception. Rather, it was recurrent in the studies scanned here. The use of multiple tools is considered important for both the authenticity and usefulness of the studies and strengthening the studies in terms of validity and reliability. Another finding reveals that scales, questionnaires/forms and tests were preferred more often than other data collection tools like observation and document analysis. In support of this situation, the bulk of the postgraduate dissertations on TPACK were conducted with a large number of participants (201 + people and 101-200 people) (Table 11). The number of studies employing methods such as observation, interview and document analysis (lesson plan, diary, etc.) revealing the change throughout a process

seems to be low. The majority of TPACK review studies in the literature (Baran & Canbazoğlu Bilici, 2015; Dikmen & Demirer, 2016; Kaleli-Yılmaz, 2015; Korucu, Usta & Atun, 2017; Wang, Schmidt-Crawford & Jin, 2018; Willermark, 2018) concluded that scale was the most common data collection tool. It is probable that scales were the most preferential data collection tool as a subsequent tendency following quantitative research approach and large sample use. Ekiz (2013) believes that the frequent use of scales in studies is due to the fact that they are easily accessible, are low-cost, are more labor-saving and time-saving compared to other data collection tools, and they minimize bias arising from prejudices and personal disposition. The researcher adds that describing the existing situation in the literature through developing scales are more preferred by researchers since they have clear-cut boundaries in terms of analysis, findings and results. Koehler, Shin and Mishra (2012) stated that the studies examining teachers' TPACK development rarely used open-ended questionnaires, performance evaluation questionnaires, interviews and observation since data coding and other operations needed in the analysis of the data obtained from these tools stand as a complex process. Another reason might be the existence of TPACK scales created to make the TPACK structure operational. The literature accommodates several TPACK scales: "Survey of Preservice Teachers' Knowledge of Teaching and Technology" (Schmidt, Baran, Thompson, Koehler, Mishra & Shin, 2009), "PT-TPACK'' (Lux, Bangert & Whittier, 2011), "IWB-based TPACK" (Jang & Tsai, 2012), ''TPACK'' (Chai et al., 2013), "Web Pedagogical Content Knowledge'' (Kavanoz, Yüksel & Özcan, 2015), ''TPCK-SRL'' (Kohen & Kramarski, 2012) and ''TPACK-EFL'' (Baser, Kopcha, & Ozden, 2016). Regarding the demand for these scales, Willermark (2018) found in the TPACK content analysis study that the "Survey of Preservice Teachers' Knowledge of Teaching and Technology" of Schmidt et al. (2009) was used with the highest frequency. Since the diversity of the scales allows the researcher to describe the problem situation in a different way, it can be counted as another reason for the intense demand for scales as a data collection tool. Nevertheless, Voogt et al. (2013) argue that the data to be obtained with the TPACK scales are more likely to reveal teachers' knowledge level they think they have within the framework of TPACK rather than the real TPACK levels of teachers/teacher candidates. The researchers defend the use of joint use of multiple data collection tools like interview and lesson plan to expose the actual TPACKs of individuals. Another finding worth of noting is that there were not found any meta-synthesis and meta-analysis studies on TPACK in the literature review. Conducting studies with these methods and identifying trends in the field of TPACK holds a potential to fill an important deficiency. However, such studies, also called analysis of analyses, require a high level of analysis and synthesis skills. These recommendations should also be taken into account before carrying out new studies in Turkey.

Subjects/Fields of Reviewed Postgraduate Dissertations on TPACK

A small part of the postgraduate studies focused on a specific subject while the rest attempted to figure out opinion/perception/competency etc. related to TPACK in a more general sense. It has been seen that it is trying to be determined (Kaleli-Yılmaz, 2015). It is notable that the subjects covered in the dissertations are largely linked to science followed by mathematics and social sciences, respectively (Table 13). Particularly, secondary school physics was handled while chemistry, biology and astronomy remained as the least discussed fields. As for mathematics, studies at high school level were more apparebt, such as derivatives, polygons, geometry and mathematical functions. This finding is in agreement with the literature (Chai et al. 2013, Setiawan et al. 2019; Wu, 2013). In the study of Chai et al. (2013), it was concluded that the majority of TPACK studies examined TPACK independently. Wu (2013) also found in the literature review that TPACK was examined independent of subject areas in most cases, while science and mathematics were dominant in field-specific studies. Setiawan et al. (2019) pointed out that the majority of the studies were in the context of science as an umbrella discipline, but there were few studies on specific fields of science such as biology, chemistry, and physics. Remembering that TPACK is a field-based knowledge structure, there rises the need for studies on defining TPACK in various fields as well as studies examining field-specific technologies (Baran & Canbazoğlu Bilici, 2015; Voogt et al., 2013, Kaleli-Yılmaz, 2015). It can be suggested that education is still full of gaps to be closed for guiding deeper change within the framework of TPACK; therefore, further development and exploration of especially field-specific technological environments is required. It is also recommended that researchers should create different data collection templates, questionnaires or process evaluations suitable for the nature of these fields.

Results of Reviewed Postgraduate Dissertations on TPACK

Most of the results of the studies were found to relate to the TPACK and TK (Technological Knowledge) of teachers and teacher candidates and the relationship between this knowledge and various variables. Only a small number of them reached results on the impact of the developed classes/training courses on the TPACK knowledge of the teachers and teacher candidates (Table 14). While TPACK of teacher candidates and that of half of the teachers was at a sufficient level, their TK was almost at an insufficient level. It was unclear whether there was a significant relationship between teacher candidates' TPACK and gender. But there was a significant relationship between teachers' TPACK and genders in support of males. As to the relationship between teacher candidates' TPACK and grade level, there was not a significant relationship. However, the relationship was significant between the teachers' TPACK and seniority years. Despite that, the TPACK level was found to be low among the teachers with bigger seniority years. Again, a significant relationship was found between teacher candidates' and teachers' TPACK and ability to own/use technology. There was also a significant relationship between the teachers' TPACK and student success. As another sub-component, it was seen that the classes/training courses developed within the framework of TPACK had a positive impact on the TPACK development of teacher candidates and teachers. In the TPACK content analysis study conducted by Kaleli-Yılmaz (2015), it was also concluded that most of the teachers and teacher candidates had sufficient TPACK but insufficient TK. On the whole,

the results of the studies were suitable for the respective study aim, and in line with the expectations with the most studied subject, the participants' TPACK and TK levels were good. The recommendation in this respect would be to perform meta-analysis studies on variables that have been studied extensively, such as TPACK and TK. Secondly, outcomes of TPACK training courses and the subsequent implementations can be made public for insight about the impact of training attempts.

Basic Recommendations Brought in Reviewed Postgraduate Dissertations on TPACK

According to the findings above, the recommendations in more than half of the dissertations were oriented towards restructuring of education faculties for the TPACK development of teacher candidates, and the rest implied restructuring in-service training for the development of teachers' TPACK levels. There were also recommendations for the provision of technological equipment for building active learning environments. In particular, there were recommendations for redesigning the curriculum based on TPACK for TPACK development of teacher candidates, teaching teacher candidates knowledge and skills necessary for technology-supported applications as a part of subject field education, developing technological software specific to field education and teaching to use them, and restructuring certain courses mainly including Teaching Practice for the application of the acquired TPACK and skills. It is crucial to integrate and apply new technologies to subject field education courses during the pre-service period because teacher candidates' having sufficient TPACK will help them be more successful in integrating technology into their lessons when they start work (Rahmawati, Budiyanto, & Basori, 2019). Kaya and Yılayaz (2013) stated that it is of vital importance to reconsider the content, duration and teaching of "Special Teaching Methods", "School Experience" and "Teaching Practice" courses in the light of TPACK since those courses are offered at education faculties in Turkey to show how to teach a specific field (mathematics, science, social studies, etc.) (PCK). It was also emphasized in the studies that in-service trainings organized for the development of teachers' TPACK should be arranged to fit into the teachers' branches/years of experience. Senior teachers should be given priority in participation in the course. In addition to this, it was recommended to address TPACK components one by one in pre-service/in-service training. To summarize, it can be suggested that the postgraduate dissertations reviewed here contained recommendations about teacher education and researchers put forward recommendations under several themes.

RECOMMENDATIONS

In this study, a total of 101 postgraduate dissertations dealing with TPACK were analyzed and it was understood that the number of postgraduate dissertations increased gradually after 2009. In this respect, it is unquestionable that the dissertations on TPACK are important. What is even more important is to produce authentic studies as required by the nature of science instead of replicating some kinds of studies. In the dissertations published on TPACK, teacher candidates and teachers took part more often as study participants. It is critical to study the TPACK of teachers or teacher candidates and to identify their levels, but that would be incomplete without looking for alternative ways by which teachers and teacher candidates can integrate technology into lessons. There should be more classes during pre-service period to help teacher candidates learn how to integrate technology into lessons in their subject field and how to improve their TK Such classes or courses should be taught by instructors who are competent in the relevant field and TPACK. At the same time, course contents in education faculties should be rearranged within the framework of TPACK and necessary updates mandated by the field-specific ICTs should be performed. In order to achieve the targeted results in the FATIH project carried out in our country, it can be thought that in-service trainings based on different TPACK models will be developed and a teacher training TPACK model suitable for Turkish culture can be created based on the findings obtained. It is recommended that future research should be inclusive of students as the way the teacher integrates technology into the lesson affects students' success, attitudes and behaviors towards the lesson. For example, research can be done on how the teacher's TPACK level affects the students. Moreover, it was seen that science and mathematics lessons and secondary school teachers were mostly chosen for the reviewed dissertations. Primary and high school teachers should be preferred in future research and more research weight should be placed onto verbal skill courses such as Turkish Language, Geography and History. The recommendation is about focusing on qualitative and mixed methods as well as quantitative methods in future TPACK studies for a great contribution to the literature. To conclude, examining the studies on TPACK in the light of these recommendations is expected to enrich the relevant literature and shed light on future studies by the same token.

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