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Thematic content analysis of technological pedagogical content knowledge studies published in the field of primary school teachers and preservice primary school teachers

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Abstract

In this research, it is aimed to analyze technological pedagogical content knowledge (TPACK) studies published in the field of primary school teachers and preservice primary school teachers by using thematic content analysis. In this research, 20 articles and 8 dissertations were analyzed by using thematic content analysis method. Each study was examined within the context of the study's *aim, method, sample, data collection tools, data analysis techniques, the topic distribution in TPACK in primary education, pedagogical practice used in TPACK development in primary education, results and suggestions.* As a result, *it was revealed that most* of the studies were conducted to determine the relationship between TPACK and different variables. It was observed that the quantitative design was used the most as a method in the studies and the scale/survey was used as a data collection tool. In addition, it was determined that the studies were mostly carried out independently of the field and carried out at the level of classroom teachers. As a result of the research, it is suggested to conduct qualitative and mixed pattern studies in order to examine the TPACK development of process-oriented teachers and preservice teachers. Additionally, considering that primary school education is a field that includes different disciplines, it is seen that field-specific studies are lacking. In order to eliminate this deficiency, it is recommended to carry out studies specific to a discipline such as mathematics or science in primary school education.

Keywords: Technological pedagogical content knowledge; thematic content analysis; literature review; primary school teachers, preservice primary school teachers

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1. Introduction

1.1. Introduce the problem

The world is in a rapid change in 21st century, thanks to the advances in technology and also the developments in information and communication technologies. This progress, which began with computers and smartphones, is taking extremely active place in human life with artificial intelligence and virtual reality. There is a generation which opened their eyes to such world and found technology in the heart of their lives. This new world is a place where it provides the individuals to reach everything by only pressing a button, consists unlimited knowledge in itself and also it is equipped with various learning tools. Therefore, school, which comes first into minds when it is mentioned learning environment, left its place to unlimited world and it has also made significant changes in the learning process of individuals. In this environment all the counterparts of education system especially teachers are required to reflect the innovations that the new age brought and design the learning tools which will address to individuals. Because today, as in the past, the teacher is the guide of both change and the future for the student.

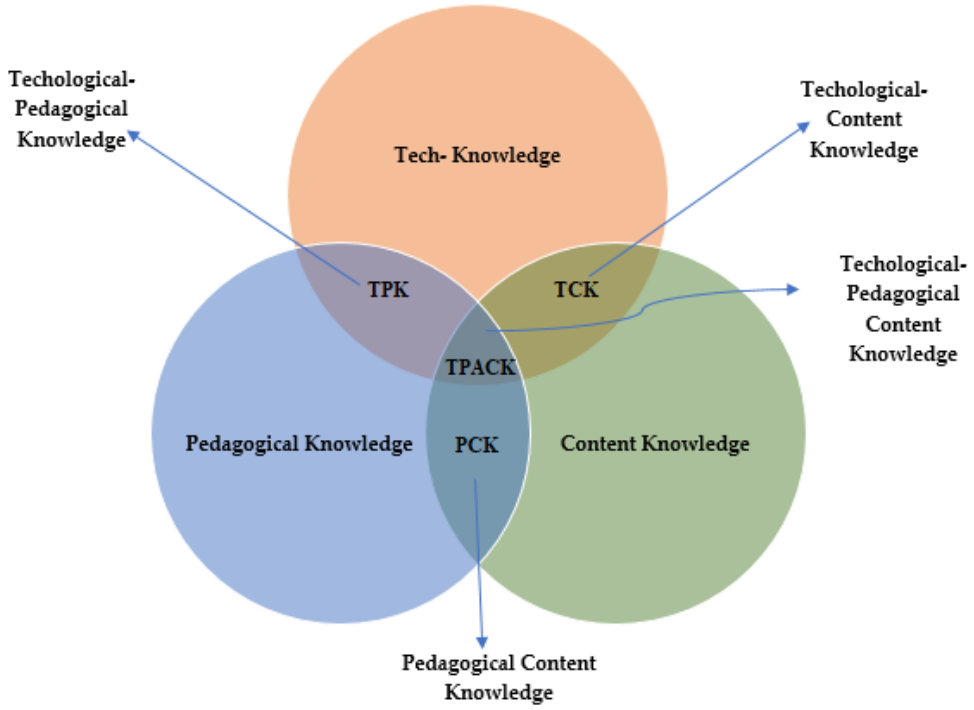
The teacher comes first amount the elements that shapes the future profile of a society. According to Wagner (2008), raising the students that are equipped with the skills of age is only possible by the teachers that are equipped with that skills. In fact, it should not be forgotten that teachers should also be 21st century learners. The existence of qualified students is possible with the guidance of qualified teachers. It was emphasized by Shulman (1986) that a qualified teacher should have pedagogical content knowledge as well as being an expert in the subject area. Acccording to Gürbüz, Erdem and Gülburnu (2013), a lot of the studies that have been done recently focused on the issue in which a teacher's having a good content knowledge with how he/she transmit his/her content knowledge in their lessons. In this context, pedagogical content knowledge emerges as an important component in terms of teacher qualifications.

Shulman (1986) who revealed the concept of pedagogical content knowledge (PCK) for the first time, explained this concept as the most useful ways of presenting ideas about a subject in a field, the strongest analogies, explanations, examples and demonstrations. In other words, PCK are ways of presenting and formulating the subject that will make understandable by others. PCK is a structure which is formed by combining the teaching strategies and content area knowledge. PCK includes the content knowledge that the teacher has and means that students at different levels, abilities and readiness levels have the knowledge and competence that will enable them to learn in the most appropriate way. PCK also includes the knowledge of what are the difficulties of learning a subject and how can it be understood easier. In fact, this information is the knowledge about the learning and concepts brought by students in different age groups and with

different pre-learning. If the student's pre-learning is misconception, there is a need for useful strategies that the teacher will employ here (Schulman, 1986). Therefore the teaching carried out by the teacher at school forms the understanding that students' have about a subject. However, the teacher's anxiety of transmitting content knowledge and traditional education mentality appears before us (Gürbüz, Erdem and Gülburnu, 2013).

The traditional teaching approach considers the learning and teaching process as a uniform teacher and student interaction. For instance, knowledge or experience is transmitted to a child by an adult directly (Baki, 2002). Considering the changes, transformations and emerging trends in the current age, education should move away from uniform practices. Besides increasing teaching abilities, it is expected from a teacher to have content knowledge and pedagogical content knowledge. Furthermore, a teacher is required to correlate them with tech-knowledge.

With the addition of technological knowledge to the PCK concept that has been developed by Shulman (1986), technological pedagogical content knowledge (TPACK) structure emerges. This structure is developed by Mishra and Koehler (2006). TPACK is when a teacher plans and organizes the subject area, taking into account the student's situation and environmental conditions, and giving place to the technological tools required by the age in teaching (Niess, 2008). TPACK model consists of intersection of three basic knowledge; technological knowledge, pedagogical knowledge and content knowledge.



Scheme 1. TPACK and elements (Koehler and Mishra, 2008)

Mishra and Koehler (2006) defines below the intersection of three basic knowledge emerges in seven knowledge as a consequence.

Technological Knowledge: (TK): Technological knowledge consists of every teaching material from white board to computer technology and further.

Pedagogical Knowledge (PK): Teacher's knowledge of practice, technique and method for accomplishing meaningful teaching.

Content Knowledge (CK): Teacher's knowledge of his/her field and current improvements.

Pedagogical Content Knowledge (PCAK): It's the combination of pedagogical and content knowledge. It consists of knowing the approaches for content knowledge teaching and planning the elements required for better learning.

Technological Content Knowledge (TCK): It is the knowledge of which technology should be used for a better presentation of content.

Technological Pedagogical Knowledge (TPK): It is the knowledge of adequacy and limits of technological materials used in the learning environment.

Technological Pedagogical Content Knowledge (TPACK): TPACK is intersection of technological, pedagogical and content knowledge, and it is a further beyond knowledge than the type of knowledge that is formed after the interaction of these three knowledge.

TPACK's purpose is applying content knowledge besides technology and creating better activities. If teacher's need of knowledge is defined true, and technologies interaction with this knowledge expressed, technology's integration with teaching can be understood better (Mishra and Koehler, 2008). Various studies on TPACK in Turkey and abroad are being carried out. The first one of them is done by Voogt, Fisser, Pareja-Roblin, Tondeur ve Braak (2013). There are 56 studies conducted between 2005 and 2011 in the research. It is stated that technology-supported courses and courses in which teachers and students take part in the process for the development of TPACK are created. In the conclusion part of the study, it was stated that even if the teachers had experience in technology, they were limited in showing this experience. The second study was done by Chai, Koh and Tsai (2013), it is a survey study in which 74 articles were reviewed that are produced between 2003 and 2001. According to the outcome at the end of the research shows, the researches were intensified in 2010 and qualitative, quantitative and mixed methods were applied in the researches. As a content knowledge, teaching technology stood out, and in the studies constructivist approach was embraced. As the third study, Wu (2013) reviewed 24 articles on TPACK which were published in international journal between 2002 and 2011. In the research it is stated that TPACK trainings given for teachers are increased. Also, it is concluded that the number of experimental studies and specific TPACK training grew more. In the state, there is

Kaleli Yılmaz's research (2015) which analyses the studies on TPACK in Turkey. In the research, 59 studies were reviewed between 2008 and 2014. In the study it is detected, according to the results, the majority of the studies were done with the aim of scale development/adaptation and reviewing TPACK sufficiency and development. It was stated that most of the screening studies were conducted and the studies conducted with pre-service teachers were more. While it is seen that the participants in the quantitative studies have high TPACK proficiency/perception/level, it has been determined that the opposite is the case in qualitative studies. In addition, it has been concluded that practices such as TPACK workshop, professional development programs, blended learning increase the TPACK level. Another study in the national field is the literature review research on TPACK by Baran and Canbazoğlu Bilici (2015). A total of 30 studies conducted in Turkey between the years 2005-2013 were examined. According to the results of the research, it is seen that scales are used extensively as data sources in TPACK studies and that there are more studies on preservice teachers. It has been stated in the literature that studies on science and mathematics disciplines come to the fore. In the light of all these researches; the reason for the emergence of the current study is that the studies in the national field only take into account the studies in Turkey and do not include studies abroad. In other words, it is thought that a holistic perspective on the field would be beneficial. Considering that primary school education is the first stage of the education process, teachers in basic education play a dominant role influencing the further stages of education, it is thought that TPACK studies in this field are important. Therefore, since the studies mentioned above are not specific to a particular field, it is thought that determining the trends of TPACK in the field of primary school teachers and preservice primary school teachers will contribute to the field. In addition, the existence of TPACK studies in primary school teachers and preservice primary school teachers in the literature and the fact that these studies were not analyzed with a holistic perspective made this study necessary. Moreover, it is thought that the thematic content analysis to be carried out on the primary school teachers and preservice primary school teachers sample in this research will fill the gap in the field.

1.2. Importance of the study

TPACK encourages researches on issues such as the professional development of the teacher and the use of technology rather than the traditional education of the teacher. It is important for the literature to determine the effect and results of the theoretical structure of TPACK in the field of primary school teachers and preservice primary school teachers on these issues. This thematic content analysis study will shed light on determining what kind of deficiencies exist in TPACK in the field of primary school teachers and preservice primary school teachers. In this context, by examining the studies on TPACK in the field of primary school teachers and preservice primary school

teachers, this study is unique in terms of revealing the purpose of TPACK studies, in which field of primary school education, with which method, and moreover, the results and suggestions in the studies. Therefore, it is thought that this research will be a resource for researchers, teachers and program developers in terms of revealing the trends in the field.

This research aims to examine TPACK studies in the field of primary school teachers and preservice primary school teachers with thematic content analysis method. For this purpose, answers were sought to the following questions regarding TPACK studies in the field of primary school teachers and preservice primary school teachers:

1. For what purposes is it done?
2. What methods are used?
3. Which sample levels are preferred?
4. Which data gathering tools are used?
5. Which data analysis methods are used?
6. Which area of primary school education is discussed?
7. Which pedagogical practice is preferred in the development of TPACK?
8. What results have been achieved?
9. What recommendations are included?

2. Method

In this research, thematic content analysis method, which is one of the content analysis types, was used. Thematic content analysis is a method based on synthesizing the trends and results of research in a field with a critical perspective using themes and templates (Çalık & Sözbilir, 2014; Çalık, Ünal, Coştu, & Karataş, 2008). According to Çalık and Sözbilir (2014), thematic content analysis studies are handled with a qualitative point of view, and the similarities and differences of these studies are presented in a comparative manner, and on the other hand, it presents a rich reference source for researchers, teachers and other interested people who cannot reach all the studies. In this study, the thematic content analysis method is used since it is aimed to examine the TPACK studies in the field of primary school teachers/preservice primary school teachers and to reveal the trends in a comprehensive way.

2.1. Data collection

In this research, in order to reach TPACK studies in the field of primary school teachers and preservice primary school teachers; international and national databases were scanned. First of all, in order to reach the publications in the international

literature on TPACK; ERIC (EBSCO), ProQuest Dissertations and Theses Global, Emerald Insight, Sage Journals, Science Direct, Scopus (A&I), Springer LINK, Taylor & Francis, Wiley Online Library Full Collection and Google Scholar databases were searched. Then for the nationally scanned publications; YOK National Dissertation Center and ULAKBIM National Database were examined. As keywords in searches; the concepts of technological pedagogical content knowledge, TPACK, primary school teachers (elementary school teachers) are included. As a result of this search, 29 studies were reached. A study was not included in the research because it was conducted to establish a theoretical basis. In addition, if there is an article produced by the same author from the postgraduate dissertation, the postgraduate dissertation was taken into account. As a result, a total of 28 studies consisting of 8 theses and 20 articles were examined in this research. Eight of these studies were conducted nationally and twenty of them were carried out internationally.

2.2. Limitation of the research

In this study, it is aimed to examine the studies on TPACK. The fact that the examined studies are selected from the field of primary school teachers and preservice primary school teachers may prevent sufficient detailed examination in terms of the subject and the content of the discipline. Because of this concern, the researcher did not put a year limit on the studies, created the opportunity to examine enough studies in the relevant field and aimed to reach reliable results.

2.3. Data analysis

The articles and dissertations obtained from the literature were examined by creating tables. As a result of the review, some parameters were determined for the analysis of the studies. These parameters are; purpose, method/pattern, sample, data collection tool, data analysis method, primary school education area, pedagogical practice used in the development of TPACK, results and suggestions. Considering these parameters, an example of the way the studies were analyzed is given in Table 1.

Table 1. Example of the parameters in which the studies examined within the scope of the research were examined

Code of the Study	Purpose	Method/pattern	Sample	Data collection tool *a*	Data Analysis method *b*	Class teaching area	The practice used to develop TPACK	Result	Suggestion

S23	Due diligence of TPAB competencies	Qualitative/Case Study	Preservice Teachers	Document	Content analysis	General	Professional Development Program	TPACK is a useful framework for integrating technology into the	Suggestions for future work

a,b The studies reviewed may contain more than one data collection tool and data analysis method. In this case, if more than one feature for a parameter appears in a study, that study is coded more than once in the same parameter. This situation may cause the frequency value of the relevant parameter to be higher than the total number of studies.

Each study was examined and coded separately according to the parameters in Table 1. Accordingly, 61 codes were obtained. The parameters in Table 1 also refer to the themes in which the codes determined through thematic content analysis are classified. The findings of the research were interpreted according to these themes and codes. In the tables created within the scope of the research, only frequency was used statistically.

Each study included in the research was coded as S1, S2, S3,…. Then, the relevant sections of the studies were read and the tables were created according to the research problems. The studies were examined one by one and the tables were filled by creating codes for each theme.

2.4. Validity and reliability of the research

In the coding phase of the research, the studies were examined over a long period of time, and attention was paid to make the coding in accordance with the determined parameters. A summary of each study was created by reading the relevant sections of the studies, and coding for the other study was not done before the coding of one study was completed. In order to ensure coding reliability, the studies were re-examined one month after the first coding and the consistency between the coding was found to be 97%. In addition, the research was sent to a researcher who is an expert in the field of thematic content analysis, and it was examined in terms of validity and reliability.

3. Results

The studies obtained within the scope of the research are presented in this section using themes and codes. The representation of the data is given under the headings of the themes and in the form of a table. The frequency distribution of the codes created for the purpose theme is given in Table 2.

Table 2. Frequency distribution of the purposes of tpack studies conducted in primary school education

Codes	Studies	f
Determining the relationship between TPACK and different variables	S7, S9, S13, S15, S16, S19, S21, S24, S25, S26, S27, S28	12
TPACK scale/survey adaptation/development	S4, S17, S18	3
The effect of the applied training method on TPACK	S3, S22	2
TPACK-based lesson planning/evaluation	S1, S8	2
Examining teachers' perceptions of technology application in the classroom	S5	1
Situation determination towards TPACK competence	S23	1
Researching teachers' teaching strategies while developing TPACK	S20	1
Understanding how teachers are encouraged to integrate technology with computer use	S12	1
Determining the course design implementation frameworks by taking into account the teachers' TPACK knowledge	S6	1
Identifying barriers/difficulties for teachers to integrate technology into their lessons	S11	1
The effect of blended learning on preservice teachers' TPACK development	S14	1
Identifying how teacher characteristics affect their implementation of the blended learning model	S10	1
Getting an idea of teachers using digital technology in math lessons	S2	1
Total		28

When Table 2 is examined, it is seen that thirteen different codes have been created for the theme of purpose. Twelve of the reviewed studies were made in order to determine the relationship between TPACK and different variables; 3 of them were made for the purpose of adapting or developing the TPACK scale/survey. In addition, it is seen that two studies were carried out in order to determine the effect of the applied education method on TPACK and to plan/evaluate a TPACK-based lesson. Furthermore with the aims of examining teachers' perceptions of technology application in the classroom, determining the situation of their competence of TPACK, searching teachers' strategies of developing TPACK, researches were made for each aim. There are studies on each of these, understanding how teachers are encouraged to use technology with applied

training, determining course design implementation frameworks by taking teachers' TPACK knowledge into account; identifying the difficulties that teachers face in integrating technology into their lessons. While a study is conducted to get an idea about teachers' use of digital technology in mathematics lessons; it is seen that there is a little number of studies have been made to determine the effect of blended learning on pre-service teachers' TPACK development; how teacher characteristics affect the implementation of the blended learning model. The frequency distribution of the codes created for the method theme is given in Table 3.

Table 3. Frequency distribution of the methods of tpack studies in primary school education

Categories	Codes	Studies	f
Qualitive	Survey	S5, S7, S13, S14, S15, S16, S19, S21, S24, S25, S26, S27, S28	13
	Scale development/adaptation	S4, S17, S18	3
Quantitative	Case Study	S2, S10, S22	3
	Other (Qualitative but not determining pattern)	S1, S8, S20	3
Mixed (Qualitative + Quantitative)		S3, S6, S9, S11, S12, S23	6
Total			28

According to Table 3, three different categories and four codes were created for the method-pattern theme. Accordingly, 13 of the studies were conducted with a survey (quantitative) design; 3 studies were conducted according to the case study (qualitative) design; It is seen that 3 studies were conducted with the other (qualitative but not pattern) method. In addition, it was determined that 6 studies were conducted with mixed (quantitative + qualitative) method and 3 studies were scale development/adaptation research. The frequency distribution of the codes created for the sample level theme is given in Table 4.

Table 4. Frequency distribution of sample level of tpack studies conducted in primary school education

Codes	Studies	f
Primary School Teacher	S1, S2, S5, S6, S7, S8, S9, S10, S11, S13, S14, S15, S16, S17, S18, S19, S20, S25, S27	19
Preservice Primary	S3, S4, S12, S21, S22, S23, S24, S26, S28	9

School Teacher	
Total	28

According to Table 4, it is seen that there are two different codes for the sample level of TPACK studies. Accordingly, while 19 of the examined studies were at the level of in-service primary teachers, 9 of them were at the level of primary school preservice teachers. The frequency distribution of the codes created for the data collection tool theme is given in Table 5.

Table 5. Frequency distribution of the data collection tool used in tpack studies in primary school education

Codes	Studies	f
Scale/Survey	S3, S4, S5, S7, S8, S9, S10, S11, S13, S14, S15, S16, S17, S18, S19, S21, S24, S25, S26, S27, S28	21
Observation	S1, S2, S12, S20, S22	5
Sound/Video records	S1, S2, S6, S10, S11	5
Interview/meeting	S2, S10, S12, S20	4
Field note	S2, S12, S22	3
Rubric	S3	1
Document	S23	1
Total		40

According to Table 5, it is seen that there are 7 different codes for the theme of data collection tools. Accordingly, it is seen that in examined studies, the scale/survey application is used in 21; observation is used in 5, sound/video record is used in 5. In addition to this it is seen that interview / meeting is used in 4, field note is used in 3 of these studies. Finally, it is seen there is one study for each of rubric and document method. The frequency distribution of the codes created for the data analysis method theme is given in Table 6.

Table 6. Frequency distribution of data analysis method used in tpack studies in primary school education

Category	Codes	Studies	f
	t-test	S3, S7, S11, S13, S14, S15, S16, S17, S19, S21, S24, S25, S28	13
	Correlation	S3, S4, S9, S13, S16, S17, S19, S27	8
	Regression	S5, S16, S17, S26, S27	5

Quantitative	ANOVA	S7, S16, S17, S25	4
	Basic Statistics	S18, S23, S27, S28	4
	Kruskal-Wallis	S18	1
	Mann Whitney U	S18	1
	Ki-square analysis	S6, S12	2
	Analytic Hierarchy Process	S8	1
Qualitative	Content analysis	S3, S6, S9, S10, S11, S12, S20, S23	8
	Descriptive analysis	S1, S2	2
	interpretative-descriptive theory	S22	1
Total			50

When Table 6 is examined, it is seen that there are two different categories and twelve different codes for the data analysis method theme. According to this, it is seen in the studies that are examined collected data are analyzed by using t-test in 13 and content analysis in 8. Moreover, data are analyzed by using such methods as correlation in 8 studies, regression in 5 studies, ANOVA in 4 studies and basic statistics (arithmetic mean/standard deviation) in 4 studies. Two studies each include descriptive analysis and chi-square analysis. Finally, Mann Whitney U, Kruskal-Wallis, analytic hierarchy process and interpretive-descriptive theory are included in the data analysis of each study. The frequency distribution of the codes created for the theme of primary school education area is given in Table 7.

Table 7. Frequency table of tpack's class education area distribution

Codes	Studies	f
Field Independent	S3, S4, S5, S7, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S21, S23, S24, S25, S26, S27, S28	23
Mathematics	S1, S2, S22	3
Science	S8	1
Information Technologies	S6	1
Total		**28**

When Table 7 is examined, it is seen that there are four codes for the TPACK's class education area distribution theme. It was seen that 23 of the studies examined were field

independent, in other words, they were not directed to a single course. In addition, while 3 studies were carried out in the field of mathematics, one each study was made in the field of Science and Information Technologies. The frequency distribution of the codes created for the pedagogical practice theme used in the development of TPACK is given in Table 8.

Table 8. Frequency distribution of pedagogical practices used in tpack development in primary school education

Codes	Studies	f
No intervention (Scale adaptation/development/survey application)	S4, S5, S7, S8, S9, S11, S13, S14, S15, S16, S17, S18, S19, S21, S24, S25, S26, S27 S28	19
Career Development Program	S3, S12, S22, S23	4
Couse Design/plab	S1, S6, S20	3
Blended Teaching	S10	1
Digital technology usage	S2	1
Total		28

In the studies, it was determined which pedagogical application was made for the development of TPACK in the field of primary school education. Here, the concept expressed as pedagogical practice, expresses what the teacher/researcher does in practice, what kind of environment he designs and which material he/she uses. When Table 8 is examined, it is seen that there are five different codes for the pedagogical practice theme used in the development of TPACK. No intervention was made in 19 of the studies reviewed. In these studies, scale adaptation, scale development and survey application were made. In addition, while professional development program was applied in 4 studies, course design/plan was used in 3 studies. Blended teaching and use of digital technology were identified in one study. The frequency distribution of the codes created for the result theme is given in Table 9.

Table 9. Frequency distribution for results

Codes		Studies	f
Relation between TPACK and different variables	Positive effect	S7, S9, S19, S26, S27	10
	Neutral effect	S3, S17, S21, S24, S25	

TPACK is a useful framework for integrating technology into the curriculum.	S8, S11, S23	3
After the application, teachers give more place to teaching strategies for using TPACK in lessons.	S20, S22	2
Junior teachers tend to have higher game pedagogical content knowledge (GPCK) than experienced teachers.	S15, S16	2
The blended learning model has a positive effect.	S10, S14	2
The adapted scale is not suitable to be used in academic studies focusing on TPACK of Turkish preservice primary school teachers.	S4	1
The general TPACK of preservice teachers is at a "good" level.	S28	1
Classroom teachers tend to have higher self-efficacy in game pedagogical knowledge (GPK) and game pedagogical content knowledge (GPCK).	S13	1
It is strongly influenced by student-teachers' previous experiences and beliefs regarding graph calculators.	S1	1
Teachers do not have sufficient technology education / lack of support from their administrators / do not have time to use technology / technology-related problems are frequently encountered in their schools.	S5	1
Teachers have difficulties in integrating TPACK sub-dimensions and cannot integrate ICT (Information and Communication Technology) based applications with TPACK.	S18	1
Instructors are less interested in an area that includes teaching teachers to use technology or TPACK.	S12	1
It is important to assess how teachers can be better prepared to create innovative pedagogies.	S6	1
Differences in the way teachers use digital technology in their classrooms seem to be related to TPACK development stages.	S2	1
Total		28

When Table 9 is examined, it is seen that 14 different codes are formed for the result theme. In ten of the studies, the relationship between TPACK and different variables (career professionalism, educational background, attitude, epistemological beliefs, metacognition, self-efficacy, taking time to use technology, gender, experience, technological knowledge, belief) were examined. Five of these studies had a positive effect, while five studies had a neutral effect.

As a result of three studies, it was revealed that TPACK is a useful framework for integrating technology into the curriculum. On the other hand, two studies show that after the implementation, teachers give more place to teaching strategies for using TPACK in lessons. Furthermore, two studies show that junior teachers tend to have higher game pedagogical content knowledge (GPCK) than experienced teachers.

While, in one of the studies on applying the blended learning model, it was concluded that the teachers were ready to apply this model, it was concluded in the other study that blended learning was effective in increasing the TPACK of preservice teachers. In a study in which the scale was adapted, it was concluded that the scale is not suitable for use in studies focusing on the TPACK of Turkish preservice primary school teachers. In the studies carried out for the determination of the situation; it has been determined that preservice teachers' TPACK is at a good level. In another study, it was seen that student-teachers were strongly influenced by their previous experiences and beliefs about graph calculators.

In one of the other due diligence studies, it was found that teachers lack sufficient technology education, lack the support of administrators, do not have time to use technology, and frequently encounter technology-related problems in their schools. In another study, it is seen that teachers have difficulties in integrating TPACK sub-dimensions and cannot integrate ICT-based applications with TPACK. Moreover, in one of the studies, it is found that instructors were less interested in an area that involved teaching teachers to use technology or TPACK.

One practice-oriented study found it important to assess how teachers can be better prepared to create innovative pedagogies. In another study, it was determined that the differences in the way teachers use digital technology in their classrooms are related to the developmental stages of TPACK. The frequency distribution of the codes created for the *suggestion* theme is given in Table 10.

Table 10. Frequency distribution for suggestion

Codes	Studies	f
Suggestions for future studies	S2, S3, S4, S6, S7, S8, S10, S11, S12, S15, S16, S17, S18, S19, S21, S22, S23, S27	18
Suggestions for practitioners and experts	S1, S5, S9, S13, S20, S25, S26, S28	8
Work without an explicit suggestions	S14, S24	2
Total		28

When Table 10 is examined, it is seen that there are three different codes for the suggestion theme. While 18 of the reviewed studies made suggestions for future studies, eight of them made recommendations for practitioners or experts.

4. Discussion and result

In this research, thematic content analysis of TPACK studies in the field of primary school teachers/preservice primary school teachers was made and the results were discussed in line with the research questions.

When the findings are examined; it is seen that studies (Table 2) are frequently conducted to determine the relationship between TPACK and different variables, and to adapt/develop TPACK scales. The fact that survey-type studies are easy in terms of application and also provide access to a large number of data may cause studies to concentrate on this field and direct researchers to this goal. Similarly, in Kaleli Yılmaz's (2015) research on the analysis of TPACK studies in Turkey, it was determined that studies on scale adaptation, scale development, determining TPACK proficiency and examining the relationship between TPACK and different variables were intense. Furthermore, it was stated that studies conducted in the form of screening included studies for similar purposes by working with different sample groups and using quantitative data collection tools. It is thought that, repeating these studies by changing sample group will not contribute to literature, after carrying out a few studies with aim of determining current status. The fact that a limited number of studies with interventions (the effect of the applied education method on TPACK, TPACK-based lesson planning/evaluation) were included in the studies examined may be due to the desire to determine the effects of the application. Again, the limited number of due diligence studies may be due to the desire of teachers or prospective teachers to determine their current TPACK levels. Moreover, the fact that hardware and technological infrastructure studies are carried out in many countries for the integration of technology into the education field may be the reason for the researches for due diligence.

In the studies examined, it is seen that, mostly quantitative research design was used (Table 3), survey and scale development/adaptation has been done in this direction. The idea of reaching the views of a larger participants on TPACK may be the reason for giving more space to survey and scale development studies. Similarly, in the studies of Baran and Canbazoğlu Bilici (2015) in which they examined the TPACK literature in Turkey, it was determined that the quantitative research design was mainly used. However, in the compilation study conducted by Chai, Koh and Tsai (2013) on TPACK between 2003 and 2011, it was stated that qualitative research design and application studies were carried out more intensively.

In the studies examined, it is seen that the studies conducted with the qualitative research design are mostly case studies. The absence of other qualitative research designs reveals the deficiency in this area. Moreover, survey studies allow the questions of "how often", "what level" and "how" to be answered. The fact that TPACK studies, which will be conducted with qualitative research designs such as action research or grounded theory, will answer the question of "why" and can fill an important deficiency in determining the trends in the literature. Besides, the existence of studies conducted with a qualitative method but not specifying a pattern, may be the reasons of field dominance, method proficiency, etc. In the research, it was concluded that the number of studies conducted with mixed (quantitative + qualitative) method is less than that of qualitative and quantitative methods. Mixed method requires more scale/measurement tools and for this reason it increases workload so this may be the excuse why it is not preferred much.

While the analyzed studies mostly took primary school teachers as samples, fewer studies included preservice primary school teachers in the sample (Table 4). Determining the TPACK levels of classroom teachers or the thought that the relationships between TPACK and the practices they include in the lessons are important may have led the researchers to mostly work with in-service classroom teachers. The data obtained from the studies conducted with the teachers involved in the education and training activities provide information in a wider perspective and also provide more useful information about determining the current situation and what is needed in this field (Kaleli Yılmaz, 2015). However, in the research conducted by Kaleli Yılmaz (2015) on the analysis of TPACK studies in Turkey, it was determined that the studies examined were mostly conducted with preservice teachers, and it was stated that the reason for this was the easy accessibility of preservice teachers. Similarly, Baran and Canbazoğlu Bilici (2015) stated that the TPACK studies they examined in the context of Turkey focused on preservice teachers as the working group. All departments were included as a sample group in the studies examined. In this context, the inclusion of national and international literature in the study, and the inclusion of only primary school teachers and preservice teachers as the sample group may be the reason for the difference between the studies.

In the studies examined, it was determined that the scale/survey was mostly used as a data collection tool (Table 5). The fact that scales/surveys are mostly used in quantitative studies and that survey studies are included more in the studies examined may be the reason for the high frequency of this data collection tool. Surveys were mostly used to determine the relationship between TPACK and other variables. The reason why surveys are included more frequently may be due to the fact that surveys provide easier data collection for TPACK and the opportunity to reach more data in a short time. The teacher can fill out the questionnaire whenever and wherever he/she wants. Moreover, he/she can fill it in section by section whenever he/she gets the opportunity. This may be the reason for preferring surveys as a data collection tool. Observation and audio/video recording are

other tools used to collect data in the studies reviewed. These data collection tools may have been used to obtain detailed, comprehensive and time-consuming information on TPACK. In this context, video recording may have been used in order to examine the data obtained from the observation in more detail and to examine the behaviors occurring in the observed environment repeatedly and in depth (Bağ and Çalık, 2017). Including a limited number of interviews as data collection tools is the reason why it takes more time than other data collection methods and contains possible bias.

The higher number of quantitative data analyzes in the studies examined (Table 6) may be due to the fact that the objectives of the studies were determined in accordance with quantitative data collection and analysis. The high use of t-test in the analysis of quantitative studies may be due to the large number of experimental studies with pre-test and post-test comparison. Again, the frequent use of correlation analysis in quantitative studies may be due to the idea of determining the relationships between TPACK and different variables and thus obtaining clues about cause and effect. The high number of studies determining the factors affecting TPACK may be effective in the frequent use of regression analysis in quantitative studies. It has been determined that content analysis is used more than descriptive analysis in qualitative studies. This may be due to the thought that this analysis would be more suitable for the purpose of the research in the evaluation of observation, audio/video recording, meeting and interview.

The fact that the studies examined are independent of the field regarding TPACK (Table 7), may be due to the determination of the research objectives without being tied to any discipline. In primary school education; the limited number of studies in the fields of mathematics, science and information technology reveals that TPACK studies are lacking in these fields. Similarly, in the literature review of Chai et al. (2013), it was stated that field-independent technologies were frequently examined in studies. It was stated that in the studies that Wu (2013) examined in the TPACK literature review between 2002 and 2011, it was stated that the field-independent TPACK was mainly examined, and it was stated that science and mathematics disciplines came to the fore in field-specific studies.

In most of the studies examined, the fact that no intervention was made in the development of TPACK in primary school teachers and preservice teachers (Table 8) may be due to the large number of survey studies. Moreover, the fact that the researchers included studies focusing on TPACK status determination in primary school education may be the reason for this situation. Also, the limited number of career development programs and course design existence may be due to the fact that pedagogical practices are ignored by researchers in TPACK development. Kaleli Yılmaz (2015) compiled the TPACK researches conducted in Turkey and states that the researches were mainly based on teaching practices. It is stated that among these applications, course designs for TPACK come to the fore, and these studies are long-term studies that show useful data

examining the change in the process. This situation can be expressed as a deficiency in TPACK studies in primary school education. In other words, the limited number of studies on which practices are useful for the development of TPACK for teachers or preservice teachers in primary school education or which methods are valid reveals that there is an important deficiency in this area.

In the conclusion part of the studies examined, it was determined that TPACK is a useful framework for integrating technology into the curriculum, and after the implementation, teachers gave more space to teaching strategies for using TPACK in lessons (Table 9). It is thought that this situation arises from the fact that the applied education method is effective in the development of TPACK of teachers or preservice teachers, making TPACK-based lesson plans and researching teachers' teaching strategies while developing TPACK. On the other hand, although there are many survey studies in the studies examined, it has been observed that the results are different from each other. It is thought that this situation occurs due to the fact that survey studies were conducted for different variables (occupational professionalism, attitude, epistemological beliefs, metacognition, self-efficiency, arranging time to use technology, gender, experience, technological knowledge, belief).

In the studies examined, suggestions were made for career development trainings for teachers and preservice teacher trainings for TPACK development, practical applications for TPACK development, intervention studies that reveal strong examples of currently applied educational technologies, making more qualitative research (Table 10). The limitations of in-service professional development for TPACK development, practical applications for TPACK development, intervention studies and qualitative research may be the reason for researchers to make these suggestions. Also, it has been suggested that, for practitioners or experts the educators should be equipped with the technological skills necessary to respond to the increasing demands of the technology-oriented workforce, teacher educators should continuously improve teachers' technological knowledge and advance collaborative TPACK. Besides that, it is recommended to integrate the TPACK model into school and education faculties programs so that preservice teachers, teachers and students can effectively benefit from the opportunities offered by technology. These suggestions may have been expressed with the thought that it would be advantageous to increase the TPACK of teachers and preservice teachers today, where the increasing use of technology in every field is rapidly integrated into the education process.

As a result, although the relevant ministry in many countries is making efforts to integrate technology into the lesson, there is actually a need for teachers who are competent in the effective use of technology. In addition to being able to use technology, the teacher should be able to use pedagogy and field knowledge together (Koehler & Mishra, 2008). In this context, increasing the TPACK levels of primary school teachers and preservice teachers comes to the fore. In addition, ways should be sought for teachers

and preservice teachers to interact between technology and teaching, to incorporate technology into learning activities and to benefit from the opportunities offered by technology in lessons. In terms of TPACK, teacher professional development programs come to the fore in order for teachers to integrate technology into their fields effectively. Therefore, it is thought that it would be beneficial to bring studies that put innovative and school-based professional experiences together to improve teachers' TPACK levels.

5. Recommendations

In line with the results obtained in the research, the following suggestions were made:

- There are very limited studies on teachers and preservice teachers' incorporating technology into learning activities by interacting between technology and teaching, their use of technology in lessons, and in this context, the development of TPACK for teachers and preservice teachers. By combining innovative and school-based professional experiences, studies can be conducted that offer teachers the opportunity to learn how to integrate technology into the classroom.
- The number of qualitative and mixed-method studies examining the TPACK development of teachers and preservice teachers during the education and training process is limited. For this reason, qualitative and mixed-method studies can be carried out in order to examine the TPACK development of process-oriented teachers and preservice teachers.
- Considering that preservice teachers with TPACK at bachelor degree will be more successful in integrating technology into the lessons when they start working, intervention studies to increase the skills of preservice primary school teachers are recommended.
- TPACK includes the presentation of concepts with the help of technology, the use of pedagogical techniques in a constructive way in teaching the content, and the knowledge of how to benefit from technology in overcoming the problem situations faced by students. PCK, which is one of the components of TPACK, includes information about how a certain subject should be taught, in short, it includes information on how to combine pedagogy and the field effectively. The frequency of field-independent studies on TPACK in primary school education draws attention. Considering that primary school education is a field that includes different disciplines, the lack of field-specific studies is striking. In order to eliminate this deficiency, it is recommended to carry out studies specific to a discipline such as mathematics or science in primary school education.
- Considering the developments in technology and the activities of the Ministry of National Education for the integration of technology in the field of education as hardware and infrastructure; it is recommended that the TPACK

model to be integrated into school and education faculty programs so that teachers and prospective teachers can benefit from these opportunities effectively.

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Appendix A.

A.1. List of examined studies

S1. Honey, S. (2018). Graphics calculators in the primary classroom: Student-Teachers' beliefs and the TPACK framework. *The International Journal for Technology in Mathematics Education*, *25*(3), 3-16.

S2. Loong, E. Y. K., & Herbert, S. (2018). Primary school teachers' use of digital technology in mathematics: The complexities. *Mathematics Education Research Journal*, *30*(4), 475-498.

S3. Goodwin, A. H. (2012). *Building pre-service teachers' knowledge of content, pedagogy, and technology through TPACK-infused course experiences: A study replication and extension*. University of Kentucky.

S4. Kaya, Z., Kaya, O. N., & Emre, I. (2013). Adaptation of technological pedagogical content knowledge scale to turkish. *Educational Sciences: Theory and Practice*, *13*(4), 2367-2377.

S5. Resendez, A. L. (2019). *Teachers' perceptions and practices on using educational technology as an instructional tool in the classroom*. ProQuest LLC. 789 East Eisenhower Parkway, PO Box 1346, Ann Arbor, MI 48106.

S6. Koh, J. H. L., & Chai, C. S. (2016). Seven design frames that teachers use when considering technological pedagogical content knowledge (TPACK). *Computers & Education*, *102*, 244-257.

S7. Azgın, A. O. & Şenler, B. (2018). İlkokullarda görev yapan sınıf öğretmenlerinin teknolojik pedagojik alan bilgilerinin incelenmesi. *Journal of Computer and Education Research, 6* (11), 47-64. https://doi.org/10.18009/jcer.346858

S8. Yasa, A. D., & Handayanto, S. K. (2021, March). TPACK-based science learning assessment in elementary school teachers with analytical hierarchy process and simple additive weighting methods. In *AIP Conference Proceedings* (Vol. 2330, No. 1, p. 060009). AIP Publishing LLC.

S9. Burke, E. A. (2021). *Technological pedagogical content knowledge and classroom technology use: A mixed methods study*. Doctoral dissertation, Concordia University Chicago.

S10. Balliet, S. J. (2020). *Elementary-School teachers' perceptions of their preparedness in implementing blended learning*. Doctoral dissertation, Grand Canyon University.

S11. Braxton III, P. H. (2016). *Elementary teachers' use of technology for student instruction: Barriers and strategies*. Doctoral dissertation, Barry University.

S12. Rowland, J. D. (2008). *Laptops as practice: A case study examining communities of practice in a ubiquitous computing environment*. Doctoral dissertation, Texas University.

S13. Hsu, C. Y., Liang, J. C., & Tsai, M. J. (2020). Probing the structural relationships between teachers' beliefs about game-based teaching and their perceptions of technological pedagogical and content knowledge of games. *Technology, Pedagogy and Education*, *29*(3), 297-309.

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S15. Hsu, C. Y., Liang, J. C., Chuang, T. Y., Chai, C. S., & Tsai, C. C. (2020). Probing in-service elementary school teachers' perceptions of TPACK for games, attitudes towards games, and actual teaching usage: a study of their structural models and teaching experiences. *Educational Studies*, 1-17.

S16. Hsu, C. Y., Tsai, M. J., Chang, Y. H., & Liang, J. C. (2017). Surveying in-service teachers' beliefs about game-based learning and perceptions of technological pedagogical and content knowledge of games. *Journal of Educational Technology & Society*, *20*(1), 134-143.

S17. Long, T., Zhao, G., Li, X., Zhao, R., Xie, K., & Duan, Y. (2020). Exploring Chinese in-service primary teachers' Technological Pedagogical Content Knowledge (TPACK) for the use of thinking tools. *Asia Pacific Journal of Education*, 1-21.

S18. Roussinos, D., & Jimoyiannis, A. (2019). Examining primary education teachers' perceptions of TPACK and the related educational context factors. *Journal of Research on Technology in Education*, *51*(4), 377-397.

S19. Yılmaz, M. U. (2020). Sınıf öğretmenlerinin teknolojik pedagojik alan bilgisi ile mesleki profesyonelliği arasındaki ilişkinin incelenmesi. *Master Thesis, Çukurova University, Social Sciences Institute, Adana*.

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S21. Can, S., Dogru, S., & Bayir, G. (2017). Determination of pre-service classroom teachers' technological pedagogical content knowledge. *Journal of Education and Training Studies*, *5*(2), 160-166.

S22. Hu, H. W., Walker, K. M., & Hsaio, W. Y. (2014). Developing elementary pre-service teachers' technological, pedagogical, and content knowledge for learning and teaching division of fractions. *International Journal of Technology, Knowledge & Society: Annual Review*, *9*(2).

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