THE ROLE OF A VIRTUAL INTERNSHIP IN DEVELOPING PRESERVICE TEACHERS' TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE

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2019

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Thesis submitted to the

Institute for Graduate Studies in Social Sciences

in partial fulfillment of the requirements for the degree of

Master of Arts

in

Educational Technology

by

Gülsüm Bayer

Boğaziçi University

2019

DECLARATION OF ORIGINALITY

I, Gülsüm Bayer, certify that

- I am the sole author of this thesis and that I have fully acknowledged and documented in my thesis all sources of ideas and words, including digital resources, which have been produced or published by another person or institution;
- this thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution;
- this is a true copy of the thesis approved by my advisor and thesis committee at Boğaziçi University, including final revisions required by them.

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ABSTRACT

The Role of a Virtual Internship in Developing Preservice Teachers' Technological Pedagogical Content Knowledge

Considering that teaching is a complex and multifaceted practice taking place in ill-structured and dynamic environments, it is very important for individuals who profess in teaching to learn how to apply the interweaving and sophisticated interactivity between the three sources of teacher knowledge, which are content, pedagogy and technology. Based on Mishra and Koehler's (2006) TPACK framework, this study examined preservice teachers' TPACK development in the context of a virtual internship named 'School of the Future'. The School of the Future (STF) is an 8-week virtual internship/ epistemic game designed to develop the TPACK of preservice teachers. A quantitative pre and posttest quasi-experimental research design aided by qualitative data was employed. Seventy-four preservice teachers participated in this study. TPACK development was measured using a survey adapted from the Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009) and the reflections written by the participants. It was anticipated that the virtual internship STF would support TPACK development of preservice teachers by making a difference from the case of its non-use. The results indicated no significant difference in the TPACK development of the participants who participated in the STF and those who did not. However, the participants who participated in the STF significantly increased their knowledge in all TPACK domains, except the CK domain. The qualitative analysis of the written reflections also supported the findings from the survey analysis by pointing development in the TPACK of the preservice teachers.

ÖZET

Sanal Stajyerlik Uygulamasının Öğretmen Adaylarının

Teknolojik, Pedagojik Alan Bilgisinin Gelişmesindeki Rolü

Öğretimin iyi yapılandırılmamış ve dinamik ortamlarda gerçekleştirilen, karmaşık ve çok yönlü yapısı göz önüne alındığında, öğretmen adaylarının öğretmenlik mesleğinin esasını oluşturan üç bilgi kaynağı olan alan bilgisi, pedagojik bilgi ve teknolojik bilgi arasındaki sıkı ve ince ilişki ve etkileşimi nasıl uygulamaya koyacaklarını bilmeleri çok önemlidir. Bu çalışma Mishra ve Koehler (2006) tarafından oluşturulan teknolojik pedagojik alan bilgisi (TPACK) yapısını temel alarak, aday öğretmenlerin TPACK gelişimini 'School of the Future' adındaki sanal stajyerlik uygulaması bağlamında araştırmıştır. School of the Future, öğretmen adaylarının TPACK bilgilerini geliştirmek için tasarlanan, sekiz haftalık bir sanal stajyerlik uygulamasıdır. Bu çalışma 74 aday öğretmenin katılımıyla, nitel bulgularla desteklenen ön-test son-test yarı deneysel araştırma yöntemini kullanmıştır. Katılımcıların TPACK gelişimleri, the Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009) ölçeğinden adapte edilen bir anket ve katılımcıların yansıtma sorularına yazdığı yanıtlar ile ölçülmüştür. Çalışmanın ilk hipotezi nicel bulgularca desteklenmemiş ve sanal stajyerlik çalışmasına katılan ve katılmayan öğretmen adayları arasında TPACK gelişimi açısından anlamlı bir fark görülmemiştir. Ancak, sanal stajyerlik çalışmasına katılan öğretmen adaylarının TPACK seviyelerinin, alan bilgisi dışında, önemli ölçüde arttığı görülmüştür. Nitel bulgular da öğretmen adaylarının TPACK gelişimini işaret eden sonuçlar göstermiş olup, nicel bulguları desteklemiştir.

ACKNOWLEDGMENTS

I would first like to thank my thesis advisor, Assoc. Prof. Diler Öner, for making this thesis possible. I am very grateful for her continuous support, which kept me going at each step of this process, and for her patience with my never-ending questions and hesitations throughout these two years of thesis preparation.

I also want to thank the other members of my thesis committee, Assist. Prof. Senem Yıldız and Assist. Prof. Gürsu Aşık, for their valuable contributions to my thesis by providing several comments, feedback and suggestions. And of course, I want to thank Assist. Prof. Mutlu Şen Akbulut for opening the doors of her classes for my study and providing all the support inside the classroom.

Finally, I owe a huge thank you to my family: My mother, Hava, my father, Bekir, and my sister, Zeynep. They always took my side, encouraged and motivated me at the most desperate times. I will always be grateful to them for believing in and standing by me.

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CHAPTER 1

INTRODUCTION

TPACK, Technological Pedagogical Content Knowledge- called "TPCK" in the literature until 2008, is a conceptual framework describing teachers' technology integration building on Shulman's (1986, 1987) conception of pedagogical content knowledge (PCK). The underlying consideration of PCK framework is the understanding that teaching is a fairly complex and multifaceted practice taking place in an ill-structured, dynamic environment and profits by various kinds of knowledge (Spiro, Feltovich, Jacobson, & Coulson, 1991). Benefiting from highly organized knowledge systems is vital also for teaching as in most of the arenas humans are attending to (Shulman, 1986, 1987). In theory, several knowledge systems have been treated as essential to teaching; however this has not always been the case in educational settings.

The first efforts put on teacher education concentrated upon content knowledge (CK) of teachers. Later on, pedagogical knowledge (PK) has become the primary focus in teacher education and pedagogical activities in classrooms have been emphasized. This two-way line of vision, considering content knowledge and pedagogical knowledge as exclusive knowledge domains, and giving focus on CK leading to the expense of the PK or giving focus on PK leading to the expense of the CK, brought on teacher education programs that dominate either pedagogy or subject matter knowledge (Shulman, 1987). Departing from the idea that the relationship between content and pedagogy was as important as they are separately, Shulman (1986) presented the concept of pedagogical content knowledge (PCK).

PCK is situated in where PK and CK overlap and it represents more than consideration of pedagogy and content apart from each other. According to Shulman (1986), even though having content and pedagogical knowledge was necessary, it was not sufficient to be a good teacher. He claimed that if teachers want to be successful, they need to be occupied with both content and pedagogy at one and the same time by making the aspects of subject matter more teachable. Thus, to manage between the two, they need to develop PCK because it is the representation of the composition of CK and PK and is about the ways of organizing, adapting, and representing specific aspects of content for instruction, the methods of representation and formulation of the subject to make it comprehensible to others. The significant point of PCK is how a particular content is being transformed to make it more suitable for teaching. A teacher manages this by interpreting the subject matter and finding various methods for representing it and making it accessible to target audience with diverse interests and abilities (Mishra, Koehler, 2006).

Thus, PCK is the useful combination of the content and pedagogy knowledge that are separated traditionally. It is an epistemological concept significant for both teacher preparation and teacher professional development knowledge. PCK as the interplay between pedagogy and content contains within it, in Shulman's (1986) words, ‘‘the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that make it comprehensible to others'' (p. 9).

According to Mishra and Koehler (2006), many things have evolved since Shulman built the PCK framework and the most related change is the prominence of new technologies in educational practice. Furthermore, these new and mostly digital technologies come along with their special necessities to be applied to teaching practice. They combine hardware and software as in computers, educational games, the Internet and a great deal of applications used by means of it. They are also candidates for playing an essential role in changing the nature of classrooms by offering a variety of representations, analogies, examples, explanations, and demonstrations assisting to make content more understandable to learners as mentioned by Shulman in 1986.

Even 20 years later from Shulman's identification of content and pedagogy were being treated separately, many researchers identified that technology have also been treated separately from pedagogy and content (Mishra & Koehler, 2006; Niess, 2005). Technology being considered as an isolated group of knowledge and skills to be learned, and the interplay among these skills being considered as difficult to acquire and implement led teacher training programs to focus on teach particular hardware and software skills in an attempt to develop knowledge bases for teachers' technology integration into their classes. Mishra and Koehler (2006) claimed that the relationships between and among content, pedagogy, and technology were complicated. It would not be appropriate to see them as isolated because even the imperatives concomitant to technologies would affect the instructional and pedagogical decisions made by a teacher.

With the recent rapid development in technology, it was anticipated that there would be radical changes in teaching and learning process. However its influence on educational settings has been quite lower than expected. According to Mishra and Koehler (2006), the primary reasons for that outcome were the lack of the consideration about how technology should be implemented in education and the redundant focus on the technology itself. The fundamental knowledge needed to be known is how teachers can integrate technology into teaching process appropriately. What forms a part of this inadvertence is the absence of efficient and good quality theoretical background and understanding to base technology integration on. Clearly, there is a need for united theoretical and conceptual models which would make it possible to bring out and specify concepts and constructs applying to various situations in educational practice.

The TPACK framework was offered as a result of a 5-years design experiment aimed to determine how teachers develop their perception of intensive use of technology as assisting them to develop their teaching with integration of technology. The study included K–12 teachers along with university faculty and aimed informing theory and practice and was intended to be beneficial for theoreticians and researchers, for practitioners and educators. Identifying a framework in educational technology is more than articulating problems with new approaches; it also brings novice perspectives for the events in the field and presents information on which to base sound, pragmatic decision making.

As a framework which has a theoretical base about the technology-teaching relationship, one of the major arguments of the TPACK framework is reconfiguring the formulation and application of teacher education, preparation of prospective teachers and their progression in teaching . Many teacher preparation programs pay too much attention to the context-neutral approaches that are inclined to fail because of overemphasizing TK without paying as much attention to develop PK, TCK, or TPCK. Therefore, a theoretically sound framework as TPACK would be assigned as a cornerstone source of information while increasing the level of technology integration in academic programs of the faculties of education. It can also have a substantial influence on the types of questions that is to be explored and researched in the field.

A good deal of methods has been developed for the purpose of enhancing TPACK of preservice and inservice teachers and addressing fundamental problems in the field. These methods vary as online courses (Albion, 2012; Niess, van Zee, & Gillow-Wiles, 2010), courses including a design for a lesson plan (Chai, Koh & Tsai, 2010; Guzey, Roehrig, 2009; Harris, Hofer, 2011; Koh, Chai, 2014; Polly, 2011), intervention programs encouraging teachers for technology integration opportunities in their classes (Jaipal-Kamani, Figg, 2015; Koh, Divaharan, 2011), and methods combining more than one method (Mouza, Karchmer-Klein, Nandakumar, Ozden, & Hu, 2014; Jang, 2010). Even though most of the methods have been successful in developing TPACK, the findings of the studies is mostly open to new questions requiring further research. This study aims to support TPACK development with the implementation of a virtual internship into an instructional technologies and material development course offered as part of teacher education programs. The virtual internship used in this study aims to develop preservice teachers’ TPACK through online meetings and collaborative design work on technology integration. TPACK by using a virtual internship has not been tested in the literature before. With the rareness of studies for developing TPACK of especially preservice teachers, this study will also meet a deficit in the literature.

The purpose of the study is to examine preservice teachers’ TPACK development in the context of a virtual internship.

The research questions are:

1) Do the preservice teachers who participate in a virtual internship experience (STF group) differ from those who do not participate (Control group) in their CK, PK, TK, PCK, TCK, TPK and TPACK scores over time (pre and post)?
2) Is there a meaningful difference between the pre and the post TK, CK, PK, PCK, TCK, TPK and TPACK scores of the preservice teachers who participate in a virtual internship experience?
3) How do preservice teachers' opinions on integrating technology into educational settings change as they participated in a virtual internship program?

The hypotheses of the study are stated as:

1) The preservice teachers who participate in a virtual internship experience (STF group) will differ from those who do not participate (Control group) in their CK, PK, TK, PCK, TCK, TPK and TPACK scores over time (pre and post).
2) There will be a meaningful difference in the CK, PK, TK, PCK, TCK, TPK and TPACK scores of the preservice teachers who participate in a virtual internship experience.

CHAPTER 2

LITERATURE REVIEW

This section starts with a detailed information part about the TPACK framework and its components and continues with the studies that have been conducted to develop TPACK. The methods that have been used in the studies; online courses, design-based courses, intervention programs based on models and integrated methods will be discussed. Next, the methods for its assessment such as self-report measures, performance assessments, interviews, observations, and multifaceted data collection are explained. The concepts epistemic frame theory, its elements, and virtual internship are also the major titles of this review. Finally, the literature review will discuss the virtual internship studies that have been conducted so far and their outcomes.

2.1 TPACK and its components

The TPACK framework, offered by Mishra and Koehler (2006), puts the knowledge of content (C), pedagogy (P) and technology (T) to the center of teaching. The focus of the framework is on the connections, interactions, affordances, and constraints between and among them rather than considering them as separate bodies of knowledge. In the framework, relationships between CK, PK, and TK are articulated in detail as in pairs: pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and the interplay between all of them: technological pedagogical content knowledge (TPACK). The components of the framework are presented in the following sections.

2.1.1 Content knowledge

Content knowledge (CK) can be explained as quantity and organization of the actual subject matter that is to be learned or taught. It is the knowledge assumed to be known and understood by teachers such as key facts, conceptions, theoretical information, and methodologies in a particular field; knowledge of explanatory frameworks organizing and connecting ideas; and knowledge of the rules of evidence and proving (Shulman, 1986; Mishra & Koehler 2006). However, only being capable of knowing and understanding truths in a domain does not seem sufficient for teachers. They must also explain the reasons for something is in the way it is, the reason for it to be a need-to-know, and how it is related to other truths, either within the discipline or without, both in theory and in practice (Shulman, 1986). Furthermore, teachers are expected to recognize why a topic has a more primary position for a discipline while others stand considerably external and the differences of inquiries in various fields. For instance, how the nature of a proof in science is different from the explanation of a phenomenon in social sciences.

2.1.2 Pedagogical knowledge

Pedagogical knowledge (PK) represents the knowledge of procedures and methodologies that one uses during the teaching and learning processes. PK is related to all matters of how students learn, managing a classroom, developing and implementing of lesson plans, and assessing students. As a multifaceted kind of knowledge, PK is associated with strategies and techniques to be applied by the teacher in classrooms, the disposition of the learner, and methods for evaluating the understanding of learners. A teacher with deep PK knows how students manage with constructing knowledge, acquiring skills, and developing habits of mind and positive attitudes toward learning. Thus, PK demands an understanding of theories about how learning happens cognitively, socially, and developmentally and a perception about the ways of their application in a classroom must be (Mishra & Koehler, 2006).

2.1.3 Pedagogical content knowledge

Pedagogical content knowledge (PCK) was described by Shulman (1986) as the knowledge that is in the most germane in a particular subject matter for teaching. He included “the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that make it comprehensible to others” (p. 9). The combination of knowledge of activities or strategies specific to content and knowledge of representations used for facilitating student learning is involved in PCK (Cox & Graham, 2009). It differs from what subject matter experts know and generic pedagogical knowledge that teachers from different disciplines have in common because it is concerned with understanding of what kind of treatments in teaching is appropriate for which content, and similarly, knowing how elements of that content should be organized so that teaching with better quality is succeeded. It is the knowledge about the representation and formulation of concepts properly, pedagogical methods, and knowledge of why some concepts are easy to learn while others are difficult, how to determine student background knowledge, and epistemological theories. Addressing learning difficulties and misconceptions students have and fostering meaningful understanding with facilitative knowledge that students also bring to the learning environment by incorporating appropriate conceptual representations and teaching methods is also involved in PCK.

2.1.4 Technology knowledge

Technology knowledge (TK) can be explained as knowing how to utilize standard technologies like books, black and chalkboards, as well as technologies more advance like the Internet and interactive white boards. Some of the skills needed to employ digital technologies are named by Mishra and Koehler (2006) as using operating systems along with the knowledge of computer hardware, using simple computer programs like word processors, spreadsheets, browsers, and e-mail. The acquisition of skills like knowing how to install or remove peripheral devices such as printers, scanners, speakers, and install/remove software programs are also included within the scope of TK. An important aspect of this knowledge is that technology is changing and developing permanently; therefore, teachers need to learn how to adapt themselves to these changes and innovations along with the entirely new technologies.

2.1.5 Technological content knowledge

Technological content knowledge (TCK) is the knowledge of how to compose representations in a subject area by making use of technologies. The newer technologies can provide more various kinds of representations, and also greater adaptability between these possible representations. Teachers need to be skilled not only in teaching a subject but also in having the knowledge of how the implementation of technology into the content might change its nature. For example, the knowledge of software, called GraphCalc used for facilitating modeling of 3D numeric data, would be considered TCK (Cox& Graham, 2009).

2.1.6 Technological pedagogical knowledge

Technological pedagogical knowledge (TPK) is about the knowledge of various technologies teachers benefit from during learning and teaching processes. TPK includes knowing the presence, elements, and potentials of these technologies and also knowing how their use might have potential influences on teaching. A teacher with deep TPK knows that there are several useful tools for a specific task, chooses a tool in regards to its suitability and knows the methods for utilizing its affordances, and applies these methods to use the tool. Any activities and necessities situated in the classroom such as keeping class records and attendance, scoring, using discussion boards or web quests can be listed as the knowledge in the scope of TPK (Mishra& Koehler, 2006).

2.1.7 Technological pedagogical content knowledge

Technological pedagogical content knowledge (TPACK) is a kind of knowledge located in where content, pedagogy and technology components intersect (Mishra& Koehler, 2006). TPACK is the heart of teaching by the use of technology as a facilitator and deep comprehension of TPACK requires:

- understanding how certain concepts can be represented with technological advances;

- using pedagogically appropriate methods that use technological aids in a facilitative way for teaching;
- taking advantage of technology while compensating problems that students face and makes content difficult or easy to learn;
- realizing what knowledge learners bring to the classroom and theories of epistemology;
- using technologies while building on present knowledge and developing new knowledge systems or strengthening existing ones (Mishra& Koehler, 2006).

Developing quality teaching methods requires fully understanding the interweaving and complex interplay between the three sources of teacher knowledge. This understanding is needed to be used by the teacher for developing context specific, fitting strategies and meaningful representations. In order to be successful in integrating technology into teaching effectively, all three components and their complex relationship should be taken into consideration, not each of them in isolation. Thus, any changing that happens in one of the components has to be compensated by also making changes in the other two. For instance, even making a choice on which particular technological tool will be the best fit for your instructional purpose will probably bring about certain limitations on the development of representations and on the course content to be covered and delivered, which in turn will affect the pedagogical process as well. Indeed, including new technologies is usually more effortful than including another module to course content because it often forces teachers to also work on overwhelming questions about the other two factors concerning their relationships and how it will affect their pedagogical approaches (Mishra & Koehler, 2009).

Therefore, expert teachers engage in TPACK anytime they teach. It requires not only restating their technological knowledge but also knowledge of all three factors and their relationships.

2.2 Developing TPACK

Although there have always been promising studies and planning for efficient integration of technology into teaching, things remain largely the same in practice (Hofer & Swan, 2008). A project on digital documentaries conducted with sixth graders, with the purpose of exploring the three components of teacher knowledge and their associational connections revealed that even if teachers are knowledgeable and confident about CK, PK, TK, PCK, TCK and TPK, they are likely to have trouble and experience a substantial difficulty in the TPACK where all the domains intersect (Hofer & Swan, 2008). With the understanding of complexity of technology integration, the challenges that teachers encounter while teaching by means of technology and the spreading of the TPACK framework, a considerable number of approaches have been offered in order to enhance TPACK of pre and inservice teachers.

Koehler and Mishra (2005) acknowledged that designing technology is one of the best ways of learning about educational technology. With this acknowledgement, they tried to overcome two undergoing fundamental problems of skill-based approach which are the obsolescence of specific technologies and their de-contextualization, lacking connection with practice in classroom (Koehler et al., 2009). They addressed these problems by design-based learning of technology involving collaborative work to solve authentic problems rather than lectures or demonstrations. By the Learning Technology by Design (LT/D) approach, the purpose is to make students understand when and how to use a technological device when it is necessary for their task. They produce various design products such as digital movies on a subject, redesign of an educational web site, and online courses for a teacher preparation program (Mishra et al., 2006). With the recent great deal of attention on play in educational practice, the LT/D model became integrated with another approach called deep-play (Koehler et al., 2011). Deep-play, as an approach for instruction, supports learners for ‘playing’ with technology by repurposing tools and technologies to achieve their own pedagogical purposes and desires by acting like active designers of technology. The researchers applied this approach in various course contexts with practicing teachers. The examples ranged from micro to macro level. Some micro level design activities can be summarized as composing a motion animation and writing a short story to be completed in a given amount of time. In macro level design activities, students are asked to develop pedagogical design projects and explain their design choices while reflecting on the learning outcomes from dealing with the projects.

In 2009, Harris, Mishra and Koehler introduced TPACK-based learning activity types which they thought may facilitate teachers’ successful integration of technology into their lessons. The first step is having the knowledge of reasonable learning activity types constructed by Harris and Hofer (2006) and Harris (2008) on a specific subject, and then combining them with various types of digital and non-digital technologies appropriately. The underlying idea of this approach is an empirical assumption that the most efficient instruction including technological support is best developed as teachers take students' learning needs for the content into consideration and make appropriate technology choices. They embrace the idea that various combinations of pedagogical strategies and different technologies are possible for different discipline based content, appropriate for different student learning needs and contextual realities.

Beside the approaches as LT/D, deep-play and learning activity types, the most focused and emphasized method in the educational technology literature is to develop TPACK through courses requiring design of a lesson plan, and programs encouraging teachers to bring different technologies and methods together in their lessons. They are categorized as online courses (Albion, 2012; Niess, van Zee, & Gillow-Wiles, 2010), design-based courses (Koh, Chai, 2014; Chai, Koh & Tsai, 2010; Harris, Hofer, 2011; Polly, 2011; Guzey, Roehrig, 2009), intervention programs based on models (Koh, Divaharan, 2011; Jaipal-Kamani, Figg, 2015) and integrated approaches (Mouza, Karchmer-Klein, Nandakumar, Ozden, & Hu, 2014; Jang, 2010).

2.2.1 Online courses

Albion (2012) explained how a technology education course, in a current Bachelor of Education program of primary school student-teachers, was redesigned in light of the TPACK framework. It was a fully online course ensuring activities and assessments designed for students' participation by using a learning management system and virtual classroom. A quiz over assigned readings was applied online in order to develop a better understanding about technology and to differ it from ICT. It included a Web Quest as a learning activity around a contemporary issue. As a part of the Web Quest activity and the final product, development and presentation of a recommendation for government policy was specified. Further, a design brief and development of an activity using learning activity types were included to facilitate sharing among students by resulting in a taxonomy that would be an effective resource for the students while assisting the development of TPACK.

Another online graduate course, conducted in the study of Niess, van Zee and Gillow-Wiles (2010) as part of an online master's degree program, was devoted to develop teachers' TPACK as an extension of their PCK by integration of dynamic spreadsheets as learning tools into mathematics and science teaching. The course aimed to challenge teachers' current PCK understanding when they dealt with integrating dynamic spreadsheets to the content and pedagogy. Within the four units of the course, the first unit made teachers focus on how spreadsheets might be incorporated into mathematics and science content as they explored their capabilities and constraints. They also engaged in online group meetings to discuss about the questions as: What is the kind of the relationship between variables and dynamic spreadsheets? The participants articulated the spreadsheet skills in diverse compositions while exploring them and considered the criteria for assessing the students in the second and the third units. The fourth unit focused on curriculum plans and how to scaffold student learning using spreadsheets and also a final portfolio including: at least ten problems on spreadsheets with related worksheets and rubrics to score, plans of how their curriculum and instruction will comprise these problems, and an inclusive reflection on considerations about integrating spreadsheets in their instruction and student learning with spreadsheets (Niess, van Zee, & Gillow-Wiles, 2010).

2.2.2 Design-based courses

Koh and Chai (2014) worked on a compulsory ICT development course at a teacher training institute, over 12 two hour-long lessons in duration, emphasizing learning through designing hands on lesson plans. The course consisted of interactive lectures lasted four weeks and reciprocal teaching sessions, 2-weeks of modeling for ICT lessons which supports authentic, meaningful, self-directed and collaborative learning, following two group-based design projects. The purpose of the projects was to design resources for an ICT lesson about a topic, lasting 30 minutes. Throughout their projects, preservice teachers not only had the chance for consulting their tutors on their technological tool preferences but also benefited from e-lessons about the pedagogical uses of ICT tools which required self-study. After completing each project, groups presented their projects for sharing and discussing about the use of pedagogical ideas. Before completing the semester, each preservice teacher designed a technology-enriched lesson plan for an ICT lesson to teach a topic.

Chai, Koh and Tsai (2010) designed a preservice teacher education ICT course “ICT for Meaningful Learning” to support integration of technology. It comprised of twelve 2-hour long sessions and three teacher knowledge base: PK, TK, and TPACK. In order to build on their PK, the first five sessions focused on understanding of pedagogical approaches within “meaningful learning with ICT” (Jonassen et al., 2008) theoretically and on experiential learning of a variety of student-centered pedagogical approaches with ICT. Further, case-based instruction and e-learning were the methods for them to gain insight about classroom management of ICT lessons. The other six sessions organized as “technology enhanced lessons” (TELs) aimed at developing their TK by the understanding about a technological tool, its convenience and constraints along with its potential pedagogical uses. TELs mostly included knowledge about skill-based practices, and scaffolding for producing design activities with creative lesson ideas suited to their prospective students. The final session was dedicated to the presentation of their Final Project which was a technology integrated lesson unit for a specific grade level. The lesson unit was comprised of a lesson plan accompanied by teaching materials, and a written justification to explain the reasons for why they selected those particular technologies and how they helped supporting the instruction together with selected pedagogical approaches.

Based on the idea that technology integration is enacted best in content related processes by deliberatively using educational technologies, Harris and Hofer (2011) investigated the development of TPACK as teachers participated in a 5-month TPACK-based professional development experience organized based upon a taxonomy of learning activities (Harris& Hofer, 2009; Harris, Mishra & Koehler, 2009) developed by the researchers for a particular content. These content-based activities had the teachers to choose suggested digital and non-digital educational technologies according to the types of learning activities and their fitness to the learning needs of the students. The taxonomy attempted to combine proper technology into lesson plans in an authentic, learner centered way by recommending coherent technologies for learning activity types for teachers to choose matching their technology-enriched instructional planning. The results suggested that if the plans are evaluated after implementation, TPACK of teachers is supported better.

Polly (2011) examined teacher-participants' TPACK development as they participated in Technology Integration in Mathematics (TIM), a year-long professional development project. The project provided teachers with 48-hour of workshops focused on using technology standards-based to teach mathematics. The 48 hours were divided into 24 hours during 4 days in the summer with four 6-hour follow up sessions. In each session, teachers were given rich mathematical tasks to work on with their colleagues, provided with examples of the process. After the completion of the task using various educational technologies, they had a discussion of their approaches. Throughout the school year, they also had the chance to get feedback and suggestions from the project personnel for their proposed lessons.

A year-long professional development program about using technological tools properly in classrooms was conducted with the participation of four inservice secondary science teachers, and beneficial outcomes were obtained. In a summer course, many technologies that could be used in instruction were introduced: tools for making concept maps, motion pictures, simulations, and movies. In the process of learning about these technologies, teachers modified activities to be inquiry-based and reflected on their classroom practices via their blogs. After learning about technological tools, they engaged in creating technology-rich lesson plans, creating a plan for integrating technology to be followed in the following school year, discussions with the university educators about the constraints they encounter while using technology in instruction. They also designed and conducted action research studies in order to go into the efficiency of using technological tools on student learning and to make reflection on their learning and practice about technology (Guzey & Roehrig, 2009).

2.2.3 Intervention programs based on models

There are also studies which developed a method for developing TPACK with its application model. Koh and Divaharan (2011) developed a TPACK-Developing Instructional Model and examined its effectiveness on preservice teachers' TPACK development through an ICT instructional intervention. The model defines three instructional phases to develop TPACK of teachers while they learn about how to use novice technological tools. The first phase starts with the purpose of making teachers accept a new technological tool via faculty modeling and while the other two phases enhancing the proficiency in technical issues and the expertise in technology integration through instructions on computer skills and design projects. A seven-week program conducted in a higher education institute to teach the pedagogical uses of the Interactive Whiteboard as a part of a 12-week ICT module that preservice teachers were attending. In Phase 1, preservice teachers' TPK was aimed to be developed via observation of faculty modeling of the tool. Next, demonstrations of tutors and the hands on activities were expected to be facilitating for the development of their TK while their TPK and TCK were tried to be developed by the resource examples. Their TPACK development was facilitated by the involvement in design in Phase 3.

Jaipal-Jamani and Figg (2015) conducted a four-week professional development program founded on TPACK by adapting a TPACK-based Professional Learning Design Model (TPLDM). The program included two workshops as three-hour long sessions, mentoring, coaching and sessions for feedback, before, during, and after classroom implementation of blogs in science instruction. Further, teachers had sessions to make collaborative planning to design instructional activities that make use of blogs to make research and exploration, during lunch and after school. The results showed that combining experience in workshops and application of that knowledge immediately into the real life teaching increased TPACK.

2.2.4 Integrated approaches

Some studies integrate several methods such as using design products and field experience to develop a new approach. An integrated pedagogical approach aimed at improving the understanding of preservice teachers for technology usage and TPACK development was described by Mouza et al. (2014). The integrated approach included a 15-weeks educational technology course, method courses focusing on curriculum and applicable ways to teach concepts of the content and also field experience in a variety of classroom settings to make it possible to connect the theory to practice. The unified treatment of the approach has processed as: the preservice teachers learned methods for planning lessons for the content they would be teaching in the methods course (PK & PCK) and they learned about the use of concept mapping software (TK) in the educational technology course. Later, they developed a lesson plan about a topic their own choice, including creating concept maps by taking the characteristics of the students into account (TCK & TPK). Then, conferring with a mentor teacher they conducted a technology-enhanced lesson and prepared reflections on their experience and lessons learned (TPACK).

Another integrated approach combined interactive whiteboards (IWBs) and peer coaching to increase science teachers' TPACK development (Jang, 2010). The study implemented the IWB-based TPACK–COIR model for one semester. The model includes four main activities: Comprehension of TPACK, Observation of peer instruction, Instruction of a real class, and Reflection of TPACK. Inservice teachers joined this study in four stages throughout one semester. In the first stage, the science teachers studied and described the content of TPACK in teams to be acquaintance with how to implement and use functions of hardware and software. Then, the teachers gave and wrote down their comments and suggestions after watching a teaching demonstration. For the third stage, they implemented an IWB technology design in their own classes. In order to evaluate their teaching performance, they shared their teaching experiences with each other, and reflected on their reflections in their journals.

2.3 Assessment of TPACK

Several methodologies have been used to measure TPACK of teachers, and these can be categorized into five types: self-report measures (Baser, Kopcha, & Ozden, 2016; Handal, Campbell, Cavanagh, Petocz, & Kelly, 2013; Jamieson-Proctor, Albion, Finger, Cavanagh, Fitzgerald, Bond, & Grimbeek, 2013; Kramarski & Michalsky, 2010; Lux, Bangert, & Whittier, 2011; Sahin, 2011; Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009; Yurdakul, Odabasi, Kilicer, Coklar, Birinci, & Kurt, 2012; Zelkowski, Gleason, Cox, & Bismarck, 2013), performance assessments (Angeli and Valanides, 2009; Brantley-Dias, Kinuthia, Shoffner, de Castro and Rigole, 2007; Britten and Cassady,2005; Graham, Tripp, & Wentworth, 2009; Groth, Spickler, Bergner, and Bardzell, 2009; So and Kim, 2009), interviews (Koçoğlu, 2009), observations (Hofer, Grandgenett, Harris, and Swan, 2011; Koehler, Mishra, & Yahya, 2007) and multifaceted data collection (Doering, Scharber, Miller, & Veletsianos, 2009; Hofer & Swan, 2008; Richardson, 2009; Trautmann and MaKinster, 2010; Voogt, Tilya and van den Akker, 2009; Wetzel, Foulger & Williams, 2008). In what follows, firstly the instruments developed for the purpose of measuring TPACK are introduced and then the studies made use of these instruments are explained.

Self-report measures consisted of mostly surveys which require students to give scores according to how they perceive themselves in a subject. Performance assessment requires direct examination of participants' performance on authentic, complicated real-life tasks. In the multifaceted data collection part, the studies which used multiple measurement approaches are mentioned briefly.

2.3.1 Self-report measures

As one of the most commonly used techniques, self-report measures request participants to rate themselves in specified degrees of agreement for a given statement in regard to technology use in teaching (Koehler, Shin, & Mishra, 2012). In this review, the self-report measures are categorized as the instruments measuring self-perception and the instruments specific to a discipline.

2.3.1.1 Instruments measuring self-perception of TPACK

The Preservice Teacher Technological Pedagogical Content Knowledge Survey (PT-TPACK) instrument was developed and validated by Lux, Bangert, and Whittier (2011) to measure TPACK perception and understanding of preservice teachers. Subsequent to formulating the PT-TPACK instrument with the help of a literature review and pilot study, an expert review was conducted for instrument validity. Internal consistency of items within the individual factors was high, with Coefficient alphas as follows: TPACK= .90; TPK= .84; PK= .77; CK= .774; TK= .75; PCK= .65 (Lux et al., 2011). In the final product, the survey included 45 items.

Another survey consisted of seven sub-scales building on the TPACK model to determine and evaluate TPACK perceptions of preservice teachers. The instrument development was completed in five phases: creating an item pool, confirming reliability and validity and translation of the TPACK survey. The survey used the TPACK model as a theoretical framework during instrument development, data collection, and interpretation of results. The internal consistency scores in Cronbach's alpha coefficient for each sub-scale were determined as: TK= .93 for, PK= .90, CK= .86, TPK=. 88, TCK= .88, PCK= .92 for, and TPACK= .92. The survey included 47 items (Sahin, 2011).

TPACK-deep scale (Yurdakul et al., 2012) was developed by grounding on the central component of the TPACK framework and other four factors: design, exertion, ethics and proficiency. The design factor relates to capabilities of preservice teachers for designing teaching process by enriching it through the help of their TPK about the content to be taught. The exertion factor relates to capabilities of preservice teachers for using technology to execute the teaching process and to measure and evaluate its effectiveness. The ethics factor refers both to competencies of preservice teachers in ethics for teaching profession and to privacy, accuracy, property and accessibility in technological fields. The proficiency factor relates to leadership of preservice teachers for integrating technology in a correct way complying with content and pedagogical approach, to offer solutions for content-related problems, teaching and technology, and to select the best fit between the possible technological solutions. The Cronbach’s alpha coefficient for the entire 33-items scale was .95, while it ranged between .85 and .92 for individual factors. Further, the test-retest reliability coefficient of the scale was calculated as .80.

TTF TPACK Survey (Jamieson-Proctor et al., 2013) was developed as part of Teaching Teachers for the Future (TTF) Project financed by the Australian Government Department of Education. The original version of the instrument was shaped at the end of an in-depth research about definition and measurement of ICT curriculum integration in classrooms and based on theories and methodologies identified in the literature (Proctor, Watson, & Finger, 2003) and included 45 items. The statement pattern, “In my class students use ICTs to . . .” was preferred in an attempt to specify the quantity and quality of students’ technology usage rather than teachers for successful ICT integration (DEST, 2002). The instrument has been evaluated broadly through statistical analysis of the data obtained from teachers; peer reviews by experts; and interviews with teachers who had recently used the instrument (Jamieson-Proctor, Watson, Finger, Grimbeek & Burnett, 2007). Results explicitly indicated two strong theoretically justifiable factors. The first factor involved 14 items and described ICT as an assistant to develop skills associated with it and to enhance learning outcomes. The second factor involved six items defining ICT as a constituent for radical changes about content students learn and the school structure and organization. In short, the instrument measured not only curriculum enhancement but also transformational dimensions in relation to ICT use by students with total of 20 items (Jamieson-Proctor et al., 2007). To administer a more efficient and reliable measurement of preservice teachers’ TPACK, the survey was extended to TPACK Confidence Survey (TCS) (Albion, Jamieson-Proctor and Finger, 2010). The newest version of the survey, the TTF TPACK Survey, aims at measuring the change in the self-perceptions of preservice teachers to use information and communication technologies with varied pedagogical strategies, and to enhance learning with ICT. The 20-item preceding TCS was enlarged with 4 more items describing how preservice teachers could promote learners' ICT use in classroom. 24 additional items were constructed to specifically determine TPK and TCK of preservice teachers. The preservice teachers rated how they perceive themselves with ICT, as well as their perception of their ability to use ICT to undertake the task described by each item. The Cronbach's Reliability Coefficients were .99 and .98 for the confidence and usefulness items, respectively (Jamieson-Proctor et al., 2013).

Kramarski and Michalsky (2010) suggested a model to integrate self-regulated learning (SRL) into preservice teachers' formation of TPCK in hypermedia environments. They used the acronym TPCK and related it to the ICT-TPCK framework introduced by Angeli and Valanides (2005). Preservice teachers' self-perceptions of their SRL skills were assessed through a questionnaire and their event-based SRL was assessed through online reflections. The questionnaire had 5 subscales of two open questions each tapping various TPCK comprehension skills validated by TPCK experts: understanding, application, analysis, synthesis, and evaluation. The interrater reliability was 84%. The reliability coefficients calculated in Cohen's kappa were: 0.96 for understanding; 0.93 for application and analysis; 0.94 for synthesis; and 0.92 for evaluation.

Shinas, Yilmaz-Ozden, Mouza, Karchmer-Klein and Glutting (2013) described the Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009) as “the most promising self-report instrument designed to date” (p. 340). The aim of the instrument was to examine TPACK development and application of preservice teachers throughout their teacher training, practicum and teaching experiences. Thus, the instrument was targeting preservice teachers majoring in elementary or early childhood education. The content validity analysis was conducted by experts and for the factor analysis instead of performing on the entire survey, the items belonged to each subscale were analyzed separately. With the elimination of the items probable to reduce the reliability coefficient and those seemed not measuring the related construct for the subscales, a second factor analysis on the remaining 47 items exhibited strong internal consistency reliability. The internal consistency reliability (coefficient alpha) ranged from .75 to .92 for the 7 TPACK subscales as following: for the TK domain items .82, for the CK domain items for mathematics .85, for social studies .84, for science .82, for literacy.75, for PK .84, for PCK .85, for TCK .80, for TPK .86 and .92 for TPACK domain. According to the results, the survey is reliable and valid to assess preservice teachers' TPACK development throughout time. The construct validity of the survey was also examined by Shinas et al. (2013) via an exploratory factor analysis with preservice teachers. They found eight factors as for the items of the instrument: TPK, PK, TK, TPACK, along with content knowledge for mathematics, science, literacy, and social studies. The overall Cronbach’s Alpha for internal consistency reliability was .71.

There are also studies over online surveys. Archambault & Crippen (2009) deployed an internet-based survey which was first constructed in an earlier research project conducted to survey teachers who gave online courses (Archambault & Crippen, 2006). The instrument used TPACK framework as a guide for skills these teachers are expected to know and be able to do. The survey comprised of 24 items to measure teachers' own perceptions of TPACK. To provide a good level of content and construct validity, several changes were made based on feedback and reviews from the experts and pilot study. Cronbach's alpha coefficient ranged from .70 for the TCK to .89 for the TK.

Graham, Borup, and Smith (2012) measured preservice teachers' TPACK through an online survey which provides instructional objectives and asks them how and why they would achieve these objectives with the help of technology. The analysis of teachers' open-ended responses for selecting technology was performed through a codebook that was formed with the given responses and showed the growth in TK, TPK and TPACK knowledge.

2.3.1.2 Instruments specific to a discipline

Adapting from the Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009), many other instruments were developed (Abbitt, 2011; Zelkowski, Gleason, Cox, & Bismarck, 2013; Price, Wright, & Rice, 2014). Zelkowski et al. (2013) developed a measure to monitor preservice secondary mathematics teachers' development of TPACK throughout the teacher preparation programs. They deleted items from the original instrument that did not specifically pertain to the teaching of secondary mathematics and added 22 items to fill gaps in the seven knowledge domain constructs by focusing on specific content areas in mathematics. Six researchers, including two external to the project, with expertise in secondary mathematics education analyzed all of the included in the survey for content validity. The final survey contained 62 items consisting of 8 TK items, 8 CK items, 8 PK items, 7 PCK items, 7 TPK items, 12 TCK items, and 12 TPACK items. The Cronbach's alpha coefficients for each domain ranged between .85 and .89.

A recently-developed survey TPACK-EFL (Baser, Kopcha, and Ozden, 2016), examining TPACK of preservice teachers majoring in teaching English as a foreign language (EFL), was constructed firstly using qualitative methods such as interviewing with experts and analyzing related documents. The expert and preservice teacher reviews were conducted to establish the content validity of the items. Later, the items were validated through 2 exploratory factor analyses. In the final version of the TPACK-EFL survey, there were 39 items as 9 items for TK, 5 items for CK, 6 items for PK, 5 items for PCK, 3 items for TCK, 7 items for TPK, and 4 items for TPACK. The Cronbach's alpha coefficient for seven domains ranged between .81 and .89.

Handal, Campbell, Cavanagh, Petocz, and Kelly (2013) designed a 30-item instrument, called TPCK-M questionnaire, for PCK identification of secondary mathematics teachers with regards to their TCK, TPK and TPCK. During the item development, the authors benefited from the related up-to-date literature and TPCK related measures. In some instances the items were altered to represent the mathematical base of the study (Archambault & Crippen, 2009; Archambault & Barnett, 2010;

Schmidt et al., 2009). The first part of the instrument included 30 items in 3 Likert-type scales- TCK, TPK, and TPCK while the other part included open ended questions to qualitatively investigate the causes of teachers' uneasiness in presenting TPCK skills in their practice. Cronbach's alpha coefficient was 0.944 for the entire questionnaire, and 0.845, 0.867, 0.924 for the TCK, TPK, and TPCK scales, respectively.

2.3.2 Performance assessments

Although a survey is a useful method for examining distinctive features of a population, the results obtained from it is not as precise as observing behavior and perception (Archambault & Barnett, 2010). Direct examination of participants' performance on authentic, complicated real life tasks is a key feature of performance assessments (Koehler, Shin, & Mishra, 2012). Further, the performance might be assessed during the process of task completion or as a result product of the performance. Designing ICT-enhanced lesson units / plans / activities is the most conventional and undergoing methodology in performance assessments. In the next section, the outputs of this methodology are explored in two categories: design products assessed with rubrics, and design products assessed with qualitative methods.

2.3.2.1 Design products assessed with rubrics

According to Britten and Cassady (2005), using actual lesson plans to examine progressive change in enhanced usage of technology in classroom provides a greater degree of validity than self-report instruments and increases contextual validity in analysis. A rubric is seen as a useful instrument in tracking change in time, diagnosing strengths and weaknesses, and it allows for comparisons among control and experimental conditions.

The Technology Integration Assessment Instrument (TIAI) is a rubric developed in order to help teachers, administrators, and evaluators systematically investigate the level and way of technology integration in classroom environment. Also, it is an instrument that provides teachers with a self-assessment opportunity for revealing their use and decision making process during technology implementation in classroom. TIAI rating scale involves 4 levels of categorization for each of the seven dimensions of a lesson plan. The categorizations stand for a continuity of technology integration; starting from its nonexistence to its being non-essential or supportive component and finally its being essential component. The dimensions to be rated comprised of: Planning, Standards Relation (Content and NETS-Students), Student Needs, Implementation: Learning and Teaching, and Assessment. Inter-rater reliability of the instrument exceeded .70 for each dimension (Britten & Cassady, 2005). Harris, Grandgenet, and Hofer (2010) adapted the TIAI to represent demonstrated TPK, TCK, and TPACK along with the convenience of chosen content, teaching methods, and technologies considered together. When it was necessary with regard to the expert suggestions, some items underwent revisions on their structure. Similarly, the strong construct validity was established through the comments from experts and face validity through feedbacks of experienced teachers as scorers who had used the rubric before. Also, the authors concluded that the rubric is reliable adequately to recommend it for further use according to the calculations.

Angeli and Valanides (2009) introduced ICT–TPCK as knowledge of synthesizing tools and their affordances, pedagogy, content, learners, and context to teach them more efficiently with integration of technology. They suggested an assessment model which combines expert, peer, and self-assessment to measure the competencies of teachers for teaching with technology through different design tasks. For peer assessment, students make evaluations to design work of their fellow students using a criteria table given to them. For self-assessment, students write a reflection paper for their first design task and conduct a self-assessment using the criteria. Once these are completed, the course expert evaluates and expresses his/ her evaluation to each learner individually. The tasks are scored by two independent raters over the criteria table with a scale scoring from 1 to 5 (inter-rater agreement Pearson's $r = 0.89$).

Graham, Tripp, Wentworth (2009) investigated how preservice teachers transforms their knowledge about technology integration into practice in the course of their field experiences. They evaluated the instructional units produced by teacher candidates as Teacher Work Samples (TWS; Renaissance Partnership, 2001), a cornerstone method for assessing preservice teachers, a method used for assessing how a preservice teacher puts what she acquired about integrating technology in a classroom into practice. Candidates planned and designed a unit of instruction that included sections for: factors related to context; learning goals; plans for assessment; instructional design; making decisions during instruction; analyzing student learning; and reflecting and self-evaluating. The TWSs were evaluated by faculty teams via rubrics adjusted from the Renaissance Partnership for Improving Teacher Quality (2001) to investigate how the candidates were integrating technological tools into their practice and how they were benefiting from the technology. Coding strategies on how they were making use of technology included: Exceeds Expectation, Meets Expectation, Partially Meets Expectation, and Not Met/Missing Evidence. They used TWSs before and after the intervention plan they made over the Teacher Preparation Program of the Brigham Young University. The intervention plan involved renewing the criteria for the TWS technology for emphasizing the importance of integrating the digital technologies of the century; and training provided to the field instructors on the new TWS expectations. The TPACK framework guided the prospective teacher while they were becoming knowledgeable about the ways of effective technology integration in various domains during the intervention. The inter-rater reliability of 93% was established from a random sample of 15 TWS.

So and Kim (2009) suggested that the reason for teachers' having difficulty in grasping the complex relationships between technology, pedagogy and content is that many teacher preparation programs teach them in theory. So, they attempted to contextualize this TPACK issue by engaging preservice teachers in a lesson design project that required them to apply PCK to problem based learning (pedagogy) and technological knowledge of various ICT tools (technology) to create a subject specific lesson package (content). The problem based learning (PBL) ICT lessons were analyzed through a rubric by the researchers with the predetermined criteria.

Koh (2013) composed a rubric to assess ICT lesson of preservice teachers considering the attributes of meaningful learning with ICT described by Howland, Jonassen, and Marra (2012) as: active, constructive, authentic, intentional, and cooperative. The guidelines of the rubric emphasized that in order to acquire the content;

an appropriate support from technology is needed for each of the five dimensions-pedagogy. The rubric was subjected to expert review for content validity. The lesson plans were examined after separated as learning activities by the researchers and a Cohen's kappa of interrater reliability was found to be at least 0.80 for each of the five dimensions.

2.3.2.2 Design products assessed with qualitative methods

Holmes (2009) examined technology integrated activities planned by senior secondary mathematics teachers. The analyses were conducted considering the TPACK framework. After the preservice teachers wrote shortly about their current thoughts on the usage of technology in math classes, they designed a classroom activity utilizing an interactive whiteboard (IWB) and its related applications. The study examined the extent to which they can design teaching and learning activities that require a composition of content, pedagogy and IWB technology knowledge. The lesson activities were evaluated in terms of characteristics of how IWB features used. The justifications for their approaches to developing IWB lessons were also indicated how they perceived the offerings of IWB for its pedagogical benefits.

According to Brantley-Dias, Kinuthia, Shoffner, de Castro and Rigole (2007), preservice teachers need all procedural, conceptual and pedagogical content knowledge and the knowledge of technology integration- a similar concept to TPACK: pedagogical technology integration content knowledge (PTICK). The authors investigated a course focusing on planning for teaching in technology-enriched environments to explore how using cases promotes the development of PTICK. The students generated a learning environment portfolio, working individually or in small cooperative groupings, and described a learning environment in which they might be teaching. They also developed a unit plan and several lesson plans along with the necessary materials that demonstrate their skills in integration of technology into their selected curriculum appropriately. Five researchers acted as primary instruments for analysis of the data. The research team used content analysis to categorize concepts and ideas, which students presented in their case analyses, case reflections, as well as their course reflection papers. For higher reliability, a wide case study database was organized for registration of the notes researchers took, protocols, timelines, artifacts, and coded data.

A qualitative approach developed by Groth, Spickler, Bergner, and Bardzell (2009) is named as the lesson study technological pedagogical content knowledge (LS-TPACK) assessment model. The model took TPACK as an implication that teachers must use technology along with content and pedagogical knowledge to facilitate students' learning of mathematical concepts. It involves a score of teachers constructing and implementing a technology incorporated lesson in a school-based lesson study group (LSG). They observe its implementation, and get information about its strengths and weaknesses. Firstly, teachers are expected to select learning objectives and appropriate technology to address problematic concepts. A four-column format is used by the teachers to direct teachers' attention toward the matching of activities to the learning needs of students and evaluating students' progress with respect to the learning objectives. The four-column lesson designed by the LSG is reviewed by university faculty at three levels of specificity and sent back to the LSG with a feedback. After the lesson has been revised, one teacher from the LSG implements it and another member serves as videographer. On the debriefing session, the recorded video is watched by the LSG and university and the members share their opinions about its strengths and weaknesses. At the end, the LS-TPACK process generated qualitative data including LSG four-column lessons, additional materials and feedbacks from the university faculty, transcriptions of the recorded lessons and debriefing. To analyze these data, university faculty makes interpretations about how technology is used by the teachers in the four-column lesson design and their observations from the debriefing session. A comparison is made between the interpretations of the faculty and the LSG's implementation and comments for the debriefing. The principal investigator uses this comparison to come to conclusion for the nature of the TPACK of the teachers.

2.3.3 Observations

Observations by researchers are usually made through video recording of a class or field note-taking of a session to track the TPACK development of teachers (Koehler, Shin & Mishra, 2009). While performance assessments put design products in the center, observations are mostly associated with practical classroom experiences. To analyze observation data, Hofer, Grandgenett, Harris, and Swan (2011) developed an observation rubric adapting from the Technology Integration Assessment Rubric (Harris, Grandgenett & Hofer, 2010). Its construct and face validity was verified by seven TPACK experts. The interrater reliability coefficient was computed as .802. Internal consistency (Cronbach's Alpha) was .914 and test-retest reliability was 93.9%.

A semester-long design seminar study whereby master's students worked with faculty members to design online courses was conducted (Koehler, Mishra, & Yahya, 2007). Learning technology by design approach was utilized to enhance the understanding of the relationships between the components of TPACK framework by teachers' collaborative works to create technology-enriched answers to the ill-structured pedagogical problems (Mishra & Koehler, 2003; Koehler & Mishra, 2005). The purpose was them to use and design technology for teaching and get knowledgeable about technology and pedagogy. The collected data consisted of detailed notes taken during discussions, e-mails, notes and products developed by participants, and the periodic surveys conducted. Content analysis was selected for the analysis of four types of data: notes taken during discussions groups had, e-mails between group members, several notes and artifacts created by groups, and self-report surveys taken regularly during the semester.

2.3.4 Interviews

Interviews include a group of verbal questions asked by an interviewer and responses given by the interviewee. The usual method for doing an interview is to record the speech in video or audiotapes or take notes and then transcribe them for a systematical analysis. In the literature, many interviews conducted to measure TPACK do not provide reliability indexes. To give an example, Koçoğlu's (2009) interpretive approach, meanly interviews including twenty-seven open-ended questions might be mentioned. Her approach toward TPACK was the integration of different technologies into teaching process, having new skills to use them ideally, and learning to cope with pedagogical issues arising from their use. The study aimed to discuss TPACK from the perspective of preservice EFL teachers in Turkey, and to explore their beliefs about TPACK which are the confidence on the improvement of the knowledge about language teaching, resolving pedagogical issues, and meanwhile using technology. TPACK and its seven components were used as an analytic framework to categorize 27 open-ended survey responses.

2.3.5 Multifaceted data collection

In many studies, using one methodology to measure TPACK did not seem to be adequate for interpreting the TPACK development; therefore, a combination of several instruments was utilized for triangulation of findings (e.g. analysis of what student produce, classroom observations, interviews, and self-assessment surveys).

Doering, Scharber, Miller, and Veletsianos (2009) developed three interactive TPACK assessment models in the context of the GeoThentic, an online teaching and learning environment, developed by the research team using the TPACK framework, focusing on the real world issues such as global warming, technologies particular to the content- Google Earth, and favorable pedagogical approaches such as problem based learning. According to the authors, TPACK should be assessed holistically from different angles. Therefore, TPACK interactive assessment models included a teacher-reported model (TRM), an evaluative assessment model (EAM), and a user-path model (UPM). The TRM allows teachers to report on their TPACK use. The EAM includes multiple choice questions specific to a module to analyze the current TPACK of teachers. The UPM method concerns with analysis of teachers' actions through the trail of data they left behind within the online learning environment. The authors specifically noted that these three assessment measures do not imply a statistical validity for measuring TPACK; they rather provide a foundation for challenging teachers about their metacognitive awareness of TPACK and making reflections.

Hofer and Swan (2008) showed a qualitative perspective for teachers to develop a TPCK knowledge base through two teachers' experiences in a digital documentary. They conducted a 3-week project for creating 3-to-5-minute documentary films about important events and people from the U.S. Civil War. Research, writing and production were the three phases of the project. The data collected through teacher interviews, teaching materials (lesson plans, handouts), and student products at each phase, and classroom observations. In this study, TPCK framework was utilized to initially categorize the data. Classroom observations, the teacher interviews, content from the collected instructional materials, and notes from research memos was coded into categories individually to represent the specific knowledge and required skills in each domain.

In order to characterize technology integration in instructional practices of preservice teachers, Schnittka, and Bell (2009) observed classroom, interviewed the preservice teachers before and after the treatment, examined lesson plans, and reflective essays. The study aimed to investigate how preservice biology teachers' use an interactive display system (IDS) designed to advance reform-based instruction and facilitate the development of TPCK including computers, digital projectors, IWBs, and the Internet connection in order to enhance teaching and learning of science, during their teaching experience.

Trautmann and MaKinster (2010) built their study on the assertion that how teachers constitute TPACK and its quality are best revealed through the analysis of their classroom experiences. For this study, the questions asked was how TPACK would transform at the end of a professional development program concentrated on science teaching via a specific technology and how the program would make contributions to these changes in TPACK. Data sources were application materials, curriculum projects, and responses to a questionnaire asking the participants to rate themselves for their skills, engagement in the applying a specific technology, observation notes and written reflections. To increase the reliability, the researchers triangulated the data types and data collection methodology. They also used their own observations during their interactions with the participants over the year.

Ozgun-Koca, Meagher, and Edwards (2010) investigated the emergent TPACK of secondary mathematics preservice teachers who were asked to constitute and implement technology integrated teaching materials during their field experience. Participants completed reports on two mathematics lessons they developed and implemented, 5 secondary level mathematics activities making use of a handheld device which has several functions in geometry. The participants filled out a survey measuring attitude toward mathematical technology twice, and an open ended exit survey. They used the TPACK framework as a lens during the analysis of surveys and collected assignments.

Canbazoglu Bilici, Guzey, and Yamak (2016) used TPACK-based lesson plan assessment instrument (TPACK-LpAI) (Canbazoglu Bilici et al., 2013) and Technological Pedagogical Content Knowledge Observation Protocol (TPACK-OP)

(Canbazoglu Bilici et al., 2012) to assess TPACK of preservice science teachers through data gathered from observations and lesson plans. Lesson plans was analyzed by using TPACK-LpAI. The instrument consists of 4 sections: first and second sections include background information and objectives of the content. The third section comprises of key indicators and attitudes toward technology enhanced science teaching (Item 1), how to make assessment (Items 2 and 3), how to interpret students' understanding of science (Items 4 and 5), how to make use of instructional strategies (Item 6), knowledge of curriculum and curriculum materials (Items 7 and 8), and the final section includes additional comments. The TPACK-OP was used for analysis of microteaching observations. It includes six parts as background information, demographic information about classroom, instructional objectives, contextual and activity information, ratings of key indicators, and further comments. Cronbach's alpha coefficient of the observation protocol was .941.

In a professional development project, Richardson (2009) gathered data from inservice eighth-grade mathematics teachers through reflections in journal entries of participants on the ways of overcoming the struggles they encounter while integrating technology when crossing from basic calculations to analyzing mathematics. The categorization and analysis of the journal entries, observations of interactions and discussions between participants were conducted by using a TPCK content analysis framework. In another study measuring teachers' TPACK, Agyei, and Voogt (2011) collected interview, observation, and survey data and used content analysis for the analysis of the observations and the lesson plans. Cavin (2008) also collected and analyzed qualitative data including audio and video recordings, observations, interviews, and course documents using especially the three components of TPACK framework. The study of Shafer (2008) aimed to measure TK, TPK, and TPACK development, researcher field notes, email records, an exit interview, member checking, and classroom observations were used as primary data sources.

Voogt, Tilya and van den Akker (2009) conducted workshops with the aim of supporting inservice teachers in developing TPACK. The workshop activities were related to TPCK framework. The instruments used included Classroom Observation Checklist derived from the tool developed and validated by Ottevanger (2001), teacher interviews, Computer Classroom Environment inventory measuring student attitudes towards an inquiry-oriented and technology-rich learning environment, Student Opinions questionnaire developed for the study and had four scales with acceptable reliability.

Doering, Veletsianos, Scharber, and Miller (2009) designed a program to report on the change in metacognitive TPACK awareness of social studies inservice teachers. Data were collected through a TPACK ratings scale before and after the program, open ended questions associated with types of domain knowledge to clarify the reason for giving their scores; their interviews and TPACK diagram positioning before and after the program.

Wetzel, Foulger & Williams (2008) examined the effects of two assignments attempting to develop TPACK added to a course about technology integration. Student surveys, student focus groups, in-depth investigation of classroom logs and presentations of students were used to gather data. The study aimed to reveal the role of that course in the TPACK development in a teacher education program.

2.4 Epistemic frame theory and its elements

According to Lave and Wenger (1991), a community of practice is a group of individuals sharing a repository of knowledge and ways of addressing similar (mostly shared) problems and objectives. Individuals reshape their identities and interests in respect to such communities while participating in the practices of the community. For instance, journalists think and work in common ways and integrate these ways to their sense of self, counting themselves as journalists (Shaffer, 2006). Being a member of a community of practice requires eager practitioners to not only learn the explicit knowledge of that community but also develop the identity of that community via the offered form, context and content in the process. The knowledge of the community, whether explicit or tacit, is collective rather than divisible among the individuals. Knowing how the community members do things, not the individuals, is discovered in a community of practice (Duguid, 2005).

Pedagogical praxis expands the extent of the concept of community of practice by saying that different communities of practices (that is to say different professions) own their specific epistemic frames. Epistemic frames specify how to know and decide things that are worth knowing, and ways of contributing to the collective body of knowledge and understanding of the community (Shaffer, 2004). Epistemic frames are not restricted to the collection of facts, interests, affiliations and activities, they also comprise of knowing where to start asking questions, what constitutes convenient evidence/information to consider/assess, how to collect evidence, when to come to a conclusion or/and move on to another issue. They are organizing principles for particular practices (Shaffer, 2006).

The epistemic frame theory suggests that an epistemic frame is consisted of the structure of the elements: skills, knowledge, identity, values and epistemology. The elements are not isolated; they are systematically linked to each other. They are internalized through an individual becomes a member of that community. As they are internalized, individuals start thinking like an engineer, journalist or physicist each with a different epistemic frame (Shaffer, 2004b; Shaffer, Hatfield, Svarovsky, Nash, Nulty, Bagley, Frank, Rupp, & Mislevy, 2009).

2.5 Epistemic game/ Virtual internship

Epistemic games are based on the epistemic frame theory which binds together the skills, knowledge, values, and epistemology of a community of practice. The elements of the epistemic frame gradually become closely tied as the individuals perceive the world using the epistemic frame of that community. Normally, this process advances gradually through professional practicum in which a student takes part in a controlled environment and makes reflections on the consequences with mentors and peers (Shaffer et al., 2009). Virtual internships are simulations of how professional practicum supports the development of the epistemic frame of a professional practice. Specifically, they use the theory to transform the actions taken by the learner into a practicum experience in a digital learning environment and link the resulting game activities to the desired outcomes of epistemic frame development (Shaffer, 2006).

Epistemic games aim to train novices of a profession to make them professionals. The key factor in turning user actions into understanding in real world is reflection (Shaffer et al., 2009). Reflecting on the actions gives the chance for taking a step back what has been done and talk with mentors and peers about what worked, what did not work, and why. Combining action and reflection is likely to develop sophisticated ways of thinking (Shaffer, 2004) which is a necessary skill for any profession. So, the learners have the opportunity for being mentored as in a practicum experience. These kinds of authentic professional training experiences help learners integrate action and reflection and develop creative and innovative thinking. Throughout time, several virtual internships have been developed and tested such as: The Pandora Project, Land Science, Escher’s World, Science.net, and Nephrotex.

2.5.1 The Pandora Project

The Pandora Project is a virtual internship program about human immune-biology and bio-medical ethics which was tested on eleven 17 and 18 years old high school students. The pre and post interviews and students’ daily online journal entries as response to questions provided by teaching staff were used as the sources of the data. The results suggested a significant difference in the concept maps the participants drew during before and after their participation. The latter had more nodes and links. The large majority of the students stated that the virtual internship experience had changed their mind about xenotransplantation and helped them understand xenotransplantation better. Also, 55% of the participants stated that they had varied viewpoints about xenotransplantation. Overall, simulated negotiations the internship provided were efficient for students' understanding of xenotransplantation. There was a strong relationship between the system of utility points and adaptation of students' roles. Challenges created by their peers in negotiation helped the students to understand their roles better. Also, different viewpoints of the stakeholders made students see the various perspectives on the issues of xenotransplantation (Shaffer, 2004c).

2.5.2 Land/Urban Science

Land/Urban Science is another virtual internship about urban planning with augmented reality: while learners experience it, the problem solving exercises are clearly guided via real world tools and practices. The internship experience with senior high school students was investigated through clinical interviews, videotapes, and field notes taken by project researchers, and plans of students. Studies show that after the internship experience, students' understanding of ecology and city planning were enhanced and they could define "ecology" more extensively and explicitly. They could give more definitive examples of the situations when ecological matters are interdependent or interconnected, also the complexity of an urban ecosystem was clearer in post concept maps than in pre concept maps. The analysis on the nodes and links in the concept maps showed a statistical significance. In the post interviews, all students (11/11) stated the workshop changed their opinions about cities. Students showed enhanced awareness for the interconnectivity of ecological issues (Beckett& Shaffer, 2005). In their post interviews, players mentioned serving the public interest, and they realized the importance of involving community to the planning process (Nash, Bagley, & Shaffer, 2012).

Studies with middle-school-aged players showed that they developed knowledge and skills about cities and understood the importance of serving the public interest through their experience (Bagley& Shaffer, 2009; Bagley& Shaffer, 2011). The references made in the post interviews included more elements of the urban planning epistemic frame. Furthermore, the co-occurrence of these elements rose as well. While none of the participants could link the elements of the epistemic frame in the pre interviews, they were able to connect them approximately half the time in post interviews. The players in this study give the impression of having developed a more professional way of thinking (Nash& Shaffer, 2012).

2.5.3 Escher's World

Escher's World is a virtual internship program on mathematics and was also tested with six high school students and the result showed their development in application of the concept of symmetry while analyzing images. After the workshop the students attended, the number of students who could use and explain formal concepts of symmetry increased strikingly. Students began to realize symmetry in the world around them. Students stated that their opinions for mathematics were changed in a positive way with the workshop (Shaffer, 1997).

2.5.4 Science.net

Science.net is about journalism and was tested with 14 middle school students. They developed their knowledge and skills with journalistic writing skills and considered being a journalist in point of journalists. In other words, the students started to develop epistemic frames for journalism profession. In result, as expected players started to develop an epistemic frame of journalism while engaging in science.net, and particular elements of that frame were developed through the design features of the game engine (Hatfield & Shaffer, 2006). Similar results such as developing the repertory of journalism skills, knowledge, identity, values, and epistemologies were indicated in other studies. The students could link particular professional journalistic features as indicated by epistemic frame theory. According to the analyses of these data, individuals who played science.net could consider themselves as journalists about writing, by pointing various elements of journalism, more appropriately linked compared to their performance before the game experience (Hatfield, 2011).

2.5.5 Nephrotex

Nephrotex, another role-playing game developed for engineering students, tested with 45 first-year engineering students, demonstrated a significant increase in learning engineering content. According to the survey analysis, the students were substantially occupied with this virtual internship (Chesler, Arastoopour, D'Angelo, Bagley, & Shaffer, 2013). By the engagement in Nephrotex, students were able to establish connections between the elements of engineering. They demonstrated a positive attitude toward a career in engineering (Arastoopour, Chesler, & Shaffer, 2014).

2.6 Summary

Studies mostly show that teachers' being knowledgeable about content, pedagogy and technology does not exactly mean that they are also knowledgeable about TPACK, the interplay among content, pedagogy and technology, in educational practice. Most of the TPACK development models aimed to overcome two fundamental problems of technology integration in classrooms: obsolescence of specific technologies and their de-contextualization. Design-based learning of technology (Mishra et al., 2006), deep-play (Koehler et al., 2011), TPACK-based learning activity types (Harris, Mishra & Koehler, 2009) are the three of basic methods developed by the contribution of the creators of the TPACK framework. Over time, there have been many other methods offered such as online courses conducted through virtual classrooms, design-based courses, intervention programs based on educational models, and integrated approaches which combine educational technology courses with other applications such as peer coaching or classroom experience. Such various methods for TPACK development led researchers also to develop different methods for assessing the achievement level of the developed methods. In this review, the assessment models were categorized into five as: self-report measures, performance assessments, interviews, observations, and multifaceted data collection.

Whereas many development and assessment models for TPACK have been suggested, one original method to develop TPACK is the use of a virtual internship. As mentioned in the examples above, very successful results have been obtained in virtual internship studies for several areas such as mathematics, engineering, and urban planning. Within the framework of epistemic frames (Shaffer, 2004), a virtual internship that specifically aims to develop preservice teachers' TPACK has not yet been examined in teacher education. Considering the fact that a teacher needs to develop TPACK ideally during her undergraduate education, this study took place in and was a part of a preservice teacher education setting. Therefore, the research questions of the study are specified as:

1) Do the preservice teachers who participate in a virtual internship experience (STF group) differ from those who do not participate (Control group) in their CK, PK, TK, PCK, TCK, TPK and TPACK scores over time (pre and post)?
2) Is there a meaningful difference between the pre and the post TK, CK, PK, PCK, TCK, TPK and TPACK scores of the preservice teachers who participate in a virtual internship experience?
3) How do preservice teachers' opinions on integrating technology into educational settings change as they participated in a virtual internship program?

The hypotheses of the study are stated as:

1) The preservice teachers who participate in a virtual internship experience (STF group) will differ from those who do not participate (Control group) in their CK, PK, TK, PCK, TCK, TPK and TPACK scores over time (pre and post)?
2) There will be a meaningful difference in the CK, PK, TK, PCK, TCK, TPK and TPACK scores of the preservice teachers who participate in a virtual internship experience.

CHAPTER 3

METHOD

3.1 Research design

This study employed a quantitative pre and posttest quasi-experimental research design aided by qualitative data from the participants' reflections to investigate if a virtual internship program develops preservice teachers' TPACK and its components. The pre and post survey data make it possible to specify the preservice teachers' TPACK profiles at the beginning and at the end of the treatment and to track their score changes in the seven different TPACK domains. Also, a quasi-experimental design is found suitable when the participants cannot be randomly assigned to an experimental and a control group, and also when the researcher cannot choose which group will get the treatment- as in most of the studies conducted in educational settings (Creswell, 2012). Because of the availability of the participants, for this study, the participants as intact groups, were randomly assigned to the experimental and control groups.

In addition, the qualitative data (reflections written by the participants both at the beginning and at the end of the study) were used to complement and expand on the quantitative findings. Using qualitative data as an addition to quantitative data is accepted as a way to externalize the complex and multifaceted situations in learning and teaching practice (Chang, Jang, & Chen, 2015).

A pretest was administered to both groups, the experimental treatment activities were conducted with the experimental group only, and meanwhile the control group was instructed with their regular lectures similar in terms of the content to the experimental group's but without introducing the virtual internship (STF) context. The control group studied on several course projects aiming the participants to work collaboratively and produce instructional multimedia for K-12 students based on the Framework for 21st Century Learning. The regular lesson activities of the control group involved discussing weekly assigned readings, sharing their personal opinions on the use of technology in K-12 education, and completing the same readings, responses, and reflections on their web-based portfolio. They also worked on the projects on providing meaningful learning with technology and developing technology integrated lesson plans. The projects varied as developing a tool commercial, a stop animation project and a learning adventure project about critical thinking, problem solving and decision making. The progression of the projects included providing feedback to each other's projects. After the completion of the STF treatment, a posttest was administered to both groups to assess the difference in their TPACK domain levels. The success level of the treatment was evaluated through comparing the results of the pretest and the posttest as well as the changes in the participants' reflection statements.

3.2 Context and participants

The available population of this study was preservice teachers studying at an English-medium public university in Istanbul. Purposeful sampling method was used for this study because the participants were preservice teachers and they were available for the study. Since the treatment of the study, participating in the virtual internship- School of the Future, required high level of English (both reading and writing), the participants needed to be from an English-medium university which is a rare condition in Turkey.

The sample of the study was formed with the students from the departments of Foreign Language Education, Guidance and Psychological Counseling, Mathematics Education, Chemistry Education, Physics Education, Primary Science Education and Primary Mathematics Education, in their junior or senior year. All participants registered to an Instructional Technologies and Material Design course aiming to support preservice teachers' technology integration into their teaching. Two sections of the course, taught by the same instructor, were randomly assigned as the experimental and the control groups (the students of the first section were assigned as the experimental group and the students of the second section were assigned as the control group). For the participants of the experimental group, participation in the virtual internship program was a requirement of the course. Thus, students were given consent forms and set free to change their course section if they were not willing to participate in the study.

The total sample size was 74 (20 participants from the first semester, and the rest from the second semester), and 38 of the participants were assigned to the experimental group while 36 of them were assigned to the control group. Thirty of the participants were from the Foreign Language Education department, fourteen of them were from the Guidance and Psychological Counseling department, one of them was from the Mathematics Education department, one of them was from the Chemistry Education department, five of them were from the Physics Education department, eight of them were from the Primary Science Education department and fifteen of them were from the Primary Mathematics Education department. In order to comply with the data collection instrument and the similarity in their nature, Mathematics Education department and Primary Mathematics Education department were considered as mathematics majors and Physics Education department, Chemistry Education department and Primary Science Education department were considered as science majors.

The participants according to their majors were distributed between the two groups as following: the STF group had 7 participants from the Guidance and Psychological Counseling department, 14 participants from the Foreign Language Education department, 11 participants from the mathematics department, and 6 participants from the science department. The control group had 7 participants from the Guidance and Psychological Counseling department, 16 participants from the Foreign Language Education department, 5 participants from the mathematics departments, and 8 participants from the science departments.

3.3 Virtual internship: School of the Future

The virtual internship ‘School of the Future’ (STF) was the primary intervention of the study. STF is a virtual internship program developed by Oner (2017) with the aim of developing TPACK of preservice teachers. The intervention included an eight week-long program which required students to participate in STF sessions for two hours a week. The participation to the STF happened via two hour-long online meetings during the class hours of the participants in a computer lab, equipped with the entire necessary technical infrastructure for the use of the STF program.

The participants from the same department constituted teams of four or five. In the context of the STF, participants were characterized as interns of a company (School of the Future) and asked for preparing a collaborative lesson plan of their own major with their team members. Each team member got together with other team members to work on that week's assignments. During the online meetings, every group worked together with a mentor whose job was to assist the participants by asking thought-provoking questions, provide necessary explanations about that week's assignment while observing and maintaining team collaboration. Two mentors who were graduate students (one was the author) and qualified in knowledge of TPACK development and assessment assisted the participants. The mentors assigned for this study were trained for the use and management of the virtual internship by the developer of the STF (thesis advisor).

Each week's assignment differed to complete a specific part of the lesson plan, some weeks the interns had to fulfil specific tasks before the online sessions and completed it with their team members in class. Some weeks they had to team up to complete a whole task in class or out-of-class until the provided due date (see Appendix A).

STF is consisted of 8 rooms, one for each week. For the first room, interns read and summarize the workflow tutorial to have an idea about how the virtual internship works and they also complete an entrance interview, which later gets used to assess the participants' initial level of TPACK. In the second room, interns investigate some given resources to understand the concept of "technology integration" and "technology use" before the class and then meet online to discuss the differences between the two concepts. During the online discussions, mentors assist the participants by asking thought-provoking questions, provide explanations while observing and maintaining team collaboration. After the online discussion, the interns create notebooks to summarize their meeting discussion and to write their definition of technology integration. In the third room, students get assigned to the resources for readings about Integrated Thinking Model and writing quality instructional objectives before the class. During the class, interns examine and discuss the meaning of thinking skills needed for 2020 and how to develop them in the online meeting. After discussion, they send topic and instructional objectives for a team instructional plan by following an instructional plan template provided to them. In the 4th room, each intern researches one of the given technological tools (blogs, microblogs, social bookmarking, wikis, narrated slide shows, rubrics and matrices) and submits a notebook report (in shared space for everyone to display) about it (using the given template for report) before the class. Then, they need to meet online to discuss which two of these tools they could use in their lesson plan and why by explaining instructional and/or pedagogical reasons and submit a notebook explaining all their reasoning. For the 5th room, interns work on Team Initial Instructional Plan based on the given template and submit it. The next room gets interns investigate two theories of learning (one familiar one unfamiliar) before the class and team meets online to discuss about these learning theories and their implications for their instructional planning. After the online discussion, they submit a notebook explaining the changes they decided to make on their initial instructional plan. For the 7th room, they research their team's instructional topic by finding credible resources and submit their notes including why it is important for students to learn this topic, if there are any known student misconceptions (or alternative conceptions) on this topic and if there are any known difficulties connected with teaching this topic. Then, team meets to discuss how the nature of their topic have implications for instructional planning and they submit their notebook explaining the changes they decided to make. The final room includes starting working on Team Final Instructional Plan based on the given template, submitting final work and completing the exit interview. The schedule of the intervention is summarized in the Appendix A.

Each room in STF serves for students to create an instructional plan step by step and every task in the STF aims to support TPACK components. The room 4 provides opportunities to develop their knowledge of TPACK domains corresponding to TK, TCK, TPK and TPACK, the room 6 provides opportunities to develop their knowledge of TPACK domains corresponding to PK, TPK, and TPACK, and the room 7 provides opportunities to develop their knowledge of TPACK domains corresponding to PCK and TCK. It should be noted that the purpose of the STF is not to develop general knowledge of content, pedagogy and technology. It provides opportunities for prospective teachers to develop their understanding of TPACK components within a context of collaborative lesson planning.

The interns have access to the resources that they need for completing their weekly assignments in the STF (see Figure 1).

Mentors assist the interns during all online meetings via a chat window while the group members discussing about the constitution of their group instructional plan (see Figure 2).

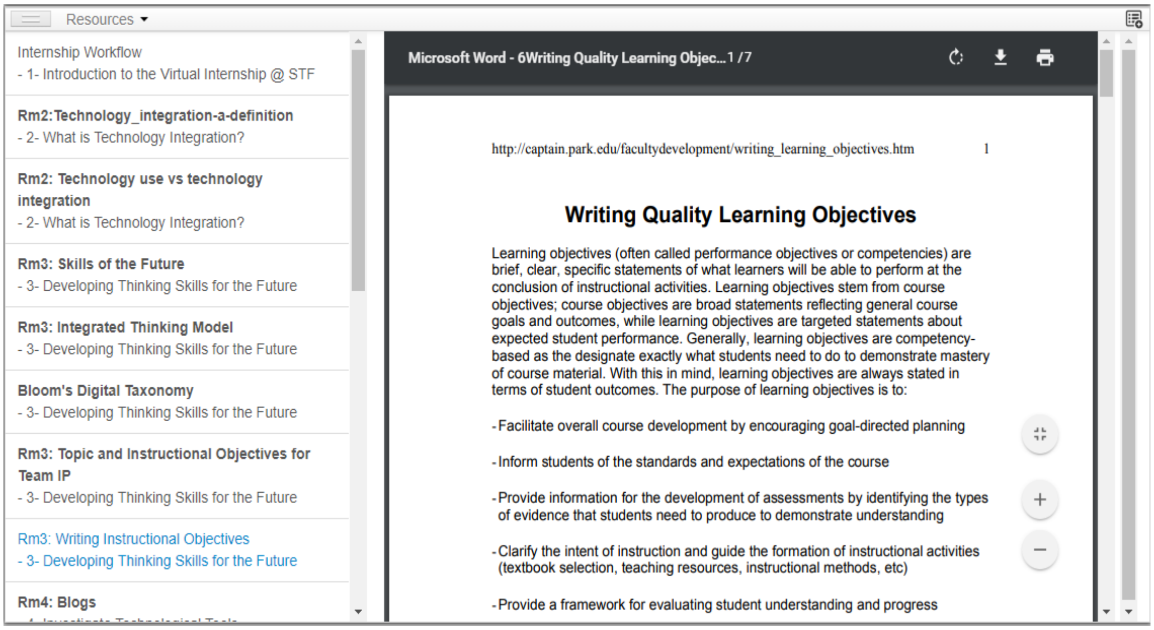

Figure 1. Resources screen in the STF

Also, after each online discussion, each intern submits a summary of their discussion and the notebooks of the week (see Figure 3).

The mentors can display the deliverables on their own account; evaluate them and send an acceptance or rejection mail to the interns (see Figure 4).

Interns get feedback for each deliverable on each week. The deliverables are examined and assessed by the mentors and feedback is sent to the interns in the name of a virtual project coordinator. The deliverables get accepted or rejected (see Figure 5 and Figure 6). If they are found incomplete or insufficient, the interns get another opportunity to complete or revise them until a provided due date. The revised notebooks are assessed for the second time and interns get a new feedback message about its acceptance or rejection.

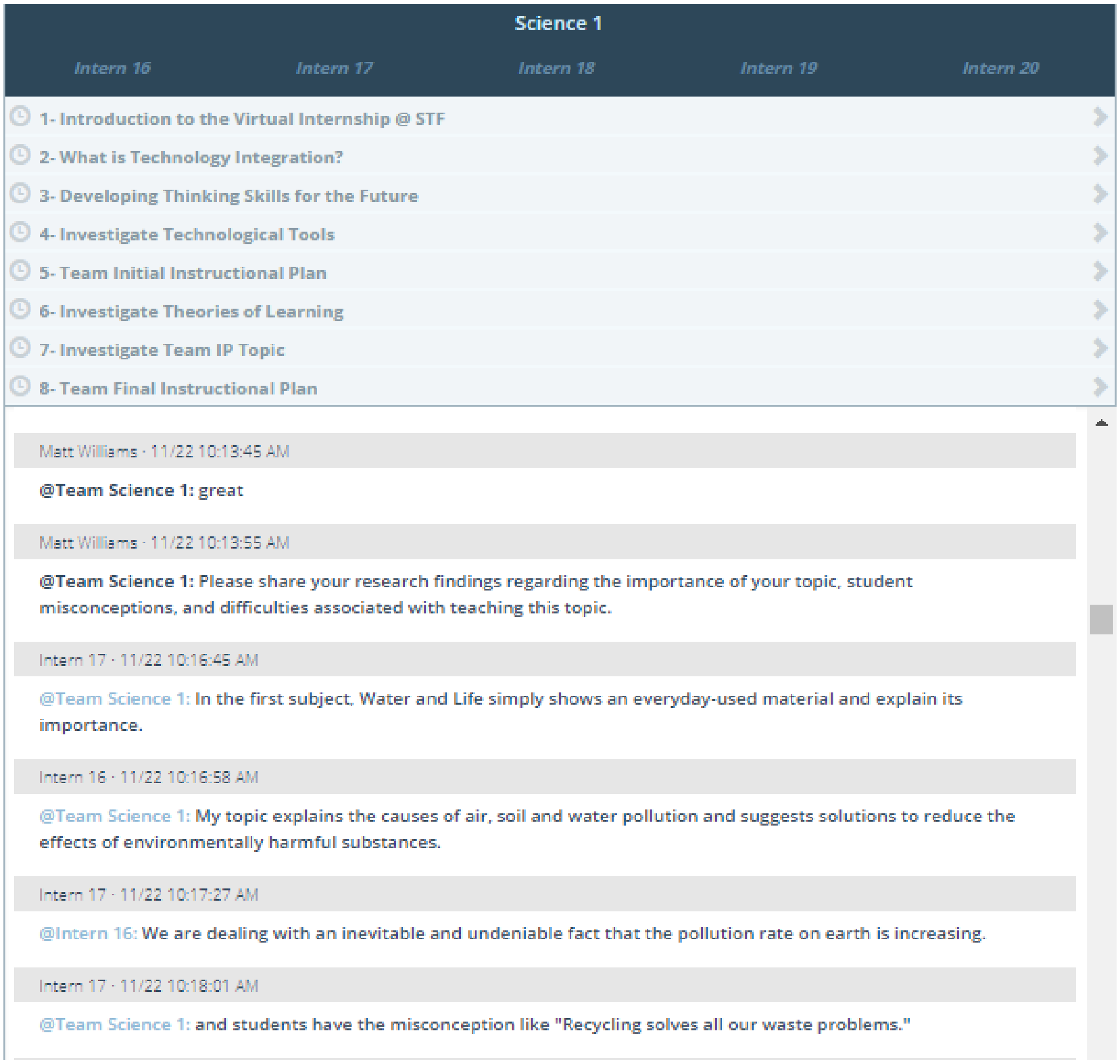

Figure 2. Online chat page of the groups

The interns could share their deliverables on the shared space for the interns of other teams to view (see Figure 7).

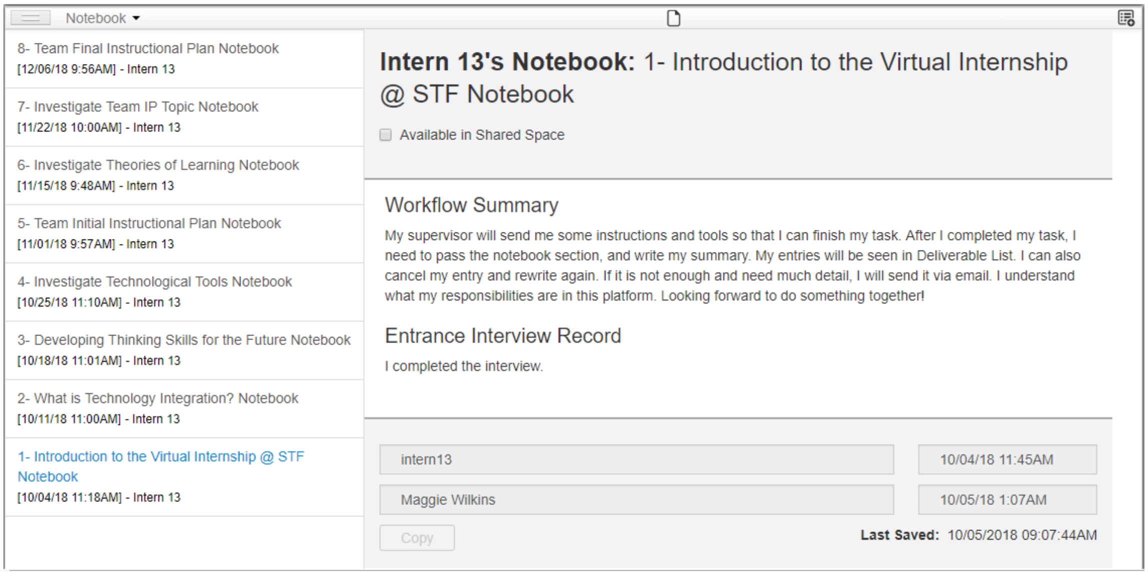

Figure 3. Notebook screen of an intern

Figure 4. Mentor screen for viewing the deliverables

From: Maggie Wilkins
To: Intern 16
Date: 11/01/18 9:57AM
Subject: RE: 4- Investigate Technological Tools

Hi Intern 16,

I see that you've submitted a notebook entry.

This notebook looks great. Nice job!

Thanks,

Maggie

Figure 5. Feedback screen 1

From: Maggie Wilkins
To: Intern 12
Date: 10/18/18 11:01AM
Subject: RE: 2- What is Technology Integration?

Hi Intern 12,

I see that you've submitted a notebook entry.

Good job on the Your Definition of Technology Integration section

However:

- Your summary of your group meeting discussion did not have the necessary details. Please check if you have all the major points discussed and summarized the points you agreed or disagreed.

You need to summarize the discussion regarding the main points discussed, not list them. You also give more details of the points you agreed and disagreed on.

Please make the above revisions and resubmit the notebook to me by the end of the next work session.

Thanks,

Maggie

Figure 6. Feedback screen 2

Shared Space ▾ Mentor: Admin ▾

Shared Space

User	Title	Type	Created Date
Intern 2	1- Introduction to the Virtual Internship @ STF Notebook	Note	Thu, 4 Oct 2018 11:17 AM
Intern 12	1- Introduction to the Virtual Internship @ STF Notebook	Note	Thu, 4 Oct 2018 11:18 AM
Matt Williams	1- Introduction to the Virtual Internship @ STF Sample Notebook	Note	Thu, 4 Oct 2018 11:18 AM
Matt Williams	1- Introduction to the Virtual Internship @ STF Sample Notebook	Note	Thu, 4 Oct 2018 11:18 AM
Matt Williams	1- Introduction to the Virtual Internship @ STF Sample Notebook	Note	Thu, 4 Oct 2018 11:18 AM
Matt Williams	1- Introduction to the Virtual Internship @ STF Sample Notebook	Note	Thu, 4 Oct 2018 11:18 AM
Matt Williams	1- Introduction to the Virtual Internship @ STF Sample Notebook	Note	Thu, 4 Oct 2018 11:18 AM
Matt Williams	1- Introduction to the Virtual Internship @ STF Sample Notebook	Note	Thu, 4 Oct 2018 11:24 AM
Intern 2	2- What is Technology Integration? Notebook	Note	Thu, 11 Oct 2018 11:00 AM
Intern 14	2- What is Technology Integration? Notebook	Note	Thu, 11 Oct 2018 11:00 AM
Intern 10	4- Investigate Technological Tools Notebook	Note	Thu, 25 Oct 2018 11:02 AM

Figure 7. Shared space of the STF

3.4 Data sources

The quantitative data of the study was gathered from the responses the participants gave to the entrance and exit survey questions, which is an adapted version of the Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009). The same survey was used both at the beginning and at the end of the virtual internship program (see Appendix B). Students took this survey as a part of the human resources department requirement in the STF program.

The survey is adapted from the Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009) by Oner (2017). The original survey aimed to examine the TPACK development and application of preservice teachers majoring in elementary or early childhood education throughout their teacher preparation program, practicum and teaching experiences. The survey was adapted by including items for the foreign language education and psychological counseling and guidance departments by taking expert opinions, and excluding the items for social sciences department. The adapted survey also included additional items to investigate demographical data such as university ID, name and surname, e-mail address and the information of if they had any teaching experience with its description (if they had). The final version of the survey included 55 items, nine of them asking demographic information. It was applied online using the SurveyGizmo web tool.

The survey included six items for TK, three questions for CK (arranged for each department- Mathematics, EFL, Science/ Physics/ Chemistry, Guidance and Psychological Counseling), seven items for PK, four items for PCK, four items for TCK, nine items for TPK, and four items for TPACK. The survey had a 5 point Likert-scales ranging from *strongly disagree* to *strongly agree*. However, since the content knowledge for the different majors is varied, the items of the CK, PCK, TCK, and TPACK domains included a sixth option as 'Not My Major' in order to avoid a possible confusion between the items belongs to each major. Thus, each participant responded to the questions of their own major.

The reliability analyses of the adapted versions of the survey mostly conducted with sample sizes as 294 preservice teachers (Zelkowski et al., 2013) for 62 items, 202 respondents in the case of Abbitt (2011) for 59 items and 124 respondents in the case of the original survey (Schmidt et al., 2009) for 47 items. To assure the reliability of the adapted survey used in this study, Cronbach's alpha value was calculated based on the data of 62 preservice teachers, different from the study participants, who took the 55-

items survey. The results indicated that the Technological Knowledge (TK) subscale had a Cronbach's alpha of .85, the Content Knowledge (CK) subscale had a Cronbach's alpha of .96 for Mathematics, .96 for Science, .92 for Guidance and Psychological Counseling, and .83 for EFL group. The Pedagogical Knowledge (PK) subscale had a Cronbach's alpha of .86 and the Technological Pedagogical Content Knowledge (TPK) subscale had a Cronbach's alpha of .92. A Cronbach's alpha value could not be calculated for the PCK, TCK and TPACK since these subscales involved single-items.

As qualitative data, five reflection questions were prepared in Turkish for the fact that one can reflect their opinions more expressively (Dewaele, 2004; Dewaele and Pavlenko, 2002) and more fluently (Aycicegi and Harris, 2004) in their native language. The reflection questions before the intervention included two questions (see Appendix C) while the post reflections included three additional questions (see Appendix D). The first two questions of the post reflection were the same as the pre reflection questions, and the last three of them included questions about the STF experience.

3.5 Data collection

Before data collection, the approval of the Institutional Review Board and Ethics Committee of the university was received. The data were collected throughout two semesters with the same procedure. The instructor of the course was informed about the study and its timeline. The participants in both of the groups were taking an Instructional Technologies and Material Development course (CET360) which is an introductory course for creating teaching and learning environments using technology. The focus of the course is two-fold: 1) developing a sound understanding of the theoretical foundations of technology-enhanced instructional materials; 2) putting these ideas into practice by designing materials that could be used in your area of teaching. The course had both lecture and lab sections. Participating in the virtual internship program was a requirement of the course, the students were informed about the study before the intervention and permission of the students to use their survey data was obtained. The students attended to the program for 8 weeks, as 2 hours a week. Their survey data were gathered before and after the participation to the virtual internship program and used as the primary data source of the study. The control group, on the other hand, only filled out the pre and post surveys without any participation to the STF experience, while receiving the same content in their regular classes.

3.6 Data analysis

The survey data were analyzed through the quantitative methods. The scores of the items were calculated using guidelines provided by Schmidt et al. (2009) via Excel and then SPSS. Since the measure used a 5 point Likert-scale ranging from strongly disagree to strongly agree, each item response was scored with a value of 1 assigned to strongly disagree, all the way to 5 for strongly agree. The questions under each subscale of the survey were averaged to produce one mean score for each subscale. For each participant, the mean score was obtained for each one of the TPACK components and TPACK itself from both the pre-survey and post-survey.

To answer the first research question (Do the preservice teachers who participate in a virtual internship experience (STF group) differ from those who do not participate (Control group) in their CK, PK, TK, PCK, TCK, TPK and TPACK scores over time (pre and post), a two-way mixed design MANOVA test was used. Prior to conducting the test, nine assumptions of two-way MANOVA were checked and fulfilled in order to avoid from violations of the requirements of the test.

To answer the second research question (Is there a meaningful difference between the pre and the post TK, CK, PK, PCK, TCK, TPK and TPACK scores of the preservice teachers who participate in a virtual internship experience?), a separate one-way repeated measures MANOVA was used to examine whether there are any differences between the TPACK domain scores of the STF group over time. Prior to conducting the test, the assumption check was performed on the STF group data as well. After the test revealed main time effects on the dependent variables, and the univariate test results indicated differences in the TPACK domain scores over time, more follow-up tests were performed to see the degree to which STF group differ for each DV. As the normality of the STF group data was checked with the Shapiro-Wilk test, it was revealed that none of the pre and post interview scores of the STF group were normally distributed. Thus, for all of the seven TPACK domains, Wilcoxon Signed Rank Tests, the non-parametric version of the paired samples t-test, were conducted in order to see the difference in the pre and post survey scores.

To answer the third research question (How do preservice teachers' opinions on integrating technology into educational settings change as they participated in a virtual internship program?), the reflection data were organized as a table and analyzed manually. After a preliminary exploratory analysis of the pre and post reflection data to obtain a general sense of it, a labeling process was carried out in order to select the specific statements that serve for the purposes of the study. After labeling of the ideas, the major themes that participants mostly made reference to in the pre and the post reflection were determined. The prominent themes and the number of the participants that made mention of those themes were compared and contrasted in detail, and they were also given as tables.

CHAPTER 4

RESULTS

Research question 1: Do the preservice teachers who participate in a virtual internship experience (STF group) differ from those who do not participate (Control group) in their CK, PK, TK, PCK, TCK, TPK and TPACK scores over time (pre and post)?

In order to analyze if there is any significant differences at the TPACK domain scores of the two groups, a preliminary two-way mixed design MANOVA test was conducted. To obtain a valid result, nine assumptions required for conducting a two-way MANOVA were checked prior to conducting the test.

Assumption Check for the two-way MANOVA

- The dependent variables CK, PK, TK, PCK, TCK, TPK and TPACK scores were measured at interval level.
- The independent variables consist of two categorical groups. The between-subjects factor variable includes STF and control groups. The within-subjects factor variable includes pre and post scores.
- The independence of observations criterion is also met. There was no relationship between the observations in each group or between the groups themselves. Each participant participated in only one of the groups; therefore, there were different participants in each group.

- The sample size was adequate for MANOVA since there were more participants in each cell than the number of dependent variables analyzed in the study (Tabachnick & Fidell, 1996).
- The cases that included univariate and multivariate outliers were removed from the study. The univariate outliers in the dependent variables were detected through boxplots and four cases (case 6, case 10, case 13 and case 21) were removed from the analysis. In order to check for multivariate outliers, a measure called Mahalanobis distance was used. The Chi-Square critical values table, as a means of detecting if a variable is a multivariate outlier using a criterion of $\alpha = .001$, was used to identify the critical value for Mahalanobis distance, as suggested by Tabachnick and Fidell (2001). The critical value was specified as 27.877 for this study. Two cases were removed from the study for being multivariate outliers (case 14, *MD*= 27. 90947; and case 19, *MD*= 36. 89935). After exclusion of the outliers, the remaining cell size was 38 for the STF group, and 36 for the control group.
- For the assumption of multivariate normality, normality of each dependent variable for all of the groups of two independent variables was tested using the Shapiro-Wilk tests of normality. The test results revealed that TK pre scores, TPK pre scores and PK post scores of the STF group were distributed normally (see Table 1) while other TPACK domain scores were not. Also, TK pre scores, PK post scores, PCK post scores, and TCK post scores of the control group were distributed normally, while other TPACK domain scores were not (see Table 2). However, researchers state that such statistics are robust to violation of multivariate normality as soon as the cell sizes are greater than 30 (Tabachnick & Fidell, 1996; Von Eye and Bogat, 2004).

Table 1. Shapiro Wilk Test Results for the STF Group

	Shapiro-Wilk Statistic	df	Sig.
Pre TK	.971	38	.422
Post TK	.937	38	.033
Pre CK	.845	38	.000
Post CK	.867	38	.000
Pre PK	.929	38	.019
Post PK	.946	38	.066
Pre PCK	.764	38	.000
Post PCK	.695	38	.000
Pre TCK	.880	38	.001
Post TCK	.774	38	.000
Pre TPK	.979	38	.694
Post TPK	.894	38	.002
Pre TPACK	.806	38	.000
Post TPACK	.716	38	.000

- The scatter plot matrices revealed that there was a positive linear correlation between each pair of dependent variables for all combinations of the two independent variables. Therefore, a linear relationship between the dependent variables assumption was met. The homogeneity of variance-covariance matrices assumption was tested using Box's M Test of Equality of Covariance Matrices. The Box's M value of 142.327 associated with a p value of .283, which was interpreted as non-significant based on Huberty and Petoskey (2000) guideline (i.e., $p < .005$). Thus, the covariance matrices between the groups were assumed to be equal for the purposes of the MANOVA (see Table 3).

Table 2. Shapiro Wilk Test Results for the Control Group

	Shapiro-Wilk Statistic	Df	Sig.
Pre TK	.969	36	.394
Post TK	.906	36	.005
Pre CK	.930	36	.025
Post CK	.742	36	.000
Pre PK	.800	36	.000
Post PK	.958	36	.087
Pre PCK	.822	36	.000
Post PCK	.966	36	.337
Pre TCK	.855	36	.000
Post TCK	.948	36	.094
Pre TPK	.627	36	.000
Post TPK	.764	36	.000
Pre TPACK	.931	36	.027
Post TPACK	.716	36	.000

Table 3. Box's M Test of Equality of Covariance Matrices[a]

Box's M	142.372
F	1.075
df1	105
df2	16050.390
Sig.	.283

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Group

Within Subjects Design: time

- A series of Pearson correlations were performed between all of the dependent variables to test the assumption that the dependent variables would be correlated with each other in the moderate range (i.e., .20 - .60; Meyers, Gamst, & Guarino, 2006). The results asserted that there was a meaningful pattern of correlations among the dependent variables ranging between .001 and .608 (*r* <.8). Indeed, there are studies asserting that multicollinearity assumption violation occurs when the correlation among dependent variables is high rather than low. Garson (2012) and Haase and Ellis (1987) stated that the correlation among the variables above .80 signals a possible multicollinearity problem. Based on these studies, there was no multicollinearity between the dependent variables to not to be appropriate for the purposes of MANOVA (see Table 4).

Descriptive statistics for the STF and the Control group indicated that there were increases at the post mean scores for all the seven TPACK domains, without exception, in comparison with pre mean scores of both groups. For the pre scores of the STF group, the lowest group mean score was the TK score (*M*= 3.43, *SD*= .64), while the highest group mean score was the CK score (*M*= 4.31, *SD*= .60). For the post scores of the STF group, the lowest group mean score was still the TK score (*M*= 3.98, *SD*= .56), and the highest group mean score was the PCK score (*M*= 4.53, *SD*= .55) (see Table 5).

Likewise, for the pre scores of the Control group, the lowest group mean score was the TK score (*M*= 3.26, *SD*= .63), while the highest group mean score was the CK score (*M*= 4.23, *SD*= .50). For the post scores of the Control group, the lowest group mean score was again the TK score (*M*= 3.70, *SD*= .69), and the highest group mean score was the PCK score (*M*= 4.42, *SD*= .50) (see Table 6).

Table 4. Pearson Correlations Associated with the Dependent Variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. TK_pre	1.0													
2. CK_pre	.091	1.0												
3. PK_pre	.175	.530	1.0											
4. PCK_pre	.292	.480	.605	1.0										
5. TCK_pre	.340	.311	.409	.528	1.0									
6. TPK_pre	.496	.178	.561	.493	.534	1.0								
7. TPACK_pre	.394	.243	.392	.410	.515	.548	1.0							
8. TK_post	.548	.232	.222	.257	.202	.281	.241	1.0						
9. CK_post	.002	.456	.487	.278	.217	.264	.072	.390	1.0					
10. PK_post	.032	.221	.394	.110	.137	.248	.162	.330	.412	1.0				
11. PCK_post	.001	.369	.263	.412	.072	.074	.002	.344	.479	.336	1.0			
12. TCK_post	.189	.175	.170	.268	.233	.143	.298	.438	.210	.163	.477	1.0		
13. TPK_post	.223	.137	.336	.161	.112	.368	.232	.608	.441	.516	.332	.373	1.0	
14. TPACK_post	.241	.160	.325	.118	.185	.245	.373	.499	.443	.486	.307	.340	.544	1.0

N=74; correlations greater than .10 are statistically significant (p <.01).

Table 5. Descriptive Statistics for the STF Group

	N	Skewness	Kurtosis	Min.	Max.	Mean	Median	SD
Pre TK	38	.416	.368	2.16	5.00	3.43	3.33	.64
Post TK	38	-.042	.710	2.50	5.00	3.98	4.00	.56
Pre CK	38	-.737	1.427	2.33	5.00	4.31	4.16	.60
Post CK	38	-.822	.640	2.66	5.00	4.39	4.33	.58
Pre PK	38	-.654	1.810	2.42	5.00	3.83	3.85	.50
Post PK	38	-.270	1.083	2.71	5.00	4.13	4.00	.47
Pre PCK	38	-.103	-.304	3.00	5.00	4.18	4.00	.60
Post PCK	38	-.604	-.710	3.00	5.00	4.53	5.00	.55
Pre TCK	38	-.083	-.631	2.00	5.00	3.53	4.00	.89
Post TCK	38	-.232	-.536	3.00	5.00	4.24	4.00	.63
Pre TPK	38	.251	.539	2.77	5.00	3.78	3.88	.46
Post TPK	38	.743	-.495	3.77	5.00	4.32	4.22	.35
Pre TPACK	38	-.504	.770	2.00	5.00	4.00	4.00	.69
Post TPACK	38	-.777	-.305	3.00	5.00	4.50	5.00	.60

That is to say, participants of the STF and the Control group rated their technological knowledge (TK) as the lowest at both pre and post interviews. On the other hand, they rated their content knowledge (CK) as the highest at the pre interview, while rating their pedagogical content knowledge (PCK) as the highest at the post interview (see Table 5 and Table 6). Further, the difference between the pre and post scores for all of the TPACK components; except for the CK, were higher in the STF group. Thus, it draws a conclusion that the STF group developed their TPACK more than the control group even though this conclusion is not found statistically significant.

Table 6. Descriptive Statistics for the Control Group

	N	Skewness	Kurtosis	Min.	Max.	Mean	Median	SD
Pre TK	36	.333	-.227	2.16	4.66	3.26	3.16	.63
Post TK	36	-.478	.302	2.00	5.00	3.70	3.74	.69
Pre CK	36	.89	-.783	3.33	5.00	4.23	4.00	.50
Post CK	36	-.479	-.652	3.00	5.00	4.38	4.33	.57
Pre PK	36	-.470	2.765	2.42	4.71	3.76	3.71	.41
Post PK	36	.165	-.345	3.42	4.71	3.99	4.00	.33
Pre PCK	36	-.009	-.101	3.00	5.00	4.19	4.00	.57
Post PCK	36	.353	-1.989	4.00	5.00	4.42	4.00	.50
Pre TCK	36	-.603	.671	2.00	5.00	3.72	4.00	.70
Post TCK	36	-.315	-.564	3.00	5.00	4.31	4.00	.62
Pre TPK	36	-.190	1.380	2.66	4.66	3.80	3.82	.40
Post TPK	36	.310	.502	3.22	5.00	4.20	4.11	.38
Pre TPACK	36	-.415	.432	2.00	5.00	3.94	4.00	.71
Post TPACK	36	-.399	-.590	3.00	5.00	4.33	4.00	.63

A two-way mixed design MANOVA examined the seven TPACK domains as dependent variables (DVs) and time (pre and post) and group (STF and control) as independent variables (IVs). Since homogeneity of variance-covariance matrices assumption was fulfilled, Wilk's Lambda was used as the test statistic (Mertler & Rachel, 2016). Using Wilk's Lambda, the test revealed that there was not a significant interaction effect of time and group on the TPACK domain scores of the participants, Wilk's Λ =.965, F (7, 66) = .344, $p > .05$, partial η^2=.035 indicating a small effect size. Again using Wilk's Lambda, there was not a significant main effect of group variable on the TPACK domain scores, Wilk's Λ = .868, F (7, 66) = 1.432, $p > .05$, partial η^2=.132 indicating a medium effect size. However, the multivariate result was significant for time, Wilk's Λ

=.426, *F* (7, 66) = 12.684, $p<.05$, partial η^2=.574, indicating a meaningful difference in the pre and post TPACK domain scores with a large effect size (see Table 7).

Table 7. Multivariate Test Results for Wilk's Lambda[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Between Subjects	Intercept	.005	1772.947[b]	7.000	66.000	.000	.995
	Group	.868	1.432[b]	7.000	66.000	.208	.132
Within Subjects	Time	.426	12.684[b]	7.000	66.000	.000	.574
	Time * Group	.965	.344[b]	7.000	66.000	.931	.035

a. Design: Intercept + Group
Within Subjects Design: Time

b. Exact statistic

The multivariate test result indicated that group -time factor interaction and group variable did not significantly affect the combined dependent variable of TK, PK, CK, PCK, TCK, TPK and TPACK scores. On the other hand, time variable significantly affected the combined dependent variable of TK, PK, CK, PCK, TCK, TPK and TPACK scores. That is, the results did not reveal a significant difference in the TPACK domain scores between the groups over time (the STF and the Control group). Therefore, the first hypothesis of the study- The preservice teachers who participate in a virtual internship experience (STF group) will differ from those who do not participate (Control group) in their CK, PK, TK, PCK, TCK, TPK and TPACK scores over time (pre and post)- was not supported by the result. However, it revealed a meaningful difference in TPACK domain scores regardless of the group in time (the pre and post).

In order to determine how and which TPACK domain scores differed in time within the STF group, further analyses were conducted to address the Research question 2.

Research question 2: Is there a meaningful difference between the pre and the post TK, CK, PK, PCK, TCK, TPK and TPACK scores of the preservice teachers who participated in a virtual internship experience?

Firstly, a separate one-way repeated measures MANOVA was used to examine whether there are any differences in the TPACK domain scores of the STF group only (as DVs) over time (as within subject variable). Prior to conducting the test, the assumption check was performed on the STF group data.

Assumption Check for the one-way repeated measures MANOVA

- The dependent variables CK, PK, TK, PCK, TCK, TPK and TPACK scores were measured at interval level.
- The independent variable consisted of two categorical groups. Time variable, the within-subjects factor, includes pre and post scores.
- The sample size was adequate for MANOVA since there were more participants in the STF group than the number of dependent variables analyzed in the study (Tabachnick & Fidell, 1996).
- There were no univariate or multivariate outliers. The cell size was 38 for the STF group.
- For the assumption of multivariate normality, normality of each dependent variable for the STF group was tested using the Shapiro-Wilk tests of normality. The test results

revealed that TK pre scores, TPK pre scores and PK post scores of the STF group were distributed normally (see Table 8) while other TPACK domain scores were not. However, researchers state that such statistics are robust to violation of multivariate normality as soon as the cell sizes are greater than 30 (Tabachnick & Fidell, 1996; Von Eye and Bogat, 2004).

Table 8. Shapiro Wilk Test Results for the STF Group

	Shapiro-Wilk Statistic	df	Sig.
Pre *TK*	.971	38	.422
Post TK	.937	38	.033
Pre CK	.845	38	.000
Post CK	.867	38	.000
Pre PK	.929	38	.019
Post PK	.946	38	.066
Pre PCK	.764	38	.000
Post PCK	.695	38	.000
Pre TCK	.880	38	.001
Post TCK	.774	38	.000
Pre TPK	.979	38	.694
Post TPK	.894	38	.002
Pre TPACK	.806	38	.000
Post TPACK	.716	38	.000

- The scatter plot matrices revealed that there was a positive linear correlation between each pair of the dependent variables for the independent variable. Therefore, a linear relationship between the dependent variables assumption was met.

- A series of Pearson correlations were performed between all of the dependent variables to test the assumption that the dependent variables would be correlated with each other in the moderate range (i.e., .20 - .60; Meyers, Gamst, & Guarino, 2006). The results asserted that there was a meaningful pattern of correlations among the dependent variables ranging between .000 and .657 (r <.8). Studies assert that multicollinearity assumption violation occurs when the correlation among dependent variables is high rather than low. Garson (2012) and Haase and Ellis (1987) stated that the correlation among the variables above .80 signals a possible multicollinearity problem. Based on these studies, there was no multicollinearity between the dependent variables to not to be appropriate for the purposes of MANOVA (see Table 9).

Using Wilk's Lambda, one-way repeated measures MANOVA test result revealed a significant time effect over the TPACK domain scores of the STF group, Wilk's $\Lambda = .346$, $F\ (7, 31) = 8.370$, $p = .000$, partial $\eta^2 = .654$ indicating a large effect size (see Table 10).

This result suggests that there is a difference in the seven combined TPACK domains- TK, CK, PK, PCK, TCK, TPK, and TPACK over time -before and after the intervention- when a virtual internship experience was introduced.

Table 9. Pearson Correlations Associated with the Dependent Variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. TK_pre	1.0													
2. CK_pre	.007	1.0												
3. PK_pre	.061	.601	1.0											
4. PCK_pre	.296	.578	.632	1.0										
5. TCK_pre	.571	.473	.484	.613	1.0									
6. TPK_pre	.579	.220	.507	.548	.561	1.0								
7. TPACK_pre	.362	.215	.376	.255	.564	.524	1.0							
8. TK_post	.657	.093	.107	.192	.411	.289	.068	1.0						
9. CK_post	.011	.489	.609	.453	.268	.223	.000	.323	1.0					
10. PK_post	.087	.245	.445	.147	.211	.348	.153	.213	.416	1.0				
11. PCK_post	.090	.352	.152	.344	.026	.011	.278	.240	.568	.218	1.0			
12. TCK_post	.071	.130	.080	.024	.156	.121	.000	.428	.156	.012	.403	1.0		
13. TPK_post	.149	.102	.326	.159	.242	.423	.182	.465	.427	.575	.300	.212	1.0	
14. TPACK_post	.272	.025	.253	.037	.251	.260	.321	.434	.347	.473	.000	.106	.569	1.0

N=38; correlations greater than .10 are statistically significant (p <.01).

Table 10. Tests of Within-Subjects Effects [a, b]

Within-Subjects Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Time	Wilk's Lambda	.346	8.370[c]	7.000	31.000	.000	.654

a. Design: Intercept
Within Subjects Design: time

b. Tests are based on averaged variables.

c. Exact statistic

Since the multivariate significance is found for the time variable, the univariate test results were used to see which DVs differ. A more conservative alpha level was applied using the Bonferroni adjustment (α= .007), a divided α value by the number of dependent variables to counteract the potential of an inflated Type I error rate due to multiple ANOVAs (Tabachnick & Fidell, 1996). The univariate test results revealed that the pre and post scores of the STF group differed significantly for all the TPACK domains except for the CK domain (F (1, 37) = .664, p>.007, partial η^2= .018 indicating a small effect size) (see Table 11).

In order to determine if there is a meaningful difference between the pre and the post TPACK domain scores of the preservice teachers who participated in a virtual internship experience in detail, further follow-up tests were conducted. The normality was checked with the Shapiro-Wilk test, and the pre and post interview scores of the STF group were not normally distributed for any of the TPACK domains (see Table 1). Thus, for all of the seven TPACK domains, Wilcoxon Signed Rank Tests, the non-parametric version of the paired samples t-test, were conducted.

Table 11. Univariate Tests

Source	Measure	Type III Sum of Squares	Df	Mean square	F	Sig.	Partial Eta Squared
Time	*TK*	5.825	1	5.825	45.800	.000	.553
	PK	1.823	1	1.823	13.723	.001	.271
	CK	.118	1	.118	.664	.421	.018
	PCK	2.224	1	2.224	9.941	.003	.212
	TCK	9.592	1	9.592	18.770	.000	.337
	TPK	5.470	1	5.470	54.964	.000	.598
	TPACK	4.750	1	4.750	16.349	.000	.306
Error (time)	TK	4.706	37	.127			
	PK	4.915	37	.133			
	CK	6.603	37	.178			
	PCK	8.276	37	.224			
	TCK	18.908	37	.511			
	TPK	3.683	37	.100			
	TPACK	10.750	37	.291			

Technology Knowledge (TK) Development of the STF Group

The median score on the TK increased after virtual internship experience (*Md* = 4.0) compared to the scores before the treatment (*Md* = 3.3). The Wilcoxon Signed Rank Test revealed a statistically significant increase in the technological knowledge (TK) scores of the preservice teachers after the STF experience, $z = -4.757$ (see Table 12 and Table 13), $p = .000$, with a large effect size ($r = .77$).

Table 12. Wilcoxon Signed Rank Test for TK Improvement

		N	Mean Rank	Sum of Ranks
TK Post- TK Pre	Negative Ranks	4[a]	2.50	10.00
	Positive Ranks	28[b]	18.50	518.00
	Ties	6[c]		
	Total	38		
a. TK_post < TK_pre				
b. TK_post > TK_pre				
c. TK_post = TK_pre				

Table 13. Wilcoxon Signed Rank Test Result

	TK Post- TK Pre
Z	-4.757[b]
Asymp. Sig. (2-tailed)	.000
a. Wilcoxon Signed Ranks Test	
b. Based on negative ranks	

Content Knowledge (CK) Development of the STF Group

The median score on the CK increased after virtual internship experience (*Md* = 4.16) compared to the scores before the treatment (*Md* = 4.33). The Wilcoxon Signed Rank Test did not reveal a statistically significant increase in the content knowledge (CK) scores of the preservice teachers after the STF experience, $z = -.854$ (see Table 14 and Table 15), $p = .393$, with a small effect size ($r = .13$).

Table 14. Wilcoxon Signed Rank Test for CK Improvement

		N	Mean Rank	Sum of Ranks
CK Post- CK Pre	Negative Ranks	11[a]	11.91	131.00
	Positive Ranks	14[b]	13.86	194.00
	Ties	13[c]		
	Total	38		

a. CK_post < CK_pre

b. CK_post > CK_pre

c. CK_post = CK_pre

Table 15. Wilcoxon Signed Rank Test Result

	CK Post- CK Pre
Z	-.854[b]
Asymp. Sig. (2-tailed)	.393

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks

Pedagogical Knowledge (PK) Development of the STF Group

The median score on the PK increased after virtual internship experience (*Md* = 4.00) compared to the scores before the treatment (*Md* = 3.85). The Wilcoxon Signed Rank Test revealed a statistically significant increase in the pedagogical knowledge (PK) scores of the preservice teachers after the STF experience, $z = -3.196$ (see Table 16 and Table 17), $p = .001$, with effect size ($r = .52$).

Table 16. Wilcoxon Signed Rank Test for PK Improvement

		N	Mean Rank	Sum of Ranks
PK Post- PK Pre	Negative Ranks	8[a]	12.75	102.00
	Positive Ranks	25[b]	18.36	459.00
	Ties	5[c]		
	Total	38		
a. PK_post < PK_pre				
b. PK_post > PK_pre				
c. PK_post = PK_pre				

Table 17. Wilcoxon Signed Rank Test Result

	PK Post- PK Pre
Z	-3.196[b]
Asymp. Sig. (2-tailed)	.001
a. Wilcoxon Signed Ranks Test	
b. Based on negative ranks	

Pedagogical Content Knowledge (PCK) Development of the STF Group

The median score on the PCK increased after virtual internship experience (*Md* = 5.0) compared to the scores before the treatment (*Md* = 4.0). The Wilcoxon Signed Rank Test revealed a statistically significant increase in the pedagogical content knowledge (PCK) scores of the preservice teachers after the STF experience, $z = -2.837$ (see Table 18 and Table 19), $p = .005$, with an effect size ($r = .47$).

Table 18. Wilcoxon Signed Rank Test for PCK Improvement

		N	Mean Rank	Sum of Ranks
PCK Post- PCK Pre	Negative Ranks	3[a]	9.00	27.00
	Positive Ranks	15[b]	9.60	144.00
	Ties	20[c]		
	Total	38		

a. PCK_post < PCK_pre

b. PCK_post > PCK_pre

c. PCK_post = PCK_pre

Table 19. Wilcoxon Signed Rank Test Result

	PCK Post- PCK Pre
Z	-2.837[b]
Asymp. Sig. (2-tailed)	.005

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks

Technological Content Knowledge (TCK) Development of the STF Group

The median score on the TCK remained the same after virtual internship experience (*Md* = 4.0) compared to the scores before the treatment (*Md* = 4.0). The Wilcoxon Signed Rank Test revealed a statistically significant increase in the technological content knowledge (TCK) scores of the preservice teachers after the STF experience, $z = -3.561$ (see Table 20 and Table 21), $p = .000$, with an effect size ($r = .57$).

Table 20. Wilcoxon Signed Rank Test for TCK Improvement

		N	Mean Rank	Sum of Ranks
TCK Post- TCK Pre	Negative Ranks	3[a]	14.00	42.00
	Positive Ranks	23[b]	13.43	309.00
	Ties	15[c]		
	Total	38		

a. TCK_post < TCK_pre
b. TCK_post > TCK_pre
c. TCK_post = TCK_pre

Table 21. Wilcoxon Signed Rank Test Result

	TCK Post- TCK Pre
Z	-3.561[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks

Technological Pedagogical Knowledge (TPK) Development of the STF Group

The median score on the TPK increased after virtual internship experience (*Md* = 4.00) compared to the scores before the treatment (*Md* = 3.44). The Wilcoxon Signed Rank Test revealed a statistically significant increase in the technological pedagogical knowledge (TPK) scores of the preservice teachers after the STF experience, $z = -4.980$ (see Table 22 and Table 23), $p = .000$, with a large effect size ($r = .80$).

Table 22. Wilcoxon Signed Rank Test for TPK Improvement

		N	Mean Rank	Sum of Ranks
TPK Post- TPK Pre	Negative Ranks	3[a]	3.25	6.50
	Positive Ranks	32[b]	18.39	588.50
	Ties	4[c]		
	Total	38		
a. TPK_post < TPK_pre				
b. TPK_post > TPK_pre				
c. TPK_post = TPK_pre				

Table 23. Wilcoxon Signed Rank Test Result

	TPK Post- TPK Pre
Z	-4.980[b]
Asymp. Sig. (2-tailed)	.000
a. Wilcoxon Signed Ranks Test	
b. Based on negative ranks	

Technological Pedagogical Content Knowledge (TPACK) Development of the STF Group

The median score on the TPK increased after virtual internship experience (*Md* = 5.00) compared to the scores before the treatment (*Md* = 4.00). The Wilcoxon Signed Rank Test revealed a statistically significant increase in the technological pedagogical knowledge (TPACK) scores of the preservice teachers after the STF experience, z = -3.400 (see Table 24 and Table 25), p = .001, with an effect size (r = .55).

Table 24. Wilcoxon Signed Rank Test for TPACK Improvement

		N	Mean Rank	Sum of Ranks
TPACK Post- TPACK Pre	Negative Ranks	3[a]	10.00	30.00
	Positive Ranks	19[b]	11.74	223.00
	Ties	16[c]		
	Total	38		

a. TPACK_post < TPACK_pre
b. TPACK_post > TPACK_pre
c. TPACK_post = TPACK_pre

Table 25. Wilcoxon Signed Rank Test Result

	TPACK Post- TPACK Pre
Z	-3.400[b]
Asymp. Sig. (2-tailed)	.001

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks

Research Question 3: How do preservice teachers' opinions on integrating technology into educational settings change as they participate in a virtual internship program?

In order to answer research question 3, the qualitative data obtained from the pre and post reflections of the STF group were analyzed. Findings are discussed under each reflection question below.

Reflection question 1: How could technology be effectively integrated into a lesson plan in your own field? Please exemplify. (Turkish: Kendi branşınızda hazırlayacağınız bir ders planı için teknoloji nasıl en etkili şekillerde kullanılabilir? Lütfen örnekler vererek açıklayınız.)

Before the treatment, eight major themes that participants mostly made reference to in the pre reflection were determined. According to the participants, the most effective ways of integrating technology into classroom would happen through: getting students watch videos, using the Internet to search for related lesson materials, visualization of abstract concepts, using educational games and simulations, using applications specific to a particular content (e.g. drawing graphics in mathematics), using online platforms, providing online courses. The themes and the number of the participants that made mention of that theme are given below (see Table 26).

The post data analysis revealed ten themes that the participants mostly made reference to as the most effective ways of integrating technology into classroom. These are getting students watch videos, using the Internet to search for related lesson materials, visualization of abstract concepts, using educational games and simulations, using applications specific to a particular content, using online platforms, using slide shows, implementing technologies that support multiple learning approaches and evaluation made on the Internet (see Table 27).

According to the pre reflection data, ten out of 21 preservice teachers suggested that getting students watch videos relevant to the subject was an effective way of technology integration. While none of them explained the reason for it, only one of them stated that "Most of the concepts of physics are observable and experimental. To make these concepts more understandable, if possible, it is best to conduct experiments in the classroom or laboratory, if not, the videos of these experiments can be viewed at the classroom." (Intern 37).

Table 26. Themes for Pre Reflection Question 1

Pre	
Themes	# of the Participants
Video	10
The Internet	7
Visualization	6
Educational games	5
Simulations	4
Applications	4
Online platforms	2
Online courses	2
Total	40

Table 27. Themes for Post Reflection Question 1

Post	
Themes	# of the Participants
Video	3
The Internet	1
Visualization	3
Educational games	1
Simulations	4
Applications	9
Online platforms	11
Slide shows	7
Multiple learning approaches	3
Internet evaluation	2
Total	44

The post data for the reflection question 1 indicated that the number of the participants who thought that video was an effective way of technology integration prominently decreased to 3 with the difference of participants being tended to explain the reason for it. Intern 27, for example, stated that “Laboratory activities are very important and effective for understanding of physics and the nature. Any lesson with support from the visual elements is beneficial to comprehension of the physical concepts.”

According to the pre reflection data, seven out of 21 preservice teachers stated that integration of the Internet into the lesson plan was an effective way for technology integration. The ways the participants thought the use of the Internet was mostly consisted of using it as a source for lesson materials such as visuals, sound recordings for listening activities, readings, short quizzes, and dictionaries. The number of the participants who mentioned the Internet as a source for materials decreased to 1 at the post reflections.

According to the pre reflection data, six out of 21 preservice teachers suggested that technology integration would be effective if it was used for visualization of abstract concepts. Intern 27 from Mathematics Teaching department stated that “Because mathematics is an abstract phenomenon, students might have trouble in constructing mathematical concepts in their minds. At this point, by using some technological programs that provide visual aid, we can transfer the concepts better. Some programs like Cabri, Geogebra, Sketchpad are good examples for this.” Intern 32 from Science Teaching department explained this idea as “3D visuals and animations would be very helpful in topics related to biology and chemistry. They would make the concepts more comprehensible and help their modeling." Also, Intern 30 stated that "There are programs that make it easier to visualize mathematical formulas. For example, some technologies help drawing a graphic when we enter a mathematical formula. If we use them, it will help students to stress less about the drawing and concentrate on the actual content." The number of the participants who thought technology integration would be effective if it was used for visualization was three at the post reflections. At the post reflections, the three participants mostly mentioned about the visualization of the abstract concepts in mathematics such as parabolas and graphics, how it would be beneficial to use them as facilitators so that students would be more interested in the essence of the matter.

According to the pre reflection data, five out of 21 preservice teachers stated that technology integration would be effective if educational games are involved in the lesson plans. They mostly emphasized that the educational games are both instructive and entertaining. Also, one of the participants stated that learning with educational games would be more permanent (Intern 31). At the post reflections, the number of the participants who stated technology integration would be effective if educational games are involved in the lesson plans was one. Intern 38 stated that "At young ages applying classroom activities that involve educational games can be beneficial in terms of diversifying learning opportunities."

The number of the participants who stated using simulations as effective tools for technology integration was four both at the pre and the post reflections. At the pre reflections they explained the reason for using simulations as they would fill the deficiency of a laboratory and the necessary supplies, while they explained it as a reusable source of information that could explain macro and micro level phenomena at the post reflections.

The number of the participants who stated using applications specific to a particular content or subject of a lesson was four at the pre and nine at the post reflections. At the pre reflection they mostly mentioned about the applications that would be beneficial for classroom activities to learn grammar and increase student motivation while learning the actual content. On the other hand at the post reflection, they were able to give names of the particular applications and what they would be using in detail. The participants named five applications that they'd be using at the pre reflections while they were able to name ten different applications with their specific reasons for use, such as Kahoot, Geogebra, Edmodo, Classdojo, ShowMe, Fino, Skype, Kidsblog, and Goodreads.

One of the most remarkable changes in the pre and post reflections regarding question 1 is that the number of the participants who declared online platforms as an effective technology integration method increased from two to eleven after the STF experience. At the pre reflections, they described an online platform as a medium that the teacher could share some course materials and the students can share up their homework and explorations about a subject. At the post reflections, they explained it more of a medium that the students can share their ideas, make discussions, prepare portfolios (Intern 25), make comments to each other's ideas by getting feedback from teachers (Intern 27, Intern 34, Intern 35, Intern 38), working on cooperative projects (Intern 18), working on a problem via brain storming studies (Intern 38), creating discussion groups that would be time consuming and hard to compose in classroom (Intern 30).

Two of the participants stated that forming online courses as out-of-class activities would be an effective way of technology integration at the pre reflection, while that idea did not appear on the post reflections. Also, three new themes emerged at the post reflections which are using slideshows for the knowledge level learning, using technologies that serve for multiple learning styles and using evaluation tools over the Internet. The seven participants specified slideshows as an effective technological aid to use at the beginning of a lesson in order to inform students about the objectives of the lesson and give the basics of content at the knowledge level. Intern 27 stated that "Narrated slide shows are useful only for the objectives in the knowledge level for its power to present information and relevant visuals directly." Intern 19, who indicated technologies that support multiple learning approaches as effective technology integration, explained his idea by stating that "I would use technologies that support learners with different learning styles and abilities for it to be beneficial for everyone. Applications such as Show Me, Google Docs, and Fino are appropriate for that purpose since they make students love technological support while making them study together as a learning community." And finally, two of the participants stated that they would use the Internet as an evaluation tool by using it to make online quizzes (Intern 22), to send homework, and for grading (Intern 30).

The analysis of the first reflection question data showed that, before the STF experience, the participants had more tendencies to benefit from technology as a source for course materials. For example, they generally perceived videos as an easy-to-access material to meet the deficit of unavailable course materials such as laboratory kits. Similarly, they mentioned simulations as an alternative in case of absence of a laboratory, visuals as a way of transferring abstract materials, and online platforms and lessons as a way of knowledge and course material transfer. On the other hand, at the post reflections, their statements were more mostly associated with integrating technology as a medium. These include viewing videos and simulations as a reusable and time saving way of presenting information, using online platforms for sharing ideas, making discussions, preparing portfolios, giving feedbacks to each other, working on collaborative projects, working on a problem via brain storming exercises, creating discussion groups that would be time consuming and hard to compose in a classroom environment. The number of the participants who considered these technologies as lesson materials were prominently decreased in the post reflection data. In addition to the increase in the number of the ideas about the effective ways of technology integration in a lesson plan, the ideas got diversified with the addition of using slide shows, implementing technologies that support multiple learning approaches and evaluation made on the Internet.

Reflection question 2: Could you state the cases that integration of technology into the instruction would be appropriate and not appropriate? Please exemplify. (Turkish: Teknolojinin öğretime entegre edilmesi sizce hangi durumlarda uygun olur ve hangi durumlarda uygun olmaz? Örnek verebilir misiniz?)

The pre reflection statements of the participants composed seven themes that they thought as the appropriate cases for technology integration and seven themes for the cases that technology integration would not be appropriate. The participants stated that technology integration would be appropriate if it was under teacher's control, provided training for its use to get the students familiar with a particular technology, and used it as a tool for material presentation and application, in any case, if it supports multiple learning styles, for saving of time and in the cases of distance learning. They also stated the cases that technology integration would not be appropriate as: the cases technology is not used for its own purposes/ not used for what it is dedicated to/ not used for the cases it is expected to be helpful , the cases technology integration becomes rather a goal to achieve than an extra help for a regular lesson, used for a lesson that is not appropriate for that technology, not every student reaches technology equally, technology taking the place of a teacher, students not being familiar with that particular technology, and students bringing their own technology (see Table 28).

The post reflection statements of the participants composed six themes that they thought as the appropriate cases for technology integration and six themes for the cases that technology integration would not be. According to post reflection statements, the participants thought the cases that technology integration would be appropriate for the cases it is used as a tool for material presentation and application, in any case, it is used to enhance student motivation, as an assistance to reach objectives, under teacher's control, and to save time. On the other hand, they stated the cases that technology integration would not be appropriate as when it is used as a goal to achieve, if students/teachers are not familiar with that particular technology, if it distracts attention, when not every student reaches technology equally and if it is not applicable to a certain lesson appropriate (see Table 29).

Table 28. Themes for Pre Reflection Question 2

Technology integration is appropriate		Technology integration is not appropriate	
Themes	# of the Participants	Themes	# of the Participants
Under teacher's control	6	Not used for its own purposes	4
Provided training for its use	5	When it becomes rather a goal than a help	4
Used as a tool	4	Not applicable to certain lessons	3
In any case	4	Not every student reaches technology equally	2
Supports multiple learning styles	2	Takes the place of a teacher	1
For saving of time	2	Students not familiar with technology	1
For distance learning	1	Students bring their own technology	1
Total	23		16

One of the most remarkable differences between the pre and post reflection statements is that the number of the participants who thought the technology integration should be under teacher's control decreased from 6 to 1 at the post reflections. At the pre reflections their concern about technology integration was mostly about the possible challenges technology bring along such as difficulties in classroom management (Intern 25, Intern 33, Intern 35) and distract students in young ages (Intern 18, Intern 38). At her pre reflection Intern 20 stated that if a teacher does not guide her students on how to use technology and does not prepare the materials before the class, technology integration would not serve its purposes and would not be appropriate. However, at the post reflection she stated “When we are integrating technology into our classes, it has to serve as a help to reach the lesson objectives. Even though its nature depends on the dynamics of each lesson, there should be a time limit for technology use. For example, a teacher might want her students to take photos of all spherical objects in the class for ten minutes instead of just let them do whatever they want with that technological tool.”

Table 29. Themes for Post Reflection Question 2

Technology integration is appropriate		Technology integration is not appropriate	
Themes	# of the Participants	Themes	# of the Participants
Used as a tool	6	Used as a goal	6
In any case	4	Students not familiar with technology	5
To enhance student motivation	2	Teachers not familiar with technology	3
As an assistance to reach objectives	1	Distracting attention	3
Under teacher’s control	1	Not every student reaches technology equally	1
For saving of time	1	Not applicable to certain lessons	1
Total	15		19

Also, more references were made at the post reflections to using technology as a tool instead of making it a goal to achieve. At her post reflection Intern 27 stated “The goal should not be learning the technology itself. It can distract students from lesson.” Also Intern 18 stated that “Learning technology is not a goal for us, we should benefit from it as a tool when we want to present a material or make some applications otherwise we would not be able to do.” Intern 35 explained it as “Our goal is meaningful learning to happen through instructional objectives, not to teach students how to use technology. We should not be teaching how a technological device works."

The number of the participants who think technology integrated into a lesson should be familiar to students and teachers also increased at the post reflections. They mostly explained it by stating that if students are not familiar with a particular technology, they first have to learn how to make use of it. This would cause an extra cognitive load for students (Intern 8, Intern 36). If they need teacher guide, if the teacher also is not familiar with it, that would only be time consuming and inefficient (Intern 18, Intern 34).

At the post reflections, they also mentioned that if a technological tool distracts students' attention more than directing them to instructional objectives it might not be an appropriate technological aid (Intern 21, Intern 27, and Intern 38). There were four participants who thought that technology should be integrated to a lesson in any case, and there was no case that it would not be appropriate. They mostly explained the statement 'in any case' by stating that many technologies are available in these days and in any case teachers might select technologies that could be helpful (Intern 22, Intern 25, Intern 32). Also, Intern 37 explained her idea as "I cannot think of a case that technology integration would be inappropriate. Even the printed books require a technological support. We cannot print even a book without printers. In this century, it is not possible to break off the relation between education and technology."

The number of the participants who thought that integration of technology would not be appropriate for some subjects decreased from 3 to 1. At the pre reflections, Intern

28 attributed her idea to technological limitations at some points as "Technological opportunities might be helpful at a wide range of lessons such as history, mathematics, and geography. However, when it comes to classes like painting, technology integration would not be that helpful because such subjects are mostly related to someone's handicraft and reflection of their inner world." She changed her idea at her post reflection by stating that "Technology can be integrated into any subject. On the other hand, concepts like social relationships, loyalty, helping each other are and should be experiential. Technology integration in these areas might not be that helpful because they are not instructional."

The analysis of the pre reflection data of the reflection question 2 showed that the preservice teachers mostly thought integration of technology as appropriate when it was used under teacher control, and if the necessary training for its use was provided. They also asserted that technology integration would not be appropriate if that technology was not used for its own purposes meaning using it not for the cases it is expected to be helpful. Having looked at the consistency between these statements, it would not be wrong to conclude that the preservice teachers thought technology integration is appropriate if students are familiar with that technology so that they would not be struggling with how to use it; otherwise using that technology becomes a goal rather than instructional objectives, and if a particular technology is serving for the purposes of instructional objectives by addition of teacher control. The post reflection results also showed similar but more powerful claims about using familiar technologies as a tool not as a goal to achieve, while none of the preservice teachers made an emphasis on teacher control.

The remaining three reflection questions were asked only on post reflections as they are related to their virtual internship (STF) experience.

Reflection question 3: What did you learn about technology integration as a result of the lesson plan that you prepared as a group? (Turkish: Grup olarak hazırladığınız ders planı sonucunda teknolojinin öğretime entegrasyonuna yönelik neler öğrendiniz?)

All of the participants stated that STF experience made them learn about technology integration and look at it from different perspectives. Eight of them specified that they learned about how to select a technology that fit the instructional purposes by considering the advantages, disadvantages and limitations that they would bring about. Six of the participants stated that they learned about new platforms and applications that could be helpful in their subject area that they had not heard of before. Intern 32 stated that "I was very surprised when I found out how many different applications with rich content were available to be used as free and easily accessible." Three of them stated that they changed their mind about technology integration in a lesson. Intern 28 stated "I used to think that technology integration into a lesson was difficult and dispensable. After the STF experience, I think that instruction cannot fully be separated from technology and technology integration increases quality of instruction and leads to better learning opportunities." Similarly, Intern 35 stated that "Even though I had prejudice about technology before I started to the STF, now I think technology is a real support for instruction. While we were preparing our lesson plan as a group, we never selected a technology randomly. We always thought about its contribution to the instructional objective we were trying to achieve or a misconception that we were dealing with. Our discussions as a group over the selection of a particular technology that served our purposes were very helpful about preparing a proper lesson plan." Four of them specified that they realized how important integrating technology into their lesson plan was and that they could get help from technology in any activity. They also asserted that technology integration would help a teacher with keeping students' attention on the instructional objectives (see Table 30).

Table 30. Themes for Post Reflection Question 3

Post	
Themes	# of the Participants
I learned about how to select a technology that fit the instructional purposes by considering advantages, disadvantages and limitations.	8
I learned about new platforms and applications.	6
Technology integration would help a teacher with keeping students' attention.	4
I realized how important integrating technology into their lesson plan.	4
I changed my idea about technology integration in a lesson.	3

Reflection question 4: Does technology integration differ depending upon the instructional objectives and teaching methods? Could you give examples? (Turkish: Öğrenme kazanımlarına ve öğretim stratejilerine bağlı olarak teknoloji kullanımı değişiklik gösterebilir mi? Örnek verebilir misiniz?)

All of the participants stated that technology integration would change depending upon the instructional objectives and teaching methods. Their explanations for this statement mostly concentrated on whether the teaching methods were designed for cooperative learning or individual learning (Intern 25), different subjects, topics and objectives would require different technological aid (Intern 19, Intern 23, Intern 24, Intern 28), whether teaching strategy is teacher centered or learner centered (Intern 30), the importance of using technologies that support different learning styles (Intern 15, Intern 16), how long would it take to accomplish that objective and whether it requires out-of-school support (Intern 26), and the level of the objective (Intern 27). Intern 27 explained her ideas as “Technology integration definitely changes according to the instructional objectives and teaching methods. For example, using technologies that would be helpful for lower level objectives in order to achieve higher level objectives would only be time-consuming. Using slideshows for an objective in analysis level would not have any meaning.” Intern 33 also stated that “Teaching strategies specify the technology that would be integrated to the lesson. Therefore, technology selection would change according to the instructional strategies. For example, direct instruction requires teachers to be more active in a lesson; therefore technologies that provide support for team work would not be very appropriate for that kind of a teaching strategy.”

Reflection question 5: In what ways could your STF experience be a guide for you to integrate technology in your lessons when you become a teacher? (Turkish: Katıldığınız STF stajyerlik deneyimi, öğretmen olduğunuzda derslerinizde teknoloji entegrasyonu konusunda size ne şekillerde yol gösterici olabilir?)

All of the participants stated that the STF experience was informative for their future teaching. Nine of the participants pointed out that the STF experience would help them preparing technology integrated lesson plans. Intern 21 stated that “It helped me a lot about preparing a lesson plan. I learned how to prepare a more organized and technology-integrated lesson plan. I had chances to think about how I could integrate technology into any part of a lesson more efficiently, and came to some conclusions about it. I think these experiences will help me prepare in-class activities in the future." Seven of them indicated this experience was very helpful about learning how to select the most appropriate technologies for the instructional objectives they would want to accomplish; six of them stated that they learned about new platforms and applications that they will be using in their real teaching experiences. Intern 32 "I used to worry about how to find the technological tool that would be best choice for the instructional objectives and the subject. Now, I know resources to look at and what to do. The team sharing was very helpful about it. The encouraging studies that we worked on for weeks convinced me about the practicality of technology integration." Three of them stated that they learned about new instructional methods to be used in the future, while two of them said that they were now more ready for preparing lesson plans that would meet different learning needs and styles by the help of technology. Intern 22 stated that "Thanks to my STF experience, I learned about how to prepare a more organized and systematic lesson plan for the students with different learning styles. By integrating technology into a lesson plan, I can make my lessons more effective and easy to learn. I will definitely use this knowledge in my real teaching practice." Finally, one of them stated that the STF experience helped him learn about time management strategies in a lesson plan.

The analysis of the reflections show that the participants found the STF experience helpful in different areas that they had difficulty in such as how to integrate technology in any lesson plan, how to know which technology will be the most appropriate for a particular learning objective, learning about new educational applications and platforms and instructional methods, and also preparing lesson plans that meet different learning needs and suit for different learning styles. They started to think technology rather as a medium than a source of lesson materials. They increased the number and the diversity of their ideas, made more powerful and TPACK oriented claims on technology integration by always laying emphasis on instructional objectives. Thus, it can be said that these results also support the quantitative survey analysis by pointing developments in the TPACK domains.

CHAPTER 5

DISCUSSION AND CONCLUSION

The present study examined the effect of the use of a virtual internship (STF) on the TPACK development of the preservice teachers. The study was conducted in an English-medium university, with 74 preservice teachers in their junior or senior years. The findings of the study suggested that the preservice teachers who participated in the virtual internship and those who did not participate in the virtual internship differed in their development of TPACK and TK, CK, PK, PCK, TCK, TPK components; however, the differences were not statistically significant.

Further analyses indicated that the STF group significantly increased their knowledge in the six TPACK domains- TK, PK, PCK, TCK, TPK and TPACK. However, they did not significantly increase their CK at the end of the STF experience. Also, the analysis of the pre and post reflections showed that the participants enhanced their understanding and conceptualization of technology integration, while all of the participants found the STF experience helpful for their future teaching practice.

5.1 The effect of the treatment condition

The analysis showed that the two groups (the STF and the Control) differed in their development of TPACK and TK, CK, PK, PCK, TCK, TPK components while the differences were not statistically significant. Although the difference in the combined TPACK variable is not significant between the two groups, it should be noted that, this result would not mean that there is no difference at all. The descriptive data of the two groups show that there is a difference in the mean scores of the two groups in pre and post surveys; however, the analysis of the data shows that this difference is not enough to mean a statistical significance. The post mean scores of the STF group are greater than the control group in all TPACK domains, with the exception of the TCK domain and the gain scores of the STF group are greater than the control group in all TPACK domains, with the exception of the CK domain (see Table 31).

Table 31. Mean Score Differences of the Groups

Group	STF			Control		
	Pre	Post	Score Gain	Pre	Post	Score Gain
TK	3.43	3.98	0.55	3.26	3.70	0.44
CK	4.31	4.39	0.08	4.23	4.38	0.15
PK	3.83	4.13	0.30	3.76	3.99	0.23
PCK	4.18	4.53	0.35	4.19	4.42	0.23
TCK	3.53	4.24	0.71	3.72	4.31	0.59
TPK	3.78	4.32	0.54	3.80	4.20	0.40
TPACK	4.00	4.50	0.50	3.94	4.33	0.39

The non-significance was not an expected result as specified in the first hypothesis of the study indicating that the two groups would differ in their TPACK development. However, it should be noted that not any study that investigated the effectiveness of a virtual internship with the inclusion of a control group took place in the literature up to today. This hypothesis was grounded on the former findings of the related studies that mostly manifested the effectiveness of virtual internships in knowledge development, content learning, making justifications and positive attitude development toward a subject (Arastoopour et al., 2014; Bagley& Shaffer, 2009; Bagley& Shaffer, 2011; Beckett & Shaffer, 2005; Chesler et al., 2013; Hatfield, 2011; Nash, Bagley, & Shaffer, 2012; Nash& Shaffer, 2012; Nulty & Shaffer, 2008; Shaffer, 1997; Svarovsky & Shaffer, 2006). Thus, the hypothesis was based on the findings of the previous literature which never made comparisons with a control group.

The reason for no significance between the two groups might be attributed to the similar course content of the control group to the experimental group's. As the students of the two groups took the same course, the content of the course was very similar while the methodologies used in the course differed. During the course, the control group also studied on projects aiming the participants to work collaboratively and produce instructional multimedia and on the projects aiming to develop technology integrated lesson plans. Even though the control group did not receive the treatment- participation in the STF-, they had many opportunities to develop their TPACK skills throughout the semester. Thus, it is safe to say that the two groups did not differ significantly in their TPACK development maybe because both of them made significant developments in the context of TPACK.

5.2 TPACK development of the STF group

The findings suggested that the preservice teachers who participated in the virtual internship significantly improved their knowledge in TPACK domains. This result is in the same direction with the previous literature that link knowledge improvement and use of virtual internships (Bagley & Shaffer, 2009). As Shaffer (2004c) revealed the significance of a virtual internship, Pandora Project, in improving the high school students' understanding of xenotransplantation, and as Nash and Shaffer (2012) indicated the effect of Land Science in improving the senior high school students' understanding of city planning and ecology, the STF also improved the preservice teachers' knowledge of TPACK and its components. Another study on a virtual internship, Escher's World, also indicated that the high school students developed their knowledge of symmetry and visual thinking in mathematics during the workshops they attended to (Shaffer, 1997). Thus, it can be concluded that the findings of the STF study is also consistent with the related literature with respect to its power on knowledge improvement.

While most of the studies on virtual internships use qualitative data involved chat records of the participants completing the tasks, this study took advantage of qualitative data obtained from additional reflection tasks given to the participants outside the virtual internship. In line with the previous findings in the literature, the analysis of the participant reflections also revealed the effectiveness of the virtual internship over the knowledge improvement and in the positive change of their attitude toward technology integration (Arastoopour et al., 2014; Nash & Shaffer, 2012).

One of the issues that should be addressed is the non-significance of CK development of the STF group while they made significant improvement in the other TPACK domains. The reason for no significant development in the CK domain between the pre and post survey might be due to the fact that the mean score (M= 4.31) for the CK domain was already high in the pre survey results (see Table 5). Indeed, the highest mean score at the pre surveys of the STF group was the CK domain. Therefore, even if the participants benefited from the STF experience, it might not have showed up in the results in terms of CK development. Indeed, there is an increase in the CK mean score at the post surveys (*M*= 4.39), while not meaning a statistically significant development.

Furthermore, it should be noted that the STF is not a virtual internship that is designed to develop general content knowledge of the facts, concepts, theories, principles, procedures, and the structure of a subject matter. Mishra and Koehler (2006) also argues that an educational program should not be intended to teach a particular content, pedagogy or technology separately; rather, the interplay between them should be taken into consideration. Therefore, the STF provides a setting to study on the content knowledge in the context of pedagogical and technological knowledge; therefore, it does not provide exact opportunities for the content knowledge development. To elaborate, the Room 7 assignments ask each student to research on their team's instructional topic to find out about why that topic is important for students to learn, the misconceptions or learning difficulties connected with it. Also, they meet to discuss how the nature of their topic has implications for instructional planning. This assignment also make students think about the teaching strategies that can be used to support student learning and to address the difficulties (make use of PCK) and how technology can help to support student learning and in addressing the difficulties associated with teaching this topic (make use of TCK and TPK). Therefore, it can readily be told that the STF does not provide opportunities for developing TPACK domains separately; it provides opportunities for developing TPACK domains in an interactional manner.

Aside from the findings of this study being in compliance with the findings of the previous studies, this study differs from the most by sampling of the college students. The majority of the previous studies sampled the high school or middle school students (Bagley & Shaffer, 2009; Bagley & Shaffer, 2011; Beckett & Shaffer, 2005; Hatfield, 2011; Nash, Bagley, & Shaffer, 2012; Nash& Shaffer, 2012; Nulty & Shaffer, 2008; Shaffer, 1997; Svarovsky & Shaffer, 2006) in order to check the effectiveness of the virtual internships. As one of the studies which sampled the college students, Nephrotex, developed for and tested with engineering students, also demonstrated a significant increase in learning engineering content (Arastoopour et al., 2014; Chesler et al., 2013). In line with the results of these studies, the current study which sampled preservice teachers also revealed a knowledge improvement in TPACK domains.

This study also differed in terms of the number of the participants. The previous studies on virtual internships were mostly conducted with small sample sizes. The Pandora Project study included eleven high school students (Shaffer, 2004c), the Land Science included twelve middle school-aged students (Bagley & Shaffer, 2009) and fourteen middle-aged students (Nash& Shaffer, 2012), the Escher's World included six high school students and the Science.net included fourteen middle school-aged students (Hatfield & Shaffer, 2006) while The Nephrotex included 45 engineering students (Chesler et al., 2013). The data analysis of these studies mostly conducted with qualitative methods. As stated by Creswell (2012), it is typical to use small sample sizes in qualitative studies in order to provide in-depth analysis and because analyzing it takes considerable time. Since this study mostly benefits from the quantitative data obtained from the surveys, the sample size was kept accordingly large. With the 74 participants including 38 participants who used the virtual internship; this study is powerful in terms of its sample size, and therefore, its power in the yield of statistical significance and confidence in results (Patel, Doku & Tennakoon, 2003).

5.3 The TPACK development seen on the reflections

The findings of the reflections were in line with the previous literature in terms of knowledge development. As many of the research conducted on virtual internships consisted of qualitative studies, their data sources mostly included student interviews and reflections. Consistent with the quantitative findings, the TPACK development of the participants of this study was also seen in the reflections. As indicated in the results of a study conducted on the virtual internship Land Science, the number of the references students made on the content- related concepts was increased in the post interviews (Nash, Bagley, & Shaffer, 2012; Svarovsky & Shaffer, 2006), the number and the diversity of the ideas about technology integration in the lesson plans was increased in this study. The results also suggested that the STF helped them develop a more professional way of thinking. They used more definitive examples, and the complexity of a classroom environment was clearer in their reflections after the STF experience.

The changes did not only appear on TPACK development, as the majority of the findings in the studies of virtual internships indicated, a virtual internship makes the participants develop a more positive attitude toward a profession or a matter (Arastoopour et al., 2014; Nash & Shaffer, 2012). All of the participating students stated that their opinions for mathematics changed in a positive way as they participated in the

Escher's World (Shaffer, 1997). Also, in the study of Chesler et al. (2013), the participating students indicated that they developed a positive attitude toward a career in engineering as they participated in the Nephrotex. Similarly, all of the participants of this study indicated that the STF experience made them learn about technology integration and look at it from different perspectives. Intern 23 also stated that "The STF made me look at technology integration from different angles. I used to think that technology integration is troublesome and time-consuming because I had to know each technological aid in detail and also how to use it. Now, I changed my opinion in a positive way as I learned about many technological tools and their efficient integration. Also, I see how it is worth knowing how to integrate technology when I think about its benefits on achieving instructional objectives and overcoming existing misconceptions of students."

5.4 Recommendations and the implications for future research

The present study makes contribution to the TPACK development research in the following ways. At first, it provides an evaluation for a new method that has not been tested in the literature which is using a virtual internship. What separates a virtual internship from other methods that have been used before such as online courses conducted through virtual classrooms, design-based courses, intervention programs based on educational models, and integrated approaches which combine educational technology courses with other applications, is that it provides opportunity for reflective practice. As argued by Dewey (2013) and Schön (1985), learning happens when someone is trying to achieve a meaningful goal while overcoming obstacles within this period. Schön (1985) also describes professionals as people who think in action in the professional practicum, the environment in which a learner has opportunities to act like a professional in a controlled environment and to reflect on the consequences of his/ her actions with peers and mentors. As the aim of the virtual internships is to train novices of a profession to make them professionals, and the major factor in turning user actions into understanding in real world is reflection (Shaffer et al., 2009), they give the users opportunities for taking a step back what has been done and talk with mentors and peers about what worked, what did not work, and why (Shaffer, 2004). Thus, the learners have the opportunity for being mentored with a virtual internship as in a practicum experience.

Secondly, the findings of this study support the previous literature and extend our knowledge about the use of a virtual internship in developing the professional thinking of college students. Especially, being the first virtual internship designed for the professional development of preservice teachers, the study provides the first impressions and implications for the future related research. Particularly, it is seen that the STF was effective in developing TPACK of preservice teachers. The combination of quantitative and qualitative findings provides a premise for the use of a virtual internship in TPACK development studies.

Thirdly, by including a control group to see whether using a virtual internship makes a difference in TPACK development with respect to the traditional methods, the current study made a contribution to the research on virtual internships as well. Though a statistically significant increase in the TPACK development was not detected in this study, further research should be conducted with the control groups in order to see the effectiveness of the virtual internship by providing more well-coordinated research designs. Since this study was conducted in a public university and the participating students had to learn the course content under equal terms, the two groups may not have sufficiently differed in treatment conditions. Thus, further analysis and retesting is needed to see the virtual internship's efficiency over other conditions such as traditional course methodologies.

Finally, by considering the technological opportunities and the need for technology integration in different subject matters, further studies can be conducted to see the effect of a virtual internship on different subjects. As the availability and the size of the sample of this study is not enough to further investigate the degree to which participants from different departments developed their TPACK, more studies should be conducted to see differences in various departments.

5.5 Limitations of the study

This study had some limitations. First, the previous literature used observations and interviews as data sources. This study only used a self-report measure and reflections as the way of data collection. The diversity in data sources might have revealed more detailed findings in terms of educational setting, the laboratory environment during the STF sessions and the discussions that students made between each other and did not reflect on the STF platform.

The teaching profession itself comprises several disciplines, and each discipline requires varying sets of knowledge and skills. For example, Guidance and Psychological

Counseling department does not have a pedagogical knowledge as in the means of other disciplines' pedagogical knowledge patterns such as classroom management, student content learning and methods and techniques of teaching. This study did not address the differences in the knowledge patterns of different disciplines such as the pedagogical knowledge differences in the Guidance and Psychological Counseling and the other departments. Therefore, the future studies should investigate the different knowledge patterns among the disciplines.

APPENDIX A

SCHOOL OF THE FUTURE TASKS (Oner, 2017)

Room	**Individual Work**		**In Class**	**Deliverable**
	Before Class	**In Class**	**Group Work**	
1- Introduction to the Virtual Internship at STF		-Interns read the workflow tutorial (Resource provided: Internship Workflow). -Interns complete the entrance interview (Resource: Link for the entrance interview).		-They summarize the school workflow. (Complete in class) - They record they complete the entrance interview. (Complete in class)
2- What is Technology Integration		Interns investigate resources (below) to understand the concept of "technology integration". (In 30 minutes) (Resources: Chart for technology integration definition Chart for technology use vs technology integration)	They then meet online to discuss the differences between technology integration and technology use. (In 30 minutes)	-They need to summarize their meeting discussion. - They need to write their definition of technology integration. (Complete in class)

Room	Individual Work		In Class	Deliverable
	Before Class	In Class	Group Work	
3- Developing Thinking Skills for the Future	They get assigned to the resources for reading.	Interns examine thinking skills needed for 2020 (Skills of the Future). (In 30 minutes)	Interns discuss the meaning of these skills and how to develop them in a meeting. (In 30- 40 minutes)	-They summarize meeting discussion. (Complete in class) - They submit the team work.
4- Investigate Technological Tools	Each intern must research one technological tool and each team member submits a NB report (shared space) on a different tool. (Submit before the class)		Team needs to meet to discuss which of these two tools they could use in their lesson plan and why. (In 30-45 minutes)	-They submit a technological tool report before the class. -They submit a summary of team discussion -explaining what two tools they picked and why -explaining instructional and/or pedagogical reasons in class.
5- Team Initial Instructional Plan			They work on Team Initial Instructional Plan based on the given template.	-Team submits the list contributing members to the team IP. - Each team member submits their Team Initial Instructional Plan as an attachment.

Room	Individual Work		In Class	Deliverable
	Before Class	In Class	Group Work	
6- Investigate Theories of Learning	Interns investigate two theories of learning (one familiar one unfamiliar). (Submit before the class)		Team meets to discuss learning theories and their implications for instructional planning. (In 30-45 minutes)	-Each intern submits definitions of learning according to the two theories (also adds to the shared space). -They submit summary of meeting discussion.
7- Investigate Team IP Topic	They research their team's instructional topic by finding credible resources.		Team meets to discuss how the nature of their topic has implications for instructional planning. (In 30-45 minutes)	-They submit their research notes on their instructional topic before the class. - They submit summary of meeting discussion. (Complete in class)
8- Team Final Instructional Plan		Interns complete the exit interview.	They start working on Team Final Instructional Plan based on the given template.	-They list contributing members. -They submit final work. (Complete in class) - They complete the entrance interview. (Submit until the due date)

APPENDIX B

ENTRANCE / EXIT INTERVIEW AT STF

Thank you for taking time to complete this entrance interview. Please answer each question to the best of your knowledge. Your responses will be kept completely confidential and will not influence your internship performance record.

DEMOGRAPHIC INFORMATION

1. Your BU ID:

2. Your name & surname:

3. Your e-mail address:

4. Gender

a. Female

b. Male

5. Age range

a. 17-22

b. 23-26

c. 27-32

d. 32+

6. Major

a. Primary Education -Math

b. Primary Education -Science

c. Mathematics & Science -Math

d. Mathematics & Science -Physics

e. Mathematics & Science -Chemistry

f. Foreign Language Education

g. Guidance and Psychological Counseling

h. Other

7. Year in College

a. Freshman (1st year)

b. Sophomore (2nd year)

c. Junior (3rd year)

d. Senior (4th year)

e. 5th year +

8. Do you have any teaching experience (including internship experience)?

a. Yes

b. No

9. If yes, please describe your teaching experience.

Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc.

Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"

TK (Technology Knowledge)

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
I know how to solve my own technical problems.					
I can learn technology easily.					
I keep up with important new technologies.					
I frequently play around the technology.					
I know about a lot of different technologies.					
I have the technical skills I need to use technology.					

Regarding questions 16-24, please answer only the questions related to your major. For others mark “Not My Major”

CK (Content Knowledge)

Mathematics					
I have sufficient knowledge about mathematics.					
I can use a mathematical way of thinking.					
I have various ways and strategies of developing my understanding of mathematics.					
EFL					
I have sufficient knowledge about EFL studies.					
I can use EFL way of thinking.					
I have various ways and strategies of developing my understanding of EFL.					
Science / Physics / Chemistry					
I have sufficient knowledge about science/ physics/ chemistry.					
I can use a scientific way of thinking.					

I have various ways and strategies of developing my understanding of science / physics / chemistry.					
Guidance and Psychological Counseling					
I have sufficient knowledge about guidance and psychological counseling.					
I can use a way of thinking used by counselors.					
I have various ways and strategies of developing my understanding of guidance and psychological counseling.					

Please continue answering all the questions

PK (Pedagogical Knowledge)

I know how to assess student performance in a classroom.					
I can adapt my teaching based-upon what students currently understand or do not understand.					
I can adapt my teaching style to different learners.					
I can assess student learning in multiple ways.					

I can use a wide range of teaching approaches in a classroom setting.					
I am familiar with common student understandings and misconceptions.					
I know how to organize and maintain classroom management.					

Please answer only the questions related to your major. For others mark "Not My Major"

PCK (Pedagogical Content Knowledge)

I can select effective teaching approaches to guide student thinking and learning in mathematics.					
I can select effective teaching approaches to guide student thinking and learning EFL					
I can select effective teaching approaches to guide student thinking and learning in science /physics /chemistry.					
I can select effective counselling approaches to support development of students.					

TCK (Technological Content Knowledge)					
I know about technologies that I can use for understanding and doing mathematics.					
I know about technologies that can assist and enhance teaching English as a foreign language					
I know about technologies that I can use for understanding and doing science /physics /chemistry.					
I know about technologies that I can use for understanding psychology and doing guidance and psychological counseling.					

Please continue answering all the questions

TPK (Technological Pedagogical Knowledge)

I can choose technologies that enhance the teaching approaches for a lesson.					

I can choose technologies that enhance students' learning for a lesson.					
My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
I am thinking critically about how to use technology in my classroom.					
I can adapt the use of the technologies that I am learning about to different teaching activities.					
I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.					
I can choose technologies that enhance the content for a lesson.					

Regarding questions 49-51, please answer only the question related to your major.

For others mark “Not My Major”

TPACK (Technology Pedagogy and Content Knowledge)

I can teach lessons that appropriately combine mathematics, technologies and teaching approaches.					
I can teach lessons that appropriately combine EFL, technologies and teaching approaches.					
I can teach lessons that appropriately combine science (physics / chemistry), technologies and teaching approaches.					
I can do guidance and counselling that appropriately combine psychology, technologies and counseling approaches.					

APPENDIX C

PRE- REFLECTION QUESTIONS

1) Kendi branşınızda hazırlayacağınız bir ders planı için teknoloji nasıl en etkili şekillerde kullanılabilir? Lütfen örnekler vererek açıklayınız.

   (How could technology be effectively integrated into a lesson plan in your own field? Please exemplify.)

2) Teknolojinin öğretime entegre edilmesi sizce hangi durumlarda uygun ve hangi durumlarda uygun olmaz? Örnek verebilir misiniz?

   (Could you state the cases that integration of technology into the instruction would be appropriate and not appropriate? Please exemplify.)

APPENDIX D

POST- REFLECTION QUESTIONS

1) Kendi branşınızda hazırlayacağınız bir ders planı için teknoloji nasıl en etkili şekillerde kullanılabilir? Lütfen örnekler vererek açıklayınız.

   (How could technology be effectively integrated into a lesson plan in your own field? Please exemplify.)

2) Teknolojinin öğretime entegre edilmesi sizce hangi durumlarda uygun ve hangi durumlarda uygun olmaz? Örnek verebilir misiniz?

   (Could you state the cases that integration of technology into the instruction would be appropriate and not appropriate? Please exemplify.)

3) Grup olarak hazırladığınız ders planı sonucunda teknolojinin öğretime entegrasyonuna yönelik neler öğrendiniz?

   (What did you learn about technology integration as a result of the lesson plan that you prepared as a group?)

4) Öğrenme kazanımlarına ve öğretim stratejilerine bağlı olarak teknoloji kullanımı değişiklik gösterebilir mi? Örnek verebilir misiniz?

   (Does technology integration differ depending upon the instructional objectives and teaching methods? Could you give examples?)

5) Katıldığınız STF stajyerlik deneyimi, öğretmen olduğunuzda derslerinizde teknoloji entegrasyonu konusunda size ne şekillerde yol gösterici olabilir?

   (In what ways could your STF experience be a guide for you to integrate technology in your lessons when you become a teacher?)

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