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Examining the Development of TPACK and the Use of SQD Strategies in Teacher Education Programs

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EXAMINING THE DEVELOPMENT OF TPACK AND THE USE OF SQD STRATEGIES IN TEACHER EDUCATION PROGRAMS

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By

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ABSTRACT

EXAMINING THE DEVELOPMENT OF TPACK AND THE USE OF SQD STRATEGIES IN TEACHER EDUCATION PROGRAMS

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Triantafyllia Sarri

May 2021

Dissertation supervised by Carol Parke, Ph.D.

The purpose of this quantitative study is to investigate the impact of technology training offered by teacher education programs on preservice teachers' TPACK development. Specifically, the study aims to investigate how the SQD strategies of: 1) teacher educators acting as role models, 2) learning technology by design, 3) collaborating with peers, 4) scaffolding authentic experiences, 5) reflecting about the role of technology in education and, 6) moving from traditional to continuous feedback, contribute to the development of each domain of the TPACK framework. The study employs a quantitative methodology for analyzing the data collected. The measurement instruments for data collection include the TPACK survey designed by Schmidt et al. (2009), and the SQD scale developed by Tondeur et al. (2016). Descriptive statistics describe the perceived knowledge of subjects on TPACK domains, and their perceptions

on the support they received while being trained. Finally, the researcher performs ten multiple linear regression analyses to determine if there is a significant contribution of the six strategies to the development of each TPACK domain. Findings indicate that the SQD strategies, when used as a set of predictors, significantly facilitate the growth of five out of seven TPACK domains.

DEDICATION

This dissertation is dedicated to my husband Thanos and my son Nikos.

Thank you for your love and support.

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My sincere gratitude goes to my dissertation chair, Dr. Parke, for her guidance, feedback and support throughout this research study. I would also like to acknowledge my dissertation committee members, Dr. Carbonara and Dr. Prier, for their help and advice. Moreover, I thank my Cohort family for the support and encouragement over the last three years. Last but not least, I thank Dr. Moss for giving me the opportunity to be part of this life-changing journey.

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LIST OF ABBREVIATIONS

TPACK: Technological Pedagogical Content Knowledge

SQD: Synthesis of Qualitative Data

TK: Technology Knowledge

PK: Pedagogical Knowledge

CK: Content Knowledge

PCK: Pedagogical Content Knowledge

TCK: Technological Content Knowledge

TPK: Technological Pedagogical Knowledge

ICT: Information and Communication Technology

TPCK: Pedagogical Content Knowledge with Technology

TM: Technology Mapping

ROL: Role Model

REF: Reflection

DES: Instructional Design

COL: Collaboration

AUT: Authentic Experiences

FEE: Feedback

Chapter 1: Introduction

In today's world, the way that students use information is more important than how much information a learning environment can offer to students. Students need to assess information critically if they are to transform it into knowledge (Buckingham, 2015). The majority of children spend several hours in digital media. Technology tools, such as computers, mobile phones and digital video, serve as more than a means to retrieve information; these media offer new ways of representing the world, communicating and building relationships. Buckingham (2015) mentions that "outside school, children are engaging with these media not as technologies but as cultural forms" (p. 22). Therefore, it is important for educators to help their students develop digital literacy and adequately understand the function of such tools.

Ferrari, Punie and Redecker (2012) reviewed 15 different frameworks, which aimed to define the concept of digital literacy. In their study, they compared the different interpretations presented in the frameworks and generated the following encompassing definition of digital competence:

> Digital Competence is the set of knowledge, skills, attitudes, abilities, strategies and awareness that is required when using Information and Communication Technology (ICT) and digital media to perform tasks; solve problems; communicate; manage information; behave in an ethical and responsible way; collaborate; create and share content and knowledge for work, leisure, participation, learning, socializing, empowerment and consumerism. (p. 84)

Buckingham (2015) mentions that digital literacy is much more than a skill to use a computer or to conduct online searches. He argues that even though children start mastering basic skills such as using browsers and search engines to locate information, the ultimate goal for educators is to help students develop a solid knowledge of how to critically evaluate information and transform it into knowledge. But, what are the skills that youth need to develop in order to appropriately use such devices, and meet the needs of the “digital” world we live in?

In an effort to outline the knolwedge needed for appropriate use of digital media, Buckingham (2015) proposes a conceptual framework that presents four aspects of digital literacy: a) representation, b) language, c) production, and d) audience. In particular, the first aspect refers to the fact that media often display specific interpretations of reality embodying certain values and ideologies. Thus, a literate user should consider issues of authority, reliability and bias regarding the information/content provided by the media. With respect to language, the framework suggests that informed digital users need to understand how language functions within media, and how language is used to deliver content. The aspect of production “*involves understanding who is communicating to whom, and why*” (p. 26). For instance, children and youth need to be cautious with commercial appeals, especially when they provide media with personal information. Finally, with respect to audience, the framework suggests that users should reflect on how media target at their audiences. For example, web users should critically evaluate how different sites are used by individuals or groups of individuals for specific purposes.

Moreover, technology integration in education has been widely investigated by several scholars and has been proven to positively affect the learning process. For instance, Keengwe et al. (2012) conducted a study to investigate how a 1:1 laptop initiative affects students' learning at a rural midwestern high school. One hundred and five high school students enrolled in 10th–12th grades participated in the study. In particular, the research study aimed to examine the effect of a 1:1 laptop initiative on students' academic performance based on perceptions both of participating high school students and participating faculty. A survey was used to collect data for the study. According to the findings, the integration of 1:1 laptop computing enhanced student motivation, and improved students' skills to work individually. Secondly, the data suggested that the initiative increased the use of technology by students both in class and at home. Finally, faculty believed that the integration of 1:1 computing had a positive impact on traditional, at-risk, and high-achieving students' learning experiences.

The presence of technology in schools calls for competent educators, who can effectively use digital tools in their teaching practices. Having technology tools in schools does not equate to positive educational outcomes. Based on research findings, placing technology tools in the classroom does not ensure that teachers will effectively use them in the learning process. In a survey conducted in 1,012 schools, the results reported that computers were mostly used to access online assignments and assessment data (Kopcha, 2010). Despite the fact that teachers are aware that technology integration can be an effective tool for expanding educational opportunities, most of them are reluctant to use technology in their teaching practices (Bauer & Kenton, 2005). Many teachers, who start teaching in schools, use computers mostly for personal rather than for instructional purposes. The overarching goal for schools is to have educators who are efficiently prepared to integrate technology in the classroom. As stated by Keengwe et al. (2009), teachers should aim to create powerful, technology-enhanced learning environments for their students while maintaining sound pedagogical practices.

Local Leadership Perspective

My professional space before joining the doctoral program in Educational Leadership was an urban, private, PK-12 school with rather limited diversity in terms of ethnicity, race and socio-economic status. The school exhibits faculty stability and excellent graduation rates for the student body; it is a supportive environment, which provides high-level resources to students. Individuals involved in the school community are engaged and respected. Faculty, students and families share a school vision, and they all work in concert towards meeting the desired educational goals. The majority of teachers have teaching experience ranging from fifteen to twenty-five years, and nearly half of them have completed graduate studies in the field of education. The school is equipped with computer labs; there are also classrooms containing Smart Boards. Teachers display relatively low confidence about using technology in their teaching practices, but they are positive in utilizing technology for administrative tasks and communication purposes. With few exceptions, most teachers are reluctant to integrate technology in their classrooms, as they feel that they lack the knowledge and skills to effectively use it as an educational tool. This lack of skills and knowledge often intertwines with their attitudes and beliefs about the effectiveness of instructional technology in the learning process. Thus, they are often negatively dispositioned towards technology integration into instruction.

On the other hand, my fourteen-year teaching experience in the aforementioned space has taught me that the majority of the student population spends much of their time in digital media, and use them to perform activities that expand from just locating information. To them, technology offers new ways of communicating and building relationships. Consequently, teachers' reluctance to incorporate technology in their classrooms contradicts the norms that students tend to follow. Buckingham (2015) mentions that:

> These media cannot be adequately understood if we persist in regarding them simply as a matter of machines and techniques, or as «hardware» and «software». Outside school, children are engaging with these media, not as technologies but as cultural forms. (p. 22)

Moreover, my graduate studies in the field of instructional technology have helped me realize the dynamic relationship existing between the learning process and the use of technology as an instructional tool, particularly when the latter intersects with content and appropriate pedagogical practices.

As educators, it is critically important to recognize the role that digital media play in our students' lives. Enhancing our teaching practices by using technology will transform learning experiences for children and youth; providing our students with the knowledge to use digital media critically will enrich their futures. Therefore, teachers should be efficiently prepared to develop engaging learning environments, which take advantage of the unlimited opportunities that technology offers.

Statement of the Problem

Koehler and Mishra (2008) argued that using technology in teaching and learning is a complex process where several factors interact and significant changes exist among different contexts and settings. Teacher educators are therefore confronted with the challenge of redesigning teacher education programs toward the development of teachers' skills with respect to integrating technology as an effective learning tool (Tondeur, 2012). Toward this effort, the U.S. Department of Education's "Preparing Tomorrow's Teachers to Use Technology" (PT3) program provided funds to support teachers' knowledge of instructional technology. Since 1999, PT3 has awarded over 400 grants to education consortia to help teachers use technology in the classroom. In 2007, 1,439 institutions offering teacher education programs in the United States participated in a survey aiming to determine the extent to which preservice teachers are prepared to use educational technology once they enter the field (Kleiner et al., 2007). The findings indicated that the majority of the institutions offer 3- or 4-credit courses focusing on the acquisition of technology skills. Ninety-three percent of the participating education programs reported that they taught educational technology within methods courses, seventy-nine percent taught technology within the field experiences of students, while seventy-one percent taught technology within content courses. The majority of institutions stated that preservice teachers were prepared to integrate technology into their teaching practices for educational purposes including advancing educational instruction and understanding of academic growth and student performance (Kleiner et al., 2007).

However, despite these findings, research evidence suggests that preservice teachers still lack the skills and knowledge to teach successfully with technology (Tondeur et al., 2013). Questions such as, "What instructional methods should be employed by teacher education programs in order to help preservice teachers develop a solid understanding of teaching with technology?" are valid questions raised by teacher educators and need to be addressed.

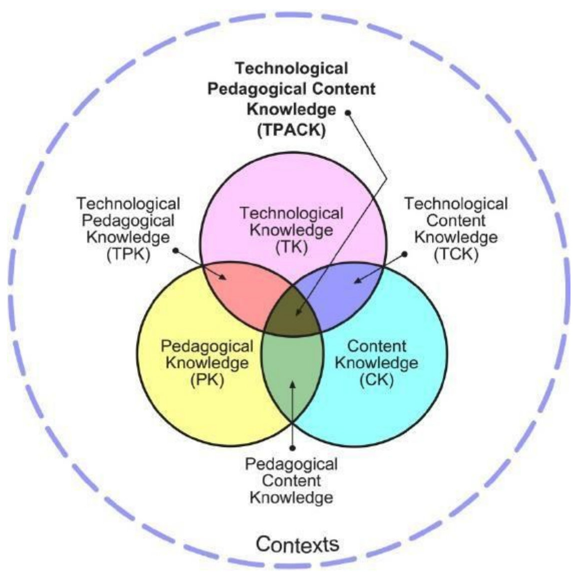
Theoretical Frameworks

This research study uses the theoretical frameworks of Technological Pedagogical Content Knowledge (TPACK) developed by Mishra and Koehler (2006) along with the Synthesis of Qualitative Data (SQD)-model designed by Tondeur et al. (2012).

The TPACK framework describes the teacher knowledge required to effectively use technology in an educational setting.

Figure 1

The TPACK framework and its knowledge components (Koehler & Mishra, 2009)



As shown in Figure 1, the framework introduces the learning components of technology, pedagogy and content and investigates the relationships among and between them. These three knowledge areas create the foundation of TPACK, which constitutes the basis of good teaching with technology (Kohler & Mishra, 2009). The seven knowledge domains emerging from the framework are the following: Technology

Knowledge (TK), Pedagogy Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Technological Pedagogical Content Knowledge (TPACK). The framework underlines the need for training preservice teachers to employ appropriate pedagogical techniques and technologies when teaching a subject content to student groups. According to the framework, technology integration does not require one single pedagogical orientation; instead, it encourages teachers to adopt technological applications and pedagogical approaches that fit their desired teaching goals. In this study, the data collected by the Survey of Preservice Teachers' Knowledge of Teaching and Technology (TPACK survey) will be used to determine the perceived knowledge of participating teachers on the seven domains of TPACK.

The SQD-model was generated by Tondeur et al. (2012) after reviewing 19 qualitative studies focusing on how teacher education programs prepare preservice teachers to integrate technology in their future classrooms. The review provides information about the training of teachers, as well as the conditions necessary to develop such preparation programs to the institutional level. More specifically, the SQD-model suggests six instructional strategies at the micro level that should be adopted by teacher education programs when training educators for technology use. Such strategies include teacher educators acting as role models, learning technology by design, collaborating with peers, scaffolding authentic experiences, reflecting about the role of technology in education and, moving from traditional to continuous feedback. The model also introduces strategies related to the institutional level. The current study includes only the six strategies at the micro level. The data collected by the SQD scale will be analysed to determine the extent to which the SQD strategies are identified by the subjects while being trained.

Purpose of the Study

The purpose of this quantitative study is to investigate the impact of technology training offered by teacher education programs on preservice teachers' TPACK development. To design effective TPACK-based interventions, research studies need to explore teachers' perceptions of how well education programs train them for effective technology use in their teaching practices. Specifically, this study aims to investigate how the SQD strategies of: 1) teacher educators acting as role models, 2) learning technology by design, 3) collaborating with peers, 4) scaffolding authentic experiences, 5) reflecting about the role of technology in education and, 6) moving from traditional to continuous feedback, contribute to the development of each TPACK domain. The study employs a quantitative methodology for analyzing the data collected, and aims to examine the following research questions:

1. What is the perceived knowledge of preservice teachers on the domains of the TPACK framework?

2. To what extent do preservice teachers identify the use of SQD strategies in their teacher education program?

3. What is the contribution of the SQD strategies to the development of each domain of the TPACK framework?

The measurement instruments for data collection include the TPACK survey designed by Schmidt et al. (2009), and the SQD scale developed by Tondeur et al (2016).

Chapter 2: A Review of the Literature

Teacher Education and Technology Integration in the Classroom

We live in an era in which individuals, organizations, and societies rely on information for growth and development. Citizens of information-age societies are required to become self-directed learners, think critically when solving problems, develop digital literacy, and reach cutting-edge scientific innovations in a technology-driven society. This shifting in the landscape creates unlimited opportunities for our educational system to transform the learning process in an engaging and effective experience for all students.

Several studies have indicated that students engage in learning and improve their critical thinking skills when learning construction takes place within student-centered environments (An & Reigeluth, 2002). The appropriate use of technology in education generates prospects for improving, expanding, and individualizing learning. When technology is successfully integrated into the classroom, learning is facilitated within a learner-centered environment and is customized to students' skills and needs. Valtonen et al. (2015) argued that the use of Information and Communication Technology (ICT) in educational settings is associated with twenty-first century skills, such as critical thinking, problem solving communication and collaboration. Consequently, the question is no longer whether technology should be integrated in the learning process, but how to best integrate technology in the twenty-first classrooms (Angeli & Valanides, 2009).

In an effort to integrate technology into K-12 classrooms, a considerable amount of funds have been allocated to advance technology access in U.S. public schools over the past 20 years (Etmer et al., 2012). However, even though there has been noticeable progress in terms of accessing technology in schools and improving teachers' training on technology integration, many concerns about whether or not technology integration has been successfully accomplished have been raised.

Based on research findings, teachers do not always master the knowledge to practice technology as an educational tool and mainly use it in their teaching practices for administrative tasks and or communication purposes (Etmer & Ottenbreit-Leftwich, 2010). The aforementioned uses of technology in classrooms are considered to be low-level. According to An & Reifeluth (2012), teachers mostly use technology for communication and low-level tasks, such as writing assignments on the computer or conducting research online, which are minimally aligned with core pedagogical goals.

Etmer et al. (2012) identified two sets of barriers to technology integration into instruction: a) first-order barriers, which include factors such as environmental readiness and lack of Technological Pedagogical Content Knowledge (TPACK) in teachers; and b) second-order barriers, which involve teachers' beliefs about learning, confidence and perceptions regarding the effectiveness of instructional technology.

It is important to mention that knowledge and beliefs are often intertwined (Voogt et al., 2012). According to Hew & Brush (2007), teacher beliefs about instructional technology are greatly affected by their knowledge levels and vice-versa. In a research study conducted by Abbitt (2010), 45 preservice teachers enrolled in a 1-credit course focusing on technology integration into teaching. The researcher used two surveys to collect the data: the TPACK survey was used to measure subjects' perceived knowledge on TPACK domains, whereas the CTIS survey was used to assess subjects' self efficacy beliefs about technology integration in the classroom. The study administered a pre- and post- test design to evaluate the relationship between self-efficacy beliefs toward technology integration and perceived knowledge on TPACK domains. The researcher conducted the analysis of the relationship of self-efficacy, technology integration, and TPACK to identify possible changes in the relationship over time. The data analysis suggested that knowledge on the framework's domains may predict self-efficacy beliefs about technology integration. Respectively, self-efficacy beliefs significantly affect the use of technology in teaching practices. The theory of self-efficacy supports that beliefs about one's ability to accomplish a desired outcome influence both thinking and action. (Bandura, 1991; Abbitt, 2010). Consequently, teachers with higher self-efficacy beliefs about their TPACK, will most likely use effectively technology as an educational tool.

With respect to preservice teachers, evidence supports that even though teacher education programs require preservice teachers to attend courses focusing on developing technology skills or technology courses that involve content and pedagogical methods, they still not feel adequately prepared and confident to use technology in their teaching practices (Wetzel et al., 2014; Gronseth et al., 2010; Tondeur et al., 2013; Angeli & Valanides, 2009). These findings pose questions regarding teacher education programs and how they could develop methods that infuse technology throughout their curriculum (Wang et al., 2018). As mentioned by Tondeur et al. (2019), "Teacher educators can be considered important stakeholders who prepare and motive a new generation of teachers for teaching in today's classroom. They can also play a key role in enhancing preservice teacher's technology-enhanced educational practices" (p. 1190).

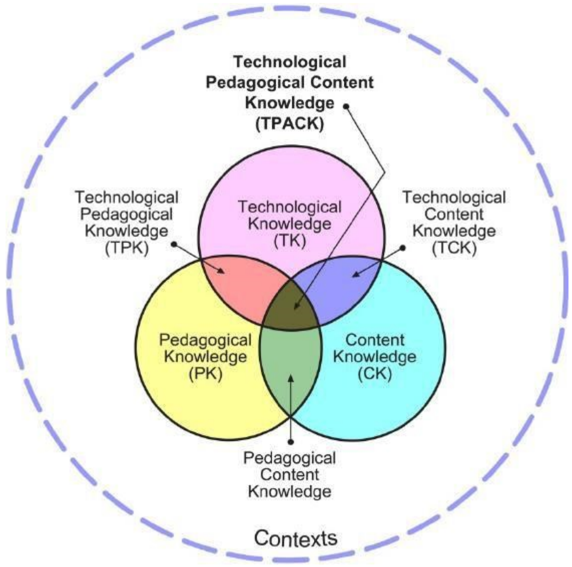
Different factors can be related to the failure of properly training teachers to instruct with technology. For instance, a major contributing factor is the focus of educational technology courses on the learning of technical skills (Angeli & Valanides, 2009). Teaching technology skills alone do not sufficiently prepare teachers to integrate technology in their practice (Tondeur et al., 2012). The insufficient number of subject-specific courses focusing on technology preparation remains an issue; thus, teachers fail to build pedagogical connections between the affordances of technology and teaching subject specific areas (Angeli & Valanides, 2009). According to Valtonen et al. (2015), teacher education plays a significant role in enhancing the use ICT for teaching and learning. The quality and quantity of technology experiences offered in teacher preparation programs significantly determines technology integration in new teachers' classrooms. As it is mentioned by Tondeur et al. (2017), limited use of technology in authentic educational settings has been reported to be related to the phenomenon of the "reality shock" or "praxis shock" that new teachers experience when they first start teaching. Therefore, teacher education programs should not only focus on how to use technology, but also how technology intersects with pedagogical and content knowledge, as directed by the concept of TPACK.

The TPACK Framework

In 2006, Mishra & Koehler (2006) developed the theoretical framework of Technological Pedagogical Content Knowledge (TPACK) to describe the teacher knowledge required to effectively use technology in an educational setting.

Figure 2

The TPACK framework and its knowledgecomponents (Koehler & Mishra, 2009)



The framework introduces three primary knowledge components, which are described below:

Technology Knowledge (TK) - knowledge of technology tools. This learning component includes the knowledge of using different operating systems and computer hardware along with the ability to employ appropriate educational software tools (Mishra & Koehler, 2006).

Pedagogy Knowledge (PK) - knowledge about the processes and practices of teaching. According to Mishra and Koehler (2006), pedagogy knowledge refers to the practices of teaching and learning such as classroom management, lesson plan development, and implementation and evaluation of student progress.

Content Knowledge (CK) - knowledge about the subject matter that is to be taught. More specifically, teachers should have a deep knowledge of the major facts, concepts, and theories of the subject areas they teach (Mishra & Koehler, 2006).

The conceptual model also "emphasizes the connections, interactions, affordances, and constraints between and among those components" (Mishra & Koehler, 2006, p. 1025). The three blended domains represent the intersections of the primary types of knowledge. This means that instead of examining these knowledge domains separately, the framework looks at them in groups of two. The emerging domains are the following:

Pedagogical Content Knowledge (PCK) - knowledge of pedagogy that is applicable to the teaching of specific content. This learning area is focused on the appropriate representation of the content that needs to be taught. It involves students' prior knowledge, and investigates how different concepts can be more or less challenging for learners to comprehend. PCK helps educators practice teaching strategies that best address students' difficulties and misconceptions (Mishra & Koehler, 2006).

Technological Content Knowledge (TCK) - knowledge about the manner in which technology and content are reciprocally related. Technology offers a rich variety of concept representations. For instance, Mishra and Koehler (2006) presented how Geometer's Sketchpad can be used for teaching geometry. This software tool enables learners to build their knowledge in geometry and construct geometrical proofs by allowing them to play with different shapes. Such an experience significantly changes the process of learning geometry, since students construct their knowledge by actively exploring concepts and theories.

Technological Pedagogical Knowledge (TPK) - knowledge of how various technologies can be used in teaching. TPK is the ability to select a technological tool based on its' affordances to change the process of teaching; for instance, using technology for creating discussion boards or for maintaining class records.

Technological Pedagogical Content Knowledge (TPACK) - knowledge of how technology, pedagogy and content can be intersected. TPACK exists at the intersection of all three primary components and constitutes the basis of good teaching with technology (Mishra & Koehler, 2006). Koehler et al. (2014) argue that "effective teacher educational and professional development needs to craft systematic, long-term educational experiences, where the participants can engage fruitfully in all three of these knowledge bases in an integrated manner" (p. 109). Moreover, Koehler and Mishra (2008) supported that the use of technology should always be situated; teachers should evaluate their students' needs along with the school resources before integrating technology into their practices.

Harris et al. (2018) supported that the TPACK-model has been cited in more than 1,200 publications and has served as a framework for both quantitative and qualitative studies (Voogt et al., 2013). Despite the extensive acceptance of this framework, Voogt et al., (2013) revealed that, besides the view of Kohler and Mishra (2006), which views TPACK as the intersection of the three learning bases, there are two more conceptions of the framework commonly used: a) TPACK is viewed as extended PCK (Niess, 2005), and b) TPAK is viewed as a unique and separate body of knowledge rather than as an accumulation of the three knowledge components (Aggeli & Valanides, 2009).

From PCK to TPACK

The development of TPACK framework builds on Shulman's Pedagogical Content Knowledge (PCK) model (Shulman, 1986). According to Shulman (1986, 1987), effective teaching involves more than isolated knowledge in a subject content and in pedagogy. Teaching approaches that lack to connect content and pedagogy in context will not achieve the desired educational goals. Instead, PCK identifies the body of knowledge that teachers need to possess. "It represents the blending of content and pedagogy into an understanding of how particular problems, issues or issues are organized, represented and adapted to the diverse interests and abilities of learners, and presented for instruction" (Shulman, 1987, p.8).

Later on, Niess (2005) used the term TPCK to describe an extended PCK model with technology. She supported that "for technology to become an integral component or tool for learning, preservice teachers must develop an overarching conception of their subject matter with respect to technology and what it means to teach with technology—a technology PCK (TPCK)" (Niess, 2005, p.510). She indicated that TPCK is combining the growth of subject matter expertise with the development of technology and of teaching and learning skills. This integration of the different domains helps teachers use technology when teaching their subject matter.

One year later, Mishra and Koehler (2006) introduced the component of technology into Shulman's PCK model as a third domain to describe the reciprocal dynamic relationship between the three knowledge bases of pedagogy, content, and technology in a particular context. Over the past few years, scholars have investigated whether there are other important factors that contribute to teacher education. For instance, Kabakci Yurdakul et al. (2012) suggested six competencies that TPACK-informed teachers should master, including designing instruction, implementing instruction, innovativeness, ethical awareness, problem solving, and field specialization.

In a different approach, based on the results of their empirical studies, Angeli and Valanides (2009) claimed that TPACK is a distinct body of knowledge that can be established and evaluated individually. According to their research, growth in any of the constituent components does not automatically lead to growth in TPACK. In their view, teacher education programs need to specifically help preservice teachers develop this type of knowledge, since it is different from its constituent components.

Instructional Models for Developing TPACK

Angeli and Valanides (2009) proposed Technology Mapping (TM) as an instructional model for developing 215 first- and second-year preservice teachers' TPACK.

Figure 3

A situative ID model for the design of technology mediated learning (Angeli & Valanides, 2009)

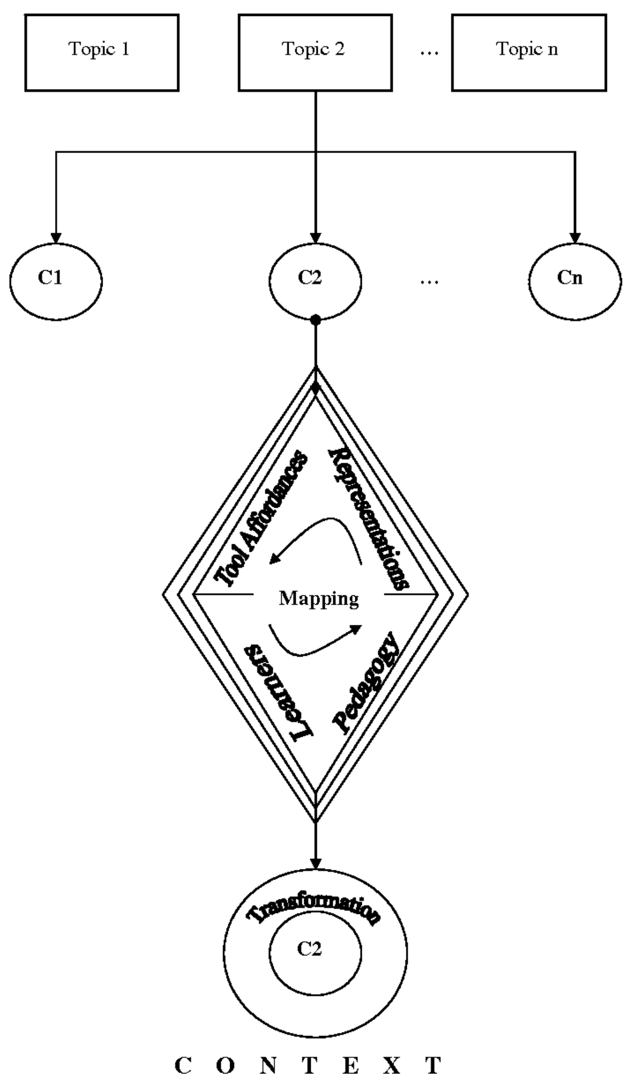


Figure 3 displays a visual representation of TM. In this model, context is a concept that encompasses several elements affecting technology integration into the classroom. For instance, teachers' beliefs and experiences with technology-enhanced environments are influential factors to the process of integration. The model encourages teachers to initially define a content field, and then focus on challenging topics of that field. Afterwards, teachers need to decide on the various content materials that should be included into instruction. The diamond shape presents the process that teachers need to follow in their effort to transform the content to be taught. Educators should decide on how the tool affordances can be used in the learning process, and employ the most appropriate pedagogical strategies for accomplishing the learning goals.

Angeli and Valanides (2009) presented TM as a technique that educators could use to facilitate teachers' technology training. In their study, participants were requested to attend lectures and laboratories mostly focused on "making visible and explicit to the students the interconnections among tool affordance, learners, content and teaching strategies" (p. 165). During lectures, preservice teachers were taught instructional design processes; in laboratories, they mapped several software tools and explored their pedagogical affordances in order to design technology-based instructional environments. The research team used self-assessment, peer-assessment, and expert assessment procedures to evaluate the design-based performances of the 215 participating teachers. An empirical investigation of the model's impact on preservice teachers' knowledge revealed that their TPACK competency had been significantly improved at the end of the course. According to Angeli and Valanides (2009), TM can be used in teacher education programs and professional development training to help teachers use technology in their practices.

Koh and Divaharan (2011) designed a TPACK-Developing Instructional Model, which includes three phases for developing teachers' TPACK as they are trained to use new ICT tools. The first phase suggests that faculty should model the use of the new ICT tools in their effort to foster teachers' acceptance of such instructional tools. Observing teacher educators using an ICT tool helps preservice teachers conceptualize how this tool can be integrated in their teaching practice. The second phase proposes the use of pedagogical modeling which displays how the technological affordances of an ICT tool can support various teaching techniques. It is important to mention that pedagogical modeling should be tailored to the specific subject matter that preservice teachers are planning to teach. According to Koh and Divaharan (2009), providing such experiences to future teachers shapes their Technological Content Knowledge. In the third phase, teachers undertake projects and create lesson plans using ICT tools. The described intervention was used with three classes of 74 preservice teachers. The qualitative analysis of their end-of-class reflections reported that the TPACK-Developing Instructional model positively affected the development of teacher's TPACK.

Similarly Lu, Johnson, Tolley, Gilliard-Cook, and Lei (2011) adapted the instructional design method of *Learning by Doing* to develop and evaluate a sequence of three technology courses at Syracuse University's School of Education. In the context of teacher education programs, *Learning by Doing* engages teachers in designing technological artifacts for instructional purposes, and using technology to teach content in authentic settings. Specifically, the participants of the study were asked to design instructional products using technology, based on various teaching scenarios. In addition, they developed and implemented lesson plans in class, which enhanced the learning process by practicing appropriate strategies and technology tools. Lu et al., (2011) collected data from 39 preservice teachers in three concurrent course sections. Pre- and post- surveys were administered to the participants before and after the completion of the couse. The research team used the TPACK survey (Schmidt et al., 2009) to assess subjects' TPACK, and examined the perceived knowledge on the different TPACK domains using a paired-sample T test for each subject. Data were also gathered by the reflection journals written by the same group of subjects. According to the results of the study, there was a significant effect on subjects' Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK) indicating that the model of *Learning by Doing* can be effective in the development of teachers' overall TPACK.

In an effort to address similar concerns about the development of teachers' TPACK, Tondeur et al. (2012) reviewed 19 qualitative studies focusing on how teacher education programs train preservice teachers to integrate technology in their future classrooms. The research team utilized a meta-ethnography approach to critically examine and synthesize the results of the study. The study provided information about the training of teachers, as well as the conditions necessary to develop such preparation programs to the institutional level. To display the interrelations among the different themes, an overarching model, the Synthesize Qualitative Data (SQD)-model, was generated.

Figure 4

SQD Model to prepare pre-service teachers for technology use (Tondeur et al., 2012)

As shown in Figure 4, themes related to the preparation of preservice teachers included: 1) using teacher educators as role models, 2) learning technology by design, 3) collaborating with peers, 4) scaffolding authentic experiences, 5) reflecting about the role of technology in education and, 6) moving from traditional to continuous feedback. Themes in the institutional level referred to technology planning and leadership, access to resources, training staff and cooperation within/between institutions. The themes of “aligning theory and practice” and “systematic and systemic change efforts” were grouped together as overarching themes, since they significantly influence both preservice teachers’ training and institution’s readiness to support the use of technology. According to Tondeur et al. (2012), “learning to teach with technology is a constructive and iterative process and in order to successfully train preservice teachers to use technology, teacher education programs need to address all these key variables thoughtfully” (p. 8).

Finally, in a study conducted by Admiraal et al. (2017), two technology-infused courses of a teacher education program in the Netherlands were evaluated to increase insights into the value of: a) providing preservice teachers with more opportunities to implement a technology-infused approach in their own teaching, b) teacher educators and in-service teachers acting as role models. The research team gathered data from 52 preservice teachers enrolled in the technology-infused courses using: a) a questionnaire at the end of the course, b) participants' lesson reports, c) course artifacts, reports and interviews of teacher educators and, d) an evaluation questionnaire that preservice teachers administered in their classrooms with their students. Findings from the courses' evaluation underlined the value of teaching with technology in authentic classroom environments. Preservice teachers had the opportunity to apply technology in their teaching practices and receive feedback from their students on the effectiveness of such an instructional approach. Findings also suggested that teacher educators and in-service teachers acting as role models is a significant motivator for using technology as a learning tool. In fact, preservice teachers mentioned that it is necessary to watch role models and reflect on these examples and their experiences (Admiraal et al., 2017).

Measuring TPACK

Researchers have underlined the need to develop reliable tools for assessing TPACK (Schmidt et al., 2009). According to Schmidt et al. (2009), using TPACK as a framework for measuring teacher knowledge could positively affect both professional development training and teacher education programs, in terms of rethinking and designing new strategies that adequately prepare teachers to integrate technology in their teaching practices.

In a study they conducted, Koehler et al. (2012) identified 66 research studies implementing TPACK assessment methods and tools. They located 141 instruments, which included 31 self-report measures, 20 open-ended questionnaires, 31 performance assessments, 30 interviews, and 29 observations. More specifically, in self-report instruments, participants rate their perceived knowledge on the domains of the framework, while open-ended questionnaires include items prompting teachers to share their experiences in TPACK-based educational/professional development courses. Methodologies such as performance-based measures assess teachers' learning by using artifacts, whereas interviews include a set of questions that are typically audio-recorded, coded and analyzed. Finally, observations, usually conducted in classrooms, aim to track the growth of teachers' knowledge over time.

Self–report measures, such as surveys, are one of the most commonly used methods to assess TPACK, while open-ended questionnaires, interviews and observations are used less often (Kohler et al., 2012; Mouza et al., 2014). It is interesting to mention that according to Kohler et al. (2012), approximately 69 % of the studies examined for their research did not exhibit any evidence of reliability, while over 90% of them failed to establish validity of the measures used. This fact raises concerns about the methods used to evaluate the effectiveness of teacher education programs with respect to teachers' preparation about technology use. Kohler et al. (2014) supported that "as research in TPACK becomes more empirical, it becomes more important that researchers scrutinize the measurement properties of TPACK instruments" (p. 105). Researchers have started to collect data using both quantitative and qualitative methods to triangulate the results and ensure reliability and consistency (Wang et al., 2018). It is apparent that using the appropriate instrument for measuring teachers' readiness for technology integration holds a significant role when investigating the impact of teacher education program in the development of TPACK.

Methods for Measuring TPACK

It is important that systematic and reliable methods are used to measure teachers' TPACK; analyzing the data of such studies helps the stakeholders to better prepare future teachers in terms of technology integration. (Schmidt et al., 2009).

In their study, Angeli and Valanides (2009) used self-assessment, peer-assessment, and expert assessment procedures to evaluate the design-based performances of 215 preservice elementary teachers in a course over three successive semesters. In fact, their model was used to measure the growth of teachers' Information Communication Technologies (ICT)-Technology Pedagogy Content Knowledge (TPCK) competency before and after completing the course. In particular, the participants were evaluated by two technology experts in collaboration with two content experts. Raters based their evaluation on two elements: specific criteria examining TPACK development, and participants' self- and peer- assessments. A Pearson correlation coefficient analysis conducted between the two ratings found a correlation (r) of 0.89. Course evaluations were also qualitatively investigated by two different independent raters. The interrater agreement was found to be 0.93 (Angeli & Valanides, 2009). According to Schmidt et al. (2009), this approach is considered to be time-consuming and context-limited.

One of the most widely used measures for evaluating TPACK's development is the TPACK survey designed by Schmidt et al. 2009. The survey was generated for assessing PreK-6 preservice teachers' knowledge on the seven domains of the framework. The authors emphasize that this instrument was developed for preservice teachers who are preparing to teach in elementary or early childhood settings. The survey includes content knowledge relating to mathematics, social studies, science, and literacy, since teachers in early childhood teach multiple subject areas. There are also demographic items and open-ended questions asking the participants to describe episodes when professors from their teacher education programs effectively modeled the desired knowledge. The data for this survey development project were collected from 124 students, who were enrolled in a 3-credit introduction to instructional technology course at a large midwestern university. The course lasted for 15 weeks and examined the use of technology for teaching all content areas in PK–6 classrooms and learning environments. The preservice teachers attended two 1-hour lectures and one 2-hour laboratory session per week. Based on the demographic information, 79.0% of the responses were from students majoring in elementary education, 14.5% of the responses were from early childhood education majors, and 6.5% of the respondents were enrolled in another major. Based on the study's results, the instrument exhibited strong internal consistency reliability ranging from 0.75 to 0.92 for the subscales. The researchers also examined the relationships between TPACK subscales using Pearson product-moment correlation. Coefficients between subscales ranged from 0.2 to 0.7; the domain of TPACK was found to be significantly correlated to all subscales. According to the authors, these findings indicate that the TPACK survey is a promising instrument for measuring preservice teachers' perceived TPACK.

Harris et al. (2010) developed the Technology Integration Assessment Rubric to assess evidence of TPACK on preservice teachers' lesson planning. The rubric was designed as a measure with which to triangulate data on teachers' understanding with additional measurement instruments (Abbit, 2011). It was specifically created for preservice educators, and it should be used by experts, e.g. experienced teachers and district-based teachers (Harris et al., 2010). According to the research group, the interrater reliability coefficient of the instrument was calculated using both Intraclass Correlation and a score agreement procedure. The Internal consistency (using Cronbach's Alpha) was 0.911, while the Test-retest reliability (score agreement) was 87.0%. Based on these results, the rubric is efficiently reliable and consistent to be adopted by other researchers as well (Harris et al., 2010).

Finally, Tondeur et al. (2016) developed a method for teachers to reflect upon their experiences during their training period. Their study utilized the output of Tondeur's et al. (2012) review as a theoretical foundation to create the instrument. The scale developed was based on SQD strategies, and tested online in 2014 with a sample of 688 last-year preservice teachers in Flanders, Belgium. In particular, the measurement tool was constructed around the six significant strategies existed in the inner circle of the SQD-model: 1) using teacher educators as role models 2) learning technology by design, 3) collaborating with peers, 4) scaffolding authentic experiences, 5) reflecting about the role of technology in education, and 6) moving from traditional to continuous feedback. The research group used Gronbach's Alpha (a) and McDonald's Omega (ω) to establish reliability of the scale. The six strategies were presented as statements, and participants were asked to rate each statement on a six-point Likert scale ranging from totally disagree to totally agree. Each of the six domains exhibited good reliability, while the entire scale presented an excellent reliability, a= 0.98 and ω= 0.90. According to the research team, results of such a measure “can provide a good stepping stone to better prepare preservice teachers from technology integration in classroom practices" (Tondeur et al., 2016).

The next chapter will discuss the methodology of this study and present the measurement tools that will be used to collect data.

Chapter 3: Methods

Purpose of the study

Research findings reveal that most preservice and in-service professional development training often fails to "support and develop educator identities as fluent users of advanced technology" (US Department of Education, 2010, p. 45). In particular, teacher education programs hold a key role in preparing preservice teachers to effectively integrate technology in their classrooms. Thus, programs need to employ thoughtful and systematic instructional strategies in their curriculum.

There are numerous studies examining preservice teachers' perceived knowledge on TPACK dimensions. However, the contribution of SQD strategies to the development of each TPACK domain in preservice teachers has not been extensively investigated, to the best of my knowledge. Therefore, my research study aims to address the following research questions:

1. What is the perceived knowledge of preservice teachers on the domains of the TPACK framework?

2. To what extent do preservice teachers identify the use of SQD strategies in their teacher education program?

3. What is the contribution of the SQD strategies to the development of each domain of the TPACK framework?

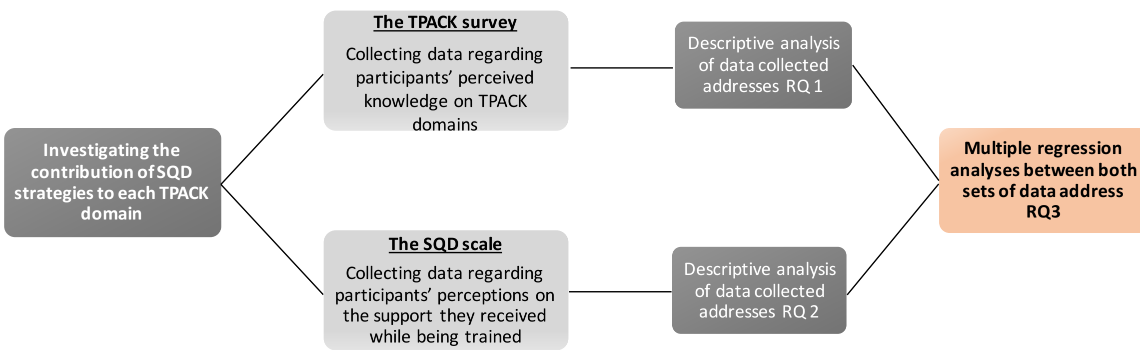
Method

First, this study will use descriptive analysis of the data gathered to describe: a) preservice teachers' perceived knowledge on all TPACK domains (treated as dependent variables) and, b) preservice teachers' perceptions towards the use of SQD strategies in their teaching training (treated as a set of predictors). Next, the dependent variables and the set of predictors will be tested to investigate their correlational relationship. Finally, the researcher will perform ten multiple linear regression analyses to determine the contribution of SQD strategies to each TPACK component.

The measurement instruments for data collection include the TPACK survey designed by Schmidt et al. (2009) and the SQD scale developed by Tondeur et al. (2016). Both measures are quantitative tools.

Figure 5

Visual Representation of the Methodology



Specifically, the output of this study will include the following:

Research Question 1: What is the perceived knowledge of preservice teachers on the domains of the TPACK framework?

To address this question, data collected by the TPACK survey will be analyzed to indicate participants' perceived knowledge on the seven TPACK domains.

Research Question 2: To what extent do preservice teachers identify the use of SQD strategies in their teacher education program?

To address this question, data collected by the survey of SQD scale will be analyzed to indicate participants' perceptions towards the SQD strategies used in their teacher program. The received training will be evaluated in relation to the six strategies included in the inner circle of the SQD-model. The SQD-model will be described in details in the next section.

Research Question 3: What is the contribution of the SQD strategies to each domain of the TPACK framework?

To answer this question, the researcher will perform ten multiple linear regression analyses to determine the contribution of SQD strategies to each TPACK component.

Preservice teachers enrolled in the Teacher Program in Pre K- 4^{th} grades in City University will be invited to complete the aforementioned surveys. Participating students should have completed their third or fourth year of their teaching training.

Setting

The Leading Teacher Program in Early Childhood Education at City University prepares preservice teachers for preschool and elementary classrooms in Pennsylvania and other states. Students in the program need to complete 131 course credits. The program covers three major fields of study: General Education, Foundations of Education, and Professional Preparation. Students complete the majority of the General Education and Foundation courses and gain experience in the field in the first two-year of their studies. Before completing the program, students also teach in an urban, suburban, or rural schools.

The Teacher Program mandates that students complete three technology-related courses. The learning objectives of the courses, as they are described in the syllabi, are the described below. The first course is an introductory course of 1-credit that aims to provide preservice teachers with a foundation of information literacy skills, including defining their information needs, conducting research effectively, evaluating their research results and citing sources using the 6th version of APA format. The second technology course is also a 1-credit course that prepares future teachers to use instructional technology for content-specific classroom applications. Specifically, students explore: 1) various uses of instructional technology in business, industry and society, 2) advanced applications of primary office productivity tools, such as word processing, graphics presentation and spreadsheets, 3) Web page development, 4) online learning, 5) instructional technology learning theories, 6) multimedia and hypermedia learning materials, and 7) use of additional classroom technologies. Lastly, in the third, 3-credit course, students learn how to practice the skills of analysis, design, development, and implementation of curriculum for PreK-4 reading and literacy learning environments. Students also study how to evaluate existing software used in PreK-4 learning environments, and create a number of technology-enriched materials including but not limited to coding, robotics and computational thinking.

As mentioned in the syllabi, all three technology courses are developed to meet standards for teacher training in the field of instructional technology proposed and adopted by the Pennsylvania Department of Education (PDE), Interstate New Teacher Assessment and Support Consortium (INTASC), National Board for Professional

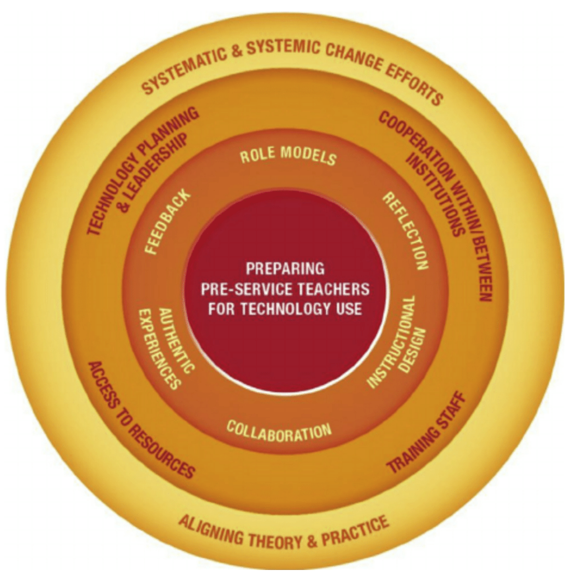
Teaching Standards (NBPTS), National Council for Accreditation of Teacher Education (NCATE), and International Society for Technology in Education (ISTE).

The SQD-model

The SQD scale used to collect data in this study, is based on the overarching SQD-model, which yielded effective key themes necessary for preparing preservice teachers at the micro and institutional level and displayed the interrelations among the different themes. It contains 24 items rated on a 6-point scale. Responses range from 1 (totally disagree) to 6 (totally agree). The scale, which is a quantitative measurement tool, investigates the extent to which the six strategies existed in the inner circle of the SQD-model, are adopted by teacher education programs.

Figure 6

SQD Model to prepare pre-service teachers for technology use (Tondeur et al., 2012)



The first strategy of the SQD-model (Role models) underlines the positive impact of teacher educators acting as role models when teaching technology courses in teacher programs. Offering examples and connecting instructional technology to real-life experiences in classrooms seem to be inspiring for preservice teachers. Based on research evidence collected by Tondeur et al. (2011), observing teacher educators integrating technology in their teaching practice motivates future teachers. In a study conducted by Admiraal et al. (2017), preservice teachers have mentioned that they need to watch role models and reflect on these examples and their experiences.

The second SQD-strategy (Reflection) underlines the need for reflection about the role of technology in education. As indicated by Goktas, Yildirim, & Yildirim (2009), discussing about the impact of technology in the learning process may be a powerful tool to change preservice teacher' attitudes towards the use of technology. Commenting on the first two strategies, Tondeur et al. (2019) supported that "teachers should act as role models and provide scaffolds to discuss and reflect upon the successful uses of technology" (p. 1192).

The third strategy (Instructional design) suggests that engaging preservice teachers in designing technology-based materials can be an excellent method for helping teachers develop their TPACK. In fact, there have been several studies where participants were asked to design instructional products and artifacts using technology based on various teaching scenarios (Koehler & Mishra, 2005; Lu et al., 2011).

Collaboration between peers and concern-sharing constitutes the forth SQD strategy that should be employed by teacher educators when training preservice teachers. Angeli and Valanides (2009) supported that preservice teachers need to participate "in a professional community that discusses new teacher materials and strategies, and supports the risk taking and struggle entailed in transforming practice" (as cited in McLaughlin & Talbert, 1993, p. 15).

The fifth strategy involves the application of technology in authentic settings. Admiraal et al. (2017) underlined the importance of teaching in authentic learning environments. He supported that teaching practice provides preservice teachers with various instructional techniques for integrating technology into instruction. A study conducted by Valtonen, et al. (2015) also confirmed the aforementioned findings. According to Valtonen et al. (2015), teaching practice with ICT applications enhance preservice teachers' self-efficacy beliefs and behavioral intentions towards the use of technology in classroom.

Finally, the sixth strategy includes the delivery of process-oriented feedback to teachers using technology. Banas and York (2014) argued that receiving constructivist feedback from peers and instructors promotes the development of preservice teachers' self-efficacy beliefs for using technology as an educational tool.

With regard to the scale's reliability, the research group used Gronbach's Alpha (a) and McDonald's Omega (ω) to establish it. Each of the six domains - one domain for each strategy - exhibited good reliability, while the entire scale presented an excellent reliability, a= 0.98 and ω= 0.90. The SQD scale is provided in Appendix A.

The TPACK survey

The TPACK survey was generated to evaluate preservice teachers' perceived knowledge on the seven domains of TPACK framework. The domains are the following: Technology Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). The survey was specifically designed for preservice teachers who are preparing to teach the elementary (PK–6) or early childhood (PK–3) level. Thus, it is focused on the content areas of literacy, mathematics, science, and social studies, since PK-6 teachers typically teach in multiple subject areas. The instrument contains 75 items for measuring self-assessments of TPACK components in preservice teachers: 8 TK items, 17 CK items, 10 PK items, 8 PCK items, 8 TCK items, 15 TPK items, and 9 TPACK items. These 75 items are rated on a 5-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument also includes demographic items and open-ended questions asking participants to describe episodes when teacher educators modeled technology integration in class. For the purpose of this study, only 47 out of the 75 items will be used. These 47 items collect quantitative data regarding the perceived knowledge of participants on the seven knowledge areas. Items asking demographic information or items collecting information about episodes when teacher educators modeled technology use in class will not be included in the survey.

Mouza et al. (2014) used the TPACK survey to investigate how and to what extent engagement in an integrated approach encompassed a technology course with method courses and field experience affected the training and practice of TPACK in preservice teachers. Based on the analysis of their data, all subscales and the instrument itself reached satisfactory alpha levels, indicating that the survey was reliable (Mouza et al., 2014). Similarly, according to Abbbit (2011), the TPACK survey is one of the most mature tools, designed specifically to evaluate the perceived knowledge of preservice teachers on TPACK constructs. Regarding, the survey’s reliability, Schmidt et al. (2009)

reported that coefficient alpha ranged from 0.75 to 0.92 for the seven subscales, which is considered to be excellent (Nunnally, 1978). The survey is provided in Appendix B.

Chapter 4: Findings

First, this study used a descriptive analysis of the data gathered to describe: a) preservice teachers' perceived knowledge on the TPACK domains (treated as dependent variables) and, b) preservice teachers' perceptions towards the use of SQD strategies in their teacher training (treated as a set of predictors). Next, the dependent variables and the set of predictors were tested to investigate their correlational relationship. Finally, the researcher performed ten multiple linear regression analyses to determine the contribution of the SQD strategies on each domain of the TPACK framework.

The participants of this study were 28 junior and senior students enrolled in the Leading Teacher Program in PreK-4th grades in City University located in central Pennsylvania. The data sources included the TPACK survey and the SQD scale. The participants completed the surveys online; the completion of both surveys took approximately 15 minutes per person on average.

Measures

The TPACK survey

This study used 47 out of 75 items of the TPACK survey: 7 Technology knowledge items (TK), 12 Content knowledge items (CK), 7 Pedagogical knowledge items (PK), 4 Pedagogical Content knowledge items (PCK), 4 Technological Content knowledge items (TCK), 5 Technological Pedagogical knowledge items (TPK), and 8 Technological Pedagogical Content knowledge items (TPACK). These 47 items are grouped into 10 subscales, and rated on a 5-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The four subscales of CK are examined individually; thus the subscales presented in the study are 10 and not 7 as expected based on the TPACK framework. Sample items included in the TPACK survey are presented below in Table 1:

Table 1

Sample items of the TPACK survey

Technology Knowledge (TK) I have had sufficient opportunities to work with different technologies
Content Knowledge – Math (CK) I have sufficient knowledge about mathematics
Content Knowledge – Social Sciences (CK) I can use a historical way of thinking
Content Knowledge – Science (CK) I have various ways and strategies of developing my understanding of science
Pedagogical Knowledge (PK) I can adapt my teaching style to different learners
Pedagogical Content Knowledge (PCK) I know how to select effective teaching approaches to guide student thinking and learning in literacy
Technological Content Knowledge (TCK) I know about technologies that I can use for understanding and doing science
Technological Pedagogical Knowledge (TPK) I can choose technologies that enhance students' learning for a lesson
Technological Pedagogical Content Knowledge (TPACK) I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn

Although the survey had been examined for its reliability by Schmidt et al. (2009), it was also tested based on this study's sample. Data analysis revealed that the survey as a whole had an excellent internal consistency, since the Cronbach's alpha exceeded 0.70 for items to be used together as a scale (Nunnally, 1978). The Cronbach's alpha for its 10 subscales ranged from 0.796 to 0.935. Specifically, the Cronbach's alpha for the overall scale and all of the subscales were the following: Overall Survey: 0.944, TK: 0.875, CK-Math: 0,869, CK-Social Studies: 0.935, CK-Science: 0.822, CK-Literacy: 0.934, PK: 0.834, PCK: 0,876, TCK: 0.796, TPK: 0.846, TPACK: 0.825. These results were excellent and confirmed the reliability of the instrument.

The SQD scale

The SQD scale contains 24 items rated on a 6-point scale. The scale investigates to what extent the six strategies of 1) using teacher educators as role models, 2) reflecting about the role of technology in education 3) collaborating with peers, 4) learning technology by design 5) scaffolding authentic experiences, and 6) moving from traditional to continuous feedback, are employed by teacher education programs. The six strategies are presented as statements and participants are asked to rate each statement on a 6-point Likert scale ranging from totally disagree (1) to totally agree (6). The use of the SQD strategies is measured based on participants' responses to the 24 items, four items for each strategy. The SQD scale is presented below:

Figure 7

Item wordings of the SQD-Scale (Tondeur et al., 2016)

For the purpose of this questionnaire, the term of Information and Communication Technology (ICT) is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc.

Survey of the SQD scale

During my preservice training…
Role model (ROL)
(ROL1) I saw many examples of ICT use in an educational setting
(ROL2) I observed sufficient ICT use in an educational setting in order to integrate applications myself in the future
(ROL3) I saw good examples of ICT practice that inspired me to use ICT applications in the classroom myself
(ROL4) The potential of ICT use in education was demonstrated concretely
Reflection (REF)
(REF1) I was given the chance to reflect on the role of ICT in education
(REF2) We discussed the challenges of integrating ICT in education
(REF3) We were given the opportunity to discuss our experiences with ICT in the classroom (i.e., during internships)
(REF4) There were specific occasions for us to discuss our general attitude towards ICT in education.
Instructional design (DES)
(DES1) I received sufficient help in designing lessons that integrated ICT
(DES2) We learnt how to thoroughly integrate ICT into lessons
(DES3) We received help to use ICT when developing educational materials
(DES4) I received a great deal of help developing ICT-rich lessons and projects to use for my internship
Collaboration (COL)
(COL1) There were enough occasions for me to work together with other students on ICT use in education (i.e., we developed ICT-based lessons together)
(COL2) I was convinced of the importance of co-operation with respect to ICT use in education
(COL3) Students helped each other to use ICT in an educational context
(COL4) Experiences using ICT in education were shared
Authentic experiences (AUT)
(AUT1) There were enough occasions for me to test different ways of using ICT in the classroom
(AUT2) I was able to learn to use ICT in the classroom through the internships
(AUT3) I was encouraged to gain experience in using ICT in a classroom setting
(AUT4) Students were encouraged when they attempted to use ICT in an educational setting
Feedback (FEE)
(FEE1) I received sufficient feedback about the use of ICT in my lessons
(FEE2) My competences with ICT were thoroughly evaluated
(FEE3) I received sufficient feedback on how I can further develop my ICT competences
(FEE4) My competences in using ICT in the classroom were regularly evaluated

Note. Response categories: totally disagree - disagree - slightly disagree - slightly agree – agree - totally agree

The SQD scale had been found to be reliable by earlier studies (Tondeur et al., 2016); however, it was also assessed for reliability based on this study's sample. The Cronbach's alpha for the overall scale and the six strategies were the following: Overall Scale: 0.946, Role model: 0.725, Reflection: 0.788, Instructional design: 0.910, Collaboration: 0.885, Authentic experiences: 0.824, Feedback: 0.907. The results regarding the internal consistency of each subscale and the SQD scale as a whole indicated that the instrument was reliable, since the Cronbach's alpha exceeded 0.70 for items to be used together as a scale (Nunnally, 1978).

The relationships between the six subscales of the instrument were also examined using Pearson product-moment correlation. Coefficients between subscales ranged from 0.384 (Role model and Authentic experiences) to 0.782 (Reflection and Feedback), demonstrating that all subscales were significantly correlated to each other at either the 0.01 level or at the 0.05 level. The six SQD strategies were treated as a set of predictors for preservice teachers' perceived knowledge on TPACK domains. Coefficients between all subscales are analytically listed in Table 2.

Table 2

Coefficients between all subscales of the SQD scale

		ROL	REF	DES	COL	AUT	FEE
ROL	Pearson Correlation	1	.397*	.393*	.439*	.384*	.432*
	Sig. (2-tailed)		.036	.038	.019	.044	.022
	N	28	28	28	28	28	28
REF	Pearson Correlation	.397*	1	.644**	.571**	.556**	.782**
	Sig. (2-tailed)	.036		.000	.001	.002	.000

	N	28	28	28	28	28	28
DES	Pearson Correlation	.393*	.644**	1	.660**	.732**	.693**
	Sig. (2-tailed)	.038	.000		.000	.000	.000
	N	28	28	28	28	28	28
COL	Pearson Correlation	.439*	.571**	.660**	1	.762**	.506**
	Sig. (2-tailed)	.019	.001	.000		.000	.006
	N	28	28	28	28	28	28
AUT	Pearson Correlation	.384*	.556**	.732**	.762**	1	.565**
	Sig. (2-tailed)	.044	.002	.000	.000		.002
	N	28	28	28	28	28	28
FEE	Pearson Correlation	.432*	.782**	.693**	.506**	.565**	1
	Sig. (2-tailed)	.022	.000	.000	.006	.002	
	N	28	28	28	28	28	28

***. Correlation is significant at the 0.05 level (2-tailed).**

****. Correlation is significant at the 0.01 level (2-tailed).**

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback

Data Analysis

The TPACK survey

The study used a descriptive analysis to investigate the perceived knowledge of preservice teachers on TPACK domains. Statements from the TPACK survey are used in the data analysis to describe the findings of this study. The statements are written in italics. The results of the analysis addressed the first research question of the study. The means and standard deviations of each scale item and each subscale were calculated.

As shown in Table 3, the TPACK domains received mean scores ranging from 3.4643 (*SD*=0.61129) to 4.2143 (*SD*=0.48665). Specifically, the Technological Pedagogical Knowledge (TPK) and Pedagogical Knowledge (PK) were attributed the highest mean score, while the lowest mean scores were received by Technological Content Knowledge (TCK) and Pedagogical Content Knowledge (PCK).

Table 3

Descriptive statistics of the TPACK subscales

	Mean	Std. Deviation	N
TK	3.7653	.68701	28
CK-Math	3.7500	.78371	28
CK-Social Studies	3.9524	.63966	28
CK-Science	3.8571	.61817	28
CK-Literacy	4.0595	.72608	28
PK	4.1327	.48861	28
PCK	3.5982	.68833	28
TCK	3.4643	.61129	28
TPK	4.2143	.48665	28
TPACK	3.9643	.40520	28

TK: Technology Knowledge, CK: Content Knowledge, PK: Pedagogical Knowledge, PCK: Pedagogical Content Knowledge, TCK: Technological Content Knowledge, TPK: Technological Pedagogical Knowledge, TPACK: Technological Pedagogical Content Knowledge

Table 4 below outlines the survey items, which were attributed the highest mean score for every TPACK domain. As shown in the table, the participants reported that *they could use a wide range of teaching approaches in a classroom setting, such as collaborative learning, direct instruction, inquiry learning and problem/project based learning*. They also acknowledged that *their teacher education program has caused them to think more deeply about how technology could influence the teaching approaches they use in the classroom.*

Table 4

TPACK items that received the highest mean score in every subscale

	N	Mean	Std. Deviation
(TK) I can learn technology easily	28	4.18	.772
(CK-Math) I can use a mathematical way of thinking	28	3.61	.916
(CK-Social Sciences) I have various ways and strategies of developing my understanding of social studies	28	4.00	.667
(CK-Science) I have various ways and strategies of developing my understanding of science	28	3.93	.813
(CK-Literacy) I have sufficient knowledge about literacy	28	4.11	.737
(PK) I can use a wide range of teaching approaches in a classroom setting (collaborative learning, direct instruction, inquiry learning, problem/project based learning etc.	28	4.36	.559
(PCK) I know how to select effective teaching approaches to guide student thinking and learning in literacy	28	3.71	.763
(TCK) I know about technologies that I can use for understanding and doing literacy	28	3.54	.693
(TPK) My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom	28	4.50	.638
(TPACK) I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn	28	4.18	.476

TK: Technology Knowledge, CK: Content Knowledge, PK: Pedagogical Knowledge, PCK: Pedagogical Content Knowledge, TCK: Technological Content Knowledge, TPK: Technological Pedagogical Knowledge, TPACK: Technological Pedagogical Content Knowledge

On the other hand, Table 5 displays the survey items received the lowest mean scores. In particular, the participants reported that *they were not very familiar with a lot of different technologies*. They also reported that *they did not feel quite confident to select technologies they could use for understanding and teaching science or to select effective teaching approaches to guide student thinking and learning in science*.

Table 5

TPACK items received that lowest mean scores in every subscale

	N	Mean	Std. Deviation
(TK) I know about a lot of different technologies	28	3.39	.916
(CK-Math) I can use a mathematical way of thinking	28	3.61	.916
(CK-Social Studies) I have sufficient knowledge about social studies	28	3.86	.756
(CK-Science) I can use a scientific way of thinking	28	3.86	.651
(CK-Literacy) I can use a literary way of thinking	28	3.96	.838
(PK) I am familiar with common student understandings and misconceptions	28	3.79	.686
(PCK) I know how to select effective teaching approaches to guide student thinking and learning in science	28	3.50	.882
(TCK) I know about technologies that I can use for understanding and doing science	28	3.46	.793
(TPK) I can choose technologies that enhance the teaching approaches for a lesson	28	4.00	.720
(TPACK) I can teach lessons that appropriately combine social studies, technologies and teaching approaches	28	3.79	.738

TK: Technology Knowledge, CK: Content Knowledge, PK: Pedagogical Knowledge, PCK: Pedagogical Content Knowledge, TCK: Technological Content Knowledge, TPK: Technological Pedagogical Knowledge, TPACK: Technological Pedagogical Content Knowledge.

The SQD scale

Similar to the TPACK survey, the data collected by the SQD scale was analyzed using a descriptive analysis. Statements from the SQD scale are used in the data analysis to describe the findings of this study. The statements are written in italics. The purpose of this analysis was to address the second research question about investigating preservice teachers' perceptions towards the SQD strategies used in their teacher training. The means and standard deviations of each scale item and each subscale were calculated.

As shown in Table 6, all six strategies received high scores with the strategies of role model and collaboration being attributed the highest mean ratings. The mean of role model was 4.4821 (*SD*=0.71339) and that of collaboration was 4.4464 (*SD*=0.97258). The strategy of feedback received the lowest with a mean of 4.0536 (*SD*=1.09154).

Table 6

Descriptive statistics of the SQD subscales

	Mean	Std. Deviation	N
ROL	4.4821	.71339	28
REF	4.3304	.89508	28
DES	4.3214	.96191	28
COL	4.4464	.97268	28
AUT	4.3304	.83348	28
FEE	4.0536	1.09154	28

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback

Table 7 presents the SQD items that received the highest mean score in each strategy. According to the analysis, participants thought that, *during their preservice training, they were encouraged when they attempted to use ICT in an educational setting.*

Moreover, they reported that *the potential of ICT use in education was demonstrated concretely*.

Table 7

SQD items that received the highest mean score in every subscale

	N	Mean	Std. Deviation
(ROL) During my preservice training, the potential of ICT use in education was demonstrated concretely	28	4.64	.780
(REF) During my preservice training, we discussed the challenges of integrating ICT in education	28	4.57	1.034
(DES) During my preservice training, we received help to use ICT when developing educational materials	28	4.57	.997
(COL) During my preservice training, I was convinced of the importance of co-operation with respect to ICT use in education	28	4.50	1.036
(AUT) During my preservice training, students were encouraged when they attempted to use ICT in an educational setting	28	4.79	.630
(FEE) During my preservice training, I received sufficient feedback about the use of ICT in my lessons	28	4.18	1.090

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback

In contrast, Table 8 shows the SQD items that were attributed the lowest mean scores in each strategy. Based on the analysis' results, preservice teachers suggested that, *during their preservice training, they had few opportunities to use ICT in the classroom through interships opportunities*, and *their competences with ICT were not as thoroughly evaluated as they wished they would be*.

Table 8

SQD items that received the lowest mean score in every subscale

	N	Mean	Std. Deviation
(ROL) During my preservice training, I saw many examples of ICT use in an educational setting	28	4.32	1.249
(REF) During my preservice training, we were given the opportunity to discuss our experiences with ICT in the classroom (i.e., during internships)	28	4.11	1.449
(DES) During my preservice training, I received a great deal of help developing ICT-rich lessons and projects to use for my internship	28	4.11	1.100
(COL) During my preservice training, there were enough occasions for me to work together with other students on ICT use in education (i.e., we developed ICT-based lessons together)	28	4.21	1.424
(AUT) During my preservice training, I was able to learn to use ICT in the classroom through the internships	28	3.71	1.357
(FEE) During my preservice training, my competences with ICT were thoroughly evaluated	28	3.93	1.274

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback

Regression Analysis

The researcher performed ten multiple linear regression analyses to address the third research question. In particular, the purpose of running a multiple regression analysis model was to examine the proportion of the variance in the dependent variables that could be explained by variation in the set of predictors, and determine if the findings were statistically significant.

Regression analysis has several assumptions including: a) normality for the residuals that result from the linear regression model, b) homoscedasticity, which refers to the circumstance in which the dependent variable is equal across the range of values of the predictors, c) linearity between dependent variables and predictors, and d) absence of multicollinearity among the predictors. All assumptions were checked before/while running the multiple regression analyses for all ten TPACK domains.

Specifically, the assumption of no multicollinearity was met, as all analyses presented that all of the VIF values were above 0.1 and all of the Tolerance values were below 10. Moreover, the assumption of no autocorrelation of residuals was also satisfied, since Durbin-Watson statistics found that there was no autocorrelation in the sample. Finally, the scatterplots of standardised residuals on standardised predicted value and normal P-P plots of regression standardized residual displayed that the assumptions of linearity and homoscedasticity have been met.

The first regression was performed between the set of predictors and the domain of Technological Knowledge (TK). Figures 8 displays the normal P-P plot of regression standardized residual for TK. The normal probability plot of the residuals is nearly linear, suggesting that the error terms are normally distributed; thus, the assumption of normality has been satisfied for the domain of TK.

Figure 8

Normal P-P Plot of Regression Standardized Residual-TK

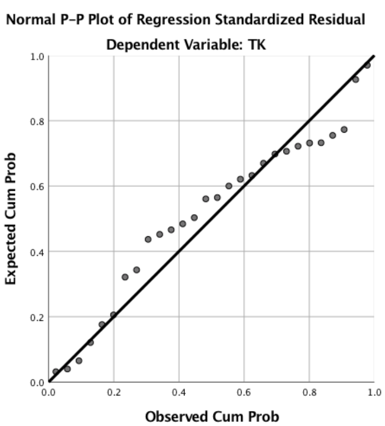
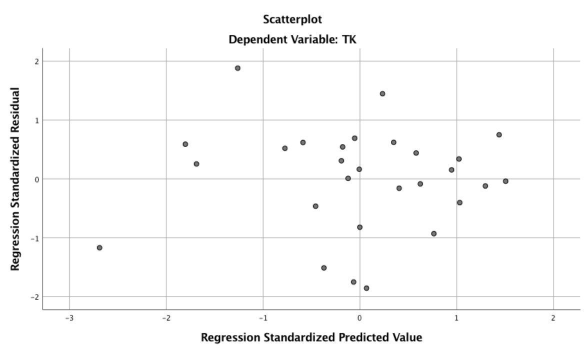


Figure 9

Scatterplot of the Residuals-TK



Moreover, Figure 9 presents a scatterplot of the residuals. The use of scatterpolots aimed to check for homoscedasticity. Figure 9 shows that data is hetoroscedastic, as there is no clear patter in the distribution. All other assumptions were checked while performing the regression analysis.

As shown in Table 9, the Adjusted R Square was calculated to be 0.280 indicating that 28% of variance in the dependent variable (TK) could be explained by variance in the set of predictors. The model revealed that the regression analysis was statistically significant ($F(6,21) = 2.754$, $p< 0.05$). The analysis also showed that the predictors of role modeling (Beta = 0.484, $t(27) = 2.562$, $p<0.05$) and refection (Beta = 0.694, $t(27) = 2.495$, $p<0.05$) significantly predicted the TK domain.

Table 9

Regression Analysis - TK

	B	Std. Error	Beta	t	Sig
ROL	.466	.182	.484	2.562	**.018***
REF	.533	.213	.694	2.495	**.021***
DES	-.090	.201	-.126	-.447	**.659**
COL	-.038	.192	-.054	-.200	**.844**
AUT	-.041	.236	.050	.173	**.864**
FEE	-2.73	.184	-.434	-1.487	**.152**
df= (6, 21) **F=** 2.754 **Sig=** .039*					
Adjusted R Square = .280					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
* p < 05. **p< .01.

Next, the set of predictors was tested with the pedagogical domain (PK). As shown in Figures 10 and 11, both assumptions of normality and homoscedasticy have been met for PK, since the error terms are normally distributed, and there is no pattern in the distrtibution. Similar to TK, all other assumptions were checked while performing the regression analysis.

Figure 10

Normal P-P Plot of Regression Standardized Residual-PK

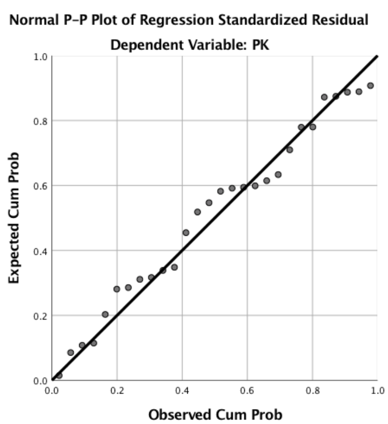
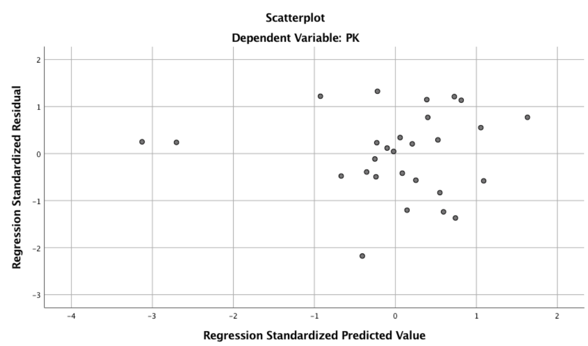


Figure 11

Scatterplot of the Residuals-PK



Regarding the analysis, the Adjusted R Square indicated that the independent variables could predict 36.5% of variance in PK (Table 10). The regression analysis model was significant ($F(6, 21) = 3.589$, $p< 0.05$), and role modeling (Beta = 0.504, $t(27) = 2.841$, $p<0.05$) was a significant positive predictor. On the other hand, collaboration (Beta = -0.741, $t(27) = -2.901$, $p<0.05$) showed a negative significance for PK. The strategy of collaboration had been attributed with a high mean score in the SQD scale, suggesting that subjects acknowledged the presence of the strategy in the program. However, based on the results, it can be assumed that the strategy was mainly used as a means to establish a collaborative climate in class, and did not specifically target the development of PK in preservice teachers.

Table 10

Regression Analysis - PK

	B	Std. Error	Beta	t	Sig
ROL	.345	.121	.504	2.841	**.010***
REF	-.216	.143	-.396	-1.515	**.145**
DES	.241	.135	.474	1.789	**.088**
COL	-.372	.128	-.741	-2.901	**.009****
AUT	.204	.158	.347	1.290	**.211**
FEE	.067	.123	.149	.544	**.592**
df= (6,21) **F=** 3.589 **Sig= .**013*					
Adjusted R Square = .365					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
*p < 05. **p <. 01.

Continuing to the domain of Pedagogical Content Knowledge (PCK), the researcher first checked for all assumptions. Figures 12 and 13 display that normality and homoscedasticity have been satisfied. Next, the researcher performed the regression analysis, through which the remaining assumptions were examined.

Figure 12

Normal P-P Plot of Regression Standardized Residual-PCK

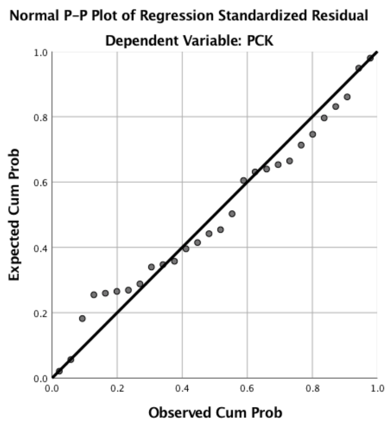
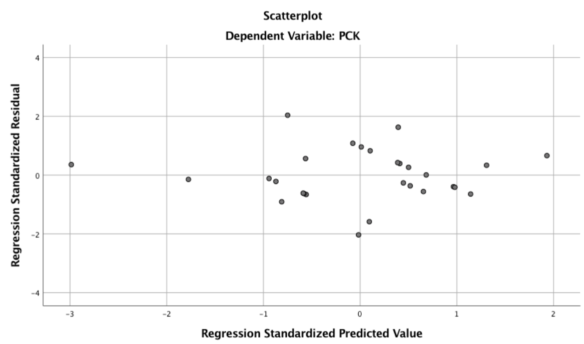


Figure 13

Scatterplot of the Residuals-PCK



The analysis revealed that the Adjusted R Square was 64.1, indicating that the set of predictors explained a significant percent of variance in PCK (Table 11). Similar to TK and PK constructs, the model showed a statistically significant regression for PCK domain ($F(6,21) = 9.042$, $p < 0.01$). The analysis revealed that the predictors of role modeling (Beta = 0.517, $t(27) = 3.880$, $p<0.05$) and feedback (Beta = .738, $t(27) = 3.581$, $p<0.05$) had significant findings. On the other side, collaboration (Beta = -.579 $t(27) = -3.016$, $p<0.05$) was found to be negatively significant for this domain as well. Reflection (Beta = -7.44, $t(27) = -3.786$, $p<0.05$) was also a negative predictor for PCK. The strategy of reflection had been highly valued by the sample of this study, whereas PCK had been attributed a relatively low mean score in the TPACK scale. A possible explanation for the negative significance might be that, while reflecting on the ICT use in education, participating teachers realized their limited knowledge on the PCK domain.

Table 11

Regression Analysis - PCK

	B	Std. Error	Beta	t	Sig
ROL	.499	.129	.517	3.880	**.001****
REF	-.572	.151	-.744	-3.786	**.001****
DES	.142	.142	.199	.999	**.329**
COL	-.410	.136	-.579	-3.016	**.007****
AUT	.319	.167	.386	1.906	**.070**
FEE	.465	.130	.738	3.581	**.002****
df= (6,21) **F=** 9.042 **Sig=** .000**					
Adjusted R Square = .641					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
*p < 05. **p <. 01

Following, the predictors were examined with the Technological Content Kowledge (TCK). Figures 14 and 15 show the normal probability plot of the residuals along with the scatter plot of the residuals.

Figure 14

Normal P-P Plot of Regression Standardized Residual-TCK

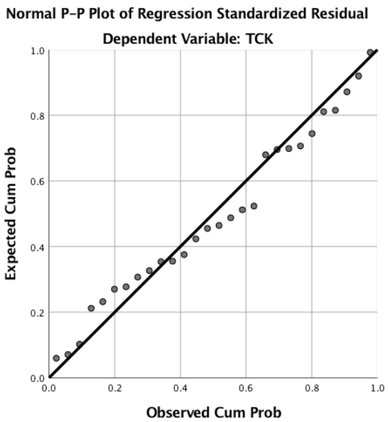
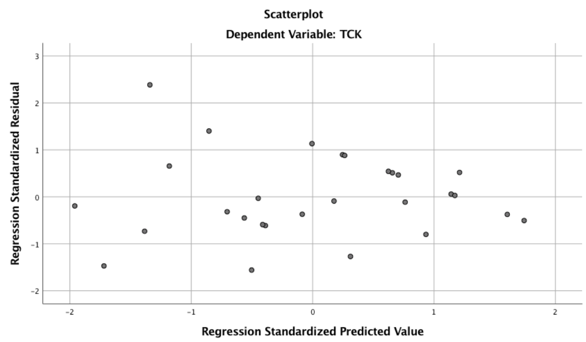


Figure 15

Scatterplot of the Residuals-TCK



With respect to the analiysis, the Adjusted R Square explained 39.6% of variance in the TCK domain (Table 12). Once again, the regression model was significant ($F(6,21) = 3.955$, $p< 0.01$), and significant predictors were the strategies of refection (Beta = 0.672, $t(27) = 2.640$, $p<0.05$) and instructional design (Beta = 0.550, $t(27) =2.130$, $p<0.05$). The results about collaboration (Beta = -.683, $t(27) = -2.741$, $p<0.05$) showed a negative significance, indicating similar findings as the aforementioned domains.

Table 12

Regression Analysis - TCK

	B	Std. Error	Beta	t	Sig
ROL	.136	.148	.159	.917	**.369**
REF	.459	.174	.672	2.640	**.015***
DES	.350	.164	.550	2.130	**.045***
COL	-.429	.157	-.683	-2.741	**.012***
AUT	.172	.193	.234	.891	**.383**

FEE	-.211	.150	-.377	-1.412	**.173**
df= (6, 21) **F=** 3.955 **Sig=** .008**					
Adjusted R Square = .396					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
*p < 05. **p <. 01.

With regard to regression analysis performed for the Technological Pedagogical Knowledge (TPK), findings showed an absence of being statistically significant. As outlined in Table 13, the Adjusted R Square displayed that only 13.4% of variance in TPK could be explained by the set of predictors. Similar results were revealed for all four subdomains of the Content Knowledge (CK). The models of TPK and of all CK subdomains were statistically insignificant, and none of the predictors reached the significance threshold. The results of all CK subscales are presented in Tables 14, 15, 16, 17. Also, the normal P-P plots and scatterplots of TPK and all four CK domains are presented in Figures 16, 17, 18, 19, 20, 21, 22, 23, 24, 25.

Figure 16

Normal P-P Plot of Regression Standardized Residual-TPK

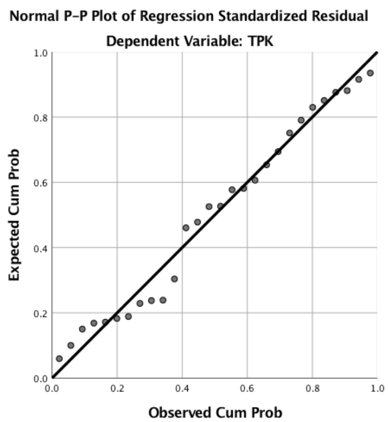


Figure 17

Scatterplot of the Residuals-TPK

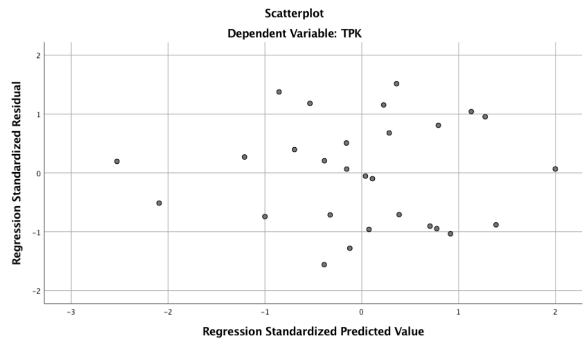


Table 13

Regression Analysis - TPK

	B	Std. Error	Beta	t	Sig
ROL	.341	.141	.500	2.414	**.025**
REF	.136	.166	.250	.821	**.421**
DES	-.011	.156	-.022	-.070	**.945**
COL	-.215	.149	-.431	-1.443	**.164**
AUT	.271	.184	.464	1.475	**.155**
FEE	-.113	.143	-.254	-.794	**.436**
df= (6, 21) **F=** 1.696 **Sig=** .171					
Adjusted R Square = .134					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
* p < 05. **p <. 01

Figure 18

Normal P-P Plot of Regression Standardized Residual-CK/Math

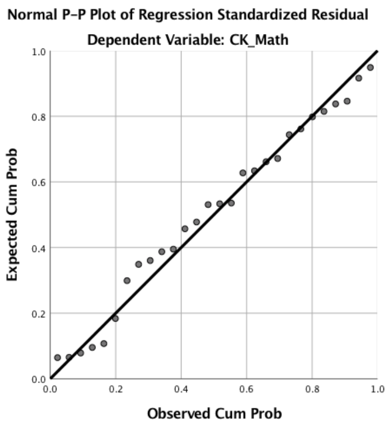


Figure 19

Scatterplot of the Residuals-CK/Math

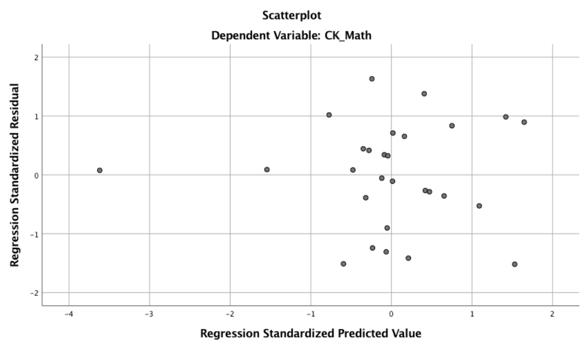


Table 14

Regression Analysis - CK/Math

	B	Std. Error	Beta	t	Sig
ROL	.147	.254	.134	.580	**.568**
REF	-.165	.298	-.189	-.5	**.585**
DES	.447	.281	.549	1.593	**.126**
COL	-.303	.268	-.376	-1.130	**.271**
AUT	.063	.330	.067	.191	**.850**
FEE	-.147	.256	-.205	-.575	**.572**
df= (6, 21) **F= .**683 **Sig=** .665					
Adjusted R Square = -.076					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
* p < 05. **p <. 01.

Figure 20

Normal P-P Plot of Regression Standardized Residual-CK/Social Studies

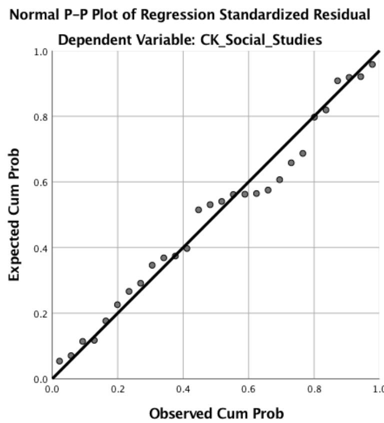


Figure 21

Scatterplot of the Residuals-CK/Social Studies

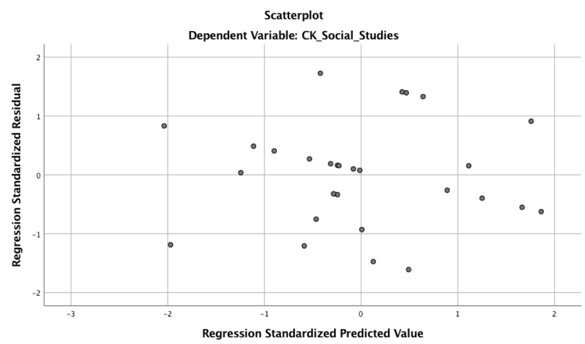


Table 15

Regression Analyis - CK/Social Studies

	B	Std. Error	Beta	t	Sig
ROL	.332	.208	.370	1.594	**.126**
REF	-.117	.245	-.164	-.479	**.637**
DES	-.004	.231	-.005	-.015	**.988**
COL	.133	.220	.202	.603	**.553**
AUT	-.103	.271	-.134	-.379	**.709**
FEE	.022	.210	.037	.104	**.918**
df= (6, 21) **F= .**628 **Sig=** .706					
Adjusted R Square = -.090					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
* p < 05. **p <. 01.

Figure 22

Normal P-P Plot of Regression Standardized Residual-CK/Science

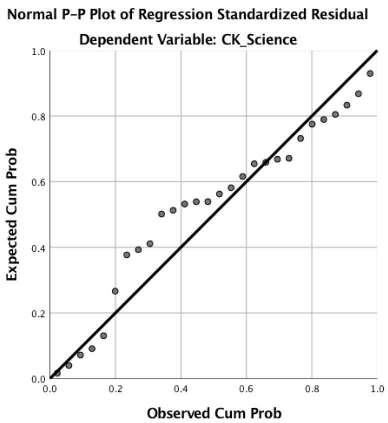


Figure 23

Scatterplot of the Residuals-CK/Science

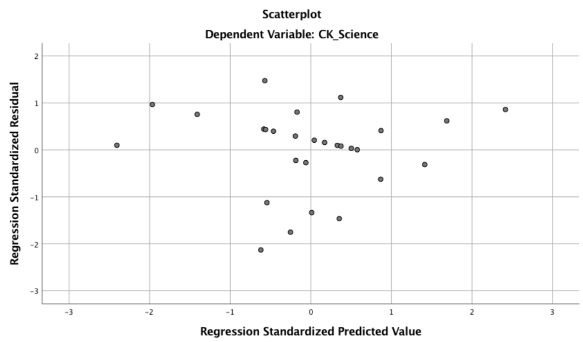


Table 16

Regression Analysis - CK/Science

	B	Std. Error	Beta	t	Sig
ROL	.335	.201	.387	1.669	**.110**
REF	-.103	.236	-.149	-.437	**.667**
DES	.128	.223	.199	.575	**.572**
COL	-.161	.212	-.254	-.760	**.456**
AUT	.128	.261	.173	.490	**.629**
FEE	-.114	.203	-.201	-.560	**.582**
df= (6, 21) **F=** .646 **Sig=** .693					
Adjusted R Square = -.085					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
* p < 05. **p <. 01.

Figure 24

Normal P-P Plot of Regression Standardized Residual-CK/Literacy

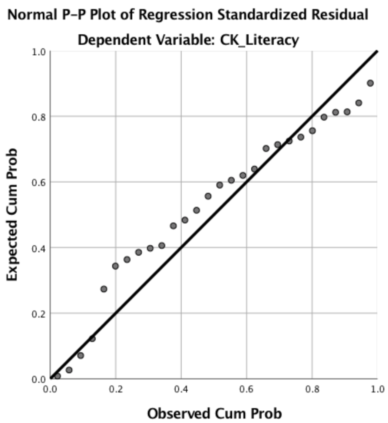


Figure 25

Scatterplot of the Residuals-CK/Literacy

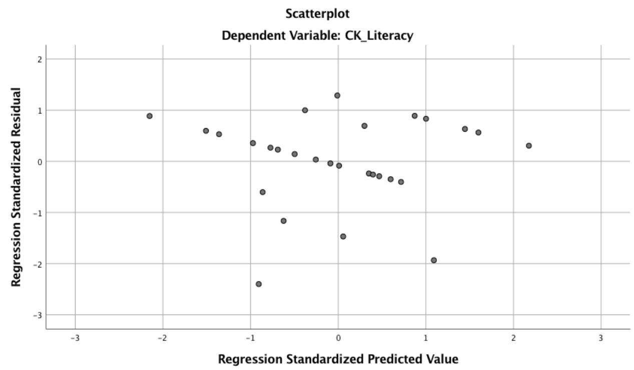


Table 17

Regression Analysis - CK/Literacy

	B	Std. Error	Beta	t	Sig
ROL	.203	.229	.200	.888	**.385**
REF	-.078	.269	-.096	-.290	**.775**
DES	.187	.254	.248	.738	**.468**
COL	.005	.242	.006	.019	**.985**
AUT	.232	.298	.266	.780	**.444**
FEE	-.108	.231	-.162	-.466	**.646**
df= (6, 21) **F=** .908 **Sig= .**508					
Adjusted R Square = -.021					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
p < 05. **p <. 01

Finally, regarding the TPACK domain, Figures 26 and 27 examine the assumptions of normality and homoscedasticity. As shown in the figures below, both assumptions have been met.

Figure 26

Normal P-P Plot of Regression Standardized Residual-TPACK

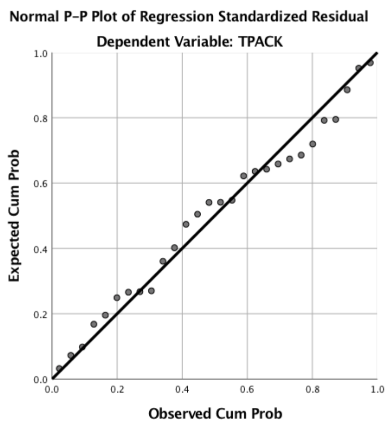
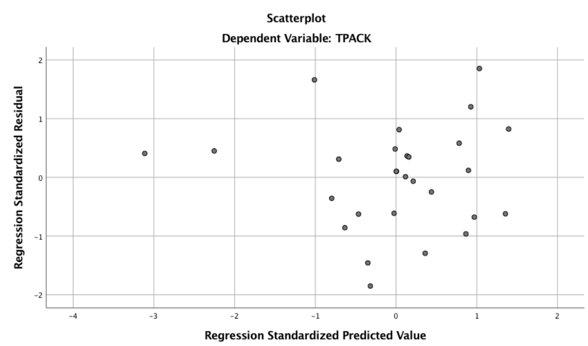


Figure 27

Scatterplot of the Residuals-TPACK



In terms of the analysis, Table 18 displays that the SQD strategies could predict 30 percent of the dependent variable. The model for the TPACK had a significant finding ($F(6,21) = 2.941$, $p < 0.05$). Significant predictors were the strategies of role modeling (Beta = 0.426, $t(27) = 2.290$, $p<0.05$) and instructional design (Beta = 6.83, $t(27) = 2.457$, $p<0.05$). Once again, collaboration (Beta = -0.714, $t(27) = 2.665$, $p<0.05$) was found to have a negative significance, following the same pattern as the other domains.

Table 18

Regression Analysis - TPACK

	B	Std. Error	Beta	t	Sig
ROL	.242	.106	.426	2.290	**.032***
REF	-.008	.124	-.017	-.062	**.952**
DES	.288	.117	.683	2.457	**.023***
COL	-.298	.112	-.714	-2.665	**.014***
AUT	.189	.137	.389	1.376	**.183**
FEE	-.166	.107	-.448	-1.558	**.134**
df= (6, 21) **F=**2.941 **Sig= .**030*					
Adjusted R Square = .301					

ROL: Role model, REF: Reflection, DES: Instructional Design, COL: Collaboration, AUT: Authentic Experiences, FEE: Feedback
p < 05. **p <. 01

As indicated by the data analysis, the SQD strategies could significantly predict five out of seven TPACK domains (CK is accounted for one main domain including all four content subscales). The next chapter will discuss the results, review the implications of the study and draw conclusions based on the research findings. Limitations of the study and future research directions will be also presented.

Chapter 5

Discussion of the Findings

The TPACK survey

The purpose of this quantitative study was to investigate the impact of technology training offered by teacher education programs on preservice teachers' TPACK development. In particular, the study aimed to investigate how the SQD strategies of: 1) teacher educators acting as role models, 2) learning technology by design, 3) collaborating with peers, 4) scaffolding authentic experiences, 5) reflecting about the role of technology in education and, 6) moving from traditional to continuous feedback, influence preservice teachers' TPACK. First, the study examined preservice teachers' perceived knowledge on TPACK domains using a descriptive analysis of the data gathered. The results of such analysis responded to the first research question, which was the following: "What is the perceived knowledge of preservice teachers on the domains of the TPACK framework?"

According to the analysis, the Technological Pedagogical Knowledge (TPK) and the Pedagogical Knowledge (PK) were attributed the highest mean scores. As a reminder, TPK refers to knowledge of how various technologies can be used in teaching, while the PK refers to knowledge about the processes and practices of teaching. In contrast, the Technological Content Knowledge (TCK) and Pedagogical Content Knowledge (PCK) received the lowest mean scores by the participants. TCK describes the knowledge about the manner in which technology and content are reciprocally related, whereas PCK refers to knowledge of pedagogy that is applicable to the teaching of specific content.

Statements from the TPACK survey are used in the discussion to describe the findings of this study. The statements are written in italics.

Notably, the TPK component includes statements that measure participants' ability to critically think about the use of technology in their classrooms and to choose technologies that enhance teaching and learning processes. The TPK subscale also evaluates if teachers can adapt the use of technologies that they have already learned about, to different teaching activities. The participants of this study highly rated all the statements included, and supported that *they could critically intergrade technology into their instruction*. Moreover, they indicated *that their teacher education program has caused them to think more deeply about how technology could influence the teaching approaches they use in their classroom*.

With regard to PK, the subscale measures subjects' familiarity with different teaching approaches and assessment methods, and their ability to adapt their teaching style to students' needs. Based on the analysis, the participants supported *that they could evaluate their students' knowledge in multiple ways, and could adapt their teaching practices based on their students' needs*. They also reported that *they felt confident about using a wide range of teaching practices in their classroom, such as collaborative learning, inquiry learning and project-based learning*.

On the other hand, the components of TCK and PCK received the lowest mean scores in the TPACK survey. This outcome aligns with findings of earlier studies, which also indicated that preservice teachers lack the knowledge for building pedagogical connections between the affordances of technology and teaching a particular content domain (Angeli & Valanides, 2009; Mouza et al., 2014). In this study, the participants mentioned that their knowledge about how technology could be used for understanding and teaching any of the four content areas - math, social sciences, science, literacy - was rather limited. They also reported a lack of confidence about selecting effective teaching approaches to guide student thinking and learning in the four content areas. The insufficient number of subject-specific courses focusing on technology preparation remains an issue for teacher education programs. Thus, preservice teachers often report their lack of confidence to connect pedagogy and technology with specific subject areas.

The SQD scale

Moving on to the survey of the SQD scale, the data analysis aimed to answer the second research question, which was the following: “To what extent do preservice teachers identify the use of SQD strategies in their teacher education program?”. Once again, statements from the SQD scale are used in the discussion to describe the findings of this study. The statements are written in italics.

As presented in chapter four, all six strategies received high scores, with the strategies of role modeling and collaboration being attributed the highest mean ratings. With regard to role modeling, the literature review has revealed the positive impact of teacher educators acting as role models when teaching technology courses in teacher programs (Admiraal et al., 2017). Offering examples and connecting instructional technology to real-life experiences in classrooms seem to be inspiring for preservice teachers. In this study, participants rated all four statements included in the subscale of role modeling with high scores. They reported that *during their technology training, the potential of ICT use in education was demonstrated concretely*, and *they had seen many examples of ICT practice that had inspired them to use ICT applications in their future* *classrooms*. These findings are very positive, and reveal that role modeling was extensively used in the teacher program.

With respect to collaboration, mean ratings for each subscale item and the subscale as a whole were also high. According to Angeli and Valanides (2009), preservice teachers need to participate "in a professional community that discusses new teacher materials and strategies, and supports the risk taking and struggle entailed in transforming practice" (as cited in McLaughlin & Talbert, 1993, p. 15). The participants of the current study mentioned *that they were convinced of the significance of collaboration in ICT use*. In fact, the responses suggested that *during their training, they had enough opportunities for collaborating with each other and helping other students on ICT use in education*.

In contrast to the aforementioned SQD strategies, feedback received the lowest mean score in the scale. The data analysis showed that preservice teachers' competences with ICT were not as thoroughly and regularly evaluated as participants wished they would be. These results are similar to findings presented in the body of literature. Previous studies have also reported that preservice teachers receive limited opportunities for feedback in their training (Mouza et al., 2014; Hsu & Lin, 2020). As mentioned by Banas and York (2014), receiving feedback from colleagues and instructors promotes the development of preservice teachers' self-efficacy beliefs for integrating technology in their future classrooms. Therefore, teacher education programs need to address all key variables of the SQD model thoughtfully.

Impact of SQD strategies on TPACK development

The third research question of this study was the following: "What is the contribution of the SQD strategies to the development of each domain of the TPACK framework?" To answer this question, the researcher performed ten regression analyses. The results indicated that the SQD strategies, when used as a set of predictors, could significantly contribute to TPACK development. The model of regression was found to be statistically significant for five out of seven TPACK domains:

- knowledge of technology tools (TK)
- knowledge about the processes and practices of teaching (PK)
- knowledge of pedagogy that is applicable to the teaching of specific content, (PCK)
- knowledge about the manner in which technology and content are reciprocally related (TCK)
- knowledge of how technology, pedagogy and content can be intersected (TPACK)

The SQD strategies were insignificant for knowledge about the subject matter that is to be taught (CK), and knowledge of how various technologies can be used in teaching (TPK). Based on these results, it can be assumed that the SQD strategies, even though they were highly valued by the partipicants, did not significantly contribute to the growth of the CK and TPK domains of the sample.

When looking at each strategy individually, we notice that role modeling was a significant, positive predictor for multiple domains including TK, PK, PCK and TPACK. This finding indicates that role modeling was effectively utilized for the development of the various TPACK domains in preservice teachers. With respect to collaboration, the results outlined a significant, negative prediction for PK, PCK, TCK and TPACK. This was an unexpected finding, since the strategy of collaboration had received the second highest score in the SQD scale, and was expected to positively affect the development of TPACK domains. Apparently, the participants had valued the presence of collaboration in the teacher program, but the strategy was mostly used for establishing a collaborative spirit among students rather than leading to the domains' growth. This finding could also stem from the fact that, when collaborating with classmates, participants perceived their knowledge construction as a team-based accomplishment; thus, their individual progress in the targeted domains was less evident.

Tondeur et al. (2012), underlined the importance of collaboration, when groups of preservice teachers working specifically on the educational use of ICT. Moreover, preservice teachers reported that the composition of their group had a significant impact on their overall experience. In fact, they prefered to collaborate with peers having the same level of knowledge on ICT use; otherwise, they felt unable to follow the pace of the more advanced learners (Tondeur et al., 2012). Furthermore, Koh et al. (2017), investigated the effectiveness of a professional development process which involved 37 in-service teachers from a primary school in Singapore. This process was higly based on teacher collaboration. The study emphasized the importance of teachers' engagement with colleages and experts in design teams. During the one-year lasted study, several design teams worked collaboratively in order to develop lesson designs using ICT in multiple subject areas. Based on the results of the study, the process had positive effects on teachers' confidence for their TPACK development and their lesson design practices.

Regarding reflection, the strategy was ranked third in the scale, and reported to be a positive, significant predictor for TK and TCK. Next, the strategy of instructional design also received a high rating. The participants reported that *during their preservice training, they received help to use ICT when developing educational materials*. Instructional design was found to be a significant predictor for the domains of TCK and TPACK. On the other side, the strategy of authentic experiences did not significantly contribute to any of the TPACK domains, whereas feedback showed a significant, positive finding for PCK.

Contributions to the Field of Educational Leadership

The findings shared the significant contribution of SQD strategies to five out of seven TPACK domains. The data analysis reported that there is a significant prediction of participants' TPACK from the six strategies when used as a set of predictors. This study contributes to the literature by providing teacher educators with insights about how to design effective technology trainings for future teachers. In a previous study, Baran et al. (2019) investigated the relationship between preservice teachers' TPACK Practical – a conceptual model including eight knowledge dimensions (Yeh et al., 2014) – and the use of SQD strategies in teacher education programs. In particular, they examined the impact of the six strategies to the overall growth of the TPACK-Practical. The value of the current study lies in the fact that examines the contribution of SQD strategies to each domain of the TPACK framework. Schmidt et al. (2009), supported that using TPACK as a framework for measuring teacher knowledge could positively affect both professional development training and teacher education programs, in terms of rethinking and designing new strategies that adequately prepare teachers to integrate technology in their teaching practices. Some years later, Tondeur et al. (2016) generated the SQD-model, to present strategies that should be employed by teacher education programs, when educating teachers for technology use in classrooms.

All conclusions found within can be used not only to enhance teacher education programs, but also to enrich professional development for in-service teachers. We live in an era that, more that ever, calls for competent teachers who can effectively use digital tools in their teaching practices. Schooling has undergone drastic changes, as the COVID-19 pandemic has forced educational institutions to practice multiple modes of instruction, mostly based on technology. Our normal, in terms of how to deliver instruction, has significantly changed. Thus, there is an imperative need for a systemic improvement in the field of instructional technology. Positive outcomes in students' learning are led by educators prepared to adjust to the new reality, and schools that support and reinforce this effort. Therefore, stakeholders — from teacher educators to administrators and policy makers — need to design technology-infused education programs that adequately prepare teachers to integrate technology in their practices.

Implications

The results of this study disclosed a statistically significant contribution of SQD strategies to most TPACK domains. Descriptive statistics for TPACK domains and SQD strategies displayed high mean scores for both sets of values, meaning that all domains/strategies included in both instruments were highly identified by the participating teachers. Findings also revealed some challenges, as the strategy of feedback and the TCK domain were attributed with a relatively low score, and collaboration was found to have a negative significance in the knowledge domains.

These results align with those of other studies and call for designing training programs that practice a technology-infused curriculum. Such programs teach technology within content courses, and provide students with authentic teaching experiences and continuous feedback on their ICT competences. For instance, Mouza et al. (2014) conducted a study to examine how an integrated approach that juxtaposed an educational technology course with methods courses and field experience through careful instructional design, could shape preservice teachers' TPACK development and practice. All methods courses focused on curriculum and appropriate methods for teaching the subject areas of math, social studies, science and literacy to elementary or middle school students. Additionally, faculty teaching method courses modelled how technology could be used alongside specific pedagogical approaches in specific content areas. Based on the results of the study, it was evident that participants had built their greatest body of TK through the technology course. Likewise, they supported that they had advanced their TPK, as they were able to observe how various pedagogical approaches were practiced in conjunction with technology use in their field experiences. They suggested that they had the opportunity to discuss the pedagogical approaches observed in their field placements with in-service teachers, and to reflect on the impact of such approaches on their own teaching practices. Finally, preservice teachers mentioned that methods courses had contributed toward the development of both their PCK and their TCK.

The above findings indicate that technology courses, when taken in conjunction with methods courses and field experience, can significantly help preservice teachers advance their TPACK and develop effective instruction for their students.

Limitations of the study and Recommendations for Future Research

The limitations of the study are identified within the following areas: first, the sample of the study was relatively small; second, the participating teachers were still working on their technology training; last, the measures used for data collection were limited to self-assessment instruments.

Regarding the sample, the study was unable to attract a significant number of participants. This was mainly due to the fact that the COVID-19 pandemic has forced higher education institutions to switch to online learning. Consequently, the recruitment process turned out to be particularly challenging, as the potential subjects did not respond to the call for online participation in the study as originally expected. Furthermore, the initial plan of the researcher was to invite students, who had finished their third or forth year of study, as these students would have completed their technology training. However, the limited participation from students of the targeted groups led to the decision to also include (Fall 2020) juniors, who were still working on the last course of their technology training. It is possible that the results would have been slightly different if the training had been completed. The data analysis has already indicated a positive relationship between the SQD strategies and most TPACK components. It is likely that a stronger relationship would have been captured - even for TPACK domains that demonstrated an absence of significant prediction - if participants had completed all three courses of their training.

Concerning the measures, both instruments used in the study were based on self-reported data. Integration of additional assessment approaches, such as observations and interviews, could be used to provide an insight of how/why specific SQD strategies are associated with specific TPACK dimensions. For instance, this study revealed that certain strategies were statistically significant for specific knowledge domains. It would be helpful to further investigate this relationship using qualitative methods.

With reference to recommendations, future research may carry out studies using a larger sample. Another research direction could also include the strategies of technology planning and leadership, access to resources, training staff and cooperation within/between institutions in the set of predictors. These strategies refer to the conditions necessary to develop effective teacher education programs on the institutional level. As mentioned in the literature review, "learning to teach with technology is a constructive and iterative process and in order to successfully train preservice teachers to use technology, teacher education programs need to address all these key variables thoughtfully" (Tondeur et al., 2012, p. 8). Thus, exploring the role of the institution-related strategies in teacher training would be of great importance.

Finally, future research may examine the extent to which teachers' pedagogical beliefs and attitudes towards instructional technology can be affected/altered by the use of SQD strategies. Etmer et al. (2012) has identified two sets of barriers to technology integration into instruction: a) first-order barriers, which include factors such as environmental readiness and lack of Technological Pedagogical Content Knowledge (TPACK) in teachers; and b) second-order barriers, which involve teachers' beliefs about learning, confidence and perceptions regarding the effectiveness of instructional technology. It would be very useful to investigate if the strategies of the SQD-model can overcome both sets of barriers.

Implications for my Leadership Agenda and Growth

Conducting this research study has been a valuable experience for me, as it has helped me build a solid knowledge base regarding my problem of practice. Moreover, this process was vital to my development as a scholar; my thinking, in terms of how to approach a scientific issue, examine all the parameters involved, and build argumentation for supporting my point of view, became more critical and thorough. In my opinion, this is indicative of my leadership growth. With regard to my leadership agenda, my plan is to continue conducting research in the field of teacher education programs, with the hope of contributing to the design of programs that help future teachers build pedagogical connections between the affordances of technology and teaching various content domains.

Conclusion

This study examined the perceived knowledge of preservice teachers on the domains of TPACK framework, along with their perceptions towards the six strategies, which exist in the inner circle of the SQD-model. Descriptive statistics for TPACK domains and SQD strategies displayed high mean scores for both sets of values. Findings also revealed some challenges, as the strategy of feedback was attributed with a relatively low score, and the area of TCK was reported to be rather limited in preservice teachers.

The study also investigated the contributions of SQD strategies to each TPACK domain. Based on the analysis, the six strategies, when used as a set of predictors, showed significant findings for five out of seven TPACK domains. This indicates a positive and significant relationship between TPACK and SQD strategies. In alignment with findings of previous studies in the literature, the results call for training programs practicing a technology-infused curriculum. Such curriculum would teach technology courses in conjunction with content courses, and provide preservice students with authentic teaching experiences and continuous feedback on their ICT competences.

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Appendix A: Survey of the SQD scale

For the purpose of this questionnaire, the term of Information and Communication Technology (ICT) is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc.

Survey of the SQD scale

During my preservice training…

Role model (ROL)

(ROL1) I saw many examples of ICT use in an educational setting
(ROL2) I observed sufficient ICT use in an educational setting in order to integrate applications myself in the future
(ROL3) I saw good examples of ICT practice that inspired me to use ICT applications in the classroom myself
(ROL4) The potential of ICT use in education was demonstrated concretely

Reflection (REF)

(REF1) I was given the chance to reflect on the role of ICT in education
(REF2) We discussed the challenges of integrating ICT in education
(REF3) We were given the opportunity to discuss our experiences with ICT in the classroom (i.e., during internships)
(REF4) There were specific occasions for us to discuss our general attitude towards ICT in education.

Instructional design (DES)

(DES1) I received sufficient help in designing lessons that integrated ICT
(DES2) We learnt how to thoroughly integrate ICT into lessons
(DES3) We received help to use ICT when developing educational materials
(DES4) I received a great deal of help developing ICT-rich lessons and projects to use for my internship

Collaboration (COL)

(COL1) There were enough occasions for me to work together with other students on ICT use in education (i.e., we developed ICT-based lessons together)
(COL2) I was convinced of the importance of co-operation with respect to ICT use in education
(COL3) Students helped each other to use ICT in an educational context
(COL4) Experiences using ICT in education were shared

Authentic experiences (AUT)

(AUT1) There were enough occasions for me to test different ways of using ICT in the classroom
(AUT2) I was able to learn to use ICT in the classroom through the internships
(AUT3) I was encouraged to gain experience in using ICT in a classroom setting
(AUT4) Students were encouraged when they attempted to use ICT in an educational setting

Feedback (FEE)

(FEE1) I received sufficient feedback about the use of ICT in my lessons
(FEE2) My competences with ICT were thoroughly evaluated
(FEE3) I received sufficient feedback on how I can further develop my ICT competences
(FEE4) My competences in using ICT in the classroom were regularly evaluated

Note. Response categories: totally disagree - disagree - slightly disagree - slightly agree – agree - totally agree

Appendix B: The TPACK survey

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Iowa State University

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State University

Version: March 3, 2009. (This document will be updated as the survey is further developed).

Starting on page two of this document is the version of the survey presented to pre-service teachers in the following papers:

Schmidt, D., Baran, E., Thompson, A., Koehler, M.J., Shin, T, & Mishra, P. (2009, April). *Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers.* Paper presented at the 2009 Annual Meeting of the American Educational Research Association. April 13-17, San Diego, California.

Schmidt, D., Baran, E., Thompson, A., Koehler, M.J., Mishra, P., & Shin, T. (2009, March).
Examining preservice teachers' development of technological pedagogical content knowledge in an introductory instructional technology course. Paper presented at the 2009 International Conference of the Society for the Information and Technology & Teacher Education. March 2-6, Charleston, South Carolina.

Shin, T., Koehler, M.J., Mishra, P. Schmidt, D., Baran, E., & Thompson, A.,(2009, March). Changing technological pedagogical content knowledge (tpack) through course experiences Paper presented at the 2009 International Conference of the Society for the Information and Technology & Teacher Education. March 2-6, Charleston, South Carolina. (paper | presentation)

How do I use the survey? The questions you want are most likely questions 1-47 starting under the header "TK (Technology Knowledge)". In the papers cited above, these categories were removed so that participants were not oriented to the constructs when answering the survey questions. The items were presented in order from 1 through 47, however. The other items are more particular to individual study and teacher education context to better understand results found on questions 1-47. You are free to use them, or modify them. However, they are not the core items used to measure the components of TPACK.

How do score the survey. Each item response is scored with a value of 1 assigned to strongly disagree, all the way to 5 for strongly agree. For each construct the participant's responses are averaged. For example, the 7 questions under TK (Technology Knowledge) are averaged to produce one TK (Technology Knowledge) Score.

Reliability of the Scores (from Schmidt et al, 2009).

TPACK Domain	Internal Consistency (alpha)
Technology Knowledge (TK)	.82
Content Knowledge (CK)	
Social Studies	.84
Mathematics	.85
Science	.82
Literacy	.75
Pedagogy Knowledge (PK)	.84
Pedagogical Content Knowledge (PCK)	.85
Technological Pedagogical Knowledge (TPK)	.86
Technological Content Knowledge (TCK)	.80
Technological Pedagogical Content Knowledge (TPACK)	.92

Thank you for taking time to complete this questionnaire. Please answer each question to the best of your knowledge. Your thoughtfulness and candid responses will be greatly appreciated. Your individual name or identification number will not at any time be associated with your responses. Your responses will be kept completely confidential and will not influence your course grade.

DEMOGRAPHIC INFORMATION

1. Your ISU e-mail address

2. Gender
   a. Female
   b. Male

3. Age range
   a.18-22
   b.23-26
   c.27-32
   d.32+

4. Major
   a. Early Childhood Education (ECE)
   b. Elementary Education (ELED)
   c. Other

5. Area of Specialization
   a. Art
   b. Early Childhood Education Unified with Special Education

c. English and Language Arts
d. Foreign Language
e. Health
f. History
g. Instructional Strategist: Mild/Moderate (K8) Endorsement
h. Mathematics
i. Music
j. Science-Basic
k. Social Studies
l. Speech/Theater
m. Other

6. Are you completing an educational computing minor?
   a. Yes
   b. No
7. Are you currently enrolled or have you completed a practicum experience in a PreK-6 classroom?
   a. Yes
   b. No
8. Are you currently enrolled or have you completed a practicum experience in a PreK-6 classroom?
   a. Yes
   b. No
9. What semester and year (e.g. Spring 2008) do you plan to take the following? If you are currently enrolled in or have already taken one of these literacy blocks please list semester and year completed.

Literacy Block-I	(C I 377, 448, 468A, 468C)
Literacy Block-II	(C I 378, 449, 468B, 468D)
Student teaching	

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"

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
TK (Technology Knowledge)					
1. I know how to solve my own technical problems.					
2. I can learn technology easily.					
3. I keep up with important new technologies.					
4. I frequently play around the technology.					
5. I know about a lot of different technologies.					
6. I have the technical skills I need to use technology.					
7. I have had sufficient opportunities to work with different technologies.					
CK (Content Knowledge)					
Mathematics					
8. I have sufficient knowledge about mathematics.					
9. I can use a mathematical way of thinking.					
10. I have various ways and strategies of developing my understanding of mathematics.					
Social Studies					
11. I have sufficient knowledge about social studies.					
12. I can use a historical way of thinking.					
13. I have various ways and strategies of developing my understanding of social studies.					
Science					
14. I have sufficient knowledge about science.					
15. I can use a scientific way of thinking.					
16. I have various ways and strategies of developing my understanding of science.					
Literacy					
17. I have sufficient knowledge about literacy.					
18. I can use a literary way of thinking.					
19. I have various ways and strategies of developing my understanding of literacy.					

PK (Pedagogical Knowledge)					
20. I know how to assess student performance in a classroom.					
21. I can adapt my teaching based-upon what students currently understand or do not understand.					
22. I can adapt my teaching style to different learners.					
23. I can assess student learning in multiple ways.					
24. I can use a wide range of teaching approaches in a classroom setting (collaborative learning, direct instruction, inquiry learning, problem/project based learning etc.).					
25. I am familiar with common student understandings and misconceptions.					
26. I know how to organize and maintain classroom management.					
PCK (Pedagogical Content Knowledge)					
27. I know how to select effective teaching approaches to guide student thinking and learning in mathematics.					
28. I know how to select effective teaching approaches to guide student thinking and learning in literacy.					
29. I know how to select effective teaching approaches to guide student thinking and learning in science.					
30. I know how to select effective teaching approaches to guide student thinking and learning in social studies.					
TCK (Technological Content Knowledge)					
31. I know about technologies that I can use for understanding and doing mathematics.					
32. I know about technologies that I can use for understanding and doing literacy.					
33. I know about technologies that I can use for understanding and doing science					
34. I know about technologies that I can use for understanding and doing social studies.					
TPK (Technological Pedagogical Knowledge)					
35. I can choose technologies that enhance the teaching approaches for a lesson.					
36. I can choose technologies that enhance students' learning for a lesson.					
37. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
38. I am thinking critically about how to use technology in my classroom.					

39. I can adapt the use of the technologies that I am learning about to different teaching activities.					
TPACK (Technology Pedagogy and Content Knowledge)					
40. I can teach lessons that appropriately combine mathematics, technologies and teaching approaches.					
41. I can teach lessons that appropriately combine literacy, technologies and teaching approaches.					
42. I can teach lessons that appropriately combine science, technologies and teaching approaches.					
43. I can teach lessons that appropriately combine social studies, technologies and teaching approaches.					
44. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
45. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
46. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.					
47. I can choose technologies that enhance the content for a lesson.					
Models of TPACK (Faculty, PreK-6 teachers)					
48. My mathematics education professors appropriately model combining content, technologies and teaching approaches in their teaching.					
49. My literacy education professors appropriately model combining content, technologies and teaching approaches in their teaching.					
50. My science education professors appropriately model combining content, technologies and teaching approaches in their teaching.					
51. My social studies education professors appropriately model combining content, technologies and teaching approaches in their teaching.					
52. My instructional technology professors appropriately model combining content, technologies and teaching approaches in their teaching.					
53. My educational foundation professors appropriately model combining content, technologies and teaching approaches in their teaching.					

54. My professors outside of education appropriately model combining content, technologies and teaching approaches in their teaching.					
55. My PreK-6 cooperating teachers appropriately model combining content, technologies and teaching approaches in their teaching.					

	25% or less	*26%-50%*	*51%-75%*	*76%-100*
Models of TPCK				
56. In general, approximately what percentage of your teacher education professors have provided an effective model of combining content, technologies and teaching approaches in their teaching?				
57. In general, approximately what percentage of your professors outside of teacher education have provided an effective model of combining content, technologies and teaching approaches in their teaching?				
58. In general, approximately what percentage of the PreK-6 cooperating teachers have provided an effective model of combining content, technologies and teaching approaches in their teaching?				

Please complete this section by writing your responses in the boxes.

73. Describe a specific episode where an ISU professor or instructor effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content was being taught, what technology was used, and what teaching approach (es) was implemented.

74. Describe a specific episode where one of your PreK-6 cooperating teachers effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content was being taught, what technology was used, and what teaching approach (es) was implemented. If you have not observed a teacher modeling this, please indicate that you have not.

75. Describe a specific episode where you effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content you taught, what technology you used, and what teaching approach (es) you

Appendix C: Concent Form to Participate in the Research Study

DUQUESNE UNIVERSITY

600 FORBES AVENUE ♦ PITTSBURGH, PA 15282

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE: Investigating the impact of the SQD-model on the development of preservice teachers' TPACK

INVESTIGATOR: Triantafyllia Sarri

Doctoral student, School of Education, Department of Foundations and Leadership, phone: 412. 396. 6101, sarrit@duq.edu

ADVISOR: Dr. Carol Parke
Associate Professor, School of Education, Department of Foundations and Leadership, phone: 412.396.6101, parke@duq.edu

SOURCE OF SUPPORT:
This study is being performed as partial fulfillment of the requirements for the doctoral degree in School of Education at Duquesne University.

STUDY OVERVIEW
This study aims to investigate the impact of technology training offered by teacher education programs on preservice teachers' Technological Pedagogical Content Knowledge (TPACK) development. Based on research findings, TPACK is the teacher knowledge required to effectively use technology in classroom. Specifically, this study aims to investigate if the use of specific instructional methods adopted by teacher education programs influence preservice teachers' TPACK. To design effective TPACK-based interventions, research studies need to explore teachers' perceptions of how well teacher education programs train them for effective technology use in their future classrooms. Therefore, your input in this research study is valuable. There are no risks to you for participating in this study. The alternative to taking part in this study is not to participate in this study. The estimated number of total subjects expected is 35 students.

PURPOSE:

You are being asked to participate in a research project that is investigating the impact of technology training offered by teacher education programs on preservice teachers' Technological Pedagogical Content Knowledge development.

In order to qualify for participation, you must:

- be a junior or a senior student in the Leading Teacher Program in Pre K-4th grades at Duquesne University.

PARTICIPANT PROCEDURES:
If you provide your consent to participate, you will be asked to complete 2 online surveys, the Survey of Preservice Teachers' Knowledge of Teaching and Technology and the Survey of SQD scale. Both surveys contain items that are rated on a point scale. The Survey of Preservice Teachers' Knowledge of Teaching and Technology contains items that are rated on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). An example of a statement included in the survey is the following: "I have had sufficient opportunities to work with different technologies". You will be asked to indicate your answer to the aforementioned statement by selecting one response from a number of options ranging from "totally disagree" to "totally agree".

The Survey of SQD scale contains items that are rated on a 6-point scale ranging from 1 (strongly disagree) to 6 (strongly agree). An example of a statement included in the survey is the following: "I was given the chance to reflect on the role of Information and Communication Technology in education". Again, you will be asked to indicate your answer to the aforementioned statement by selecting one response from a number of options ranging from "totally disagree" to "totally agree".

If you agree to participate, you will receive two invitations to complete the two surveys online, one invitation for each survey. You will be asked to complete the surveys once. The expected duration for completing both surveys will not be more than 45 minutes.

RISKS AND BENEFITS:
There are no risks to you for participating in this study.
There will be no direct benefits to you as a result of participating in this study. However, if you desire, explanations of the methodology and issues related to this study will be provided. There are greater benefits to society by your participation in this study, by helping the evaluation and in consequence the development of technology training offered to preservice teachers by the teacher education programs.

COMPENSATION:
There will be no compensation for participating in this study.
There is no cost for you to participate in this research project.

CONFIDENTIALITY:
Your participation in this study, and any identifiable personal information you provide, will be kept confidential to every extent possible, and will be destroyed 3 years after the data collection is completed. Your name will never appear on any survey or research instruments. All electronic forms will be kept secure. There will be no association of the consent form with the data which you provide. In addition, any publications or presentations about this research will only use data that is combined together with all subjects; therefore, no one will be able to determine how you responded.

RIGHT TO WITHDRAW:
You are under no obligation to start or continue this study. You can withdraw at any time without penalty or consequence by choosing not to submit the surveys. In case you have submitted the survey and then decide to withdrawn, the data already collected will stay anonymous and it will not be identified by name.

SUMMARY OF RESULTS:
A summary of the results of this study will be provided to at no cost. You may request this summary by contacting the researchers and requesting it. The information provided to you will not be your individual responses, but rather a summary of what was discovered during the research project as a whole.

FUTURE USE OF DATA:
Any information collected that can identify you, will not be used for future research studies, nor will it be provided to other researchers.

VOLUNTARY CONSENT:
I have read this informed consent form and understand what is being requested of me. I also understand that my participation is voluntary and that I am free to withdraw at any time, for any reason without any consequences. Based on this, I certify I am willing to participate in this research project.

I understand that if I have any questions about my participation in this study, I may contact Triantafyllia Sarri at 412. 396. 6101 or at sarrit@duq.edu, or Dr. Carol Parke at 412. 396. 6101or at parke@duq.edu. If I have any questions regarding my rights and protections as a subject in this study, I can contact Dr. David Delmonico, Chair of the Duquesne University Institutional Review Board for the Protection of Human Subjects at 412.396.1886 or at irb@duq.edu.

Participant's Signature   Date

Researcher's Signature Date

If the subject is unable to sign their name, the following signature line should also be placed under the area for the subject's name and signature:

Name of Witness to Subject Signature of Witness to Subject

Date/Time

Mark or Consent Mark or Consent