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Examination of Teachers' Perceived Technological Pedagogical Content Knowledge and its Relationship to Lesson Design

Jocelyn McDonald
Walden University

Walden University

College of Education

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Jocelyn McDonald

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Review Committee
Dr. Carla Lane-Johnson, Committee Chairperson, Education Faculty
Dr. Michael Marrapodi, Committee Member, Education Faculty
Dr. Jennifer Lapin, University Reviewer, Education Faculty

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Abstract

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Jocelyn McDonald

M.Ed., Houston Baptist University, 2014

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Educational Technology

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Abstract

School districts are increasingly adopting 1-to-1 technology initiatives to support 21st century teaching and learning; yet, there are still many challenges with the effective integration of technology into teacher instructional practices. Teacher's technological, pedagogical, content knowledge (TPACK) is an integral part in planning the instructional process for effective integration. In this quantitative study, teachers' knowledge of technology, content, and pedagogy was examined through the lens of TPACK and its relationship to their lesson design practices. Two validated TPACK instruments were used to collect data on 117 in-service teachers in a large, urban school district with a 1-to-1 technology initiative. A MANOVA and correlational analysis were performed, and results of this study indicated there were no statistically significant differences between teachers' constructs of TPACK and their years of experience in a 1-to-1 technology initiative. However, statistical significance was found between teachers' constructs of TPACK and their content area. Additionally, a correlation was found between teachers' TPACK, their lesson design practices, and design disposition. The results of this study may positively impact social change by informing school administrators and other educational change leaders in the planning of teacher instructional support to further develop teachers in the implementation of technology integration to support the 21st century learning needs of today's students.

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Dedication

In honor of my grandmother, Shirley McDonald, I dedicate this journey to her love, encouragement, and persistent support throughout my life. Her belief in me extended beyond her years on earth and I am grateful to honor her in this accomplishment.

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There are various people I would like to acknowledge throughout this scholarly journey. I will like to thank my dissertation chair, Dr. Carla Lane-Johnson, for continuous motivation, guidance, and encouragement.

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Chapter 1: Introduction to the Study

Introduction

The facilitation of instruction to support 21st century teaching and learning is a monumental component in the success of the diffusion of innovation in a school district's one-to-one initiative (Blau, Peled, & Nusan, 2016; Zheng, Warschauer, Lin, & Chang, 2016). While there are varying factors that may affect the effectiveness of a one-to-one technology initiative, the instructional process is an essential factor that has a direct impact on the success of effective technology integration (Zheng et al., 2016). Therefore, teacher's knowledge of technology, content, and pedagogy are essential attributes in a one-to-one technology initiative (Blau et al., 2016). In this study, I examined these attributes through the lens of Mishra and Koehler's (2006) technological, pedagogical, and content knowledge (TPACK) model as it relates to teachers' lesson design practices (LDPs) and their design disposition (DD). Understanding teachers' instructional approach, through their LDPs and DD, in a one-to-one technology initiative may provide insight into its effect on the implementation of technology integration (Harper & Milman, 2016; Koh, Chai, Hong, & Tsai, 2015).

Investigating teachers' level of knowledge in technology integration through an examination of their perceived TPACK in an established one-to-one technology adoption initiative can inform educational change leaders on the needs of teachers and the instructional progress of a school district in the change process (Hall & Hord, 2011, 2017; Sauers & McLeod, 2017). The results of this investigation present an insightful look into teachers' instructional experience with technology in the implementation process of a school district's technology initiative. The findings of this study provide indicative evidence of how the process of instructional change can unfold within teachers' instructional practices and can also assist change leaders' decisions in planning professional support and next steps (see Hall & Hord, 2011). The results from this study can also inform administrative actions to better support teachers in their technology use for the lesson design process and instructional implementation. In addition, the findings of this study may support reconfiguring the direction of professional learning opportunities to support 21st century learning needs and skills.

In this chapter, an overview of the study is provided. The background of the study is discussed and provides insight on school organizations shift to one-to-one technology initiatives. The problem with the adoption of one-to-one technology initiative is stated and highlights the issue with implementation of technology integration in these initiatives. In addition, the purpose of the study is discussed, the research questions and hypotheses, that will drive the study, are identified, and the theoretical and conceptual framework, that will guide the study, are explained. Furthermore, assumptions, limitations, and potential contributions and implications for positive social change are discussed.

Background

One-to-one technology programs, in which students are supplied with mobile computing devices for use in a class, grade level, school, or district (Zheng et al., 2016), have been viewed as the cornerstone in supporting the development of today's learners' 21st century skills (Bernard, Bethel, Abrami, & Wade, 2008; Russell, Bebell, & Higgins, 2004; Zheng et al., 2016). Various technology initiatives began appearing in the late 1980s (Donovan, Hartley, & Strudler, 2007) and 1990s (Penuel, 2006; Zheng et al., 2016), during a time in which the potential of technology to enhance learning proliferated (Dwyer, 1994). According to Penuel (2006),

> ubiquitous, 24/7 access to computers makes it possible for students to access a wider array of resources to support their learning, to communicate with peers and their teachers, to become fluent in their use of the technological tools of the 21st century workplace. (p. 332)

The Apple Classroom for Tomorrow project was one of the first K–12 initiatives launched (Donovan et al., 2007; Pautz & Sadera, 2016). The project displayed potential evidence of ubiquitous technology being able to support teachers' pedagogical practices in the classroom (Dwyer, 1994; Pautz & Sadera, 2016). Research from this initiative found promise not only in the supporting constructivist pedagogies but also in supporting the facilitation of collaborative learning, student initiative, and cognitive processing (Baker, Gearhart, & Herman, 1990; Dwyer, 1994; Pautz & Sadera, 2016).

Microsoft's Anytime, Anywhere Learning program was another high-profile initiative (Belanger, 2000; Healey, 1999; Penuel, 2006; Rockman et al., 1998) that originated during the early phases of one-to-one technology adoption and offered comprehensive leasing and financing options (Healey, 1999). This program was developed on the concept of increasing computer access for K–12 students and engendering meaningful, real-world educational benefits (Rockman et al., 2000). Similar to ACOT, Donovan et al. (2007) posited that Microsoft's Anytime, Anywhere Learning program “helped to establish a foundation and starting point for future one-to-one computing programs” (p. 264).

Since these earlier initiatives, there has been rapid growth in the adoption of one-to-one technology initiatives across K–12 schools and districts (Donovan et al., 2007; Pautz & Sadera, 2016; Topper & Lancaster, 5013; Towndrow & Wan, 2012). Many schools have been driven to implement one-to-one initiatives to better prepare and develop students’ 21st century skills. Holen, Hung, and Gourneau (2016) stated “one of the challenges in preparing students for the 21st century is the disparity in students’ ability to access technology” (p. 1178). However, as more schools and districts adopt these initiatives, the accessibility gap closes but other concerns for the sustainability of these initiatives remain. According to Donovan et al. (2007), facilitators of change must be aware of teacher concerns that have the potential to impact the sustainability of one-to-one laptop initiatives.

Despite schools and district one-to-one technology initiatives, teachers are faced with a multitude of issues (Minshew & Anderson, 2015; Towndrow & Wan, 2012). These issues include external and internal barriers when trying to integrate technology into their pedagogical design and instructional practice (Minshew & Anderson, 2015). Devoogd, Hodgson, Hively, and Tovar (2015) examined the readiness of teachers to implement one-to-one technology across all grade levels in a large school district. They found that although teachers received technology professional development, half of them did not feel prepared to implement the one-to-one technology devices in their instruction as well as teach the necessary skills and concepts needed for an online environment.

Stoilescu (2014) investigated challenges teachers face with technology integration and found that there is a dissonance between teachers' theoretical and practical conceptions of technology integration. The author posited the need for teachers to be supported to develop planning to use technology efficiently. Shifflet and Weilbacher (2015) examined discrepancies in which teachers perceive and implement technology in their instruction. Although a teacher may believe that technology integration is in the best interest of students to support 21st century learning needs, the fruition of their beliefs does not always translate into their instructional practices due to the influence of external barriers (Shifflet & Weilbacher, 2015).

Problem Statement

Facilitating instruction is a fundamental component of integrating technology to support 21st century learning, which has attributed to an upsurge in the adoption of technology initiatives by schools and districts (Varier et al., 2017). Among these adopted technology initiatives are one-to-one technology programs in which student and teachers are supplied with computing devices, such as a laptop or tablet (Topper & Lancaster, 2013). Despite the prevalence of schools adopting one-to-one technology (Holen et al., 2017; McLeod & Richardson, 2013; Zheng et al., 2016) and the looming ubiquity of technology in education (Beeson, Journell, & Ayers, 2014; Blau et al., 2016), a gap is still present in the application of effective technology integration in teachers' instruction and lesson design practices (Stoilescu, 2014; Towndrow & Wan, 2012;).

Although previous research shows that a one-to-one technology model can positively impact outcomes of the learning process, recent research on teachers' use of technology for instruction in a one-to-one technology initiative found minimal connections between technology, pedagogy, and content (Blau et al., 2016). These connections were based on teacher interactivity with technology versus pedagogical interactivity with technology (Blau et al., 2016), which is an important component for the effective implementation for technology integration. This gap presented a need to examine teachers' perceptions of their implementation of technology integration to support 21st century skills and their ability to connect their content and pedagogical approaches with technology with regards to their LDPs. It is important to understand and recognize teachers' instructional position during an organization's implementation phase of the change process because it can enhance the quality and the extent in which technology is integrated into instruction (Devoogd et al., 2015). Additionally, further research is needed in understanding teacher LDPs in technology-enriched learning environments (McKenney, Kali, Markauskaite, & Voogt, 2015) that may assist the facilitation and development (Devoogd et al., 2015) of a district's one-to-one technology initiative.

Purpose of the Study

The purpose of this quantitative study was to investigate teachers' level of knowledge in technology integration, in an established one-to-one technology district initiative, through an examination of their perceived TPACK, LDPs, and DD. A one-to-one technology district initiative is an adopted program in which a school district has provided access to a technological device for all students and teachers. These devices provide teachers and student access to digital resources and content that are to support

21st century teaching and learning. In this study, I examined teachers' TPACK by teaching experience in a one-to-one technology classroom and content area. In addition, I determined whether teachers' perceived TPACK correlates with their LDPs and DD.

Research Questions and Hypotheses

I designed this study to profoundly understand the implementation of technology integration through the investigation of the relationship between a teacher's TPACK and their LDPs in a district-adopted, one-to-one technology initiative. The research questions and hypotheses that guided this study were:

Research Question 1: Is there a significant difference in teachers' constructs of TPACK based on the number of implementation years in one-to-one technology initiative?

$H_0$1: There is not a significant difference in teachers' constructs of TPACK and the number of implementation years in a district one-to-one technology initiative.

H_a1: There is a significant difference in teachers' constructs of TPACK and the number of implementation years in a district one-to-one technology initiative.

Research Question 2: Is there a significant difference in teachers' constructs of TPACK based on the content area of a district wide one-to-one technology initiative?

$H_0$2: There is not a significant difference in teachers' constructs of TPACK and their content area in a district with a one-to-one technology initiative.

H_a2: There is a significant difference in teachers' constructs of TPACK and their content area in a district with a one-to-one technology initiative.

Research Question 3: Is there a relationship between teachers' TPACK and their LDPs?

$H_0$3: There is no correlation between teachers' TPACK and their LDPs in a district with a one-to-one technology initiative.

H_a3: There is a positive correlation between teachers' TPACK and their LDPs in a district with a one-to-one technology initiative.

Research Question 4: Is there a relationship between TPACK and DD?

$H_0$4: There is no correlation between teachers' TPACK and their DD in a district with a one-to-one technology initiative.

H_a4: There is a positive correlation between teachers' TPACK and their DD in a district with a one-to-one technology initiative.

Theoretical and Conceptual Framework

The theoretical framework for this study was based on Rogers's (2003) diffusion of innovation theory. The diffusion of innovation theory provides a framework to explain the process of social change of an innovation throughout a social system (Rogers, 2003). This theory aligned with this study, in that, I investigated teachers' perceived TPACK in a one-to-one technology district initiative and its' relationship to teacher's LDPs and DD.

The conceptual framework for this study was based on Mishra and Koehler's (2006) TPACK framework for technology integration. TPACK examines the interconnectivity of three components of knowledge needed to effectively implement technology into the classroom: technology, pedagogy, and content (Mishra & Koehler, 2006). The relationship among these components can be used as an analytical lens to study educational change in successful technology integration and designing pedagogical strategies (Mishra & Koehler, 2006).

As applied to this study, the design of the TPACK framework has the capacity to inform school districts implementing a one-to-one technology adoption. This is exhibited by the ability of the framework to measure teachers' knowledge of integrating technology within the context of their specific content area and pedagogical approaches during the implementation process of the adoption. Additionally, the TPACK framework provides insight into and brings awareness of potential teacher needs to provide targeted support and professional learning experiences during the implementation process.

Nature of the Study

In this study, I used two validated TPACK instruments to conduct a quantitative investigation. The first TPACK instrument, the TPACK Meaningful Learning survey, provided a comprehensive measure of teachers' perceptions of their TPACK. The second TPACK instrument, the TPACK, DD, and LDPs survey, measured teachers' LDPs and DD in regard to their TPACK.

Due to the nature of the variables that were investigated, this study did not support the use of an experimental design in which variables are manipulated (see

Frankfort-Nachmias & Nachmias, 2008). Therefore, I employed a cross-sectional survey design to investigate the research questions. This form of design allowed for generalization of the sample of teachers in a large school district to a larger population by surveying a random sample of teachers about their perception of their TPACK and LDPs within the implementation process of one-to-one student technology initiative (see Gay, Mills, & Airasian, 2012; Warner, 2013).

Definitions

21st century skills: Skills that equip students to be self-directed learners that think critically, communicate effectively, collaborate with others, and problem solve (Smith & Hu, 2013); often referred to as four components: (a) critical thinking, (b) communication, (c) collaboration, and (d) creativity (Lowther, Inan, Strahl, & Ross, 2012).

Content knowledge (CK): Knowledge about a particular academic subject (Chai, Koh, Ho, & Tsai, 2012; Koh, Chai, & Tsai, 2014; Mishra & Koehler, 2006).

Design disposition (DD): Anticipation and comfort level with which an individual is able to engage in the design process (Koh et al., 2015).

Information communication technology (ICT): Tools and resources in which technology is used to communicate, create, and manage information (Blurton, 1999).

Lesson design practices (LDPs): Approach to design lessons (Koh, Chai, Hong, et al., 2015).

One-to-one technology: Initiative in which every student and teacher is provided with a computing device (Zheng et al., 2016).

Pedagogical content knowledge (PCK): Knowledge that blends content and pedagogical principles and strategies into the instructional process of teaching and learning (Beeson et al., 2014; Mishra & Koehler, 2006; Padmavathi, 2017).

Pedagogical knowledge (PK): Knowledge about the instructional process and methods with respect to the subject matter to be taught (Chai et al., 2012; Koh et al., 2014).

Technological content knowledge (TCK): Knowledge about how technology can support and enhance learning (Padmavathi, 2017) and the appropriateness of the representation of a subject matter through technology (Blau et al., 2016; Koh et al., 2014).

Technological knowledge (TK): Knowledge of ICT tools (Koh et al., 2014).

Technological, pedagogical, content knowledge (TPACK): Synthesized knowledge about technology, pedagogy, and content for the integration of ICT (Koh & Chai, 2016).

Technological pedagogical knowledge (TPK): Knowledge about the implementation of technology through various methods of teaching (Koh & Chai, 2016; Koh, Chai, Benjamin, & Hong, 2015).

Technology-enhanced learning (TEL): The application of ICT tools in the instructional process (Kirkwood & Price, 2014).

Technology integration: The implementation of ICT tools in the instructional process to support teaching and learning (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017).

Assumptions

Since the selected district of study adopted a one-to-one technology initiative across 46 high schools to support 21st century teaching and learning, I made several assumptions concerning this study. One assumption was that teachers were provided with technology support throughout the school year regardless of their numbers of years in teaching at a campus with a one-to-one technology program. Each campus in the selected district has an assigned staff member for technical and instructional technology support. This campus-level support was provided in addition to district-level support. Another assumption was that teachers would respond honestly about their perceptions of their use of technology, LDPs, and DD. An additional assumption was that all teachers were supported equally, and therefore, teachers were capable of implementing the district's one-to-one initiative. I also assumed that the campus administration supported the implementation of this initiative. My final assumption was that the district provided teachers with a variety of digital resources for effective implementation to take place.

Scope and Delimitations

Participants in this study were teachers in an urban school district with an implemented one-to-one technology initiative to support 21st teaching and learning for 5 years or more. Teachers that participated in this study taught at a campus in which every student and teacher were given access to a laptop device. The target population for this study were high school teachers who taught a core subject area. Elementary and middle school teachers were not included as participants. High school teachers who taught subjects outside of math, science, English, and social studies were not included in this study. Since the district for this study was a large, urban school district, a large sample was accessible that allowed results from this study to be generalizable to a larger population.

Limitations

In this quantitative study, I investigated high school teachers' perceptions of their TPACK as it related to their LDPs and DD. The participants were high school teachers who taught the subject areas of math, science, social studies, or English. Since teachers' responses were self-reported, data collected may have potentially contained participant bias or inaccurate responses due to participants' comfortability level or reporting data that would perceive them as being seen unfavorable. Other limitations of the study entailed reduced access to all district high schools as research sites to be fully representative of the population and a reduced sample size due to a limited data collection period and incomplete survey responses.

Significance of the Study

The significance of this study was hinged substantially on the support and needs of teachers in a one-to-one technology initiative. Effective integration of technology in the classroom is largely dependent on teachers' knowledge of technology, pedagogy, and content. The interaction of these three forms of knowledge support teachers' implementation of technology in a district's one-to-one technology initiative.

In this study, I examined teachers' perceptions of their TPACK and its relationship to their LDPs and DD. Investigating teachers' level of knowledge of technology integration, through an examination of their perceived TPACK in an established one-to-one technology adoption initiative, has illuminated areas of the implementation phase for schools and school districts to consider. The results from this study inform educational change leaders of teachers' perceptions of their instructional experiences, which can be used to navigate the direction of professional learning and school support in the change process. The findings of this study provide insight into instructional encounters in the implementation process of one-to-one technology in schools. The results of this study also provide feedback on instructional change and can support and inform change leaders' decision-making when planning the next steps. The findings of this study have the potential to inform administrative actions to provide targeted support for teachers in their use of technology in LDPs and instructional implementation as well as reconfigure the direction of professional learning opportunities to support 21st century student learning.

Summary

In this chapter, I provided context for the nature of this study to justify and outline the need for research to support teachers in the effective integration of technology to support 21st century student learning. A background on the topic of one-to-one technology district initiatives in schools was provided and the issues with the implementation of such initiatives were stated. The theoretical framework, the diffusion of innovation theory, and conceptual framework, TPACK, were identified as the guiding factors for the study. In addition, I identified the research questions and hypotheses that drove the study.

In Chapter 2, the theoretical framework and conceptual framework are discussed in detail. In Chapter 2, I also discuss current literature and research on the matter of one-to-one technology and TPACK. In addition, I also discuss lesson design and teachers' LDPs in TEL environments.

Chapter 2: Literature Review

Introduction

The purpose of this quantitative study was to investigate teachers' level of knowledge in technology integration, in an established one-to-one technology district initiative, through an examination of their perceived TPACK, LDPs, and DD. Specifically, I first examined secondary high school teachers' TPACK constructs in regard to their teaching experience, years experienced in the one-to-one technology initiative, and content area. Secondly, I then examined the relationship between teacher's overall TPACK and its relationship with their perceived LDPs that had the potential to impact the application of technology integration into their instructional practices.

I developed this literature review to provide a contextual understanding of the topic to support the need for research. In addition, I discuss substantial findings and contributions to current research. The literature review is divided into four topical sections: theoretical foundation, conceptual framework, lesson design and technology integration, and lesson design and TPACK.

Literature Search Strategy

To conduct a scholarly literature search, I used Walden University's library to access variety of education databases. The selected databases included ERIC, Education Source, Sage Journals, Science Direct, Taylor and Francis, and LearnTechLib. In addition to using education databases, literature was also searched based on the reference section of articles that were acquired from the education databases. I selected articles using this search strategy to provide more insight on topics as well as to support and strengthen points.

I used an array of key search terms and combinations of key search terms to select and refine the scholarly literature reviewed. Key terms used in this search were *one-to-one technology, TPACK, lesson design, design disposition, diffusion of innovation, technology integration*, and *technology-enhanced learning*. Combination of key search terms included *technological pedagogical content knowledge, one-to-one technology and TPACK, technology integration and one-to-one technology,* and *one-to-one technology and the diffusion of innovation*.

Theoretical Foundation

The adoption of one-to-one technology initiatives becomes more prevalent as schools aspire to enhance active learning and equip students with 21st learning skills, such as creativity, communication, collaboration, and critical thinking (Blau et al., 2016). Holen et al. (2017) stated “to continue leading the world in technological advancement, a technologically competent workforce is essential. One of the goals of U.S. one-to-one technology initiatives is to support this very need to sustain national confidence, security, and economic competitiveness” (p. 24).

Diffusion of Innovation

There are various theories that address elements of technological innovations in educational environments. Rogers’s (2003) theory about the diffusion of innovation is a widely used framework in the adoption and diffusion of technology and is the most appropriate for examining organizational adoption of technological innovations, such as one-to-one technology initiatives, in secondary education (Celik, Sahin, & Aydin, 2014; Sahin, 2006; Sahin & Thompson, 2006). The diffusion of innovation theory provides a blueprint in understanding how members within an organization adopt and implement an innovation through particular communication channels over a period of time (Rogers, 2003). This theory has the potential to inform and embody social change in the structure and function of schools and districts within their social systems (Rogers, 2003).

Although technological innovations are typically structured and designed to be advantageous to the intended adopter, the intention of this benefit may not always be realized. This is evident in many school districts that adopted one-to-one technology initiatives where the expectation of teacher implementation is essential to the initiative but may not be realized in the practice of teacher’s instruction. Rogers (2003) posited that the rate at which a technological innovation is adopted is dependent on the perceived attributes of the innovation by the members within an organization. That is, that teacher’s perceived attributes of technology use in the classroom within the social system of their school district impacts the rate of technological use in the classroom. Other factors possibly affecting the rate of adoption is a teacher’s and/or school’s innovation-decision process and the nature of communication channels diffusing the innovation throughout the process (Rogers, 2003). Rusek, Starkova, Chytry, and Bilek (2017) stated,

> if we think of the teacher community on a school, regional, state or international level (enhanced by technology and social/professional networks), the theory enables a method of introducing innovation with more success than if it was

> ordered by the school management or even ministry of education (curriculum). (p. 511)

Adopter Categories

The innovativeness of teachers in a school district can be viewed on a continuum and classified within a dimension in which the individual adopts an innovation over time (Rogers, 2003). In the diffusion of innovation theory, an individual's innovativeness is the cornerstone to understanding behaviors in the innovation-decision process (Sahin, 2006). Therefore, Rogers (2003) categorized adopter behaviors based on innovativeness into five categories: (a) innovators, (b) early adopters, (c) early majority, (d) late majority, and (e) laggards. These adopter behaviors are presented as a normal distribution curve of an innovation adoption based on the innovativeness of those within the social system. The five segments are arranged based on the propensity of each adopter category to adopt an innovation (Jwaifell & Gasaymeh, 2013).

Innovators are identified as individuals who first adopt an innovation, who are usually the initial 2.5% who do (Rogers, 2003). Innovators are known to take an interest in a new idea and experiment (Celik et al., 2014; Wilson, 2015). Rogers (2003) described innovators as venturesome, and risk takers that typically stand out of local peer networks. They are more comfortable with the uncertainty associated in the process of adoption (Rogers, 2003; Wilson, 2015) and are accepting of potential setbacks (Rogers, 2003).

The next 13.5% of teachers to adopt an innovation in an organization are referred to as the early adopters (Rogers, 2003). This group of adopters is more integrated into the social system of an organization (Celik et al., 2014; Rogers, 2003), and therefore, has a stronger influence on potential adopters (Wilson, 2015). They typically hold leadership positions, so other members of the social system may seek their advice about an innovation (Sahin, 2006). Celik et al. (2014) stated that early adopters "adopt new ideas in their initial stages, thereby helping reduce uncertainties in this regard, and convey their subjective judgments about the innovation to their immediate environment through interpersonal communication" (p. 302). Wilson (2015) posited that influence on peers in an organization heightens the potential for greater innovation.

The next set of teachers to adopt an innovation are the early majority, and these adopters consist of the next 34% of individuals in an organization (Rogers, 2003). Rogers (2003) described this category of individuals as more deliberate, typically adopting an innovation just before the average member of an organization would do so. As compared to the innovators and early adopters, their innovation-decision process is generally longer because they are not likely to be the first or last to try an innovation (Celik et al., 2014). According to Rogers, they "provide interconnectedness in the system's interpersonal networks" (p. 284). Therefore, the early majority has a strong influence on the adoption of an innovation through communication with peers (Wilson, 2015).

The next 34% to adopt an innovation in an organization are the late majority (Rogers, 2003). Rogers (2003) described this category of individuals as being more skeptical and cautious. Celik et al. (2014) posited that the late majority are suspicious when approaching an innovation and typically start the process of adoption after the large majority has already adopted and innovation. These individuals are more conservative and disfavor risks (Celik et al., 2014). Their extended wait to adopt an innovation is often a response to pressure from peers (Wilson, 2015). Rogers asserted that pressure from peers is necessary to motivate the late majority to adopt an innovation. The last 16% of adopter are the laggards (Rogers, 2003). They typically consult with others who have traditional values similar to their own (Celik et al., 2014; Wilson, 2015).

With respect to Roger's theory, teachers, as the adopters within the organizational unit of a school district, will adopt new ideas over time, and therefore, can be classified into Rogers's categories of adoption. According to Rogers (2003), it should not be assumed that an organizations' adoption of an innovation will happen simultaneously throughout the organization. Respectfully, it should not be assumed that a school district's adoption of one-to-one technology initiatives to support 21st century teaching and learning will happen simultaneously throughout its organization. Diffusion scholars recognize that a person's adoption of an innovation is not instant (Rogers, 2003). The innovation can have intended and unintended consequences that potential adopters may perceive as desirable or undesirable (Wilson, 2015).

Rogers (2003) stated that an innovation has the potential to change in the adoption and implementation process. Once an innovation is put in to use by an individual or an administrative unit that makes decisions for a school or district, then the implementation process in action (Rodger, 2003). During this phase, teachers would presumably implement technology to support the cause for the district initiative. However, there may still be potential questions about the outcomes of using the innovation in which continued support is still needed (Wilson, 2015).

Rogers (2003) stated "an individual's attitude or belief about an innovation have much to say about his or her passage through the stages of the innovation-decision process" (p. 174). In addition, an ample amount of knowledge is needed to move on to the implementation stage of the innovation-decision process. Harper and Milman (2016) proclaimed understanding the effects of one-to-one technology in K–12 classrooms is a vital component to successful implementation.

One-to-One Technology

Over the last decade, there has been mixed results from the adoption of one-to-one technology initiatives across the country (Holen et al., 2017; Topper & Lancaster, 2013). Sauers and McLeod (2017) conducted a quantitative study to determine the impact one-to-one classrooms had on teachers' technological competency and integration in comparison to those of teachers who were not a part of the same technological initiative. The results of their research indicated that teachers teaching at schools with a one-to-one technology initiative had a statistically significant impact on their behaviors (in regard to their technology competency) and integration compared to non-one-to-one teachers. However, various research has indicated teachers' transformation of their pedagogical practices has been a slow process (Sauers & McLeod, 2017).

Various research on one-to-one technology adoptions has shown that the fruition of the implementation phase has not been realized for the intention of the innovation (Blackley & Walker, 2015; Devoogd et al., 2015; Mobile Technology Learning Center, 2016). In an examination of teacher readiness to implement one-to-one technology in a large, urban school district, Devoogd et al. (2015) reported that although 76% of teachers acknowledged they received professional development on how to use technology, 48% of those teachers did not feel prepared to teach the necessary skills required for one-to-one technology. Another study reported, that in the third year of a district's one-to-one technology initiative, 91% of classrooms were still teacher directed with low-level technology integration, such as presentation, lecture, and demonstration (Mobile Technology Learning Center, 2016). This provides evidence that although teachers' TK is increasing with their use of technology, there is still a deficit in the pedagogical use of technology in which student use is embraced as well.

Blackley and Walker's (2015) investigation on the impact one-to-one technology has on teaching and learning revealed little authentic integration of technology occurs in teachers' pedagogical practices. The schools examined in their study had a one-to-one technology initiative in place for more than 7 years. The implications of their study results led the researchers to inquire whether generative change has occurred in teacher instructional practices as well as question what potential mechanisms can be put into place to enhance learning versus technology being used as an add-on to traditional teaching practices (Blackley & Walker, 2015). The researchers suggested that schools that are implementing one-to-one technology initiatives to consider identifying and assimilating digital pedagogies (Blackley & Walker, 2015).

In an investigation on the transformation of teacher practices in one-to-one environments, Lindsay (2016) found transformative pedagogical approaches are infrequent and the main pedagogical uses for mobile devices, in one-to-one classes, are used to access information and support task activities. However, in the study it was revealed that media production was more frequently used. Swallow's (2015) research on the decline in Year 2 of one-to-one technology initiatives reported that teachers' instructional practices were comparable to 20th century teaching methods.

Despite the adoption of technology-enriched environment through the one-to-one initiatives to support 21st century learning, technology is still being utilized with traditional pedagogical practices (Swallow, 2015). Harper and and Milman (2016) recommended that researchers should shift focus from research regarding the impact of one-to-one technology initiatives on student achievement to "contextual factors regarding planning, design, development, implementation and evaluation" (p. 140). This is particularly relevant to those researchers who are promoting the effectiveness and efficiency of these type of initiatives (Harper & Milman, 2016).

Technological Pedagogical Content Knowledge (TPACK)

Introduction

Now that technology has become more prevalent in schools, concerns have shifted from access to technology to how it is being used in the classroom (McLeod & Richardson, 2013). This has led to researchers and organizations in creating conceptual models and standards to support teachers in the effective use of technology in instruction (McLeod & Richardson, 2013). One conceptual model, that has been popular in research and implementation in schools, is Mishra & Koehler's (2006) TPACK framework. Hilton (2016) described TPACK as a framework that unify's content, pedagogy, and technology in a way that support teachers' delivery of effective instruction that is infused with technology. While Padmavathi (2017) stated, "TPACK is a framework to understand and describe the kinds of knowledge capabilities needed by the teachers for effective pedagogical practice in a technology enhanced learning environment" (p. 2).

Mishra and Koehler (2006) argued that TPACK, as a conceptually based theoretical framework, can transform the conceptualization of educational practices. The basis of TPACK draws on the knowledge forms of technology, pedagogy, and content as individual constructs that intertwine to synthesize interconnected levels of knowledge needed in supporting the relationship of technology integration and teacher instructional practices. Phillips, Koehler, and Rosenberg (2016) asserted that the framework is well-known and has transformed contemporary understanding of the interplay between technology, pedagogy, and content. Chai, Koh, and Tsai (2013) posited that TPACK is an effective framework with abounding uses in the field of educational technology field of research and development and provides comprehensive ways to evaluate technology enhanced lesson designs.

TPACK is a complex, developed knowledge form requiring thoughtful pedagogical uses of technology in instruction (Mishra & Koehler, 2006). It was built on the foundation of Shulman's (1986) excogitation of PCK by extending it to technology integration and teachers' pedagogy (Mishra & Koehler, 2006). Shulman's PCK framework is based on the delineation of teacher's professional knowledge (Phillips, Koehler, Rosenberg, & Zunica, 2017) and was the first to highlight the importance of integrated knowledge, pedagogy and content, that teachers need for effective learning outcomes (Padmavathi, 2017). The PCK framework differentiated teachers from content experts with the notion that expert teachers have a combination of both PK and CK

(Phillips et al., 2017). With the addition of ICT knowledge to Shulman's (1986) PCK framework, TPACK extends the conceptualization of teacher knowledge to technology rich classroom environments (Olofson, Swallow, & Neumann, 2016).

For effective innovative pedagogies to be realized, teachers need to master and integrate these three forms of knowledge (Avidov-Ungar & Shamir-Inbal, 2017; Blau et al., 2016). Beeson et al. (2014) conveyed when teachers think within the framework of TPACK, they synchronously consider their TK, PK, and CK as contributing factors to their instructional decisions. This especially significant as CK and PK plays a vital role in teachers' implementation of technology into their instruction (Beeson et al., 2014).

TPACK Model

As seen in Figure 1, the TPACK model is constructed in an overlapping, circular illustration based on the framework's core constituents: technology, pedagogy, and content. The interaction of these three forms of knowledge display the interconnected knowledge areas in the model as they overlap. Therefore, the model entails seven constructs of knowledge: TK, PK, CK, PCK, TPK, TCK, and TPACK.

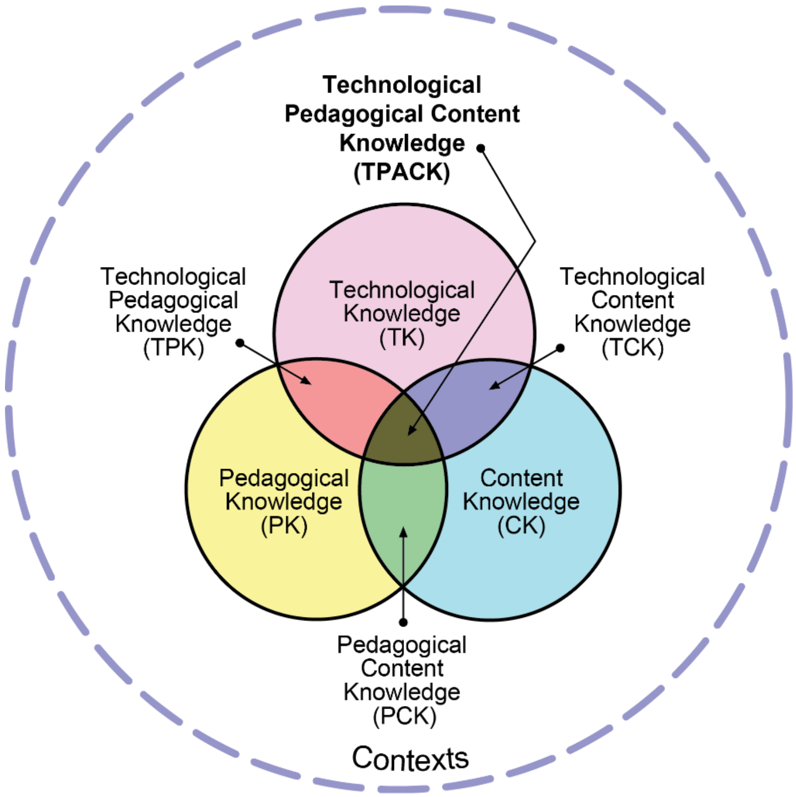

Figure 1. TPACK framework. Reproduced by permission of the publisher, © 2012 by tpack.org

Technological Knowledge (TK)

TK refers to knowledge about how to use emerging technology (Hilton, 2016) as well as in using technological hardware or software applications and associated peripherals (Chai et al., 2013). Mishra and Koehler (2006) explained TK as knowledge about technologies in which one may require skills for operation such as, software installation, ability to use productivity tools (word processors, spreadsheets, and e-mail), as well as creating and archiving documents. This also includes knowledge about internet-based tools and applications such as wiki's, blogs, and social media (Chai et al., 2013). However, as technology continues to change the nature of TK will also shift

(Mishra & Koehler, 2006). This emphasizes the importance of a teacher's ability to acquire information and adapt to inevitable changes in technology (Mishra & Koehler, 2006).

Pedagogical Knowledge (PK)

PK refers to the knowledge regarding the instructional process and practices which a teacher applies in the classroom. Chai et al., (2013) defined PK as "knowledge about students' learning, instructional methods, different educational theories, and learning assessment to teach a subject matter without reference toward content" (p. 33). PK encompasses general effective teaching methods (Hilton, 2016) such as classroom management, the implementation and development of lesson planning, and assessment and evaluation (Chai et al., 2013; Mishra & Koehler, 2006; Padmavathi, 2017). It also includes principles and teaching strategies to understand and support the learner. Therefore, PK requires knowledge about cognitive, social, developmental theories of learning (Mishra & Koehler, 2006). Mishra and Koehler (2006) stated "A teacher with deep pedagogical knowledge understands how students construct knowledge, acquire skills, and develop habits of mind and positive dispositions toward learning" (p. 1027).

Content Knowledge (CK)

CK is the knowledge about a particular, academic subject area that is taught in the instructional process. This form of knowledge requires teachers to know and understand central facts, concepts, organizational frameworks to connect ideas, and theories about a particular subject area (Mishra & Koehler, 2006). When teachers have in depth knowledge about their content, they are able to encapsulate the necessary skills and attitudes required for a subject to be correctly represented to students (Mishra & Koehler, 2006; Padmavathi, 2017; Shulman, 1986).

Pedagogical Content Knowledge (PCK)

PCK attributes to content knowledge within the context of the instructional process. It is a representation of the interplay between pedagogy and content in which the content is arranged and embodied for instruction (Mishra & Koehler, 2006). Although PCK may differ within disciplines, it helps to develop instructional practices within the content area (Padmavathi, 2017). According to Mishra and Koehler (2006), “PCK is concerned with the representation and formulation of concepts, pedagogical techniques, knowledge of what makes concepts difficult or easy to learn, knowledge of students’ prior knowledge, and theories of epistemology” (p. 1027).

Technological Pedagogical Knowledge (TPK)

TPK is the emerging knowledge formed from the interplay between technological and pedagogical knowledge. It entails knowledge about various technologies, whether standard or emerging, that can be used in a teaching and learning environment (Marich & Greenhow, 2016; Mishra & Koehler, 2006). TPK is grounded in knowledge of existing and specific technologies that will enable and support teaching methodologies without reference to specific content (Chai et al., 2013). Keane (2016) posited TPK is knowledge in which one understands how particular technologies influences teaching and learning (Keane, 2016) as well as use technology in different ways to support the instructional process (Marich & Greenhow, 2016).

Technological Content Knowledge (TCK)

TCK is the emerging knowledge formed between the interplay of technological and content knowledge. This form of knowledge entails knowing and understanding how technology can impact and be used within a subject area (Hilton, 2016). While TCK embodies “knowledge about how to use technology to represent/research and create the content in different ways” (Chai et al., 2013, p. 33), Marich and Greenhow (2016) asserted the combination of content and technology presents the need to understand “that changing content representations using technology may change the content itself” (p. 2942). Padmavathi (2017) posited TCK enhances the student learning experience and that this form of knowledge suggests applying and using a variety of technologies in the instructional process, depending on the nature of content. When teachers are knowledgeable about how to apply and use technology to their content, they are able to alter ways in which learners receive and understand concepts (Padmavathi, 2017).

Technological Pedagogical Content Knowledge (TPACK)

TPACK is a synthesized form of knowledge that is emerged from the interactions of TK, PK, and CK. This form of knowledge entails one to know and use various emerging technologies that enables teaching, representation, and facilitation of knowledge within a particular subject area (Chai et al., 2013). According to Mishra and Koehler (2006),

> TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge

> of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (p. 1029)

TPACK represents an understanding of effective ways to use technology to support content and pedagogical strategies in that learning is enhanced; content is more comprehensible, structurally observable and explicit for the learner; and instruction can be implemented in different ways due the variety of contextual factors (Pamuk, Ergun, Cakir, Yilmaz, & Ayas, 2015).

Lesson Design and Technology Integration

Lesson design is an essential component in the implementation of meaningful technology integration to support 21st century learning needs of today's student. Although teaching is increasingly acknowledged as a design science (Koh & Chai, 2016; McKenney et al., 2015), research shows there is still a need to understand teacher's perceptions of the lesson design process (Koh & Chai, 2016) and generate a knowledge base to develop empirical and theoretical support for teachers as designers (McKenney et al., 2015). Laurillard (2012) defined design science and how it encompasses teaching by stating:

> A design science uses and contributes to theoretical science, but it builds design principles rather than theory, and the heuristics of practice rather than explanations, although like both the sciences and the arts, it uses what has gone

> before as a platform or inspiration for what it creates. Teaching is more like a design science because it uses what is known about teaching to obtain the goal of student learning and uses the implementation of its designs to keep improving them. (p. 1)

In addition to today's teachers planning lessons with existing instructional resources and activities, teachers are also designing learning activities and developing technology enhanced learning resources (McKenney et al., 2015). Kirschner (2015) asserted that understanding the role of design is a critical component for technology enhanced learning to be realized into the instructional process of teaching and learning. In addition, Matuk, Linn, and Eylon (2015) affirmed it is essential for teachers to be involved in instructional design process to sustain the relevance of technology enhanced learning. However, teacher's design competencies can affect the implementation of a school's technology integration initiative.

There are a variety of challenges teachers face when designing technology enhanced lessons to promote 21st century student learning. Koh, Chai, Benjamin, et al. (2015) stated "teachers often experience difficulties in developing lessons that can engender 21CL" (p. 537) and posited that the rapid proliferation of tools for technology integration presents challenges for teachers in the process of designing technology enriched lessons. These challenges are further complicated through external demands of the school system, educational legislation, and local priorities set by school districts and administration (Boschman, McKenney, & Voogt, 2014; Koh, Chai, Benjamin, et al., 2015; Koh, Chai, & Tay, 2014).

Another factor in which teacher's design competencies can affect a technology integration initiative, is their knowledge and belief mode of thinking. Teacher's practical knowledge and belief is an existing orientation in which they use, adapt, design, and re-design curriculum to accommodate their instructional needs (Boschman et al., 2014). While their practical knowledge is based on the prior experiences and accumulation of knowledge about teaching, their belief mode of thinking attributes to cognitive dissonance in shifting pedagogical practices (Koh, Chai, Benjamin, et al., 2015). However, design thinking can enable teachers to transcend their belief mode of thinking to practical applications of working creatively with ideas which has the potential to lead teachers in becoming more flexible and adaptable in teaching and learning (Koh, Chai, Benjamin, et al., 2015).

More recently, researchers have begun to investigate connections teachers make between their knowledge of technology integration to specific instructional practices by exploring the enactment of their pedagogical reasoning (Harris, Phillips, Koehler, & Rosenberg, 2017). In a study to understand teacher's reasoning to use technology to facilitate specific pedagogical strategies, Heitink, Voogt, Fisser, Verplanken, and van Braak (2017) found that information and communication technologies were more often used to activate learning. It was also found that although many teachers reasoned about using technology to adapt their instruction to accommodate student needs, it was not realized in their instruction (Heitink et al., 2017).

Boschman et al. (2014) found that teachers' practical concerns affect their design reasoning. McKenney et al. (2015) endorsed Boschman et al. stating, "Teachers intuitively address classroom practical concerns while designing technology-rich learning activities and materials but are also influenced by their own existing knowledge and beliefs, as well as external priorities such as examination systems" (p. 193). Teachers instinctively address their practical concerns when designing technology enhanced activities for instruction (Boschman et al., 2014; McKenney et al., 2015).

Matuk et al. (2015) conducted a study to examine teachers' adaptation and customization of available TEL resources, a manipulation of TEL curriculum resources. The researchers found that teachers had varying approaches and strategies for use in their instruction (Matuk et al., 2015). Characteristics of the variations were attributed to teacher's prior knowledge of student's abilities, instructional goals, their positions toward technology and pedagogy, and their instructional role in the designing process (Matuk et al., 2015).

In a study to examine teachers' design talk as they collaborated to design technology enriched, student-centered lessons, Koh and Chai (2016) found that there are seven design frames used by teachers. Koh and Chai stated that "design frames show the different lenses used by the teachers to design their lessons" (p. 250). Koh and Chai identified these design frames as (a) idea development, (b) design management, (c) perception, (d) enactment, (e) institutional, (f) design scaffold, and (g) interpersonal frame. Koh and Chai stated

> when designing ICT- integrated lessons, a design frame would include how teachers understand the pedagogical problems faced when teaching particular topics; how teachers draw upon their existing pedagogical repertoire; and how

> teachers consider and adapt their pedagogical repertoire to formulate new pedagogical solutions in view of their current teaching goals. (p. 245).

In a design-based research study to facilitate the use of technology as cognitive tools to transform teachers' instructional practice from teacher-centered instruction to more of a constructivist approach that is student-centered, Wang, Hsu, Reeves, and Coster (2014) found that 68% of teachers modified their instructional approaches after being provided professionally development opportunities on using technology as cognitive tools. The researchers indicated the there was a gradual change in teachers' instructional practices from teacher-centered to student-centered over a two-year period (Wang et al., 2014). However, the researchers also indicated the necessity for teachers to have more time to enhance pedagogical practices to integrate technology (Wang et al., 2014).

Lesson Design and TPACK

According to Wang et al. (2014), "teachers' classroom technology integration is usually passive, teacher-centered, and treats technology as a 'learn from' tool similar to the way students learn from classroom teachers" (p. 101). This opposes the idea of creating a technology-enhanced learning environment that facilitates student's ability to use technology to support cognitive processing (Wang et al., 2014). Empirical research has consistently found that teacher's approach to technology integration is largely used with students for the transmission of information (Koh, Chai, Hong, et al., 2015). This provides evidence that teachers may lack the knowledge required to design meaningful learning with technology and therefore presents a need to understand the interplay of TPACK and teachers' LDPs (Koh, Chai, Hong, et al., 2015).

The process of designing technology-enhanced lessons is the conduit through which teachers develop TPACK (Koh, Chai, Hong, et al., 2015). According to Chai et al. (2013), "it offers a comprehensive way of evaluating designed ICT integrated lessons, thereby helping educators to identify weaknesses and strengthen course design" (p. 37). McKenney et al. (2015) affirmed that a teacher's design capacity to integrate technology is based on his or her ability to blend technology, pedagogy, and content. This is characterized largely through the need of contextualizing these three forms of knowledge to align with lesson objectives and instructional goals. Although evidence from empirical studies found that TPACK emerges when teachers engage in designing technology enhanced lessons (Koh, Chai, Benjamin, et al., 2015), their perceptions of lesson design navigates their use of TPACK in the designing process (Chai et al., 2013; Koh, Chai, Benjamin, et al., 2015). Koh, Chai, Benjamin, et al. (2015) argued that teachers need to use design thinking as a basis to construct their TPACK to strategically address the complex nature of technology enhanced lesson design. Therefore, the process of design thinking can support a teacher's TPACK to be able to engender 21st century learning (Koh, Chai, Benjamin, et al., 2015).

Although the emergence of TPACK is noted to be an essential factor in teachers' deconstruction of knowledge and skills needed to design 21st century lessons (Chai, Koh, & Teo, 2018; Harris et al., 2017) However, the emergence of teachers' TPACK has not had a significant impact on their ability to effectively integrate technology in the classroom (Chai et al., 2018; Heitink et al., 2017; Pringle, Dawson, & Ritzhaupt, 2015; Tondeur, Aesaert, Pynoo, van Braak, Fraeyman, & Erstad, 2017). Tondeur, van Braak, et al. (2017) stated the achievement of technology integration, in educational change, is a complex process. When teachers are challenged to design technology enriched lessons it prompts their TPACK which can influence their pedagogical practices (Koh & Chai, 2016). Koh and Chai (2016) posited it is useful to examine teachers approach to design and the effect it has on their TPACK considerations.

Pringle et al. (2015) used TPACK as a lens to examine teachers, in a technology initiative, enactment of technology integration through lesson planning to investigate their practices of technology integration within “the ambit of reform” (p. 68) teaching practices. It was found that there was an increase of technology-rich practices but little improvement in the reform of specific pedagogical practices (Pringle et al., 2015). Wang et al. (2014) stated “the adoption of a new tool will not have any impact on teaching and learning unless the tool is used to implement pedagogical strategies that help students deploy meaningful cognitive strategies” (p. 102).

Koh, Chai, Benjamin, et al. (2015) argued that teachers need to consider TPACK in the design thinking process to develop students 21st century competencies. According to Koh and Chai (2016), teachers’ TPACK develop when they immerse in collaborative discourse in the designing process of technology integrated lessons. When teachers are challenged to design technology enriched lessons, it prompts their TPACK which can influence their pedagogical practices (Koh & Chai, 2016). Koh, Chai, Benjamin, et al. (2015) posited design thinking can be supported by using TPACK as epistemic resources when developing technology enriched lesson that target 21st century instructional competencies.

Koh, Chai, Hong, et al. (2015) found that teachers' perceptions of their LDPs and their DD were critical factors that influence teachers' perceived TPACK. Since what teachers' do instructionally appear to have a greater effect on their perception of their TPACK, Koh, Chai, Hong, et al. (2015) suggested there is a need to carefully consider teachers' LDP in their instruction for technology integration. In addition, their design works needs to be considered as their apprehension indirectly affects the perceptions of their TPACK (Koh, Chai, Hong, et al., 2015)

Summary

According to Holen et al. (2017), one-to-one technology initiatives prepare students to be more technologically competent for the future workforce. Designing for pedagogical change is increasingly being acknowledge as an essential competency that teachers need (Koh, Chai, Benjamin, et al., 2015; Laurillard, 2012). TPACK encapsulates teachers' pedagogical knowledge to integrate technology (Koh & Chai, 2016). Koh and Chai (2016) posited is useful to examine teachers' approach to design and the effect it has on their TPACK considerations. However, many studies on teachers designing technology enriched lessons are qualitative, small scale studies in which limited numbers of teachers are able to contribute (Cober, Tan, Slotta, So, & Konings, 2015; Kirschner, 2015). Kirschner (2015) recommends the need for future research in this area that can be generalizable to different settings and use a broader methodological design such as surveys and experiments. Although there is minimal research on teacher design practices with technology, there is very little research on the matter using quantitative approaches. In addition, Koh, Chai, Benjamin, et al. (2015) stated that little is understood about how the different construct of TPACK are transformed by teachers or their transformation of contextual knowledge into technology enhanced lesson designs.

In the Chapter 3, I identify and describe the research design, population, and sampling and recruitment procedures. I also describe instrumentation, define operational constructs, and provide a detail data analysis plan. In addition, I discuss threats to validity and ethical procedures.

Chapter 3: Research Method

Introduction

The purpose of this quantitative study was to investigate teachers' level of knowledge in technology integration, in an established one-to-one technology district initiative, through an examination of their perceived TPACK, LDPs, and DD. In this study, I examined teachers' TPACK by the district's implementation year and content area. In addition, I aimed to determine whether teacher's perceived TPACK correlates with their LDPs and DD.

This chapter is organized in four sections: research design and rationale, methodology, threats to validity, and ethical procedures. In the research and rationale section, I state the variables of the study and explain the rationale behind the research design chosen. In the methodology section, the target population and sampling procedures is described. I also detail procedures for participant recruitment and data collection as well as describe selected instrumentation and operational constructs. In the threats to validity section, I describe and address potential threats to external and internal validity as well as threats to construct or statistical conclusion validity. In the ethical procedure section, I identify and anticipate ethical issues and explain the procedures to address ethical concerns.

Research Design and Rationale

In this quantitative study, I examined teachers' perceived TPACK in a one-to-one technology initiative and investigated the relationship between their TPACK, LDPs, and DD. The research questions and hypothesis that guided this investigation were:

Research Question 1: Is there a significant difference in teachers' constructs of TPACK based on the number of implementation years in a one-to-one technology initiative?

$H_0$1: There is not a significant difference in teachers' constructs of TPACK and the number of implementation years in a district one-to-one technology initiative.

H_a1: There is a significant difference in teachers' constructs of TPACK and the number of implementation years in a district one-to-one technology initiative.

Research Question 2: Is there a significant difference in teachers' constructs of TPACK based on the content area of a district wide one-to-one technology initiative?

$H_0$2: There is not a significant difference in teachers' constructs of TPACK and their content area in a district with a one-to-one technology initiative.

H_a2: There is a significant difference in teachers' constructs of TPACK and their content area in a district with a one-to-one technology initiative.

Research Question 3: Is there a relationship between teachers' TPACK and their LDPs?

$H_0$3: There is no correlation between teachers' TPACK and their LDPs in a district with a one-to-one technology initiative.

H_a3: There is a positive correlation between teachers' TPACK and their LDPs in a district with a one-to-one technology initiative.

Research Question 4: Is there relationship between teachers' TPACK and DD?

H_04: There is no correlation between teachers' TPACK and their DD in a district with a one-to-one technology initiative.

H_a4: There is a positive correlation between teachers' TPACK and their DD in a district with a one-to-one technology initiative.

I developed Research Questions 1 and 2 to determine whether there was a significant difference between variables. The dependent variable for Research Questions 1 and 2 was teachers' perceived TPACK. The independent variable for Research Question 1 was the implementation years teachers had participated in a one-to-one technology initiative. The independent variable for Research Question 2 was the teachers' content area. However, the third and fourth research questions examined the correlation between variables: TPACK, LDPs, and DD.

The research design is the blueprint that guides researchers in various stages of an investigation and is the foundation to the collection, analysis, and interpretations of data (Frankfort-Nachmias & Nachmias, 2008). I employed a survey design in this study to investigate teachers' TPACK, LDPs, and DD. Survey research requires the collection of standardized, quantifiable information (Gay et al., 2012) and allows for generalization from a sample to a population (Warner, 2013).

There are generally one of two designs used in survey research: cross-sectional and longitudinal designs (Gay et al., 2012). Since I collected the data at a single point in time, a cross-sectional design was used for this study. In regard to the specific research questions, the appropriate research design to investigate Research Questions 1 and 2 was a cross-sectional survey design. A cross-sectional survey design was appropriate because survey data were only collected in a singular period of time versus the collection of data over time in a longitudinal survey design. To investigate Research Questions 3 and 4, I employed a correlational method with a cross-sectional survey design. Correlational research allows researchers to determine the degree to which a relationship exist between variables (Gay et al., 2012).

Methodology

Population

A population is a unit of analysis that conforms to a designated set of specifications as defined by the specific nature of a research problem (Frankfort-Nachmias & Nachmias, 2008). Although these specifications are employed to define a target population, collection of data from an entire population, in many cases, is not feasible or necessary (Gay et al., 2012). Frankfort-Nachmias and Nachmias (2008) stated that

> a well-designed sample ensures that if a study were to be repeated on a number of different samples drawn from the same population, the findings obtained from each sample would not differ from the population parameters by more than a specified amount" (p. 167).

Therefore, a well-selected sample should be generalizable to a population, in that the results of a sample will also be applicable to results of other samples from the same target population.

In this study, I investigated a school district's one-to-one technology initiative by examining teachers' TPACK as it relates to their number of years in the implementation of the initiative, their content area, LDPs, and DD. The target population for this study were high school teachers in schools that were a part of a district's one-to-one technology initiative. The population for this study consisted of approximately 500 teachers from over 15 high schools that serviced approximately 65,000 students.

Sampling and Sampling Procedures

In a quantitative investigation, a sample must be representative of population (Frankfort-Nachmias & Nachmias, 2008; Warner, 2013). Frankfort-Nachmias and Nachmias (2008) stated "a sample is considered to be representative if the analyses made using the sampling units produce results similar to those that would be obtained had the entire population been analyzed" (p.167). To support the integrity of a representative sample, I used a probability sampling design. A probability sampling design allows for specification of the probability that an individual was selected from a defined population (Gay et al., 2012). Four probability sampling techniques were considered: random sampling, stratified sampling, cluster sampling, and systematic sampling (see Gay et al., 2012).

I selected a stratified sampling technique with the intent of ensuring representation of different groups of the population of teachers. Using a stratified sampling technique supported a more precise sample by strategically and randomly selecting from subgroups of the population (see Gay et al., 2012). Procedures for this sampling technique included: (a) defining the population, (b) determining the sample size, (c) identifying the variables and subgroups (i.e., strata), (d) classifying of members in the population as the identified subgroup (i.e., strata) and (e) randomly selecting individuals from each subgroup (Gay et al., 2012).

Sample size is inversely related to the standard error, or variance of survey estimates (Shapiro, 2008). In planning survey research, Shapiro (2008) posited setting a desired variance and using a power analysis to determine a sample size in a study. Many quantitative researchers use power analyses to identify appropriate sample sizes for research investigations (Faul, Erdfelder, Lang, & Buchner, 2007; Shapiro, 2008). Statistical power is dependent on the significance level of a test, the sample size, and the effect size parameters (Faul, Erdfelder, Lang, & Buchner, 2007). Establishing criterion for a desired size with a 95% confidence interval is useful method in determining a sufficiently reliable sample (Shapiro, 2008).

Faul et al. (2007) stated "the power ($1-\beta$) of a statistical test is the complement of β, which denotes the Type II or beta error probability of falsely retaining an incorrect H_0" (p. 176). To determine an appropriate sample size for this investigation, I used the G*Power3 (Faul et al., 2007) power analysis software to conduct a priori analysis for two statistical tests, a MANOVA and correlation. The priori power analysis was an efficient method to control for the statistical power, prior to conducting an investigation (Faul et al., 2007), by computing the sample size as a function of the significance level, statistical power, and the effect size as desired by the researcher (Faul, Erdfelder, Buchner, & Lang, 2009). The significance level and statistical power values were prespecified as $\alpha = .05$ and $1\text{-}\beta = .95$ for both statistical tests. The G*Power analysis software provided options for use of Cohen's (1988) standard measures for effect size conventions. These conventions are based on size: small = .1, medium = .3, and large = .5 (G*Power 3.1 Manual, 2017). To calculate the sample size for the MANOVA, I completed a *F* test with special effects and interactions with a large effect size of 0.5 for four groups, two predictors, and seven response variables. The power analysis for the MANOVA with special effects and interaction calculated a total sample size of 35. To calculate the sample size for the correlational test, an exact test for a correlation with a bivariate normal model was completed with a large effect size of 0.5. The power analysis for the correlational test calculated a total sample size of 46.

Procedures for Recruitment, Participation, and Data Collection

Before recruiting participants for the study, I submitted a research proposal of procedures to the selected school district for approval. After approval was granted, campus principals were contacted individually to obtain additional permissions before engaging teachers from their campus as prospective participants for the study. Since informed consent was required of human participants to conduct research (Frankfort-Nachmias & Nachmias, 2008), an informed consent form was developed for participants acknowledging the protection of participant rights.

I used anonymous data collection procedures to collect data from the school district. To recruit participants, an e-mail invitation was constructed with a Survey

Monkey link. The e-mail invitation was sent to teachers at approved campuses individually and provided an overview and goals of the study as well as an estimated time commitment to complete the survey. After clinking the link, respondents were required to read the informed consent, then select to agree or disagree to participate in the study. If the respondent selected not to participate in the study, then they were exited out from the survey. If the respondent agreed to participate in the study, then they were required to provide a digital signature acknowledging their consent.

To ensure privacy during data collection, I did not share the identities of individual participants. Details that identified participants, such as the study locations and digital signatures, were also not shared. Participant responses were identified by entry number.

Instrumentation and Operation of Constructs

I used two validated instruments for this investigation. The selected surveys have interrelated factors that directly supported alignment of the TPACK constructs within the TPACK framework. I used the two surveys to address different research questions.

Quantitative Instrument 1: Research Question 1 and 2. To address Research Question 1 and Research Question 2, Koh, Chai, and Tsai (2014) construction of Chai, Koh, and Tsai (2011) TPACK Meaningful Learning Survey was used to measure teachers' perceived constructs of TPACK in regard to its significance to their content area and number of years in a district's implementation of a one-to-one technology initiative. Permission was obtained from Koh, Chai, and Tsai (2014) as seen in Appendix

B. However, the instrument was directly aligned to Research Question 1 and 2 in that it measures the seven constructs of TPACK: TK, PK, CK, PCK, TPK, TCK, and TPACK.

Chai et al. (2011) initial construction of this instrument was found to be valid and reliable for a sample of 214 preservice teachers with an overall Cronbach alpha of 0.95 and eigenvalues greater than 1. A confirmatory factor analysis yielded a satisfactory model fit (Chai et al., 2011). Koh, Chai, and Tsai's (2014) construction of the instrument provided further validation though an exploratory and confirmatory factor analysis. The instrument was found to have high internal validity with a Cronbach alpha of 0.96. In addition, each construct of TPACK had high internal validities with all having Cronbach alphas greater than 0.90.

Quantitative Instrument 2: Research Question 3 and 4. To address Research Question 3 and 4, Koh, Chai, Hong, et al.'s (2015) survey, on examining teachers' DD, LDPs, and their relationship to TPACK, was used. Permission to use the instrument was obtained from the researchers and is included in Appendix A This instrument was directly aligned to nature of Research Question 3 and 4 in that the instrument was designed to provide a quantitative analysis of the relationship between TPACK, LDP, and DD.

The instrument was initially pretested with 93 preservice Singaporean teachers and then again combining 201 preservice and in-service Singaporean teachers (Koh, Chai, Hong, et al., 2015). Through an exploratory factor analysis, Koh, Chai, Hong, et al. (2015) established the survey instrument was valid and reliable. The results indicated that all items had adequate scores for skewness and kurtosis (Koh, Chai, Hong, et al., 2015).

Eigenvalues greater than 1 were obtained for TPACK, LDPs, and DD (Koh, Chai, Hong, et al., 2015). All three factors were found to have good internal reliability with minimum Cronbach alphas of 0.90 for each factor. Koh, Chai, Hong, et al. (2015) conducted confirmatory factor analysis that further supported the instrument was valid and reliable.

Operation of Constructs

For this investigation, the operational constructs of each variable were defined as follows:

Implementation Time of One-to-One Technology: the number of years a teacher has experience teaching in a one-to-one technology initiative

Content Area: the specified area of knowledge in which information is taught and delivered by a teacher

Lesson Design Practices (LDP): the tinkering of lesson ideas to structure and organize activities and resources to enhance lesson plans through design and redesign (Koh, Chai, Hong, et al., 2015)

Design Disposition (DD): a teacher's perceived comfort level in which they are able to engage in the ambiguous process of designing and redesigning lessons (Koh, Chai, Hong, et al., 2015)

TPACK Dimensions: the seven constructs of the TPACK framework (TK, PK, CK, PCK, TPK, TCK, and TPACK)

TK: knowledge about how to use emerging technology (Hilton, 2016)

PK: knowledge about instructional processes and practices in which a teacher applies in the classroom

CK: the knowledge of a subject area that is to be learned and delivered through the instructional process

PCK: the content knowledge within the context of the teaching process

TPK: knowledge about various technologies, whether standard or emerging, that can be used in a teaching and learning environment (Mishra & Koehler, 2006; Marich & Greenhow, 2016)

TCK: knowledge entails knowing and understanding how technology can impact and be used within a subject area (Hilton, 2016)

TPACK: knowledge entails one to know and use various emerging technologies that enables teaching, representation, and facilitation of knowledge within a particular subject area (Chai et al., 2013)

Data Analysis Plan

The Statistical Package for Social Sciences (SPSS) was used to analyze data for this study. Using SPSS, descriptive and inferential statistics was used as methods for data analysis. Both statistical tests support researchers in developing explanations and understanding relationships between variables. Descriptive statistics allows for an effective approach to summarizing and organizing data by describing statistical observations (Frankfort-Nachmias & Nachmias, 2008). Whereas, inferential statistics are data analysis techniques in which researchers are able to make inferences about a population based on the collected data from a sample (Gay et al., 2012).

Statistical Test

Prior to the analysis of collected data, methods were used for screening and cleaning data. Frankfort-Nachmias and Nachmias (2008) stated “data cleaning is the proofreading of data to catch and correct errors and inconsistent codes” (p. 314). I generated a frequency distribution as a method of data cleaning to examine the pattern of responses. Participants who did not complete the survey were removed from the data set.

Research Question 1 and Research Question 2. A factorial MANOVA was performed to investigate Research Question 1 and Research Question 2. Warner (2013) stated “MANOVA can be used to compare the means of multiple groups in nonexperimental research situations that evaluate differences in patterns of means on several Y outcome variables for naturally occurring groups” (p. 779). This statistical test was selected due to the nature of the variables. The outcome variables, or dependent variables, for both research questions are the seven TPACK constructs (TK, PK, CK, PCK, TPK, TCK, and TPACK). The factorial MANOVA was able to assess the significant difference between the seven constructs of TPACK and implementation years of one-to-one technology for Research Question 1 and the seven constructs of TPACK and content areas for Research Question 2. The first factor, one-to-one implementation years, was a categorical variable with three different levels (0–2 years, 3–4 years, and 5 or more years). The second factor, content area, was a categorical variable with four different levels (English, math, science, and social studies).

Test of assumptions for a MANOVA were performed. To detect univariate outliers, a boxplot analysis was conducted. To determine whether the data were normally distributed, Sharpiro-Wilk test was conducted. A bivariate correlation procedure was run to test for multicollinearity. To test the assumptions of linearity, the data file was split based on the categorical independent variable for each research question (content area and one-to-one implementation years) to generate a scatterplot matrix. To test for multivariate outliers, Mahalanobis distance was calculated in a regression procedure. Box M Test was conducted to test the assumptions of homogeneity of covariances across groups (Warner, 2013). If the Box M test was found to be significant, then Pillai's trace was to be reported as the overall statistic. In addition, the Levene's test was performed to indicate error variance of the dependent variables across groups.

Once the MANOVA procedure was performed, the descriptive statistics and the overall MANOVA results were analyzed. If significance of the overall test was detected, a test between-subjects effect was be performed to determine which variable was statistically significant. To further evaluate significance, a Tukey pairwise comparison was obtained to compare means differences. According to Warner (2013), Type III sum of squares should be used to correct for confounding between factors that may occur.

Research Question 3 and Research Question 4. The Pearson Product-Moment correlation (Pearson's *r*) was used to analyze data in this study. Pearson's *r* assessed the degree to which variables are linearly related using a bivariate correlation procedure (Green & Salkind, 2014). Therefore, Research Question 3 and 4 investigated the degree to which teacher's TPACK is related to their LDPs, and DD. This statistical test allowed for the examination of the correlation between TPACK and LDPs and TPACK and DD.

Test for the assumptions of Pearson's correlation were conducted. To interpret linearity and detect outliers, I conducted a scatterplot analysis. The Sharpiro-Wilk test was performed to determine normality of data. To conduct the overall statistical test a bivariate correlation procedure was performed to determine the statistical significance of the correlational coefficient. The magnitude of the correlation coefficient and coefficient of determination was analyzed. To further analyze the statistical significance, I ran a regression analysis and conducted a path analysis to see show how TPACK, LDPs, and DD are related. In the path analysis I identified the degree to which TPACK, LDPs, and DD interacted and contributed to the variance (Gay et al., 2012).

Threats to Validity

Validity is an imperative factor for researchers to seek and consider in an investigative study. Its essential trait of measurement enables researchers to access whether the intended measure of a variable is being measured (Frankfort-Nachmias & Nachmias, 2008; Warner, 2013). Therefore, potential threats to validity need to be identified.

External Validity

External validity "is the degree to which results from a study can be generalized to groups of people, settings, and events that occur in the real world" (Warner, 2013, p. 17-18). Bracht and Glass (2011) categorized threats of this form of validity as population validity and ecological validity. Population validity entails dealings of generalizing to a population and ecological validity entails the environment, or settings, in which the study is designed.

The target population for this study were teachers who are a part of a school district's one-to-one technology initiative. To ensure population validity, participants in this study were randomly selected from an accessible population that was representative of the target population and a test of significance will be conducted. Claims about groups was restricted in the event the results, from the study, cannot be generalized.

Threats to ecological validity lie in the specificity of variables (Gay et al., 2012). To ensure ecological validity, variables have been described explicitly to support generalization and replication of the study (Bracht, & Glass, 2011). Operational descriptions of independent and dependent variables have been defined in a way that can be applied outside the setting of the study. These operational definitions were stated in the operation of constructs section above.

Internal Validity

Frankfort-Nachmias and Nachmias (2008) stated "the effort to attain internal validity is the guiding force behind the design and implementation of a research project" (p. 95). Intrinsic factors that may pose threats to internal validity include instrumentation and interactions with selections (Frankfort-Nachmias & Nachmias, 2008). To address these factors, the study employed the following:

***Instrumentation*.** The two selected instruments for this study, The Meaningful Learning TPACK survey and the relationship between TPACK, LDP, and DD survey, that were used to measure the dependent variables. Both surveys were previously empirically validated and deemed reliable through a series of statistical test by the original researchers for each instrument. The Meaningful Learning TPACK survey was used to measure the dependent variables in Research Questions 1 and 2. The TPACK, LDP, and DD survey was used to measure the independent variables in Research Question 3 and 4.

***Interaction of selection*.** Participants in this study was randomly selected and encompassed a variety of characteristics from different settings. These characteristics include variety of teaching experience, teaching certifications, and levels of degrees such as bachelor's, master's, and doctoral degrees. In addition, some participants had different levels one-to-one technology integration experience and had experience teaching different subject areas.

Construct Validity

An instrument, used in a study, must exhibit construct validity for findings to be substantial (Frankfort-Nachmias & Nachmias, 2008). Since the selected instruments for this study used a survey method in which variables were measured through a participant's self-report, validity was not assumed. According to Warner (2013), evidence that is used to assess the validity of self-report questionnaires include the content of the questionnaire (content validity) and the correlations of scores with other variables on the questionnaire (criterion-oriented validity). To ensure construct validity in this study, the selected instruments were previously validated, deemed reliable, are aligned with the theoretical framework and assumptions in which the study employed.

Ethical Procedures

As the researcher in this investigation, I abided by a code of ethics and consider ethical procedures for this study. Therefore, I obtained the necessary permissions and approvals before gaining access to participants. An application was completed and submitted to the Institutional Board Review (IRB). The documents and approval number are included in the appendix. An informed consent form was developed in which it acknowledged the protection of participant's rights during data collection process. Participants were ensured anonymity and confidentiality. Therefore, their names were disassociated from the study.

To receive permission to gain access to study participants, a letter was written and sent to the proper authorities. It identified the benefits and potential impact of the study. The research site was respected and did not require any disturbance of the school's setting.

Summary

A quantitative study was conducted to examine teachers' perceived TPACK, in a one-to-one technology initiative, and investigate the relationship between their TPACK, LDP, and DD. A cross-sectional survey was used to collect data at single point in time. The target population for this study were high school teachers who were a part of a district's one-to-one technology initiative and teach a math, science, social studies, or English content area.

Koh, Chai, and Tsai (2014) construction of Chai, Koh, and Tsai (2011) TPACK Meaningful Learning Survey was used to measure teachers' perceived TPACK based on the number of implementation years of the one-to-one initiative and content area. Koh, Chai, Hong, et al. (2015) survey, on examining teachers' DD, LDPs, and their relationship to TPACK, was used to determine whether there was a correlation between teachers' perceived TPACK and their LDP and teachers' TPACK and their DD. SPSS was used to statistically analyze data. A factorial MANOVA was performed to analyze teachers' perceived constructs of TPACK in regard to its significance to their content area and number of years in a district's implementation of a one-to-one technology initiative. The Pearson's *r* was used to analyze the degree to which teacher's TPACK is related to their LDPs, and DD.

To ensure external and internal validity, participants were randomly selected from an accessible population and the two selected instruments for this study were previously validated and deemed reliable. A letter was written to grant permission to access participants who was assured confidentiality. Additionally, an informed consent form was developed to acknowledge the protection of participant's rights during data collection process.

In Chapter 4, I describe the data collection and recruitment process. I also reported the descriptive statistics and statistical analysis of the findings. This analysis is organized by the research questions along with tables and figures to illustrate results. This analysis includes exact statistics, confidence intervals, effect sizes, and probability values as appropriate to the study.

Chapter 4: Results

Introduction

The purpose of this quantitative study was to investigate teachers' level of knowledge in technology integration, in an established one-to-one technology district initiative, through an examination of their perceived TPACK, LDPs, and DD. In this study, I examined teacher's perceived TPACK by their years experienced in the one-to-one technology initiative and content area. In addition, I aimed to determine whether teacher's perceived TPACK correlated with their LDPs and DD. The research questions and hypothesis that guided this investigation were:

Research Question 1: Is there a significant difference in teachers' constructs of TPACK based on the number of implementation years in a one-to-one technology initiative?

$H_0$1: There is not a significant difference in teachers' constructs of TPACK and the number of implementation years in a district one-to-one technology initiative.

H_a1: There is a significant difference in teachers' constructs of TPACK and the number of implementation years in a district one-to-one technology initiative.

Research Question 2: Is there a significant difference in teachers' constructs of TPACK based on the content area of a district wide one-to-one technology initiative?

$H_0$2: There is not a significant difference in teachers' constructs of TPACK and their content area in a district with a one-to-one technology initiative.

H_a2: There is a significant difference in teachers' constructs of TPACK and their content area in a district with a one-to-one technology initiative.

Research Question 3: Is there a relationship between teachers' TPACK and their LDPs?

$H_0$3: There is no correlation between teachers' TPACK and their LDPs in a district with a one-to-one technology initiative.

H_a3: There is a positive correlation between teachers' TPACK and their LDPs in a district with a one-to-one technology initiative.

Research Question 4: Is there relationship between teachers' TPACK and DD?

$H_0$4: There is no correlation between teachers' TPACK and their DD in a district with a one-to-one technology initiative.

H_a4: There is a positive correlation between teachers' TPACK and their DD in a district with a one-to-one technology initiative.

This chapter is organized into three sections: data collection, statistical methods, and data analysis.

Data Collection and Data Analysis

The population for this study was high school teachers who taught in a school district with a one-to-one technology initiative. After receiving the school district's approval to conduct research, further approval from school principals was required before teachers could be invited to participate in the study. 29 high schools were approached to participate in the study, and 13 school principals granted approval for their campus teachers to be invited. Upon receiving approval from Walden's IRB and the school principal's approval, I e-mailed a total of 506 teachers an invitation with a Survey Monkey link to participate in this study. In addition, some participating campuses also e-mailed their teachers the Survey Monkey link as well.

Due to the timing of Walden's IRB approval and the ending of the district's academic year, the data collection process occurred over the last 3 weeks of school. Of the 506 teachers that were invited to participate, 135 teachers responded to the survey, equaling a 26.3% response rate. The survey link included the informed consent form, which teachers were required to sign to participate; demographic questions (comprising four items); the TPACK Meaningful Learning survey questions (34 items); and the TPACK, LDPs, and DD survey questions (18 items). Of the 135 participants, only 117 completed the Meaning Learning survey and 52 completed the TPACK, LDP, and DD survey. The 18 participants who did not complete the survey were removed from the data set. Therefore, the total sample size for the Meaningful Learning survey was 117, and the total sample for the TPACK, LDP, and DD survey was 52.

I exported the data collected from the survey from Survey Monkey, then organized and assembled them in the SPSS software. The values for the independent variables, content area and one-to-one technology implementation years, were assembled into categorical values. The categorical variable, content area, had four levels: 1 = math, 2= science, 3 = social studies, 4 = English. The categorical variable, one-to-one technology implementation years, had three levels, which were recoded into the following categorical ranges: 1 = 0–2 years, 2 = 3–4 years, and 3 = 5 years or more.

Participants rated themselves on a 7-point Likert scale for each section of the seven TPACK constructs: 1= *strongly disagree*, 2 = *disagree*, 3 = *slightly disagree*, 4 = *neither agree or disagree*, 5 = *slightly agree*, 6 = *agree*, and 7 = *strongly agree*. For both surveys, the TPACK Meaningful Learning survey and TPACK, LDP, and DD survey, each item response was scored with a value from 1 to 7 (1 = *strongly disagree* and 7 = *strongly agree*). The values of item responses collected for each section of the seven constructs of TPACK (i.e., TK, CK, PK, PCK, TCK, TPK, and TPACK) were averaged to create a TK score, PK score, CK score, PCK score, TCK score, TPK score, and a TPACK score.

Results

Descriptive and Demographic Characteristics of the Sample

The sample size for this study was representative of the school district's one-to-one technology teacher population. The sample population included a variety of teachers from different content areas, schools, teaching experience, and education degree levels. Table 1 displays percentages of participants by content area displaying degree level, teaching experience, and one-to-one technology implementation experience.

Table 1

Participant Demographics

Content area	Degree Level			Years Experiences Teaching				One-to-One Implementation Years		
	Bachelor's	Master's	Doctorate	1-5	6-10	11-20	20 or more	0 – 2 years	3 – 4 years	5 or more
Math	46.7%	40.0%	13.3%	33.3%	40.0%	13.3%	13.3%	26.7%	46.7%	26.7%
Science	53.3%	40.0%	6.7%	40.0%	40.0%	20.0%	0.0%	26.7%	33.3%	40.0%
Social studies	33.3%	60.0%	6.7%	40.0%	13.3%	33.3%	13.3%	40.0%	20.0%	40.0%
English	40.0%	60.0%	0.0%	26.7%	13.3%	46.7%	13.3%	33.3%	20.0%	46.7%
Total	43.3%	50.0%	6.7%	35.0%	26.7%	28.3%	10.0%	31.7%	30.0%	38.3%

Note. Participants percentages are based on N = 60 with n = 15 per strata

Using the RAND function in Excel, I employed a stratified sampling technique to randomly select participants from each strata of content area: math, science, social studies, and English. Since the a priori power analysis for MANOVA calculated a sample size of 35 with a large effect of .50, 15 random participants were selected from each content area. This changed the total sample size from 117 to 60, which was slightly above the required sample size to achieve the needed power of a MANOVA. The sample was representative of the population in that teachers were randomly selected from each content area and equally grouped into content areas.

Table 2

Participants by Content Area and One-to-One Implementation Years

Content	Implementation Years			*n*
	0–2 years	3–4 years	5 or more years	
Math	4	7	4	15
Science	4	5	6	15
Social studies	6	3	6	15
English	5	3	7	15
n	19	18	23	60

Note. *n* = number of participants per strata

Since there were only 52 completed responses for the TPACK, LDP, and DD survey, I used a convenience sampling technique. Based on the a priori power analysis for correlations, a sample size of size of 46 was sufficient with a large effect of .50 and a power of .95.

I employed a factorial MANOVA to determine whether there was significance between teachers' content area and their perceived constructs of TPACK as well as whether there was significance between teachers' implementation years of one-to-one technology and their perceived constructs of TPACK. Additionally, Pearson's product-moment correlation was performed to determine whether there was correlation between teachers' TPACK, their LDPs, and their DD. The results of this investigation are organized by the statistical test performed.

MANOVA Statistical Analysis

Descriptive statistics for one-to-one implementation years. As seen in Table 3, teachers with 3–4 one-to-one implementation years reported a slightly higher TK mean score (*M* = 5.83, *SD* = .74) than teachers with 0–2 and 5 or more one-to-one implementation years. Teachers with 5 or more one-to-one implementation years reported higher PK scores (*M* = 6.11, *SD* = .64) than those with 0–2 and 3–4 one-to-one implementation years. Teachers with 3–4 one-to-one implementation years reported higher CK mean scores (*M* = 6.74, *SD* = .41), while teachers with 0–2 and 5 or more one-to-one implementation years reported similar CK mean scores. Teachers with 5 or more one-to-one implementation years reported higher PCK scores (*M* = 6.01, *SD* = .78) than teachers with 0–2 and 3–4 one-to-one implementation years. Teachers with 3–4 one-to-one implementation years reported higher TPK scores (*M* = 5.94, *SD* = .87) than those with 0–2 and 5 or more one-to-one implementation years. Teacher with 3–4 years one-to-one implementation years reported higher TCK mean scores (*M* = 5.96, *SD* = .85) than those with 0–2 and 5 or more one-to-one implementation years. Teachers with 5 or more one-to-one implementation years reported slightly higher TPACK mean scores (*M* = 4.91, *SD* = 1.19) than those with 0–2 and 3–4 one-to-one implementation years.

Table 3

TPACK Constructs Descriptive for One-to-One Implementation Years

	Implementation year	*M*	*SD*	*N*
TK	0–2 years	5.57	.98	19
	3–4 years	5.82	.74	18
	5 or more years	5.45	1.17	23
	Total	5.60	.99	60
PK	0–2 years	5.89	.62	19
	3–4 years	6.05	.82	18
	5 or more years	6.11	.64	23
	Total	6.02	.69	60
CK	0–2 years	6.46	.63	19
	3–4 years	6.74	.41	18
	5 or more years	6.48	.47	23
	Total	6.55	.52	60
PCK	0–2 years	5.36	1.32	19
	3–4 years	5.42	1.41	18
	5 or more years	6.01	.78	23
	Total	5.63	1.20	60
TPK	0–2 years	5.80	.74	19
	3–4 years	5.94	.87	18
	5 or more years	5.70	1.03	23
	Total	5.81	.89	60
TCK	0–2 years	5.75	.96	19
	3–4 years	5.96	.85	18
	5 or more years	5.68	1.06	23
	Total	5.79	.96	60
TPACK	0–2 years	4.86	1.05	19
	3–4 years	4.81	1.21	18
	5 or more years	4.91	1.19	23
	Total	4.86	1.13	60

Note. Mean comparison of TPACK construct by one-to-one implementation years

Descriptive statistics for content area. As seen in Table 4, math teachers reported higher TK scores (*M* = 6.20, *SD* = .76) than science, social studies, and English teachers. English teachers reported higher PK scores (*M* = 6.20, *SD* = .67) than math, science, and social studies teachers. Math and English teachers reported the same mean scores (*M* = 6.72, *SD* = .44; *M* = 6.72, *SD* = .67) for CK. Science and social studies teachers reported slightly lower CK scores (*M* = 6.23, *SD* = .44; *M* = 6.53, *SD* = .60). English teachers reported slightly higher PCK scores (*M* = 5.95, *SD* = 1.09) than math, science, and social studies teachers. English teachers reported slightly higher TPK scores (*M* = 6.11, *SD* = .74) than math, science, and social studies teachers. Math teachers reported higher TCK scores (*M* = 6.13, *SD* = .76) than science, social studies, and English teachers. Social studies and English teachers reported similar TPACK scores (*M* = 5.00, *SD* = 1.21; *M* = 5.03, *SD* = .99). Math and science teachers reported slightly lower TPACK scores (*M* = 4.68, *SD* = 1.37; *M* = 4.73, *SD* = 1.00).

Table 4

TPACK Constructs Descriptive for Content Area

	Content area	*M*	*SD*	*N*
TK	Math	6.20	.76	15
	Science	4.94	1.06	15
	Social studies	5.71	.86	15
	English	5.55	.93	15
	Total	5.60	.99	60
PK	Math	5.83	.82	15
	Science	5.97	.50	15
	Social studies	6.09	.72	15
	English	6.20	.67	15
	Total	6.02	.69	60
CK	Math	6.72	.44	15
	Science	6.23	.52	15
	Social studies	6.53	.60	15
	English	6.72	.36	15
	Total	6.55	.52	60
PCK	Math	5.72	1.76	15
	Science	5.37	.65	15
	Social studies	5.47	1.06	15
	English	5.95	1.09	15
	Total	5.63	1.20	60
TPK	Math	5.61	1.08	15
	Science	5.53	.96	15
	Social studies	5.97	.68	15
	English	6.11	.74	15
	Total	5.81	.89	60
TCK	Math	6.13	.76	15
	Science	5.71	.67	15
	Social studies	5.56	.98	15
	English	5.76	1.31	15
	Total	5.79	.96	60
TPACK	Math	4.68	1.37	15
	Science	4.73	1.00	15
	Social studies	5.00	1.21	15
	English	5.03	.99	15
	Total	4.86	1.13	60

Note. Mean comparison of TPACK construct by content area.

Statistical assumptions for MANOVA. I examined statistical assumptions for a MANOVA prior to conducting the MANOVA statistical test. These assumptions included univariate and multivariate outliers as well as tests for normality, linearity, and multilinearity. Tests for homogeneity of covariances and variances were also included.

Univariate and multivariate outliers. To determine univariate outliers in the data, boxplots for the seven constructs of TPACK were analyzed. Various outliers were found in the data for each content area. Outliers found in the boxplot analysis were neither measurements or data entry errors and therefore were not removed from the data. Before transformation of data methods were considered, a test for normality was performed.

To determine multivariate outliers, a linear regression was run to compute a Mahalanobis distance for each case. The Mahalanobis distance values were compared against a chi-square (χ^2) distribution with an alpha level of .001 and degrees of freedom equal to the number of dependent variables TK, PK, CK, PCK, TPK, TCK, and TPACK. The critical values Mahalanobis value for seven dependent variables was 24.32. The Mahalanobis distance values were sorted for each case. The highest Mahalanobis value computed was 11.70. Therefore, the data did not contain any multivariate outliers and the assumption for multivariate outliers was not violated.

To determine whether the data were normally distributed, Sharpiro-Wilk's test of normality was performed. This test was performed for content area and one-to-one implementation years. Table 5 and Table 6 display results of the Sharpiro-Wilk's test.

Content area normality. TK scores were normally distributed for math and social studies as assessed by Shapiro-Wilk's test ($p > .05$). TK scores for science and English were found significant (p = .037; p = .029). PK scores were normally distributed for math, science, and English, $p > .05$. PK scores were found significant for social studies (p = .011). CK scores were normally distributed for science ($p > .05$). CK scores for math, social studies, and English were found significant (p = .000; p = .002; p = .001). PCK scores were only normally distributed for social studies ($p > .05$). PCK scores for math (p = .000), science (p = .017), and English (p = .015) were found significant. TPK scores for math, social studies, and English were normally distributed ($p > .05$). TPK scores for science (p = .009) were found significant. TCK scores for math, science, and social studies were normally distributed ($p > .05$). TCK scores for English (p = .001) were found significant. TPACK scores for science, social studies, and English were normally distributed ($p > .05$). TPACK scores for math (p = .043) were found significant.

Table 5

Content Area Test for Normality

	Content area	Shapiro-Wilk		
		Statistic	df	Sig.
TK	Math	.89	15	.07
	Science	.87	15	.04
	Social studies	.94	15	.43
	English	.87	15	.03
PK	Math	.93	15	.26
	Science	.91	15	.12
	Social studies	.84	15	.01
	English	.89	15	.07
CK	Math	.69	15	.00
	Science	.96	15	.66
	Social studies	.78	15	.00
	English	.76	15	.00
PCK	Math	.72	15	.00
	Science	.85	15	.02
	Social studies	.92	15	.19
	English	.85	15	.02
TPK	Math	.90	15	.10
	Science	.83	15	.10
	Social studies	.93	15	.23
	English	.90	15	.11
TCK	Math	.91	15	.12
	Science	.96	15	.67
	Social studies	.89	15	.07
	English	.74	15	.00
TPACK	Math	.88	15	.04
	Science	.95	15	.51
	Social studies	.95	15	.59
	English	.94	15	.44

Note. Significance level $p < .05$.

Since various negative skewness values were reported, a square root transformation method was applied to normalized data. After the square root transformation was applied, all TK, PK, TPK, and TPACK scores were normally distributed for each content area of math, science, social studies, and English, as assessed by Sharpiro-Wilk's test ($p > .05$) The transformation application corrected normalization for only five values. CK scores for math ($p = .000$), social studies ($p = .004$), and English ($p = .001$) alpha values had very little or no change and were not normally distributed. PCK scores for math ($p = .000$), science ($p = .017$), and English ($p = .015$) alpha values had very small increase and were not normally distributed. TCK scores for English ($p = .004$) had a very small increase in significance and were not normally distributed.

A second attempt to correct normalization for the seven of the 28 values, a logarithmic base10 transformation, for strongly negatively skewed data, was applied to all data. The same seven alpha values for CK, PCK, and TCK were still significant and not normally distributed. An inverse transformation, for extremely negatively skewed data, was also applied and the same seven significant values for CK, PCK, and TCK were still found significant and was not normally distributed. Therefore, violations of normality were found throughout the data for TK, PK, CK, PCK, TPK, TCK, and TPACK among the content areas of math, science, social studies, and English and the transformation values will not be used.

One-to-one implementation years normality. TK scores were normally distributed for teachers with 0–2 and 3–4 implementation years normally distributed for math and social studies as assessed by Shapiro-Wilk's test ($p > .05$). TK scores for teachers with 5 or more one-to-one implementation years were found significant (*p* = .038). PK scores were normally distributed for 0–2 years, 3–4 years, and 5 or more one-to-one implementation years (*p* > 0.5). CK scores were found significant for all 3 levels of one-to-one implementation years (*p* = .002; *p* = .000; *p* = .017). PCK and TPK scores were only normally distributed for teachers with 3–4 one-to-one implementation years (*p* > .05). PCK and TPK scores were found significant for teachers with 0–2 and 5 or more years of one-to-one implementation (*p* = .040; *p* = .025 and *p* = .012; *p* = .025). TCK score were normally distributed for teachers with 0–2 and 3–4 one-to-one implementation years (*p* > .05). TCK scores for teachers with 5 or more one-to-one implementation years were found significant (*p* = .029). TPACK scores were normally distributed for teachers with 3–4 and 5 or more one-to-one implementation years (*p* > .05). TPACK scores for teachers with 0–2 one-to-one implementation years were found significant.

Table 6

One-to-One Implementation Years Tests of Normality

		Shapiro-Wilk		
	Implementation years	Statistic	*df*	Sig
TK	0–2 years	.955	19	.478
	3–4 years	.963	18	.652
	5 or more years	.909	23	.038
PK	0–2 years	.963	19	.628
	3–4 years	.908	18	.078
	5 or more years	.923	23	.077
CK	0–2 years	.813	19	.002
	3–4 years	.693	18	.000
	5 or more years	.891	23	.017
PCK	0–2 years	.895	19	.040
	3–4 years	.912	18	.092
	5 or more years	.900	23	.025
TPK	0–2 years	.866	19	.012
	3–4 years	.905	18	.070
	5 or more years	.900	23	.025
TCK	0–2 years	.914	19	.089
	3–4 years	.912	18	.092
	5 or more years	.903	23	.029
TPACK	0–2 years	.786	19	.001
	3–4 years	.956	18	.521
	5 or more years	.960	23	.471

Note. Significance level $p < .05$.

Since various negative skewness values were reported across levels of one-to-one implementation years, a square root transformation method was applied to normalized data. After the square root transformation was applied, TK, PK, and TCK scores were normally distributed ($p > .05$) for each level of one-to-one implementation years (0–2 years, 3–4 years, and 5 or more years). The transformation application corrected normalization for only five values. The CK scores for 0–2, 3–4, and 5 or more one-to-one implementation years alpha values (*p* = .002; *p* = .002; *p* = .017) had very little or no change and were not normally distributed. PCK scores for 5 or more one-to-one implementation years (*p* = .015) alpha value actually decreased and TPACK scores for 0-2 one-to-one implementation years (*p* = .006) alpha value had very small increase and they were still not normally distributed.

Multicollinearity and linearity. Pearson's correlation coefficient was used to determine multicollinearity among TK, PK, CK, PCK, TPK, TCK, and TPACK. There was no multicollinearity among the seven constructs of TPACK as assessed by Pearson's correlation. A test for linearity was performed between the seven constructs of TPACK (TK, CK, PK, PCK, TCK, TPK, and TPACK) for each group of the independent variables, content area and one-to-one technology implementation years. A scatter plot matrix was used to analyze linearity for each construct of TPACK. Based on the scatter plot matrices, linearity was not consistent among all the dependent variables for each group. Since the inconsistent interactions were approximately linear, data linearity was assumed for all the relationships.

Homogeneity of variances and covariances. To test for homogeneity of covariances, Box's test was evaluated. Box's test was performed to test assumptions of homogeneity of covariances. An alpha level of .001 was used for Box's test as a criterion of significant violations of the assumptions of homogeneity across the groups. Box M for content areas indicated there was no statistical significance across groups, $F(84, 7113) = 1.31$ and $p = .032$. Box M for one-to-one implementation years also indicated there was no statistical significance across groups, $F(56, 8551) = 1.24$ and $p = .111$.

Levene's test was performed to test equality of error variances across content area and one-to-one implementation years groups for TK, PK, CK, PCK, TPK, TCK, and TPACK. In regard to content area, Levene's test did not report statistical significance ($p > .05$) for TK ($p = .875$), PK ($p = .066$), CK ($p = .238$), TPK ($p = .113$), TCK ($p = .137$), and TPACK ($p = .407$). In regard to one-to-one implementation years, Levene's test did not report statistical significance ($p > .05$) for TK ($p = .312$), PK ($p = .566$), CK ($p = .065$), TPK ($p = .301$), TCK ($p = .519$), and TPACK ($p = .486$). PCK was the only variable that reported significance for both content area and one-to-one implementation years ($p = .048$; $p = .032$). Since the PCK alpha value for content area ($p = .048$) was approximately equal to the alpha criterion of .05, equal variance for content area PCK scores were not assumed but within acceptable limits. Although the one-to-one implementation years PCK alpha values ($p = .032$) appear to violate the assumption for equal variance, because the similarity in the sample size for each group reduces concerns for violations of homogeneity.

Research Question 1. Mean differences for 0–2, 3–4, and 5 or more one-to-one implementation years were relatively low for each construct of TPACK. Based on the overall MANOVA for one-to-one implementation years, the multivariate test indicated there were no statistically significant differences (using $\alpha = .05$ as the criterion) between one-to-one implementation years and TPACK constructs, $F(14, 102) = .678$, $p = .791$; Wilk's $\Lambda = .837$; partial $\eta^2 = .085$. The corresponding η^2 effect size of .085 indicated a large effect for this interaction.

Research Question 2. Based on the overall MANOVA for content area, the multivariate test indicated statistically significant differences (using $\alpha = .05$ as the criterion) between content areas and TPACK constructs, $F(21, 144) = 1.74$, $p = .032$ ($p < .05$); Wilk's $\Lambda = .5.24$; partial $\eta^2 = .194$. To determine which of the TPACK constructs contributed to the statistically significant difference, a test between subjects was analyzed. The test between subjects showed there was statistical significance between content areas for TK, $F(3, 56) = 4.89$; $p = .004$; $\eta^2 = .208$. There was also a statistical significance between content areas for CK, $F(3, 56) = 3.27$; $p = .028$; $\eta^2 = .149$.

A Tukey post hoc test was performed to compare difference among content area for each TPACK construct. The Tukey post hoc test revealed that the TK mean differences between math and science teachers (1.23, 95% CI [0.38, 2.14]) was found statistically significant ($p = .002$). The CK mean difference between math and science teachers (.4833, 95% CI [.0107, .956]) was found statistically significant ($p = .043$). CK mean differences were the same between English and science teachers (.4833, 95% CI [.0107, .956]) as the CK mean difference for math and science teachers and therefore was also statistically significant ($p = .043$). There was no statistically significant difference found among the four content areas for PK, PCK, TPK, TCK, and TPACK scores.

Out of the seven TPACK constructs, all content area teachers reported higher CK scores ($M = 6.55$, $SD = .52$). PK scores ($M = 6.02$, $SD = .52$) were the next highest score reported. TPACK scores ($M = 4.86$, $SD = 1.13$) were the lowest scores reported. TPK scores and TCK scores were relatively similar ($M = 5.81$, $SD = .89$; $M = 5.79$, $SD = .96$).

PCK scores were slightly higher than TK scores (*M* = 5.63, *SD* = 1.20; *M* = 5.55, *SD* = .93).

Table 7

Mean Comparison of TPACK Constructs

	TK	PK	CK	PCK	TPK	TCK	TPACK
M	5.60	6.02	6.55	5.63	5.81	5.79	4.86
N	60	60	60	60	60	60	60
SD	.99	.69	.52	1.20	.89	.91	1.13

Note. Mean comparison of TPACK constructs.

Pearson Correlation Analysis for TPACK, LDP, and DD

Statistical assumptions for Pearson's correlation were examined prior to conducting Pearson's product-moment statistical test. These assumptions included an examination of linear relationships and outliers as well as a test for bivariate normality. To determine linearity between TPACK, LDP, and DD, a simple scatter plot was requested and analyzed for each relationship, TPACK and LDP, TPACK and DD, and LDP and DD. Based on the scatter plot analysis, a linear relationship was determined between TPACK, LDP, and DD. The simple scatter plot was also used to detect outliers. There were no significant outliers found. Although outliers can have an influence on Pearson's *r*, the few outliers that were observed were not due to data or measurement errors. To determine whether the data were normally distributed, Sharpiro-Wilk's test of normality was performed for TPACK, LDP, and DD. TPACK and LDP were normally distributed, $p > .05$. However, teacher's DD scores were found to be significant, $p = .000$.

Table 8

TPACK, LDP, and DD Descriptive

	TPACK	LDP	DD
M	5.08	5.39	6.16
N	52	52	52
SD	1.17246	.99821	.80878

Note. Comparison of mean scores.

Research Question 3. A Pearson's correlation was performed to assess whether a relationship existed between teachers TPACK and LDP. The Pearson's correlation test found a moderate, positive statistical significance between teacher's TPACK and their LDP, $r(50) = .461$ and $p = .001$. The r^2 was .21 accounting for 21% of the variance. Table 9 displays the correlations between the variables.

Table 9

Pearson's Product-Moment Correlations

		TPACK	LDP	DD
TPACK	Pearson Correlation	1	$.461^{**}$	$.357^{**}$
	Sig. (2-tailed)		.001	.009
	N	52	52	52
LDP	Pearson Correlation	$.461^{**}$	1	.215
	Sig. (2-tailed)	.001		.125
	N	52	52	52
DD	Pearson Correlation	$.357^{**}$	.215	1
	Sig. (2-tailed)	.009	.125	
	N	52	52	52

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

Research Question 4. A Pearson's correlation was performed to assess whether a relationship existed between teachers TPACK and DD. The Pearson's correlation test found a moderate positive, statistical significance between teacher's TPACK and their DD, $r(50) = .357$ and $p = .009$. The r^2 was .13 accounting for 13% of variance.

To further explore the positive relationship between TPACK and LDP and the relationship with TPACK and DD, a multiple regression was run to determine whether teacher's LDP and DD predict teacher's TPACK. The multiple regression model statistically significantly predicted TPACK, $F(2, 49) = 9.65$, $p < .001$, adj. $R^2 = .253$. R^2 for the overall model was 28.2% with an adjusted R^2 of 25.3%. That is when LDP and DD were used as predictors, 28.2% of the variance in teachers' TPACK could be predicted.

Table 10

ANOVA[a]

Model	Sum of Squares	*df*	Mean Square	*F*	Sig.
Regression	19.804	2	9.902	9.645	.000[b]
Residual	50.304	49	1.027		
Total	70.108	51			

[a.] Dependent Variable: TPACK

[b.] Predictors: (Constant), DD, LDP

Table 11

Regression Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients	*t*	*Sig.*
	B	Std. Error	Beta		
(Constant)	.118	1.219		.097	.923
LDP	.473	.146	.403	3.251	.002
DD	.392	.180	.271	2.183	.034

Note. Dependent Variable: TPACK

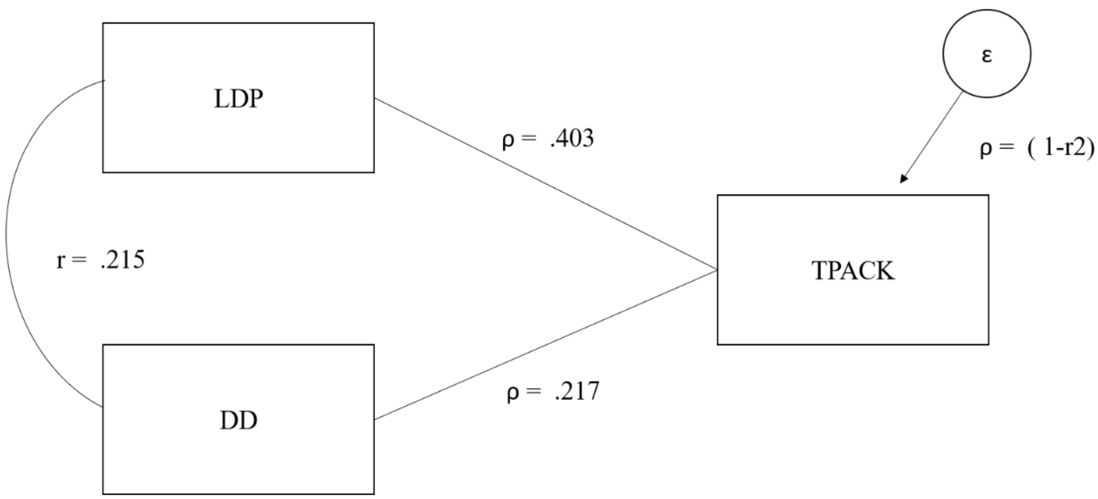

Figure 2. Path analysis of TPACK, LDP, and DD.

Summary

A MANOVA was conducted to determine whether significance existed between teacher's one-to-one technology implementation years, content area, and their perceived constructs of TPACK (TK, PK, CK, PCK, TPK, TCK, and TPACK). Teacher's one-to-one implementation years were factored into three levels: 0–2 one-to-one implementation years, 3–4 one-to-one implementation years, and 5 or more one-to-one implementation years. Teacher's content areas were factored into four levels: math, science, social studies, and English. The MANOVA results revealed there were no statistically significant differences between the three levels of one-to-one implementation years and seven TPACK constructs, $F(14, 102) = .678$, $p = .791$; Wilk's $\Lambda = .837$; partial $\eta^2 = .085$. However, there were statistically significant differences found between teacher content areas and TPACK constructs. A Tukey post hoc revealed the differences were found between math and science teachers for TK and CK. A significant difference was also found between English and science teachers for CK.

A Pearson product-moment correlation was conducted to determine whether there was a relationship between teacher's TPACK and their LDPs and TPACK and their DD. A moderate, positive correlation was found between LDP and TPACK, $r(50) = .461$ and $p = .001$. A positive, moderate correlation was also found between TPACK and DD, $r(50) = .357$ and $p = .009$.

In the next chapter, findings of the statistical test computed is analyzed and the results of the study are interpreted. Limitations of the study of the study are discussed. Recommendations for further research are described and implications for social change are discussed.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this quantitative study was to investigate teachers' level of knowledge in technology integration, in an established one-to-one technology district initiative, through an examination of their perceived TPACK, LDPs, and DD. In this study, I examined teachers' perceived constructs of TPACK by their years' experience in a one-to-one technology district initiative and their content area (i.e., math, science, social studies, and English). Additionally, I sought to determine whether a correlation existed between teacher's TPACK, their LDPs, and their DD.

In this chapter, I analyze and interpret the findings from the statistical tests performed. The limitations of the study are discussed, and recommendations for further research are suggested. I also discuss the implications for positive social change and the potential impact of the study findings on stakeholders.

Interpretation of the Findings

The results of this study revealed there were no statistically significant differences between teachers' perceived constructs of TPACK and their years' experience in a one-to-one technology district initiative. However, I did find statistically significant differences between teachers' perceived constructs of TPACK and their content area (i.e., math, science, social studies, and English). In addition, positive, moderate correlations were found between teachers' TPACK, their LDPs, and their DD. I discuss and interpret the findings of this study in the following subsections: TPACK constructs and implementation years, TPACK constructs and content area, TPACK and lesson design, and TPACK and DD.

TPACK Constructs and One-to-One Implementation Years

The constructs of TPACK are drawn out of the interconnectedness of TPACK that synthesize the levels of knowledge needed in supporting effective instruction infused with technology (Padmavathi, 2017). Although there have been mixed results in the adoption of one-to-one technology initiatives (Holen et al., 2017; Topper & Lancaster, 2013), empirical research continues to indicate that the transformation of teachers' pedagogical practices in a technology-rich environment, like one-to-one technology initiatives, has been a slow process (Sauers & McLeod, 2017). In this study, I used a MANOVA to determine whether significant differences existed between the seven constructs of TPACK and one-to-one technology implementation years. Small mean differences were observed between one-to-one implementation years within each TPACK construct. These findings indicated there were no statistically significant differences between teachers who had less years' experience in teaching in a one-to-one technology environment than those who taught in the district's one-to-one initiative longer. The results from this study affirm the slow process of the transformation of teachers' pedagogical practice in a one-to-one, technology-rich environments.

Although, there were no statistical mean differences between the years experienced teachers had in a one-to-one initiative, there were significant differences found between the constructs of TPACK. I found that teachers had a very strong perception about knowledge of their specific content but a weaker perception of their

TPACK. TPACK is synthesized knowledge of technology, pedagogy, and content for effective technology integration (Chai et al., 2012; Koh, Chai, & Tsai, 2014; Mishra & Koehler, 2006). These findings suggest a need for teacher development on the interplay of technology, pedagogy, and content for effective instruction versus an isolation of technology development.

TPACK Constructs and Content Area

I used a MANOVA to determine whether significant differences existed between the seven constructs of TPACK and teachers' core content area. The multivariate test indicated there were statistically significant differences between teachers' constructs of TPACK and the core subject area they teach. The results from this study revealed math teachers had a stronger perception of their knowledge about the technology tools and resources used to communicate, create, and manage information (i.e., TK) than social studies and English teachers and more significantly stronger than science teachers. Although not more statistically significant than social studies and English teachers, science teachers appear to need more support in developing TK.

The results from this study also revealed that math and English teachers had a statistically stronger perception of their content area than science teachers. Although social studies teachers reported a lower CK, there were no statistically significant differences between math and science teachers for CK. Additionally, there were no statistically significant differences found among math, science, social studies, and English teachers for PK, PCK, TPK, TCK, and TPACK. However, out of the seven TPACK constructs, teachers' perceptions of their CK were significantly different from the other constructs: TK, PK, PCK, TPK, TCK, and TPACK. Because CK is knowledge about a particular academic subject (Chai et al., 2012; Koh, Chai, & Tsai, 2014; Mishra & Koehler, 2006), the results suggest that teachers were more knowledgeable and comfortable teaching their respective content areas.

Interestingly, the results revealed that teachers reported higher CK and PK scores than the other TPACK constructs but a lower PCK, which is the integrated knowledge of content and pedagogy. This finding suggests that teachers may need more support in integrating content and pedagogy, and therefore, may have a barrier with the addition of technology in the development of their TPACK. TPACK embodies an understanding of effective technology integration to support content and pedagogical strategies in which content is more comprehensible and explicit for student learning using a variety of instructional methods (Pamuk et al., 2015). Teachers did report lower knowledge of technology than CK and PK, which presumably had an effect on the interplay of technology between the other constructs of TPACK (i.e., TPK, TCK, and TPACK). The findings of this study affirm that although TPACK is noted to be an essential factor in teachers’ deconstruction of knowledge (see Chai et al., 2018; Harris et al., 2017), the emergence of TPACK has not had an impact on teachers’ ability to effectively integrate technology into instruction (Chai et al., 2018; Heitink et al., 2017; Pringle et al., 2015; Tondeur, Aesaert, et al., 2017).

TPACK and Lesson Design Practices (LDPs)

LDPs is the approach teachers take to design lessons (Koh, Chai, Hong, et al., 2015). As aforementioned by Chai et al. (2013) and Koh, Chai, Benjamin, et al. (2015), teachers' perceptions of lesson design leads their use of TPACK. In this study, I used Pearson's product-moment correlation to determine there was a moderate, positive relationship between teachers' TPACK and their LDPs, $r(50) = .461$ and $p = .001$. A multiple regression further found that teachers' LDPs were a predictor of teachers' TPACK. This positive correlation between TPACK and teachers' LDPs affirms that teachers' perception of their LDPs influences their TPACK and suggests further support in the development of teachers' LDPs for effective technology integration to support instruction.

TPACK and Design Disposition (DD)

DD is the anticipation and comfort level a teacher possesses when engaging in the design process (Koh, Chai, Hong, et al., 2015). I conducted a Pearson's product-moment correlation and determined there was a moderate, positive relationship between teachers' TPACK and their DD, $r(50) = .461$ and $p = .001$. A multiple regression further found that teachers' LDPs were also a predictor of teachers' TPACK. Koh, Chai, Hong, et al. (2015) posited that teacher's comfort levels in the design process should be considered because teachers' apprehension may have an indirect effect on their TPACK. Therefore, teachers' design competencies are an essential factor that can affect the integration of technology instruction because it shapes how their instructional belief mode of thinking attribute cognitive dissonance in shifting pedagogical practices (Koh, Chai, Benjamin, et al., 2015).

Limitations of the Study

Limitations are aspects of the study that may impact the research design or findings of the study (Gay et al., 2012). There were various limitations of this study. I organized these limitations into the following subsections.

Data Collection

The data collection process was limited to a 3-week period time. Due to the timing of the end of the academic school year and receiving the final approval to conduct research from Walden University, the collection process could only occur in a 3-week window. I collected data until teachers' last contract day with the district. Although there were teachers who participate in summer school, the available population would have reduced significantly because only specific schools were approved as research sites.

Research Sites

The selected study district was a large, urban school district with over 40 high schools that were a part of the one-to-one technology initiative. Research sites were limited in availability due to another district initiative to improve school performance. I approached 29 high school to participate in this study; however, only 14 schools responded to the request and 13 of those principals actually approved for their schools to be research sites for the study.

Survey Completion

Survey completion was limited due to the minimal time period for data collection. I used two surveys in this study, and each had a significant difference in the completion rate. Over 500 teachers were invited to participate in the study, and 135 teachers responded; however, 117 teachers completed the first survey (i.e., the TPACK Meaningful Learning Survey) and only 52 teachers completed the second survey (i.e., TPACK, LDP, and DD Survey).

Violations of Normality

I found violations of normality in some parts of the data. For Research Questions 1 and 2, there were violations of TPACK constructs in regard to teachers' content area and their one-to-one technology. Transformations methods were applied due to the negative skewness of the scores. Although the transformation corrected normality for some of the scores, there were still areas of the data where Sharpiro-Wilk's test alpha values were significant. However, I did not use the transformations in the multivariate test with the understanding there may be a reduction in power. For Research Questions 3 and 4, TPACK and LDPs were normally distributed, but the normality for DD was found to be significant. Transformation methods were not applied, and I made a decision to use the data as is with the understanding there may be a reduction in power.

Recommendations

Empirical research has consistently found deficits in teachers' pedagogical practices in one-to-one technology environments with minute authentic technology integration and infrequent transformative pedagogical approaches (Blackley & Walker, 2015; Lindsay, 2016; Sauers & McLeod, 2017; Swallow, 2015). Additionally, in this study I found that teachers' perceived TK and perceived TPACK were relatively lower than other constructs of TPACK, and there were no significant differences in teacher's one-to-one technology implementation years. Since various TPACK research studies have been conducted focusing on preservice teachers versus in-service teachers, further TPACK research is needed on in-service teachers in one-to-one technology environments.

In addition, there was minimal research on teacher design practices in technology-rich environments, like one-to-one technology initiatives. Many of the existing studies about teachers' lesson designs for technology-rich environments are small-scale qualitative studies in which there are limited numbers of teacher participants (Cober et al., 2015; Kirshner, 2015). There is also little understood about how teachers transform components of TPACK and their CK into technology-integrated lesson designs (Koh, Chai, Benjamin, et al., 2015). In this study, I found a positive relationship between teachers' LDPs and their TPACK. Therefore, further research is needed to support the instructional process in understanding teacher LDPs in one-to-one technology initiatives.

Implications of Social Change

Teachers' facilitation of instruction is a monumental component in 21st century teaching, and the adoption of one-to-one technology initiatives have become more ubiquitous to support these efforts. Therefore, examining teachers' level of knowledge of technology integration in an established one-to-one technology initiative may inform change leaders and adminstrative actions on ways to support teacher design and the implementation of instruction. It is essential to understand the position of teachers in the midst of organizational change because it can affect the quality and extent of the implementation of technology (Devoogd et al., 2015). A deeper understanding of teacher experiences in the implementation of technology has the potential to bring awareness to the planning and development of teachers and provide feedback on how the change process is unfolding. It may also support the direction of reconfiguring professional learning opportunities for teachers.

Conclusion

The instructional process is an essential factor in the role of effective technology integration in the implementation of one-to-one technology initiatives. In this study, I investigated teachers' knowledge of technology integration through an examination of teachers' perceived TPACK, LDPs, and DD. The results of this study revealed there were no significant differences in teachers' constructs of TPACK based on their years experienced in a one-to-one technology initiative, suggesting a slow process in the transformation of teachers' pedagogical practice in one-to-one, technology-rich environments. The findings also revealed that although teachers have strong perceptions of CK and PK, their perceptions of their ability to integrate content and pedagogy was lower. Therefore, the addition of TK adds an extra barrier in the development of their TPACK. Additionally, the positive correlation found between teachers' TPACK, their LDPs, and their DD suggests a need to develop teachers' LDPs and DD because they influence their TPACK. Further research is needed in understanding in-service teachers' constructs of TPACK and LDPs in one-to-one technology environments that can support the facilitation and growth of a school district's one-to-one technology initiative.

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Appendix A: Permission to Use TPACK, LDP, and DD Survey Instrument

1/29/2019 Re: Permission to Use Survey for Doctoral Research

Reply all | Delete Junk | •••

Re: Permission to Use Survey for Doctoral Research

JM Jocelyn Mcdonald
Mon 7/17/2017, 8:27 AM
[redacted]

Reply all |

Sent Items

Dr. [redacted]

Thank you so much for your quick response. I am very grateful an will be sure to use the citation below.

Kind regards,

Jocelyn McDonald, M.Ed.
Educational Technology Ph.D. Student
[redacted]

[redacted]
Sent: Thursday, July 13, 2017 8:50 PM
To: Jocelyn Mcdonald
Cc: [redacted]
Subject: RE: Permission to Use Survey for Doctoral Research

Dear Jocelyn,
Thank you for the interest in our work. You can have permission to use the survey. When administering the survey, please cite as:
Koh, J. H. L., Chai, C. S., Hong, H. Y., & Tsai, C. C. (2015). A survey to examine teachers' perceptions of design dispositions, lesson design practices, and their relationships with technological pedagogical content knowledge (TPACK). *Asia-Pacific Journal of Teacher Education*, *43*(5), 378-391.
All the best for your dissertation.

Best regards,
[redacted]

From: Jocelyn Mcdonald [redacted]
Sent: Friday, July 14, 2017 12:34 AM
To: K[redacted]
Subject: Permission to Use Survey for Doctoral Research

Greetings [redacted]

https://outlook.office.com/owa/projection.aspx 1/2

Reply all | Delete Junk | ...

permission to use the survey you validated from your article titled *A survey to examine teachers' perceptions of design dispositions, lesson design practices, and their relationships with technological pedagogical content knowledge (TPACK)*, as an instrument for my research.

Using this survey will be an added value to my research. Please let me know if there are any specific procedures I need to follow to be granted permission. I look forward to hearing from you soon and thank you in advance for your time.

[redacted]

Appendix B: Permission to Use TPACK Meaningful Learning Survey Instrument

2/25/2019 [redacted]

RE: Permission to Use Sruvey for Doctoral Research

[redacted]

Mon 2/25/2019 3:24 PM

To:Jocelyn Mcdonald <[redacted]

Dear Jocelyn,

Yes, please go ahead and use the survey for Koh and Chai (2014) with the listed citation. All the best for your study.

Regards,

[redacted]

From: Jocelyn Mcdonald [redacted]
Sent: Tuesday, 26 February 2019 3:45 AM
To: [redacted]
Subject: Permission to Use Sruvey for Doctoral Research

Greetings [redacted]

I am a doctoral student at Walden University, in the United States, currently in the process of submitting my dissertation proposal to conduct research in relation to TPACK and Lesson Design in schools with One-to-One Technology Initiatives. You previously gave me permission to use the survey you validated from your article titled *A survey to examine teachers' perceptions of design dispositions, lesson design practices, and their relationships with technological pedagogical content knowledge (TPACK)*, as an instrument for my research.

In addition to collecting data using the survey instrument above, I am also seeking permission to use the adapted Meaningful Learning Survey used in

Koh, J. H. L., & Chai, C. S. (2014). Teacher clusters and their perceptions of technological pedagogical content knowledge (TPACK) development through ICT lesson design. Computers and Education. https://doi.org/10.1016/j.compedu.2013.08.017

Using this survey will be an added value to my research. Please let me know if there are any specific procedures I need to follow to be granted permission. I look forward to hearing from you soon and thank you in advance for your time.

Kind regards,

Jocelyn McDonald, M.Ed.
Educational Technology Ph.D. Student
Walden University (USA)
[redacted]

Appendix C: Consent Form

CONSENT FORM

You are invited to take part in a web-based online research study about technology integration and lesson design. The researcher is inviting core, academic teachers who teach math, science, social studies, or English language arts courses a[redacted]o be in the study. With the permission of your campus principal, your name/contact information was obtained from your campus. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by a researcher named Jocelyn McDonald, who is a doctoral student at Walden University. [redacted] but this study is separate from that role.

Background Information:
The purpose of this study is to learn about high school teacher's knowledge and use of technology, academic content, and pedagogy in instruction and lesson design practices in a school district that provides laptop computers to students and teachers.

Procedures:
If you agree to be in this study, you will be asked to complete an online survey that will take approximately 30 minutes

Voluntary Nature of the Study:
This study is voluntary. You are free to accept or turn down the invitation. No one [redacted] your campus will treat you differently if you decide not to be in the study. If you decide to be in the study now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Being in the Study:
There are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life such as fatigue, stress, or becoming upset. Being in this study would not pose risk to your safety or wellbeing.

You will receive no direct benefits from participating in this research study. However, your responses may help me learn more about teacher's needs, experiences and issues that are encountered in the process of implementation of one-to-one technology in schools.

Payment:
There is no compensation for participating in this study.

Confidentiality and Privacy:
Reports coming out of this study will not share the identities of individual participants. Details that might identify participants, such as the location of the study, also will not be shared.

Survey Monkey does not collect identifying information such as your name, email address, or IP address. Therefore, your responses will remain anonymous. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study. Data will be kept for a period of at least 5 years, as required by Walden University.

As the researcher, I will not use your personal information for any purpose outside of this research project. As the researcher, I will know that you have agreed to participate in the study. However, your responses will still remain anonymous to me as Survey Monkey supports anonymous reponses.

Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact me, researcher, via phone at [redacted]r email [redacted]f you want to talk privately about your rights as a participant, you can call the Research Participant Advocate at Walden university at [redacted] Walden University's approval number for this study is **05-09-19-0538835** and it expires on **May 8, 2020.**

Please print or save this consent form for your records.

Obtaining Your Consent
If you feel you understand the study well enough to make a decision about it, please indicate your consent by selecting your choice below.

ELECTRONIC CONSENT: Please select your choice below. You may print a copy of this consent form for your records. Agreeing to participate in this study indicates:

- You have read the above information
- You voluntarily agree to participate
- You are 18 years of age or older

☐ Agree (*Please sign or initial the box to indicate your consent.)*

☐ Disagree *(Select disagree is do not want to participate in the study)*

This has been approved by the Institutional Review Board of WALDEN UNIVERSITY as acceptable documentation of the informed consent process and is valid for one year after the stamped date.

2019.05.0
9 15:32:29
-05'00'

Appendix D: Request for Principal Permission Letter

April 5, 2019

Jocelyn McDonald
Doctoral Candidate, Walden University
[redacted]

Attn: [redacted] Principals

Permission to Conduct Doctoral Research Project at [redacted] Schools

Greetings Principal [redacted]

My name is Jocelyn McDonald, and I am an educational technology doctoral candidate at Walden University. I am kindly requesting your school's participation in a doctoral research study that I am conducting titled: **Examination of Teachers' Perceived Technological Pedagogical Content Knowledge (TPACK) in a One-to-One Technology District Initiative and its' Relationship to Lesson Design Practices and Design Disposition**.

The District office has granted me permission to conduct research in the district and approval to approach schools for my research. I invite you to consider your school in taking part in this doctoral research. This study will meet the requirements of the Research Committee and Walden University.

In this regard, I am conducting surveys for data collection among core, high school teachers. The intention of this study is to learn about high school teacher's knowledge, use of technology integration, academic content, and pedagogy in instruction and how it relates to teacher's lesson design practices.

Therefore, may I request you to kindly grant permission to allow me to invite teachers to participate and conduct surveys among the teachers of your campus to collect the necessary data needed for my doctoral research. This study is voluntary, and information provided by your teachers will be kept confidential and used for academic purpose only.

Please contact me if you have any questions or concerns.

Thank you and with warm regards,

Jocelyn McDonald
Doctoral Candidate, Walden University
[redacted]