PRE-SERVICE TEACHERS' PERCEPTIONS OF THEIR ABILITIES FOR TECHNOLOGY INTEGRATION: A MIXED METHODS CASE STUDY

by

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A dissertation

submitted in partial fulfillment

of the requirements for the degree of

Doctor of Education in Educational Technology

Boise State University

May 2017

BOISE STATE UNIVERSITY GRADUATE COLLEGE

DEFENSE COMMITTEE AND FINAL READING APPROVALS

of the dissertation submitted by

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Dissertation Title: Pre-Service Teachers' Perceptions of their Abilities for Technology Integration: A Mixed Methods Case Study

Date of Final Oral Examination: 13 March 2017

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DEDICATION

To Missy, Ethan, and Callie,

because I could not have completed the journey

without your support.

I love you all.

ACKNOWLEDGEMENTS

First of all, I want to express my gratitude to the pre-service teachers I am privileged to serve at Dordt College, and particularly the ones who willingly agreed to participate in this study. I literally could not have completed this project without you!

This work could not have been accomplished without the help and support of my committee, Dr. Jesús Trespalacios, Dr. Patrick Lowenthal, and Dr. Norm Friesen. I am indebted to all of you gentlemen for helping to shape me as an academic and as a writer. Thank you, Jesús, for your willingness to serve as my program advisor and dissertation chair. Your mentorship and guidance throughout the process of developing this dissertation have helped me clarify my own thinking. You have helped to give me confidence in my own abilities as a researcher and an academic, and your support has meant so much to me. Thank you, Patrick, for always pushing me to take the next step, for your encouragement to write throughout my doctoral work, and for the opportunity to write with you. Thank you, Norm, for your mentorship in developing my understanding the nature of qualitative research, and for serving as a model for the kind of writer I hope to continue to become. The combined wisdom and experience you three brought together as my committee have benefited me immensely, and you all have challenged and encouraged me throughout the past few years.

I am thankful to Dr. Ross Perkins, program coordinator for the Ed.D. in Educational Technology at Boise State University. About three weeks in to my doctoral study in the Fall semester of 2013, we had a one-on-one meeting, and I expressed my

feeling of inadequacy. Your simple statement of, “You can do this, Dave,” gave me encouragement at a critical moment. Thank you for your support, Ross.

Thanks to Dr. Gloria Stronks for keeping me after class one day in the summer of 2005 as a M.Ed. student. Your simple question of, “Have you ever thought about teaching at the college level? You should!” caused me to re-envision my vocational calling. This word of encouragement started me on this path, and I am grateful that you named what you saw in me then, and how God has blessed me on this path.

I am so grateful for my fantastic colleagues at Dordt College who have been a constant source of encouragement and accountability for me throughout my doctoral studies. Thanks for listening to me go on and on about the things I have been learning, thanks for challenging me to take it to our students, and thanks for helping to cover some of my courses in this last semester, so I can finish well. I am grateful to be part of this outstanding group of Christian educators.

I could not have run this race without the support of my family. Thank you, Dad and Mom, for your unwavering support. To my incredible kids, Ethan and Callie; you have put up with your dad being far too busy over the past few years, and I am grateful for your patience and understanding. I hope my dedication to doing excellent work can serve as an inspiration to you, so you will know that you too can achieve great things by applying your gifts. And to Missy, my best friend and the love of my life…how can I begin to express my gratitude to you? You have sacrificed more than anyone else, and have always picked up the slack, and have given me the encouragement I needed to persevere through my studies. I could not have done this without you, love.

The soundtrack for the writing of this dissertation was provided by Paper Route, Adam Young, Balmorhea, Color Therapy, Modest Mussorgsky, Rend Collective, Josh Garrels, MuteMath, The Accidentals, and Bethel Music. I highly recommend them for your listening pleasure.

Finally, thanks be to God for the gifts He has given me, and for the opportunities to use them! It is in moments like these that Philippians 4:13 comes to mind: “I can do all this through him who gives me strength.” Soli Deo Gloria.

ABSTRACT

This case study was developed to understand pre-service teachers' perceptions of their abilities to integrate technology into the classroom, and to understand their perceptions of how those abilities developed. The case that was investigated in this study is the teacher preparation program at a small comprehensive college located in the upper Great Plains region of the United States. Utilizing a convergent parallel mixed-methods design, both a survey as well as semi-structured interviews provided data to understand pre-service teachers' perceptions of their preparation for technology integration. The TPACK framework for technology integration (Mishra & Koehler, 2006) and self-efficacy theory (Bandura, 1986, 1997) were used as a theoretical framework for understanding pre-service teachers' self-efficacy for technology integration.

The results of this study indicate that pre-service teachers generally feel confidence with regard to their abilities to integrate technology, but also feel a sense of pressure to be able to teach with technology. The results further suggest that there are a variety of things teacher educators can do to support pre-service teachers in their learning to integrate technology, including modeling technology integration, providing both formal and informal learning opportunities to develop technological knowledge and skills, and helping pre-service teachers understand the link between technological knowledge, pedagogical knowledge, and content knowledge. Additionally, the pre-service teachers participating in this study indicated that they believe a practical course in technology integration would help to prepare them for teaching in contemporary classrooms. Based on the findings of this research, a plan of action is suggested for teacher educators interested in fostering pre-service teachers' abilities to integrate technology in the classroom.

Descriptors: Pre-service teachers, teacher preparation, technology integration, TPACK, self-efficacy.

TABLE OF CONTENTS

DEDICATION iv

ACKNOWLEDGEMENTS v

ABSTRACT viii

LIST OF TABLES xv

LIST OF FIGURES xvii

LIST OF ABBREVIATIONS xviii

CHAPTER 1: INTRODUCTION 1

Research Context 2

Statement of the Problem 3

Purpose of the Study 5

Theoretical Framework 6

The TPACK Framework 7

Technology Self-Efficacy 9

Research Questions 10

Overview of Methods 11

Significance of the Study 12

Definition of Terms 13

Chapter Summary 15

CHAPTER 2: REVIEW OF THE LITERATURE 17

Understanding the Challenges of Technology Integration 19
The Teacher Prepaation Program: Fostering Technology Integration...................23
Teaching Technology Integration 24
The Stand-Alone Technology Course and Alternatives 25
Frameworks for Technology Integration 27
The RAT Model 28
The SAMR Model..29
Technology Integration Matrix 31
The TPACK Framework..32
Examining the TPACK Framework...35
The Development of the TPACK Framework 37
The Structure of the TPACK Framework 38
Debate about the Nature of the TPACK Framework 40
Perspectives on the Role of TPACK as a Framework for Learning to Integrate Technology 43
Summing Up the Role of the TPACK Framework 47
Self-Efficacy and Technology Integration 48
Teacher Beliefs and Technology Integration 48
Bandura's Self-Efficacy Theory and the Development of Self-Efficacy ..50
Technology Self-Eficacy and Technology Integration 54
Linking TPACK and Technology Self-Efficacy...56
Positioning the Study within Self-Efficacy for Technology Integration 60
Chapter Summary 63
CHAPTER 3: METHODS 64

Case Study Research and the Approach of the Researcher 65
Yin's approach 66
Stake's approach 66
Placing Myself in the Research...66
Design of the Study...68
Type of Case Study 68
The Value of Mixed Methods in Case Study Research 69
Selection of Participants 70
Instrumentation 74
Description of Survey 74
Description of Semi-Structured Interviews 75
Data Collection 76
Program Document Review 77
Survey 78
Interviews..79
Data Analysis 80
Quantitative Analysis...81
Qualitative Analysis...81
Creating a Trustworthy Account of the Research.......................................83
Member Checking...84
Triangulation...85
Thick Description...85
Chapter Summary 87

CHAPTER 4: RESULTS 88

Research Context 88

Results of Program Review 95

Description of Participants 98

Survey Participants 99

Interview Participants 103

Data Analysis Procedures 106

Survey Analysis 106

Qualitative Analysis 111

Presentation of Findings 116

Finding 1: Pre-service teachers generally feel confident in their abilities to teach with technology, regardless of their gender, year in college, or major/endorsement area. 117

Finding 2: Pre-service teachers feel a sense of pressure or expectation to be able to integrate technology into their teaching practices. 125

Finding 3: Modeling effective technology integration is an important part of pre-service teachers developing the self-efficacy to integrate technology into their own teaching practices. 131

Finding 4: Both formal and informal learning opportunities positively impact pre-service teachers' confidence for working with technology. 138

Finding 5: Technological knowledge is an important component for self-efficacy in technology integration, but pedagogical knowledge and content knowledge are also necessary. 145

Finding 6: Pre-service teachers believe that a practical course in educational technology would help to prepare them to integrate technology in the classroom. 152

Chapter Summary 157

CHAPTER 5: DISCUSSION AND CONCLUSIONS 159

Reviewing the Findings 160

Research Question 1: Perceptions of Abilities for Technology Integration 160

Research Question 2: Origins of Abilities for Technology Integration ...162

A Final Piece to the Puzzle: Desire for a Technology Course 167

Implications for Practice 168

Promote Self-Efficacy 169

Utilize the TPACK Framework for Structuring Learning Experiences ...170

Model Technology Integration 172

A Plan of Action 174

Limitations of this Study 178

Recommendations for Further Research 180

Conclusion 181

REFERENCES 183

APPENDIX A 201

APPENDIX B 211

APPENDIX C 213

LIST OF TABLES

Table 1 Technology Integration Matrix 33

Table 2 Research questions and methods of data collection and analysis 71

Table 3 Pre-service teachers invited to participate in the survey 72

Table 4 Subscales of survey, including reliability statistics 75

Table 5 Data collection methods and timeline 77

Table 6 Pre-service teachers who completed the survey 99

Table 7 Semi-structured interview participants 104

Table 8 Survey participants by gender 107

Table 9 Survey participants by year in the Teacher Preparation Program 107

Table 10 Survey participants by major or endorsement area 108

Table 11 Survey participants' comfort working with various technologies 109

Table 12 Reliability statistics for survey subscales 110

Table 13 Descriptive statistics for survey subscales 110

Table 14 Correlations between demographic items and subscales 112

Table 15 Code categories and frequencies 115

Table 16 Descriptive statistics for Gender comparison 121

Table 17 MANOVA results for Gender 122

Table 18 Descriptive statistics for Class comparison 123

Table 19 MANOVA results for Class 123

Table 20 Descriptive statistics for Major/Endorsement comparison 124
Table 21 MANOVA results for Major or Endorsement 125
Table 22 Mean scores for TK subscale by class grouping 147
Table 23 Comparison of subscale mean scores 148
Table 24 Examples of Differentiated Technology Integration Courses 175

LIST OF FIGURES

Figure 1 The TPACK framework illustrated 36

Figure 2 Approach for mixing methods in this case study 70

LIST OF ABBREVIATIONS

CK	Content Knowledge
PDS	Professional Development School
PCK	Pedagogical Content Knowledge
PK	Pedagogical Content Knowledge
SE-TI	Self-Efficacy for Technology Integration
TCK	Technological Content Knowledge
TK	Technological Knowledge
TPK	Technological Pedagogical Knowledge
TPACK	Technological Pedagogical Content Knowledge
TPP	Teacher Preparation Program

CHAPTER 1: INTRODUCTION

There are new challenges facing teachers today. One of these challenges is the steady increase of technology (e.g., computers, Internet) in schools over the past decade. The increasing amount of technologies present creates an additional burden for today's teachers because there are concerns about how they will be used: What are the best ways to incorporate educational technologies that will positively impact student learning?

The presence of educational technologies has become the norm for today's classrooms (Brown & Green, 2013; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Gray, Thomas, & Lewis, 2010; Picciano, Seaman, & Allen, 2010). In fact, digital tools such as computers, tablets, digital projection systems, digital cameras, and the Internet are now considered "basic infrastructure" in K-12 schools (Ruggiero & Mong, 2015). Many schools are using or considering 1:1 technology programs to make student access to information and communications technologies (ICTs) readily available (Brown & Green, 2013; Hew & Brush, 2007). With this extensive and increased access to ICTs in schools, a cultural expectation has developed that technology-enhanced teaching will improve learning outcomes for students (Barreto & Orey, 2014; Hew & Brush, 2007; Koc & Bakir, 2010; Laferrière, Hamel, & Searson, 2013). Technology integration has therefore become basic job requirement for teachers in contemporary society (Lawless & Pellegrino, 2007; Ruggiero & Mong, 2015; Teo, 2011). Teachers are expected to be able to effectively integrate technology into the classroom from their first days in the profession.

Research Context

The setting for this research is the Teacher Preparation Program at Dordt College, a private, comprehensive college located in the upper Midwestern United States. Dordt College enrolls approximately 1400 undergraduate students, and Education is the most popular major on campus with over 250 students studying in the Teacher Preparation Program. The program has multiple options, including 1) Elementary Classroom (all subjects), 2) Elementary Subject Area Specialist (art, music, physical education, Spanish, or special education), 3) Secondary Subject Area Specialist (with 20 different subject options), and 4) K-12 Subject Area Specialist (art, music, physical education, Spanish, or special education). Additionally, Education majors can choose to add other endorsements to these four major options, including options such as early childhood, middle school, English as a second language, many different subject area minors, and athletic coaching. While these different choices provide a range of pathways through the program, all Education majors take the same ten core courses, which is comprised of educational foundations, learning theory, diversity in education, general methods, educational psychology, and philosophy of education, among others. Notably absent in the curriculum, however, is a course in educational technology.

When the curriculum of the program was revised six years ago, the faculty determined that the Education major required too many credits. The faculty thus reduced the total number of credits that students needed to take by eliminating some courses. One of the courses eliminated through this process was “Media and Technology in Education,” a course formerly required for all education majors. There were two reasons the department targeted this course for removal. First, the faculty deemed learning technology skills in isolation of their pedagogical context ineffective, an idea which has been borne out in the literature (see Kovalik, Kuo, & Karpinsky, 2013; Lambert & Gong, 2010). Second, different teachers need different kinds of technology knowledge and experiences (e.g., an early childhood educator would use very different technology tools than a high school history teacher.) Thus, the expectation was advanced that technology integration would be modeled and developed in all methods courses instead, to demonstrate the connection between technology and pedagogy more clearly, and contextualized within different content areas.

Unfortunately, over the years, this goal of modeling and development of technology integration skills in the methods courses has been inconsistent. One reason for this inconsistency is that different faculty members place varying degrees of importance on this aspect of teaching and learning in methods courses. Further, program assessment data also indicates that graduating seniors and recent graduates (with 1, 3, and 5 years of experience) rate their learning about educational technology relatively lower than other aspects of the program. Graduates specifically commented on their lack of preparation for teaching with technology. With the present cultural expectations of a high-technology classroom and technologically savvy novice teachers (see Davies & West, 2014; Ruggerio & Mong, 2015; Teo, 2011), this situation must be addressed.

Statement of the Problem

The challenges of integrating technology into the classroom may be more pronounced for young teachers entering the profession (Kovalik, Kuo, & Karpinski, 2013; Pierson & Cozart, 2005), because more experienced colleagues and administrators might have unrealistic expectations regarding young teachers' comfort and expertise in using technology (Gilakjani, 2013). Most pre-service teachers today are comfortable using technology in their personal lives, for communication, social networking, or entertainment (Bennett & Maton, 2010; Fluck & Dowden, 2013). They have not, however, had the experience of planning for and using educational technologies for teaching, or perhaps have never imagined how they might use technologies in the classroom (Kovalik et al., 2013). In fact, research indicates pre-service teachers are no better at integrating technology into their teaching than their more experienced colleagues (Ertmer et al., 2012; Pegler, Kollewyn, & Crichton, 2010).

Meaningful technology integration must go beyond simply using a computer. Thus, today's pre-service teachers must develop not only content knowledge and pedagogical skill, but also abilities to wisely integrate technology with these other key domains of teaching expertise. The Technological, Pedagogical, and Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) is one popular framework to help pre-service teachers learn about technology integration (Abbitt, 2011; Harris et al., 2010; Mouza & Karchmer-Klein, 2013; Pamuk, 2012). However, questions remain about pre-service teachers' self-confidence for this kind of technology integration, because of their still-developing pedagogical knowledge (Bate, 2010; Koehler, Mishra, & Yahya, 2007; Pierson & Cozart, 2005). Pre-service teachers have the combined challenge of learning about educational technologies, learning about pedagogy, and learning the content knowledge. These different knowledge domains are all essential for effective technology integration (Graham, Borup, & Smith, 2012; Herring & Smaldino, 2015; Polly, 2014). At the same time, teachers' beliefs, and specifically their self-efficacy for teaching with technology, have a substantial impact on their decisions of whether or not to use an educational technology (Ertmer, 2005; Gilakjani, 2013; Southall, 2013).

Purpose of the Study

Teacher educators play an essential role in fostering pre-service teachers' abilities to integrate technology and pedagogy (Ertmer & Ottenbreit-Leftwich, 2010; Southall, 2013). Many teacher preparation programs rely on a stand-alone technology course to demonstrate how to integrate technologies (Kay, 2006; Ottenbreit-Leftwich, Glazewski, & Newby, 2010). Too often though, these stand-alone technology integration courses often emphasize how to use the technologies, without making a connection to pedagogy or content areas (Wang & Chen, 2007). Research indicates that simply teaching how to use an educational technology without also emphasizing how to teach with it (i.e., the pedagogies involved) does not result in the meaningful integration of technology (Lawless & Pellegrino, 2007; Lambert & Gong, 2010; Mishra & Koehler, 2006).

Compounding the problem of helping pre-service teachers develop the skills and attitudes needed for technology integration is the fact that technologies for teaching and learning are ever-evolving (Barreto & Orey, 2014; Ertmer & Ottenbreit-Leftwich, 2010). Additionally, different schools and districts have different technologies available for teachers and students use. Because of these realities, it is impossible to prepare pre-service teachers fully for every technology they might encounter. Instead, as Ertmer (2005) advocated, programs must foster a sense of self-efficacy for technology integration in pre-service teachers. Modeling and the associated vicarious learning can be powerful influences on self-efficacy, as can opportunities for practicing using various educational technologies (Ertmer & Ottenbreit-Leftwich, 2010; Mishra & Koehler, 2006;

Southall, 2013). Research suggests that providing such opportunities for pre-service teachers as part of their teacher preparation program may be essential for developing their skills and attitudes for technology integration (Kay, 2006; Mishra & Koehler, 2006; Teo, 2011). To best prepare pre-service teachers for the demands of teaching with technology, teacher educators should definitely have a grasp of their students' abilities to use educational technologies, but this may not be enough. Knowledge of their self-efficacy for teaching with technology is also valuable, as this may be an important predictor of their abilities to effectively integrate technology (Abbitt, 2011; Ertmer & Ottenbreit-Leftwich, 2010).

Thus, the purpose of this study was to understand how pre-service teachers perceive the development of the knowledge, skills, and self-efficacy necessary for technology integration. The emphasis in this study was exploring how pre-service teachers express their technology self-efficacy. This case study is an investigation of the experiences of pre-service teachers studying the Teacher Preparation Program at Dordt College. In particular, this study seeks to understand to the opportunities pre-service teachers have to learn about technology integration, with the intention of strengthening the training and support for the challenging task of effectively integrating technology and pedagogy.

Theoretical Framework

The demands of effective technology integration are challenging for pre-service teachers (Gill, Delgarno, & Carlson, 2015; Kovalik et al., 2013; Sadaf, Newby, & Ertmer, 2016). In order to effectively integrate ICTs for teaching and learning, pre-service teachers must develop a variety of different knowledge bases, including content knowledge, pedagogical knowledge, and technological knowledge. Pre-service teachers need to develop an understanding of how these different knowledge areas interact for effective technology integration to occur (Gill et al., 2015; Mishra & Koehler, 2006). This is further complicated by the fact that new technologies are constantly being developed or adapted for use in schools (Spector, 2016). Because of this, pre-service teachers must be lifelong learners, who are able to discover new technologies, explore the capabilities of these technologies, and evaluate their potential for teaching and learning (Ertmer & Ottenbreit-Leftwich, 2010; Fluck & Dowden, 2013). Self-efficacy theory can help explain how pre-service teachers think of their abilities to learn about new technologies and teach with technology. Self-efficacy is a strong predictor for whether or not teachers will use technology in their teaching (Perkmen & Pamuk, 2011; Southall, 2013; Teo, 2009). Self-efficacy is a key part of self-directed learning (Zimmerman, 1995), which is essential for lifelong learning.

The TPACK Framework

In order to understand how pre-service teachers develop the self-efficacy needed for effective technology integration, a framework for understanding technology integration is needed. In this study, I used the TPACK framework for technology integration as a theoretical framework to investigate how pre-service teachers develop the knowledge and skills needed to integrate technology into their teaching practices. TPACK is an acronym for Technological, Pedagogical, and Content Knowledge, three knowledge domains teachers must exhibit for effective technology integration to take place (Koehler & Mishra, 2009; Mishra & Koehler, 2006; Voogt, Fisser, Roblin, Tondeur, & van Braak, 2013). Mishra and Koehler (2006) developed the TPACK framework as a means of describing the complex interrelationships between the technological knowledge, pedagogical knowledge, and content knowledge domains in effective technology integration. This framework draws on earlier work by Shulman (1986, 1987) about teacher knowledge domains, and incorporates technological knowledge into his Pedagogical Content Knowledge model (Koehler & Mishra, 2005; Mishra & Koehler, 2006).

The TPACK framework is comprised of three knowledge domains teachers need in order to effectively integrate technology into the classroom. First, technological knowledge is the domain of teacher knowledge comprised of understanding how to use various technologies. Second, pedagogical knowledge is the domain comprised of knowledge of teaching methods. Third, content knowledge includes knowledge of the subjects to be taught. The TPACK framework illuminates how these three teacher knowledge domains interact and overlap in effective technology integration (Koehler & Mishra, 2009, Mouza & Karchmer-Klein, 2013). Effective technology integration requires knowledge of how to use technologies, how to teach with them, and how to contextualize their use for learning particular content (Cox & Graham, 2009; Mishra & Koehler, 2006; Schmidt et al., 2009).

The TPACK framework was originally developed for teacher educators to support teachers in the development of the knowledge domains necessary for learning to integrate technology (Mishra & Koehler, 2006). Additionally, much of the ongoing research with regard to the development and application of TPACK in practice is taking place in the context of pre-service teacher education (Herring, Koehler, & Mishra, 2016; Herring & Smaldino, 2015; Voogt et al., 2013). As this study is being conducted in a teacher preparation program, this makes the TPACK framework a useful tool for describing and understanding how the different knowledge domains develop in pre-service teachers (Herring & Smaldino, 2015).

The TPACK framework is used widely in teacher preparation today for a variety of purposes (Voogt et al., 2013). Some researchers use TPACK to describe how technology integration develops (Baran, Chuang, & Thompson, 2011; Koehler, Mishra, & Yahya, 2007; Pamuk, 2012). Others use TPACK as a way of organizing learning opportunities to foster technology integration (Koh & Divaharan, 2011; Mishra & Koehler, 2006; Mouza & Karchmer-Klein, 2013). Still others use the TPACK framework to examine and explain teachers' beliefs and decision-making about technology (Abbitt, 2011; Cox & Graham, 2009; Graham et al., 2012). In this study, the TPACK framework will be used as a theoretical framework to describe the knowledge and skills needed for technology integration. Specifically, the TPACK framework will be used to elaborate the technological knowledge held by pre-service teachers, and how it connects with their growing pedagogical knowledge within the context of the content areas they intend to teach, and thus how their skills for technology integration develop.

Technology Self-Efficacy

Pre-service teachers develop knowledge and skills for technology integration in light of their technology self-efficacy (Fluck & Dowden, 2013; Wang, Ertmer, & Newby, 2004). Bandura (1986, 1997) explored the role of self-efficacy as a characteristic of Social Cognitive Theory. Bandura (1997) defined self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). Self-efficacy plays a vital role in many different aspects of a teacher's work (Klassen, Durksen, & Tze, 2014). With regard to technology integration, self-efficacy theory suggests that if teachers believe they are capable of using a particular technology for teaching and learning, they will be able to do so. Ertmer and her colleagues, in particular, have focused their attention on the importance of self-efficacy for pre-service teachers learning to integrate educational technologies into their teaching practices (Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Sadaf, Newby, & Ertmer, 2016).

Technology is always changing. Therefore, developing Technological Knowledge may prove to be difficult for teachers. However, Ertmer and Ottenbreit-Leftwich (2010) suggested that developing self-efficacy could foster the attitudes needed for effective technology integration. Research suggests that teachers with higher self-efficacy view themselves as capable learners (Klassen, Durksen, & Tze, 2014), and that individuals with greater technology self-efficacy are more likely to use technology (Compeau & Higgins, 1995). Thus, self-efficacy theory was a key aspect in my theoretical framework for explaining pre-service teachers' beliefs about technology integration. Understanding pre-service teachers' technology self-efficacy will provide insight into the ways they approach learning to integrate technology (Abbitt, 2011; Sadaf et al., 2016; Southall, 2013).

Research Questions

The following questions guided this study:

RQ1: What are pre-service teachers' perceptions of their ability to integrate technology into the classroom?

RQ2: To what do pre-service teachers attribute their ability to integrate technology into the classroom?

Overview of Methods

This research study utilized a case study approach to describe pre-service teachers' self-efficacy for technology integration. This case study comprises a single embedded design (Yin, 2013), examining the Dordt College Teacher Preparation Program as the unit of analysis. Participants were invited to participate purposefully, to ensure that a selection of students at different points in the program (i.e., both first year students, as well as students preparing to student teach, as well as students in the middle of their program), students with different majors (e.g., elementary education, secondary education), and both male and female participants. By purposefully inviting participants in this way, I was able to include a representative sample, as suggested by Creswell (2013).

Using a convergent parallel mixed-methods design (Creswell, 2012; Guest, 2013), multiple methods of data collection were utilized to answer the research questions, including surveys, semi-structured interviews, and document review. A survey instrument comprised of items measuring pre-service teachers' perceptions of their knowledge and skill of technology integration as well as their technology self-efficacy was used to collect data from a broad sample of students in the program. These data allowed me to discern general trends among the students in the program regarding their beliefs about teaching with technology. Semi-structured interviews with pre-service teachers provided a more nuanced look at how they experience learning to integrate technology in the teacher preparation program. Finally, reviewing documents, such as course syllabi and program assessment reports, provided corroborating sources of data. Course syllabi included explanations of how technology integration is modeled or explicitly taught by faculty members. Program assessment reports included results of an annual survey administered to all graduates of the teacher preparation program, and there are several items in this survey related to opportunities to learn about technology integration. All of these data were taken together to triangulate results from the findings and provide a “thick description” (Lincoln & Guba, 1985) of the current realities of preparing pre-service teachers for technology integration. A detailed explanation of the research methodology is described in Chapter Three.

Significance of the Study

The traditional stand-alone technology course previously offered in the Teacher Preparation Program at Dordt College was effective for familiarizing pre-service teachers with various media and technology. However, it was not successful for preparing students for integrating technology and pedagogy. On the other hand, the current approach is to model technology integration in methods courses. Unfortunately, this approach does not seem fully effective, based on departmental assessment data. This may be because faculty members have varying levels of comfort for using educational technologies in their own teaching practices, and thus there has not been enough technology learning to foster strong technology integration skills in students. Therefore, this study was intended to explore and describe the current state of fostering technology integration within the program. Using the TPACK framework and technology self-efficacy as a theoretical framework allowed me to identify and understand the opportunities pre-service teachers have to develop the knowledge, skills, and self-efficacy needed for technology integration.

Bishop and Spector (2014) have noted, "the challenges for effective technology integration in learning, instruction, and performance are quite significant and the research is somewhat limited" (p. 817). In this light, this study adds a specific case to the literature on preparing pre-service teachers for technology integration. Many teacher preparation programs include a technology integration course (Kay, 2006; Ottenbreit-Leftwich, Glazewski, & Newby; 2010); the program at Dordt College is unique in that it does not currently include such a course. Thus, the outcomes of this study describe pre-service teachers' experiences in learning to integrate technology into their teaching, how they acquired the necessary teacher knowledge domains (i.e., Technological Knowledge, Pedagogical Knowledge, and Content Knowledge), and how their self-efficacy for technology integration developed. This study is aimed at understanding how pre-service teachers learn to use educational technologies through their course work, and, more importantly, how they develop the ability to wisely integrate technology and pedagogy within their intended teaching context (i.e., specific content areas and grade levels.)

Definition of Terms

In this study, the following definitions for important terms will be used:

Content Knowledge is knowledge about the subject matter to be learned or taught (Mishra & Koehler, 2006).

Educational Technology is any tool used by an educator in the support of the processes of teaching and learning (Lever-Duffy & McDonald, 2011). In this study, the specific focus will be on digital tools, such as computers and the Internet.

Pedagogical Content Knowledge is a teacher knowledge domain combining knowledge of content and knowledge of the most effective pedagogies for teaching that content (Mishra & Koehler, 2006). Shulman (1986) described pedagogical content knowledge as, "the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that make it comprehensible to others" (p. 9).

Pedagogical Knowledge is a teacher knowledge domain comprised of "deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses, among other things, overall educational purposes, values, and aims" (Mishra & Koehler, 2006, p. 1026).

Self-Efficacy was defined by Bandura (1997) as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). Individuals with high levels of self-efficacy are able to put their knowledge and skills into action, believing that they will be successful.

Technological Content Knowledge is a teacher knowledge domain that encompasses "knowledge about the manner in which technology and content are reciprocally related" (Mishra & Koehler, 2006). That is, the application of technology can impact a student's understanding of the content, and also the *way* a student can come to understand the content may be directly shaped by the technologies.

Technological Pedagogical Knowledge is a teacher knowledge domain comprised of the knowledge of how different pedagogical approaches can impact (and are impacted by) the application and use of technologies for teaching and learning (Mishra & Koehler, 2006).

Technological Pedagogical Content Knowledge is a teacher knowledge domain that represents the intersection of technological knowledge, pedagogical knowledge, and content knowledge, and "represents a class of knowledge that is central to teachers' work with technology" (Mishra & Koehler, 2006, p. 1029).

Technological Knowledge is a teacher knowledge domain comprised of the knowledge and skills required to operate particular technologies (Mishra & Koehler, 2006). Technological knowledge includes knowledge of how to use both digital tools (e.g., computers) as well as non-digital tools (e.g., books) (Mishra & Koehler, 2006), but this study emphasizes the integration of digital tools.

Technology Integration is the process of determining the tools (and the methods for implementing them) to address pedagogical situations and problems (Roblyer & Doering, 2013).

Chapter Summary

This chapter introduced the problem of preparing pre-service teachers for technology integration generally, and specifically how this challenge takes shape for the Education Department at Dordt College. In subsequent chapters, the particular case of fostering technology integration knowledge, skills, and attitudes within the Teacher Preparation Program at Dordt College will unfold. In chapter 2, a review of the literature on promising practices for technology integration in pre-service teacher education will be elaborated. This literature review begins with an examination of the challenges of effective technology integration. Building upon this discussion, the TPACK framework is examined as a means of organizing the technology integration component of a teacher preparation program, followed by an articulation of self-efficacy theory, and its importance for pre-service teachers learning to integrate technology into their teaching practices. The literature review concludes with a description of the place of this case study within the literature regarding preparing pre-service teachers for technology integration, which leads into chapter 3, where the research context and methodology employed in the present study are elaborated. The results of the study are conveyed in chapter 4, and chapter 5 includes a discussion of the implications for this study for teacher educators, as well as limitations of this study and suggestions for further research.

CHAPTER 2: REVIEW OF THE LITERATURE

Teachers are responsible for a wide array of duties each day, and the planning, instruction, assessment, management, and communication tasks can be draining for teachers (Armstrong, Henson, & Savage, 2009). Potentially adding to the challenges are the new and different pressures placed on teachers due to the steady increase of digital technologies available in classrooms in recent years (Hew & Brush, 2007; Hsu & Kuan, 2013; Ruggerio & Mong, 2015). The presence of digital technology at all grade levels—elementary, middle school, and high school—is pervasive, and all teachers are expected to use technology in some ways in schools today, in both teaching and communicating (Ruggiero & Mong, 2015). Thus, technology integration has become a basic requirement for teachers today (Ruggerio & Mong, 2015; Teo, 2011).

A large number of educational technologies (e.g. computers, Internet) are often available in today's schools. The reauthorization of Elementary and Secondary Education Act of 2001 in the United States is one reason for this prevalence of digital technologies (Ertmer, 2005). This legislation increased the attention on technology integration by mandating its use across K-12 education (Davies & West, 2014). As a result, many classrooms today are equipped with digital tools for teaching and learning, such as computers, tablets, digital cameras, interactive whiteboards, and document cameras (Brown & Green, 2013; Davies & West, 2014; Gray, Thomas, & Lewis, 2010; Picciano, Seaman, & Allen, 2010; Roblyer & Doering, 2013). Internet access is now considered "basic infrastructure" in K-12 schools (Hsu & Kuan, 2013, p. 26). In order to make student access to educational technologies readily available, many schools are using or considering 1:1 technology programs or “bring-your-own-technology” programs (Brown & Green, 2013; Brown & Green, 2014, Project Tomorrow, 2013). A wide variety of software applications—some developed for school use, and others adapted from other settings—are also present (Brown & Green, 2014; Hsu & Kuan, 2013). Social media use is on the rise among many students in K-12 schools (Kidd & Carpenter, 2014), and online learning in K-12 schools continues to grow in popularity and prevalence (Gemin, Pape, Vashaw, & Watson, 2015; Picciano et al., 2010). The presence of these educational technologies—and expectations of their appropriate use for teaching and learning—adds a layer of complexity to an already demanding role that K-12 teachers play. The sum of these technological changes has added pressures to teacher preparation programs to ensure that the novice teachers stepping into today’s classrooms are adequately prepared to use a wide variety of educational technologies to benefit their teaching and, more importantly, their students’ learning.

This chapter explores the relevant literature related to preparing pre-service teachers for technology integration. After beginning with a description of the challenges of integrating technology and pedagogy, attention will shift to different approaches that teacher preparation programs use to support the development of the knowledge, skills, and attitudes necessary for effective technology integration. This description leads into an exploration of the TPACK framework (Mishra & Koehler, 2006), followed by an exploration of the role of self-efficacy for effective technology integration. This chapter concludes by locating this study within the relevant literature related to preparing pre-service teachers for technology integration.

Understanding the Challenges of Technology Integration

The rise of digital technologies and the expectation of their successful integration into the classroom provides many pre-service teachers a substantial challenge (Abbitt, 2011; Kivunja, 2013). Spector (2016) suggested that “successful integration of an educational technology is marked by that technology being regarded by users as an unobtrusive facilitator of learning, instruction, or performance” (p. 166). While successful integration might already be the norm for low-tech tools (e.g., non-digital classroom technologies such as pencils, notebooks, and overhead projectors), digital tools may provide teachers with more challenges because of their uncertainty or unfamiliarity with the tools (Barreto & Orey, 2014; Gilakjani, 2013). Ruggiero and Mong's (2015) study suggested that the "use of technology in the classroom makes learning easier and more engaging but must be tempered with using it wisely and efficiently to meet instructional goals" (p. 169). Often, teachers feel pressure to teach with educational technologies just because they are present (Gilakjani, 2013; Ruggiero & Mong, 2015), but this does not mean they are integrated well (Copriady, 2014; Hew & Brush, 2007). Preparing pre-service teachers for effective technology integration is an ambitious goal, as working with ICT tools in an instructional context can often provide challenges for veteran teachers, let alone novice teachers (Copriady, 2014; Lawless & Pellegrino, 2007; Pegler, Kollewyn, & Crichton, 2010; Richardson, Ertmer, Aagard, Ottenbreit, Yang, & Mack, 2008).

Davies and West (2014) noted that many educators take a narrow view of “technology,” thinking only of electronic devices, such as computers. They suggested that such educators also have a correspondingly narrow view of “technology integration,” as “having and using this equipment in the classroom” (Davies & West, 2014, p. 842). Roblyer and Doering (2013) proposed a much broader definition for technology integration; they considered “technology integration” to instead be the process of determining the tools, and methods for implementing these tools, to address pedagogical situations and problems. In this broad perspective, a wide variety of technologies—including both digital and analog tools—can be considered forms of educational technology.

It is not surprising when considering the integration of educational technologies that many educators first think of digital tools (Davies & West, 2014), but analog technologies continue to play a substantial role in contemporary schools as well. Mishra and Koehler (2006) noted, that both “standard technologies, such as books, chalk and blackboard,” as well as “more advanced technologies, such as the Internet and digital video”, require a level of knowledge and skill to be implemented well in classrooms (p. 1027). Low-tech tools such as pencil and paper might not seem like “technologies” to many teachers because they are so commonplace in classrooms. Little thought is given to their presence, because there is such a long history of their acceptance, but this may, in fact, be an appropriate example of highly effective technology integration. As Bishop and Spector (2014) have suggested,

> One indicator of successful technology integration is that the focus—in the classroom or with the learner—is no longer on the technology itself, but rather on the task at hand. For example, in today’s classroom, no one talks about a piece of chalk and how to use it to mark on a blackboard and teachers do not submit to special in-service workshops on the use of a book, how to turn pages, where to

> find the index, and the like. When educators and learners have stopped talking about how to point and click, how to search and find, how to drag and drop, how to cut and paste, and so on, then we know they have integrated those techniques into their routine suite of technology-oriented behaviors. (p. 817)

Integration of these low-tech educational technologies is not the focus of this study. However, this view of technology integration may help to illustrate the level of familiarity and comfort needed for teaching with a technology. With this depiction of technology integration in mind—one in which the use of the tool has become second nature to teachers and students—the integration of many digital technologies is still relatively cumbersome.

New technologies are constantly being developed or adapted for use in schools; there is always something new for teachers to learn when it comes to educational technology (Ertmer et al., 2012). Technology integration has been described as a “moving target” (Ruggiero & Mong, 2015). The ways teachers use technology for teaching and learning are always changing; new methods and tools are continually introduced, even as others quietly disappear from use. Learning how to *use* ICT tools may simply be the first step; *teaching* with ICT tools requires a different set of skills that develop over time (Hew & Brush, 2007; Koehler et al., 2007; Laferrière et al., 2013). Thus, learning to integrate technology and pedagogy might best be considered a process, and not an event (Ruggiero & Mong, 2015). The challenges of effective technology integration are indeed, as Bishop and Spector (2014) have wryly suggested, “quite significant” (p. 817) for professional educators.

Research indicates that novice teachers joining the ranks of practicing educators are no better at technology integration than their more experienced peers (Albion, 2011; Bate, 2010; Ertmer & Ottenbreit-Leftwich, 2010; Pegler et al., 2010; Yong, Gates, & Harrison, 2016). In fact, novice teachers may actually be worse than veterans at technology integration, due to their still-developing pedagogical knowledge (Gilakjani, 2013; Martin, 2011). Research conducted by Gilakjani (2013) indicated that teaching experience matters greatly for technology integration. Many novice teachers are expected to be naturally inclined to use technology, and might thus be expected to easily integrate technology into their teaching, but research does not bear this assumption out (Bate, 2010; Pierson & Cozart, 2005; Southall, 2013). Ertmer and Ottenbreit-Leftwich (2010) framed the concept in this way: “Although today’s students [i.e., pre-service teachers,] may be fairly knowledgeable about a variety of ICT tools, they have little to no knowledge about how to use these tools to facilitate student learning” (p. 269). According to Gilakjani (2013), the literature indicates that experienced teachers are better able to examine a technology and draw from their pedagogical knowledge to see how it might be useful. Novice teachers, on the other hand, have the challenge of not only learning to use a new tool, but also the challenges of becoming familiar with the demands of the curriculum and learning effective classroom management (Gilakjani, 2013). This suggests an important role for the teacher preparation program for supporting pre-service teachers in developing the knowledge, skills, and attitudes necessary for effective technology integration.

The Teacher Preparation Program: Fostering Technology Integration

While even veteran teachers may wrestle with technology integration, the challenges of integrating educational technologies into classroom practice may be more pronounced for novice teachers entering the profession (Janssen & Lazonder, 2016; Kovalik, Kuo, & Karpinski, 2013; Pierson & Cozart, 2005). More experienced colleagues and administrators may have unrealistic expectations regarding young teachers' comfort and expertise in using technology (Gilakjani, 2013). While many pre-service teachers today are comfortable using technology in their personal lives, for communication, social networking, or entertainment (Bennett & Maton, 2010; Fluck & Dowden, 2013), they have not had the experience of using educational technologies for teaching, or perhaps have never imagined how they might use personal technologies as part of the teaching and learning process (Kovalik, Kuo, & Karpinski, 2013).

Unfair expectations about their technological abilities aside, teachers entering the profession will be expected to integrate technology into their teaching practices (Davies & West, 2014; Ruggerio & Mong, 2015). Digital technologies for teaching and learning are more available than ever before (Brown & Green, 2014; Gray, Thomas, & Lewis, 2010; Project Tomorrow, 2013). Further, technology integration skills are now considered an entry-level job requirement for today's teachers (Teo, 2011). In their study of novice teachers and their perceived challenges upon entering the profession, Chesley and Jordan (2012) conducted focus groups of teachers with less than three years of teaching experience and asked them what was missing from their teacher preparation programs. One of the strongest themes that emerged: "We needed to learn how to integrate technology" (Chesley & Jordan, 2012, p. 43). Today's teacher educators must be mindful of the demands and challenges of technology integration in K-12 schools, and seek to encourage pre-service teachers by “embedding digital pedagogy in our pre-service higher education” (Kivunja, 2013, p. 132). In other words, preparing pre-service teachers for technology integration requires instructors who model technology integration in the courses they teach.

Teaching Technology Integration

Teacher preparation programs must, therefore, plan for how the pre-service teachers they serve will become acquainted with educational technologies. There are many approaches for modeling technology integration available for teacher educators to consider. Kay (2006) conducted a meta-analysis of articles describing different approaches for developing technology integration strategies among pre-service teachers. In his analysis, Kay submitted ten different strategies teacher preparation programs might employ, including 1) integrating technology into all courses, 2) using multimedia (e.g., video case studies), 3) developing the Education faculty members' skills so that they can integrate technology into their teaching, 4) a stand-alone technology course, 5) modeling effective use of technology, 6) collaboration between colleges and K-12 schools, 7) field-based learning, 8) targeted workshops, 9) improving access to educational technologies, and 10) partnering pre-service teachers with mentor teachers. Kay noted that some institutions use a combination of these different strategies concurrently.

Ottenbreit-Leftwich, Glazewski, and Newby (2010) conducted a similar analysis into different ways teacher preparation programs approach teaching technology integration, finding six general approaches: 1) information delivery of technology integration content, 2) hands-on technology skill building activities, 3) practice with technology integration in the field, 4) technology integration observation or modeling sessions, 5) authentic technology integration experiences, and 6) technology integration reflections. In summing up this variety of approaches, they advise teacher educators to "consider various experiences and select the most appropriate learning experiences to achieve their intended goals of preparing preservice teachers to use technology in their future classrooms" (Ottenbreit-Leftwich et al., 2010, p. 23).

The Stand-Alone Technology Course and Alternatives

Given this wide variety of options for methods for fostering technology integration in pre-service teachers, it might be surprising that many teacher preparation programs rely on a stand-alone technology course to demonstrate how to use particular technologies (Kay, 2006; Ottenbreit-Leftwich et al., 2010; Wang & Chen, 2007). Kay (2006) suggested that the stand-alone technology course is prevalent despite real disadvantages to this approach, foremost of which is that learning these technology skills in isolation may not necessarily result in them using them well in the field. However, Ottenbreit-Leftwich et al. (2010) also noted that,

> While nearly all agree that stand-alone technology 'skills' classes do not provide adequate or appropriate experiences to prepare prospective teachers to effectively use technology in their future classrooms, there is little empirical evidence that the large number of other methods and models are any more effective. (p. 7)

Problematically, stand-alone technology courses often emphasize how to *use* the technologies, rather than how to *teach* with them (Mishra & Koehler, 2006). Research indicates that simply teaching how to use an ICT tool without emphasizing how to teach with it (i.e., the pedagogies involved) does not foster effective integration of technology

(Christensen & Knezek, 2014; Koehler, Mishra, & Yahya, 2007; Lambert & Gong, 2010; Tournaki & Lyublinskaya 2014). Christensen and Knezek (2014) argued that verifying pre-service teachers technology skills is different than providing them opportunities to apply them within content areas for learning. Simply having experience working with computers and other educational technologies is not enough to prepare pre-service teachers for the integration of technology and pedagogy in their teaching practices. The presence of a computer lab as part of a teacher preparation program and the inclusion of a course dedicated to learning educational technologies does not automatically translate into teachers being well-prepared for technology integration (Lambert & Gong, 2010).

Alternatives that supplement or replace the stand-alone technology course must be seriously considered. To prepare pre-service teachers with the knowledge, skills, and attitudes to effectively integrate technology into their teaching, teacher educators may need to rethink their approach toward teaching technology integration (Lambert & Gong, 2010; Ottenbreit-Leftwich et al., 2010; Wang & Chen, 2007). When interviewed, novice teachers have reported that they would like the professors in their teacher preparation programs to model technology integration in their courses and demonstrate how to plan lessons that integrate technology (Chesley & Jordan, 2012). Kovalik, Kuo, and Karpinsky (2013) found three essential factors for fostering technology integration: (a) "well-designed technology-rich courses throughout teacher education programs that emphasize pedagogy as well as embedding and modeling appropriate technology knowledge, skills, and integration" (p. 180), (b) adequate assessment strategies for knowledge and skills related to ICT, and (c) opportunities to observe high-quality technology integration in real classrooms by practicing teachers. These kinds of firsthand opportunities should also be bolstered with more firsthand opportunities to work with educational technologies by embedding them in all of their coursework, “not just those taught by tech-savvy professors” (Chesley & Jordan, 2012, p. 43).

Research suggests that the ICT tools that will be present in pre-service teachers’ classrooms within even just a few years of commencing their career will be vastly different from the tools available to them at the present (Brown & Green, 2013; Davies & West, 2014; Project Tomorrow, 2013). Therefore, it does not make sense to try to teach pre-service teachers everything about how to use current tools. Instead, teacher educators should stress the value of learning to solve instructional problems incorporating technology (Ertmer & Ottenbreit-Leftwich, 2010; Kovalik et al., 2013; Lambert & Gong, 2010). Rather than focusing on learning to use particular technologies, pre-service teachers would be better off developing the skills for lifelong learning (Christensen & Knezek, 2014; Mishra & Koehler, 2006). Cultivating habits of mind for selecting the best technologies and pedagogies for the content they are teaching will pay dividends in the long run (Holden & Rada, 2011). Thus, a re-conceptualization of the traditional stand-alone technology course demonstrating how to use ICT tools is necessary; pre-service teachers need to see the connection between technologies available, the pedagogical approaches they should consider, and the content they teach.

Frameworks for Technology Integration

In recent years, many different frameworks for describing technology integration have been developed, each with a particular purpose or intended context for use. Several notable frameworks include the RAT model, the SAMR model, the Technology Integration Matrix, and the TPACK framework (Hanover Research, 2013; Hughes, Thomas, & Scharber, 2006; Koehler & Mishra, 2009). Each of these models will be described below to illustrate their strengths and weaknesses, the contexts in which they are often used, and their suitability for use in supporting the development of the knowledge, skills, and self-efficacy for technology integration in pre-service teachers.

The RAT Model

The RAT model for technology integration was first introduced by Hughes (2005) and further developed by Hughes, Thomas, and Scharber (2006). The acronym RAT stands for replacement, amplification, and transformation, the three levels of technology usage depicted in this model. Hew and Brush (2007) described the RAT model as a means of understanding “technology-supported pedagogy” (p. 227). At the replacement level, a digital technology is used to replace another format, such as a student highlighting vocabulary words with a word processor instead of circling them on a worksheet (Hughes et al., 2006). The task remains unchanged, but the tool or medium being employed is different. At the amplification level, a digital technology is used to increase productivity or efficiency, such as students editing each other’s writing using a word processor rather than editing handwritten documents (Hew & Brush, 2007). The task still remains fundamentally unchanged at this level of technology implementation, but the affordances of the technology have a benefit for teaching or learning that are unmatched by not using the technology. At the transformation level, a digital technology is used modify the instructional methods, the students’ learning process, or even the way the content is organized or presented (Hughes et al., 2006). An example of transformation could be students using web-authoring software to create hypertext-based stories, a task that could not be accomplished without using that technology (Hughes, 2005). The RAT model is a helpful way for describing classroom technology integration at varying levels, but has not found widespread acceptance to date, as evidenced by the minimal impact it has made in the body of scholarly research on technology integration with only a few publications referencing the work of Hughes and colleagues. This may be because other models were developed around the same time that proved more popular among practitioners (Green, 2014).

The SAMR Model

The SAMR model was developed by Puentedura (2006, 2014). This model is very similar to the RAT model, though with four levels of technology usage being depicted: substitution, augmentation, modification, and redefinition. SAMR's similarities to the RAT model were noted by Green (2014) in her explanation of and critique of different technology integration models. Comparable to the RAT model, the SAMR model describes different uses of technology from simply substituting a digital technology for another tool, to functional augmentation, to task modification, to complete task redefinition (Puentedura, 2014).

The following descriptions of the four levels in the SAMR model are adapted from Puentedura (2006, 2014). At the substitution level, one technology is swapped for another, such as using a word processor instead of pencil and paper to write an essay. The task assigned to students is unchanged; only the tools are different. At the augmentation level, a technology that provides moderate functional improvements over another technology is employed, but the task remains unchanged. An example might be a modern word processor, with features such as spellcheck, grammar check, and the ability to copy and paste—all features that make the work easier, but do not necessarily change the work being assigned. At the modification level, the technologies being employed allow for significant redesign of the task being assigned to the students. An example might be using a collaborative word processor, such as Google Docs, and having students develop work interactively in real time by concurrently editing a shared document. At the redefinition level, the task being assigned is completely transformed and might barely resemble the original task. An example might be assigning students to maintain a public blog, sharing their work with an authentic audience of readers from around the world, rather than just writing for the teacher. Puentedura (2006) argued that the schoolwork assigned to K-12 students must be transformed with the modification and redefinition applications of technology in order for U.S. students to remain competitive in international educational assessments.

The SAMR model has found widespread acceptance in K-12 education (Green, 2014; Hanover Research, 2013), but some authors have sharp critique for this model (Green, 2014; Hamilton, Rosenberg, & Akcaoglu, 2016). Particularly, while practitioners have enthusiastically embraced the SAMR model, there is scant record of it in the scholarly literature, even by its developer, Dr. Puentedura (Hamilton et al., 2016). Hanover Research (2013) commented that Puentedura has published "many articles" about SAMR (p. 17), but their references only point back to Puentedura's blog. Without rigorous examination and research into how this model actually functions to explain technology integration, questions remain about its value as a theoretical framework (Green, 2014; Hamilton et al., 2016).

While it may be true that the SAMR model describes how technology is used in K-12 classrooms, it does not account for the different contexts in which technology integration takes place (Hamilton et al., 2016). The SAMR model places a great importance on the technologies being implemented and the products being generated, rather than the processes of learning and teaching (Hamilton et al., 2016; Harmes, Welsh, & Winkleman, 2015). Additionally, a technology integration model should indicate not only how technologies are being utilized, but also the pedagogies being employed (Davies, 2011; Graham et al., 2012; Green, 2014). Without also considering pedagogy, Davies (2011) argued that the concept being considered is technology adoption, rather than technology integration.

Technology Integration Matrix

The Technology Integration Matrix (TIM) was developed by the Florida Center for Instructional Technology (Allsopp, Hohlfeld, & Kemker, 2007; Hanover Research, 2013). The TIM was created to, "assist teachers, schools, and districts in evaluating the level of technology integration in classrooms and to provide teachers, supervisors, and administrators with models of how technology can be integrated into instruction in meaningful ways" (Allsopp et al., 2007, p. 2). Where other technology integration models emphasize the technologies being used, the TIM recognizes the importance of the pedagogies also being practiced (Harmes et al., 2015).

The TIM describes five different levels of technology acceptance on the part of teachers, including entry, adoption, adaptation, infusion and transformation (Florida Center for Technology Integration, n.d.). These five levels are further elaborated by five characteristics of "meaningful learning environments," including these descriptors: active, collaborative, constructive, authentic, and goal directed (Florida Center for Technology Integration, n.d.). The intersections of these five levels of technology acceptance and five descriptors of learning environment usage result in a matrix of 25 combinations of technology integration and learning environment (Hanover Research, 2013), as illustrated in figure 1. The characteristics of the learning environment and the levels of acceptance can be combined to describe a type of technology integration, such as “collaborative: entry” or “goal directed: transformation” (Hanover Research, 2013).

The TIM is a beneficial resource for describing students’ use of technology as guided by the teacher’s comfort level. Because of the inclusion of pedagogical approaches and not technology alone, it can be a valuable tool for evaluating teachers’ technology integration (Harmes et al., 2015). The overall emphasis, however, is not about uncovering the teacher’s thinking about technology; the TIM is designed to describe the way students are using technology (Hanover Research, 2013). As a model, the TIM may benefit pre-service teachers by providing them examples of effective technology integration. However, the TIM does not explain how the knowledge and skills for technology integration develop in pre-service teachers.

The TPACK Framework

While the RAT model, SAMR model, and the TIM all describe different levels of technology usage on the part of the students, the TPACK framework takes a different approach. The TPACK framework was developed to explain the knowledge bases teachers must have to effectively integrate technology into their teaching practices (Koehler & Mishra, 2009; Mishra & Koehler, 2006). Expressing their vision of technology integration, Koehler & Mishra (2009) stated, “At the heart of good teaching with technology are three core components: content, pedagogy, and technology, plus the relationships among and between them” (p. 62). The name “TPACK” is an acronym for

Table 1 Technology Integration Matrix[a]

	Entry	Adoption	Adaptation	Infusion	Transformation
Active	Students use technology for drill and practice and computer-based training.	Students begin to utilize technology tools to create products, for example using a word processor to create a report.	Students have opportunities to select and modify technology tools to accomplish specific purposes, for example using colored cells on a spreadsheet to plan a garden.	Throughout the school day, students are empowered to select appropriate technology tools and actively apply them to the tasks at hand.	Given ongoing access to online resources, students actively select and pursue topics beyond the limitations of even the best school library.
Collaborative	Students primarily work alone when using technology.	Students have opportunities to utilize collaborative tools, such as email, in conventional ways.	Students have opportunities to select and modify technology tools to facilitate collaborative work.	Throughout the day and across subject areas, students utilize technology tools to facilitate collaborative learning.	Technology enables students to collaborate with peers and experts irrespective of time zone or physical distances.
Constructive	Technology is used to deliver information to students.	Students begin to utilize constructive tools such as graphic organizers to build upon prior knowledge and construct meaning.	Students have opportunities to select and modify technology tools to assist them in the construction of understanding.	Students utilize technology to make connections and construct understanding across disciplines and throughout the day.	Students use technology to construct, share, and publish knowledge to a worldwide audience.
Authentic	Students use technology to complete assigned activities that are generally unrelated to real-world problems.	Students have opportunities to apply technology tools to some content-specific activities that are based on real-world problems.	Students have opportunities to select and modify technology tools to solve problems based on real-world issues.	Students select appropriate technology tools to complete authentic tasks across disciplines.	By means of technology tools, students participate in outside-of-school projects and problem- solving activities that have meaning for the students and the community.
Goal Directed	Students receive directions, guidance, and feedback from technology, rather than using technology tools to set goals, plan activities, monitor progress, or self-evaluate.	From time to time, students have the opportunity to use technology to either plan, monitor, or evaluate an activity.	Students have opportunities to select and modify the use of technology tools to facilitate goal setting, planning, monitoring, and evaluating specific activities.	Students use technology tools to set goals, plan activities, monitor progress, and evaluate results throughout the curriculum.	Students engage in ongoing metacognitive activities at a level that would be unattainable without the support of technology tools.

[a] Based on information from Florida Center for Technology Integration (n.d.)

"Technological, Pedagogical, and Content Knowledge" (Thompson & Mishra, 2007), and the framework is descriptive of how these three teacher knowledge domains interact when technology is being used wisely to support student learning (Koeler, Mishra, Kereluik, Shin, & Graham, 2014).

The TPACK framework has several features that make it an attractive model for use in this study. First, while other frameworks were developed to describe levels of technology adoption by practicing teachers, the TPACK framework was developed to explain and predict how pre-service teachers develop the abilities to teach with technology (Koh & Divaharan, 2011; Mishra & Koehler, 2006; Pamuk, 2012). Both the widely known though theoretically unsubstantiated SAMR model and the peer-reviewed though less-widely known RAT model intend to describe specific levels of technology usage in the classroom, while the TPACK framework is aimed at explaining how the different knowledge bases required for technology integration are developed. The TIM, on the other hand, while very useful for explaining student use of technology in learning environments, is less focused on the teacher's use of technology. In contrast to the TIM, the TPACK framework is intended to describe how teachers learn to make decisions about which technologies they will integrate and how they will use them. The TPACK framework is a more useful theoretical framework for this study than any of these other models, because the focus of this research project is examining how pre-service teachers develop the knowledge, skills, and self-efficacy for effective technology integration. In the following section, the TPACK framework will be examined in detail, including the development of the framework, the structure of the framework, some ongoing debate about the nature of the framework, and role of the TPACK in teacher preparation.

Examining the TPACK Framework

Learning to integrate technology into teaching is a challenging process. Ruggerio and Mong (2015) emphasized that technology integration is a process, and not an event; carrying this concept to pre-service teachers, we might say that learning to integrate technology is also a process and not a one-time event. It takes time to develop the knowledge, skills, and attitudes needed for effective technology integration (Archambault & Barnett, 2010; Gill et al., 2015, Koehler et al., 2014). The term “integration” implies bringing two or more things together into a unified whole. The process of learning how to unify technology and pedagogy, within the context of a particular content area will take time, effort, and discipline on the part of pre-service teachers and teacher educators alike. However, a model for structuring this learning is available in Mishra and Koehler’s (2006) TPACK framework. Figure 1 illustrates a visual representation of the knowledge domains described in the TPACK framework.

Koh and Divaharan (2011) provided short, helpful descriptors of each of the seven domains within the TPACK framework:

1) Technological Knowledge (TK) – knowledge of technology tools.
2) Pedagogical Knowledge (PK) – knowledge of teaching methods.
3) Content Knowledge (CK) – knowledge of subject matter.
4) Technological Content Knowledge (TCK)—knowledge of subject matter representation with technology.
5) Technological Pedagogical Knowledge (TPK)—knowledge of using technology to implement different teaching methods.

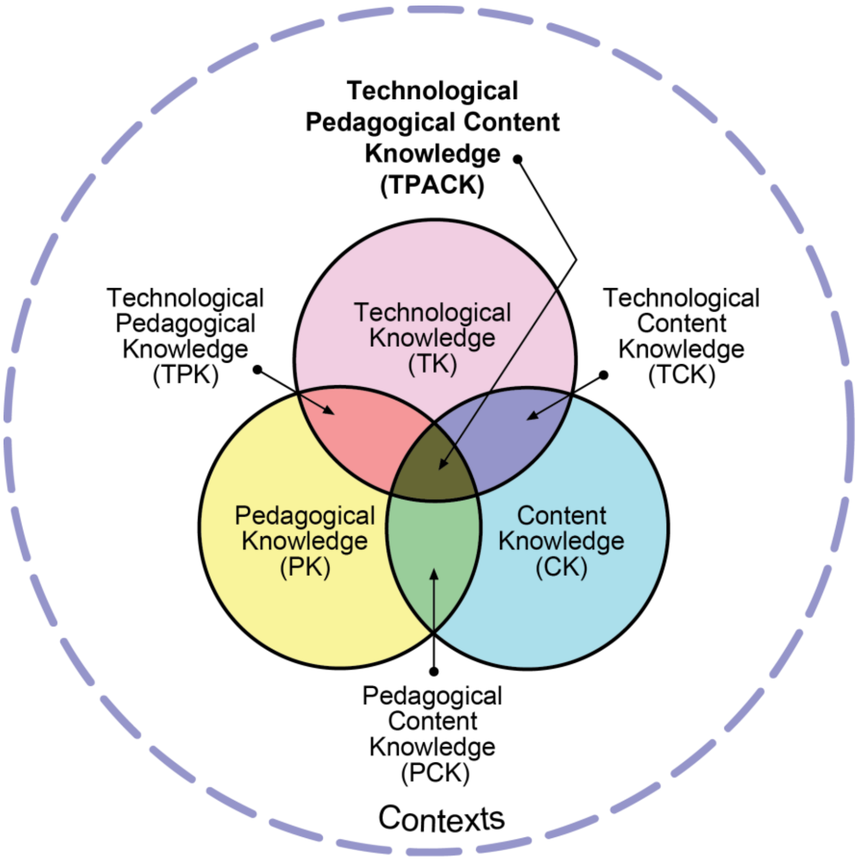

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Figure 1 The TPACK framework illustrated

6) Pedagogical Content Knowledge (PCK)—knowledge of teaching methods with respect to subject matter content.

7) Technological Pedagogical Content Knowledge (TPACK)—knowledge of using technology to implement teaching methods for different types of subject matter content. (Koh & Divaharan, 2011, p. 37-38)

In the TPACK framework then, three overlapping teacher knowledge domains are described: technological knowledge, pedagogical knowledge, and content knowledge (Mishra & Koehler, 2006). The intersection of the three teacher knowledge domains is the essence of technology integration: the teacher is drawing on knowledge of particular educational technologies, as well as appropriate pedagogical methods, and contextualizing their use within a particular content area (Koehler & Mishra, 2009).

The Development of the TPACK Framework

The TPACK framework was developed by Mishra and Koehler to address the fact that, "in education the reality [of technology integration] has lagged far behind the vision" (Mishra & Koehler, 2006, p. 1018). Building upon earlier work on teacher knowledge domains by Shulman (1986, 1987), Mishra and Koehler conducted a design experiment over several years to develop the framework. Shulman (1986) had proposed the concept of "pedagogical content knowledge," which he described as,

> for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that make it comprehensible to others. Since there are no single most powerful forms of representation, the teacher must have at hand a veritable armamentarium of alternative forms of representation, some of which derive from research where as other originate in the wisdom of practice. (p. 9)

The knowledge domain of pedagogical content knowledge goes beyond either content knowledge alone (i.e., knowledge of *what* to teach: the content to be taught in a given discipline) or pedagogical knowledge alone (i.e., knowledge of *how* to teach: the methods and strategies used for teaching and learning). Pedagogical content knowledge is a separate knowledge domain, in which knowledge of content and knowledge of the pedagogies most effective for teaching that content blend (Mishra & Koehler, 2006). In their explanation of Shulman's pedagogical content knowledge model, Mishra and

Koehler (2006) noted, “having knowledge of subject matter and general pedagogical strategies, though necessary, was not sufficient for capturing the knowledge of good teachers” (p. 1021). The pedagogical content knowledge domain demands both a deep knowledge of the content as well as a strong understanding of good pedagogy. These types of knowledge combine as the domains overlap: different methods are selected for teaching mathematics and reading, for example, because of the demands of the various content areas. Shulman (1987) suggests that pedagogical content knowledge represents “the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction” (p. 8). This model is the theoretical basis for the TPACK framework.

Mishra and Koehler (2006) created the TPACK framework by building upon Shulman’s pedagogical content knowledge model with the addition of a third knowledge domain: technological knowledge. Technological knowledge is essential for effective technology integration (Archambault & Barnett, 2010; Canbazoğlu Bilici, Yamak, Kavak, & Guzey, 2013). Mishra and Koehler argue that knowledge of how to use various technologies is not enough. Technological knowledge is one domain needed, but both pedagogical knowledge and content knowledge are also essential for true integration to take place (Koehler & Mishra, 2009).

The Structure of the TPACK Framework

The essential idea in the TPACK framework is that pre-service teachers will be best prepared for the challenges of technology integration by considering not only the ICT tools but also the pedagogies involved in using them, and the ways that the context of the content area influences how the tools will be employed (Mishra & Koehler, 2006; Pamuk, 2012). Thus, the domains within the TPACK framework encompass technological knowledge, pedagogical knowledge, and content knowledge, but also the overlaps between these domains: technological content knowledge, technological pedagogical knowledge, pedagogical content knowledge, and technological pedagogical content knowledge.

The TPACK framework offers a structure for exploring the way technology functions as part of the teaching and learning environment. Traditionally, a teacher preparation program might separate these different knowledge domains. TK would be developed in the stand-alone technology course. PK would arise from methods courses and field experiences. CK would be developed through coursework within the content major (e.g., a social studies teacher will likely take courses in history, geography, economics and the like to develop CK). However, this approach may not give enough emphasis to the complex interrelatedness of these domains that the TPACK framework illustrates. For example, understanding how to contextualize pedagogy for teaching different content areas (as PCK) is different than understanding how different technologies can be used to teach specific content (as TCK), which is different than understanding how technologies and pedagogies complement each other (as TPK). Ideally, pre-service teachers will come to understand how understanding how all three of these domains interact and influence each other, but this will likely require a shift to the traditional teacher preparation program (Cox & Graham, 2009; Kivunja, 2013; Koh & Divaharan, 2011; Mishra & Koehler, 2006). The TPACK framework is becoming a leading framework for explaining how technology integration develops (see Voogt et al., 2013), but there are ongoing debates about the nature of the framework and questions about how TPACK should be implemented in a teacher preparation program remain.

Debate about the Nature of the TPACK Framework

The TPACK framework has found wide acceptance among both practitioners and researchers in the field of Educational Technology (Herring, Koehler, Mishra, Rosenberg, & Teske, 2016; Voogt et al., 2013). The TPACK framework was originally introduced by Koehler and Mishra (2005) as TPCK: technological pedagogical content knowledge, and this term was used to both describe the central construct as well as name the framework. However, at the suggestion of a group of practitioners and researchers, the framework was renamed as TPACK to make it more memorable, and easier to speak (Thompson & Mishra, 2007). Mishra and Koehler were amenable to this modification in naming, particularly because "these three knowledge domains should not be taken in isolation, but rather that they form an integrated whole, a 'Total PACKage' as it were, for helping teachers take advantage of technology to improve student learning" (Thompson & Mishra, 2007, p. 38).

In the decade since Koehler and Mishra (2005) first unveiled the TPACK framework, researchers have also debated the nature of TPACK, how individuals develop TPACK, and how it functions in practice. TPACK is a seriously researched theoretical framework for technology integration, and there have been two handbooks elaborating the theoretical basis, ongoing research, and practical applications of this scholarship for educators since the framework was introduced (American Association of Colleges for Teacher Education, 2008; Herring, Mishra, & Koehler, 2016). Also, many other peer reviewed articles have been written describing the development of the TPACK concept, various views on the role of technological knowledge, the connection between TPACK and teacher beliefs, means of measuring TPACK, and strategies for developing TPACK (Voogt et al., 2013). With all of this research ongoing, it is unsurprising that different scholars take different views of TPACK. Some researchers view TPACK as a hierarchy of knowledge domains, others consider the TPACK knowledge domains as intractable from one another, and still others suggest TPACK as descriptive of the evolution of technology integration over time. Each of these views will be discussed below.

The hierarchical perspective: TPACK integrating knowledge domains.

The TPACK framework by its nature explores the interrelationships between different knowledge domains. This perspective has been named the "integrative" TPACK model by Colvin and Tomayko (2015). Pamuk (2012) suggested that the structure of the domains within the TPACK framework is hierarchical; that is, teachers must first have TK, PK, and CK before they can develop the other knowledge domains. In this perspective, the TCK, TPK, PCK, and TPACK domains integrate the different knowledge bases from the three primary knowledge domains. Cox and Graham (2009) affirmed this viewpoint in their depiction of an "elaborated model" of the TPACK framework that provides firm barriers between the different domains. While this perspective is helpful for teacher educators for describing the range of knowledge domains necessary for technology integration, it is not the only perspective.

The intractable perspective: TPACK transforming knowledge domains.

In contrast to the hierarchical perspective, other researchers propose that the knowledge domains are intractable from one another. This viewpoint has been named the "transformative" TPACK model (Colvin & Tomayko, 2015), signifying that the knowledge domains interact in functionally different ways as they combine. In this view, the TCK, TPK, PCK, and TPACK knowledge domains are unique and separate, different from the three foundational domains. In this perspective, the TK, PK, and CK knowledge domains are transformed through their interaction, and the result is a completely new form of knowledge that cannot easily be discerned as constituent parts. Gill, Delgarno, and Carlson (2015) suggested that the TK, PK, and CK knowledge domains cannot function independently in true technology integration, noting that

> the development of understandings of the pedagogical affordances of technology, although requiring both technological knowledge and pedagogical knowledge, won't be acquired automatically once these subsidiary types of knowledge are developed, in the absence of modeling, reflection and opportunities to practice the use of technologies for learning. This has implications for the way in which technology skill development is supported during a course (that is, it needs to be carried out in the context of exploration of the associated pedagogical issues). (p. 54)

In a similar vein, Archambault and Barnett (2010) argued that the knowledge domains in the TPACK framework cannot be unraveled and that the boundaries between the domains are "fuzzy" (p. 1661), which, in their view, diminishes the usefulness of TPACK as an explanatory model.

<u>The evolutionary perspective: TPACK describing change.</u>

While the hierarchical (integrative) and intractable (transformative) perspectives are perhaps more popular viewpoints, other perspectives on the TPACK framework have been offered. Cox and Graham (2009) have also indicated their perspective that the

TPACK framework is in fact descriptive of how knowledge domains may evolve over time. What might constitute TPACK today might be considered PCK in the future as a given technology become commonplace (e.g., books are not generally conceived as "technologies" today, because they have such wide acceptance; few educators would raise the question, "how will I integrate book technology into my pedagogical content knowledge?") In this evolutionary perspective, emerging technologies are the focus of the TK domain, because once a technology becomes widely adopted, few are concerned about the challenges of effectively integrating it into practice.

Summing up this variety of perspectives, Colvin and Tomayko (2015) have suggested that, "While most scholars agree that the attainment of TPACK is a worthy goal for teachers, the question of how to get there remains unanswered" (p. 70). Regardless of which particular perspective one espouses, it is important to keep Mishra and Koehler's original intent for the TPACK framework in mind. TPACK is intended to acknowledge the complexity of how teacher knowledge develops, and because of that, it "argues against teaching technology skills in isolation and supports integrated and design-based approaches as being appropriate techniques for teaching teachers to use technology" (Mishra & Koehler, 2006, p. 1045). Therefore, teacher educators must consider the role the TPACK framework will play within the teacher preparation program.

Perspectives on the Role of TPACK as a Framework for Learning to Integrate Technology

The three domains depicted in the TPACK framework—and particularly the overlap between them—are deemed essential for developing strong technology integration knowledge and skills in pre-service teachers (Koehler et al., 2014; Tournaki & Lyublinskaya, 2014). Many researchers suggest utilizing the TPACK framework as a means of structuring learning activities regarding technology integration for pre-service teachers (Abbitt, 2011; Harris et al., 2010; Koh & Divaharan, 2011; Mouza & Karchmer-Klein, 2013; Pamuk, 2012). However, there are several perspectives on the role of TPACK in teacher preparation. Some researchers view TPACK as an explanatory framework for technology integration, others argue that it is a teaching tool, and still others describe it as a means of structuring learning activities. Each of these perspectives will be illuminated below.

TPACK as an explanatory framework.

Some researchers have suggested that the TPACK framework is explanatory; that it provides a structure for describing understanding how effective technology integration takes place (Baran et al., 2011; Colvin & Tomayko, 2015; Habowski & Mouza, 2014; Schmidt et al., 2009). Because TPACK is a complex knowledge domain comprised of the overlap of PCK, TPK, and TCK, which are in turn comprised of the overlaps of TK, PK, and CK, the TPACK framework helps to explain the development of the abilities to integrate technology. Many of the studies aimed at quantifying pre-service teachers' TPACK knowledge (e.g., Baran at al., 2011; Schmidt et al., 2009) embody this perspective. From this viewpoint, the TPACK framework is most useful as a theoretical construct (Colvin & Tomayko, 2015). However, while it is certainly helpful to be able to explain how pre-service teachers develop the knowledge needed for technology integration, this is not the only way that the TPACK framework is used in teacher preparation.

TPACK as a teaching tool.

While some researchers view TPACK as an explanatory lens, others argue that TPACK should be used as a teaching tool, a way to help pre-service (and in-service) teachers structure lessons for effective technology integration (Abbitt, 2011; Graham, Borup, & Smith, 2012; Kivunja, 2013; Mouza & Karchmer-Klein, 2013; Polly, 2014). As an example of this perspective, Graham et al. (2012) described the TPACK framework as "a lens for understanding how teacher candidates make decisions about the use of information and communication technology in their teaching" (p. 530). Thus, teacher educators too can use the TPACK framework as a means of instructing future educators in how to integrate technology.

Kivunja (2013) called for a "lived experience" with the TPACK framework for pre-service teachers (p. 137). This sort of teaching would demand a deeper engagement with not just educational technologies *or* pedagogies, but instead, sustained experiences working through the joys and challenges of real instructional problems involving technology integration (Kivunja, 2013). Likewise, Mouza and Karchmer-Klein (2013) made the case that technology integration must be taught around the TPACK framework, acknowledging the need for flexible abilities concerning technology for teaching and learning. They noted two reasons in this call for flexibility: 1) technologies are always changing, and teachers thus need to be able to continue to develop new technological skills, and 2) teaching with technology requires a nuanced understanding for the interactions between the three knowledge domains of technology, pedagogy, and content. From this viewpoint, TPACK serves as a teaching tool to better prepare them to adapt to the challenge of technology integration with this kind of flexibility.

<u>TPACK as a way of structuring learning.</u>

Still other researchers have implied that TPACK might best be thought of as a means of structuring learning opportunities for teachers (Harris et al., 2010; Koehler & Mishra, 2005; Koh & Divaharan, 2011; Tournaki & Lyublinskaya, 2014). Koehler and Mishra's (2005) early work that led to the design of the TPACK framework was aimed at helping pre-service teachers work through ill-structured instructional problems as a means of developing the different knowledge domains required for technology integration. This is one approach to structuring learning opportunities, but it is not the only one. Koh and Divaharan (2011) advocated a three-phase approach for fostering TPACK. This three-phase approach is comprised of (a) exposure to technologies and modeling by instructors, (b) developing proficiency with working with technologies and developing PCK through methods courses, and (c) designing lessons that exhibit technology integration for specific content areas. At each phase of this approach, pre-service teachers have opportunities to learn at the level best suited for their development as teachers (Koh & Divaharan, 2011).

Koehler et al. (2014) suggested three pathways teacher preparation programs often use for fostering the development of technological pedagogical content knowledge among pre-service teachers. Some programs use a PCK-to-TPACK approach (e.g., the approach described by Harris & Hofer, 2009), where pedagogical content knowledge is first developed before introducing educational technologies. Other programs take a TPK-to-TPACK approach (e.g., Angeli & Valanides, 2009), in which the development of technological pedagogical knowledge is fostered before pre-service teachers take content-specific methods courses. Still other programs utilize an approach in which PCK and

TPACK develop simultaneously (e.g., Koehler & Mishra, 2005). In this approach, the program emphasizes ill-structured instructional problems in which pre-service teachers design solutions that involve the integration of technology within a particular content area (Koehler et al., 2014). PCK is developed through understanding the pedagogies used to teach that content area, and TPACK is simultaneously developed by the integration of technological knowledge in solving the problem within that instructional context (Koehler et al., 2014). Each of these three approaches for creating learning environments where pre-service teachers can develop TPACK may have benefits in some circumstances.

In this section, three perspectives for the role of the TPACK framework in the teacher preparation program were examined: the explanation view, the teaching tool view, and the learning opportunities view were discussed. This third view—TPACK as a means of structuring learning within a teacher preparation program—is the perspective most closely aligned to this research project. This study emphasizes investigating how technology integration learning opportunities are structured, and how pre-service teachers perceive how their knowledge and skills are developing through their work in the teacher preparation program.

Summing Up the Role of the TPACK Framework

An excellent teacher preparation program designed to foster technology integration skills should focus on not just the technologies involved, but also the pedagogical methods needed, and contextualizing this integration within a content area (Abbitt, 2011; Mishra & Koehler, 2006; Polly, 2014). Because of its emphasis on developing knowledge and skills in all three of these essential domains required for effective technology integration, the TPACK framework may be ideally suited for helping teacher educators to structure learning opportunities for pre-service teachers.

Self-Efficacy and Technology Integration

Helping pre-service teachers develop the different knowledge domains and providing opportunities for putting this knowledge into practice is essential for technology integration to take place. There are cases, however, when teachers have sufficient knowledge about particular technologies, as well as the pedagogical content knowledge required to teach well, and they might still avoid teaching with technology. Research indicates that teacher's beliefs about technology are an important factor to consider for understanding technology integration (Abbitt, 2011; Ertmer, 2005; Hew & Brush, 2007; Wang, Ertmer, & Newby, 2004). Sadaf et al. (2016) noted the importance of teacher beliefs for technology integration; they argued from the literature that pre-service teachers' beliefs about teaching with technology are one of the strongest predictors of their actual technology integration in classrooms. While the TPACK framework is helpful for understanding technology integration practices, it may not be enough on its own. Teacher beliefs about educational technologies are another factor that must be considered to understand how and why teachers choose to integrate technology.

Teacher Beliefs and Technology Integration

There are several reasons that teachers might choose not to integrate particular ICT tools into their teaching practices, but a principal reason stems from the teacher's beliefs about their abilities to use educational technologies. Copriady (2014) indicated that one of the foremost reasons teachers choose not to use a given technology for teaching and learning is that they do not feel adequately prepared to do so. They may fear that their relatively weak skills at using technology will be observed by the students, leading to embarrassment at their lack of knowledge. Along the same lines, Gilakjani (2013) bluntly stated, "Teachers do not use computer technology if they lack confidence" (p. 263). Copriady (2014) argued that the mere presence of technology in the classroom is not enough to pressure teachers into using it; teacher attitudes, beliefs, and knowledge are more influential for whether or not teachers will integrate technology into their teaching practices. This perspective is strongly supported by many authors (Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Perkmen & Pamuk, 2011; Wang et al., 2004).

Research indicates that a teacher's beliefs and attitudes towards computers and other educational technologies can explain and even predict his or her use of technologies for teaching and learning (Abbitt, 2011; Ertmer, 2005; Perkmen & Pamuk, 2011). A large and growing body of research literature indicates that teachers' beliefs about technology may be one of the greatest influences on how (or whether) they will integrate technology into their teaching practices (An & Reigeluth, 2012; Brinkerhoff, 2006; Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Ertmer et al., 2012; Hew & Brush, 2007; Kao, Tsai, & Shih, 2014; Koc & Bakir, 2010; Teo, 2009). A particular area of interest in the literature is teachers' self-efficacy for teaching with technology (Brinkerhoff, 2006; Ertmer, 2005; Ertmer et al., 2012; Koc & Bakir, 2010; Lambert & Gong, 2010; Lee & Lee, 2014; Richardson, et al., 2008; Sadaf et al., 2016; Teo, 2009; Wang et al., 2004). Self-efficacy is, therefore, an important factor to consider for whether teachers will use a certain ICT tool in their teaching practices.

Bandura's Self-Efficacy Theory and the Development of Self-Efficacy

Self-efficacy, in its broadest sense, is the confidence of success in a task to be undertaken (Walsh, 2008). Self-efficacy theory, therefore, has much broader implications than just how teachers use technology, and it applies to many diverse aspects of the teaching profession. Bandura (1986, 1997) suggested that self-efficacy is an essential element of his Social Cognitive Theory for Learning, and defined self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). According to social cognitive theory, self-efficacy beliefs influence cognitive functions, and therefore behaviors, through cognitive, motivational, and affective processes (Bandura, 1997; Klassen & Usher, 2010). Thus, an individual's self-efficacy beliefs impact much of their functioning when confronted with a challenging or novel situation, because "efficacy beliefs influence how people think, feel, motivate themselves, and act" (Bandura, 1995, p. 2). Bandura (1997) explained four sources of information that support the development of self-efficacy, including, 1) enactive experiences, 2) vicarious experiences, 3) verbal persuasion, and 4) physiological state. It may be helpful to consider briefly each of these and their implications for teacher educators helping pre-service teachers to develop their abilities and grow into effective, professional teachers.

First, enactive experiences are first-hand opportunities to practice a skill. By practicing a skill and finding a positive outcome, an individual will develop self-efficacy for completing that task—and similar tasks. Enactive experience capitalizes on the idea that success breeds success; as individuals experience taking risks and seeing positive outcomes, they may begin to "ascribe poor performance to faulty strategies rather than to inability" (Bandura, 1986, p. 399). Bandura (1997) indicated that this is the most influential of the four self-efficacy information sources. Self-efficacy, once established through performance attainments in this manner, tends to generalize to other situations as well. Bandura (1997) noted, "After people become convinced that they have what it takes to succeed, they persevere in the face of adversity and quickly rebound from setbacks. By sticking it out through the tough times, they emerge from adversity stronger and more able" (p. 80). For teacher educators, this means designing for small victories early on can provide dividends later, creating higher levels of self-efficacy for the challenging tasks that are part of the teaching profession. For pre-service teachers, this means that taking small, tentative steps may pave the way for greater confidence in the future, assuming that these first steps are successful and result in positive outcomes.

The second source of information, vicarious experience, is provided by seeing other people successfully perform a task. Vicarious experiences allow individuals to "persuade themselves that if others can do it, they should be able to achieve at least some improvement in performance" (Bandura, 1986, p. 399). Modeling, therefore, is an exceptionally important form of vicarious experience in education (Bandura, 1995; Mueller, 2009). For teacher educators, this means modeling may be indispensable for fostering pre-service teachers' self-efficacy (Ertmer & Ottenbreit-Leftwich, 2010; Koh & Divaharan, 2011; Kovalik et al., 2013). For pre-service teachers, having multiple opportunities to collaborate with both their instructors and classmates and learn from them may also be beneficial and supportive of developing self-efficacy (Koehler et al., 2007). While vicarious experiences may be less impactful than first-hand experiences (i.e., enactive attainment), they do play an essential role in educational settings, as individuals often learn by watching others, and then practice the skills themselves (Bandura, 1997; Mueller, 2009; Walsh, 2008).

Third, verbal persuasion can be an influential source of information impacting self-efficacy. Verbal persuasion involves encouraging an individual to the point of convincing them that they will be successful in completing a given task. Bandura (1986) conceded, “It is probably more difficult to produce enduring increases in perceived efficacy by persuasory means than to undermine it” (p. 400). Persuading students this way might mean first setting them up for success by carefully selecting learning opportunities, and not thrusting them into situations they are not yet prepared to engage, which would increase their likelihood of failure (Bandura, 1995; Zimmerman, 1995). Additionally, evaluative feedback plays a vital role in this regard; feedback that specifically relates to personal capabilities can positively affect self-efficacy (Bandura, 1997). Zimmerman (1995) reported that frequent, immediate feedback provides positive benefits for students’ self-efficacy. For teacher educators, this means providing specific, actionable, encouraging feedback for pre-service teachers at all points as they develop the necessary knowledge and skills for teaching (Abbitt, 2011; Ertmer & Ottenbreit-Leftwich, 2010).

A final source of information informing self-efficacy is physiology. Bandura (1997) notes, “In judging their capabilities, people rely partly on somatic information conveyed by physiological and emotional states” (p. 106), which means that some of their self-efficacy can be impacted by their internal state, both mentally and physically. In particular, fear can have a detrimental effect on performance (Bandura, 1986; Zimmerman 1995). Thus, Bandura (1997) noted that a fourth way to enhance self-efficacy is to “reduce stress levels and negative emotional proclivities” (p. 106). While this may be easier said than done, research indicates that mood is a powerful influence on this source of self-efficacy information (Bandura, 1995, 1997; Zimmerman, 1995). For teacher educators, this might mean creating a classroom environment where taking small risks is something to celebrate, an atmosphere that is positive, encouraging, and relaxed. Pre-service teachers who learn in this sort of environment—while not guaranteed to develop strong self-efficacy beliefs—may be more likely to experience positive outcomes (Ertmer & Ottenbreit-Leftwich, 2010; Kovalik et al., 2013). This source of self-efficacy information may be the most challenging for teacher educators to influence, but it warrants consideration.

All four of these sources of self-efficacy information may have significance for an individual, and teacher educators should certainly consider them all for the benefit of the students. While the development of positive self-efficacy has implications for many aspects of the teaching profession (Klassen, Durksen, & Tze, 2014; Woolfolk Hoy, Davis, & Pape, 2006), it may be a crucial complement to the knowledge domains of the TPACK framework for pre-service teachers’ technology integration practices. Considering the role of self-efficacy in the world of education, Zimmerman (1995) noted, “merely possessing knowledge and skills does not mean that one will necessarily use them effectively under difficult conditions” (p. 213). However, Bandura (1986) proposed, “Students who develop a strong sense of self-efficacy are well equipped to educate themselves when they have to rely on their own initiative” (p. 417). Increasing a sense of positive self-efficacy means fostering a sense of believing in one’s self. If pre-service teachers come to view themselves as capable learners and that they are able to learn about educational technologies, their beliefs can influence their actual practices. By believing they can teach with technology, they actually can do it.

Technology Self-Eficacy and Technology Integration

Pre-service teachers need opportunities to develop self-efficacy for teaching with technology in parallel with their development of the knowledge and skills for technology integration. Self-efficacy research indicates that teachers' beliefs and attitudes towards computers and other educational technologies can explain and even predict their use of technologies for teaching and learning (Abbitt, 2011; Perkmen & Pamuk, 2011). Researchers have found that, while knowledge and skills are certainly necessary, self-efficacy may be more important for teachers to put their knowledge and skills working with educational technologies into action (Copriady, 2014; Ertmer & Ottenbreit-Leftwich, 2010; Gilakjani, 2013; Kramarski & Michalsky, 2015). Therefore, developing a sense of technology self-efficacy may be critical for effective technology integration. While computers are certainly not the only form of digital technologies available in schools today, much of the existing research bases focuses specifically on "computer self-efficacy" rather than "technology self-efficacy" more broadly.

Compeau and Higgins (1995) defined "computer self-efficacy" as "judgment of one's capability to use a computer" (p. 192). They explained that the research conducted through the early 1990s indicated, "individuals will use computing technology if they believe it will have positive outcomes" (Compeau & Higgins, 1995, p. 205). However, the results of their study indicate that the situation may be more complicated. In their estimation, Bandura's (1986) Social Cognitive Theory offered a better explanation for how individuals use technology, because this theoretical framework "acknowledges that beliefs about outcomes may not be sufficient to influence behavior if individuals doubt their capabilities to successfully use the technologies...an understanding of both self-efficacy and outcome expectations is necessary to understand computing behavior" (p. 205). Similarly, Holden and Rada (2011) noted that self-efficacy is an essential aspect to whether teachers will accept a particular educational technology for use in their teaching practice. Teachers exhibiting more positive attitudes toward technology and greater self-confidence for using a given technology are much more likely to integrate that technology into their teaching (Holden & Rada, 2011).

Teacher educators would thus do well to consider how to increase pre-service teachers' self-efficacy for technology integration (Abbitt, 2011; Copriady, 2014; Perkmen & Pamuk, 2011). Increasing technology self-efficacy is actually a practical consideration; many pre-service teachers will find themselves in high-tech classrooms as they begin their professional careers. Teacher educators must do all they can to prepare pre-service teachers for the challenges that come with teaching in that environment, and this includes fostering their technology self-efficacy. Because, as Gilakjani (2013) explained,

> Individuals with higher computer self-efficacy beliefs see themselves as able to use computer technology. Those with lower computer self-efficacy beliefs become more disappointed and anxious when working with computer technology and hesitate to use computer technology when they face problems. (p. 263)

It may be helpful for teacher educators therefore to rethink their personal beliefs about technology and the design of coursework aimed at developing the abilities needed for technology integration. What is the purpose of teaching technology skills for pre-service teachers? How should they be taught? Perhaps a change in focus is required, a shift away from the perspective that teacher educators are teaching pre-service teachers how to *use technology* (Lambert & Gong, 2010; Lee & Lee, 2014; Perkmen & Pamuk, 2011). Rather, teacher educators should consider the role of technology learning opportunities throughout the teacher preparation program as fostering the *integration of technology and pedagogy*, viewing technology as "a tool that helps students to learn content in different and effective ways" (Perkmen & Pamuk, 2011, p. 48). The use of the TPACK framework and the development technology self-efficacy can—and should—go hand-in-hand.

Linking TPACK and Technology Self-Efficacy

Different individuals will have differing areas of strength and weakness for teaching with technology (Ertmer et al., 2012; Hsu & Kuan, 2013). While this is the case, emphasizing the interrelatedness of the TPACK knowledge domains and the development of technology self-efficacy can help to meet the learning needs of all pre-service teachers for teaching with technology. The TPACK framework can be a useful means of structuring the learning opportunities regarding the knowledge and skills needed for effective technology integration. Emphasizing the development of self-efficacy can be an effective way to cultivate the attitudes necessary for effective technology integration for all pre-service teachers.

There are some initial attempts to explore the relationship between the TPACK framework and pre-service teachers' technology self-efficacy. Perkmen and Pamuk (2011) suggested that pre-service teachers' capability to use instructional technologies in the classroom is a direct function of their self-efficacy. Teachers must both have knowledge about technology as well as a belief that there is value in teaching with technology for good technology integration to take place. Recognizing this, Abbitt (2011) investigated the link between the TPACK framework and self-efficacy beliefs. He used two survey instruments to measure each of these domains and synthesized the results. Abbitt's (2011) study concluded that a pre-service teacher’s TK, PCK, and TPK were statistically significant, positive predictors of an individual's self-efficacy for technology integration.

More recently, Kramarski and Michalsky (2015) conducted a study investigating the impact of instruction and practice at developing lessons using the TPACK framework as a structure for technology integration. They were particularly interested in the impact of this approach on pre-service teachers’ self-efficacy for technology integration. The results of this study indicated a significant correlation between technology self-efficacy beliefs and the development of lessons that incorporate the TPACK framework's knowledge domains (Kramarski & Michalsky, 2015). The implication of this result is that individuals with higher levels of technology self-efficacy are better able to translate their beliefs into constructivist teaching practices (i.e., student-centered technology integration), rather than simply using technology tools for presentation of content (i.e., teacher-centered technology integration) (Kramarski & Michalsky, 2015). While these are just two studies, they are suggestive of the value of connecting these two theoretical frameworks.

Considering how to foster the development of knowledge, skills, and attitudes for technology integration then, emphasizing both teacher knowledge domains (Mishra & Koehler, 2006) as well as teacher technology beliefs (Ertmer, 2005) may be a clear path forward. Enactive experiences aimed at mastery will have the strongest effects on the development of self-efficacy (Bandura, 1997). Pre-service teachers' technology knowledge and skills evolve over time (Mishra & Koehler, 2006). As they continue to develop a more robust view of the role of educational technologies, they become better able to discern the tools and skills that will be most relevant to their future teaching practice (Abbitt, 2011; Graham et al., 2012; Koh & Divaharan, 2011). Coursework should be structured to allow for repeated exposure to learn, observe, and practice the skills needed for technology integration (Kivunja, 2013; Wang & Chen, 2007). This sort of curriculum design for the teacher preparation program will provide occasions for enactive experiences for pre-service teachers learning to integrate technology (Bandura, 1997). Abbitt (2011) specifically recommended the TPACK framework as a means of developing technology self-efficacy in the structure of the teacher preparation program. However, even with the TPACK framework to guide their learning, pre-service teachers will need multiple opportunities to work with different educational technologies, and develop learning activities that incorporate these technologies within their content areas (Graham, Borup, & Smith, 2012; Tournaki & Lyublinskaya, 2014). They also will need chances to explore how various technologies could be best used for teaching key concepts in different content areas (Ertmer & Ottenbreit-Leftwich, 2010; Harris et al., 2010; Tournaki & Lyublinskaya, 2014). These types of first-hand, enactive experiences will strongly support the development of technology integration abilities.

Vicarious learning experiences, verbal encouragement, and a supportive learning environment all have a role to play as well (Bandura, 1997). Pre-service teachers need opportunities to observe exemplary technology integration repeatedly throughout their teacher preparation program to develop self-efficacy (Ertmer & Ottenbreit-Leftwich, 2010; Koh & Divaharan, 2011; Mouza & Karchmer-Klein, 2013; Wang et al., 2004). The TPACK knowledge domains can, and should, be used to frame these learning experiences (Abbitt, 2011; Mishra & Koehler, 2006; Polly, 2014). Likewise, pre-service teachers should have opportunities to interact with their instructors and their classmates, soliciting regular input and feedback on their developing knowledge, and the abilities to integrate the various TPACK knowledge domains (Colvin & Tomayko, 2015; Koehler et al., 2007). Conducting this work in an appropriately-challenging atmosphere of support and encouragement, should help develop technology self-efficacy (Gilakjani, 2013; Lambert & Gong, 2010; Kovalik et al., 2013).

It is true that neither the TPACK framework nor an emphasis on technology self-efficacy can be guaranteed to produce effective technology integration abilities for pre-service teachers. Although the TPACK framework has found wide acceptance (Voogt et al., 2013), it is not a panacea that will solve all technology integration concerns for pre-service teachers (Archambault & Barnett, 2010). Likewise, Wang et al. (2004) noted that "enhanced self-efficacy beliefs do not automatically translate into the actual use of technology" in the classroom (p. 242). In spite of this, Wang et al. (2004) encouraged teacher educators to focus on developing pre-service teachers' self-efficacy for technology integration, because, "[self-efficacy beliefs] are a necessary condition for technology integration" (p. 242). These approaches may inform teacher educators' work, but pre-service teachers' experiences may still vary.

Positioning the Study within Self-Efficacy for Technology Integration

This study is a mixed methods case study investigating how pre-service teachers perceive their abilities to integrate technology into the classroom. The theoretical framework, as described above, emphasizes both self-efficacy theory as well as the TPACK framework for technology integration. In this section, this study will be positioned within the existing literature related to preparing pre-service teachers for technology integration, and the research on self-efficacy for technology integration in particular.

Presciently, Bandura (1986) described the challenges associated with an increasingly technological society, and the importance of strong self-efficacy for coping, stating, "Rapid technological and social changes constantly require adaptations calling for self-reappraisals of capabilities" (p. 418). This is definitely the case for today's teachers—including pre-service teachers—who find themselves in classrooms that are often brimming with educational technologies (Davies & West, 2014), and a general societal expectation that more technology leads to better learning outcomes (Barreto & Orey, 2014; Laferrière et al., 2013). A strong sense of self-efficacy for technology integration is needed to effectively teach in such an environment (Abbitt, 2011; Canbazoglu Bilici, Yamak, Kavak, & Guzey, 2013; Lee & Lee, 2014).

Because self-efficacy beliefs have strong implications impacting many areas of the teaching profession, there has been much interest in recent years in researching teacher self-efficacy. Research on self-efficacy among teachers burgeoned during the first decade of the 21st century, with hundreds of studies being conducted (Klassen & Usher, 2010). A comprehensive body of research regarding teacher self-efficacy has continued to develop in 2010 and beyond (Huang, 2016; Klassen, Durksen, & Tze, 2014; Klassen & Tze, 2014; Zee & Koomen, 2016). These studies, however, span the whole range of the teaching profession (Klassen & Usher, 2010; Walsh, 2008; Woolfolk Hoy et al., 2006). Narrowing focus to only consider the literature related to self-efficacy for technology integration results in fewer research reports, but there is still considerable diversity present.

Using the search terms “pre-service teachers,” “self-efficacy,” and “technology integration,” a search of three research databases was conducted, including Academic Search Complete, ERIC, and Education Research Complete. This search resulted in only 14 results, all of which were peer-reviewed articles. Of these 14 articles, twelve were quantitative studies of various types, one was a mixed methods study, and one was a literature review. Because of this very small number of studies, another search was undertaken using the Learning and Technology Library database, which is more specifically dedicated to the field of educational technology. Using the same search terms listed above, this search resulted in 307 results, comprised of 209 conference papers, 88 journal articles, eight ebooks, and two dissertations. Eliminating the conference papers from the results, and adding the search term, “case study” to the previous, the results were limited to 36 articles. Most of these, however, were articles related to using case studies as a teaching tool to help pre-service teachers learn about technology integration, rather than exemplifying a case study methodology for the study. Only six of the original 88 articles were case studies related to developing self-efficacy for technology integration among pre-service teachers, somewhat similar to this study. Even these, however, had noteworthy differences from the present study, emphasizing the effects of specific interventions on pre-service teachers' self-efficacy rather than seeking to capture their broad perceptions of their self-efficacy for teaching with technology.

Much of the existing literature related to self-efficacy for technology integration in pre-service teachers fits into three broad categories. The first group is made up of experimental or quasi-experimental studies; this was the largest category in the literature. These studies generally seek to measure pre-service teachers' self-efficacy for technology integration before and after a technology-oriented treatment, such as instruction in how to teach with a specified technology tool, such as iPads (see Heo, 2009; Keengwe, Pearson, & Smart, 2009; Minshew & Anderson, 2015). The next group of similar studies includes investigations of the effectiveness of a particular instructional method. While a somewhat smaller collection, these studies are similar to the first group in that they evaluate pre-service teachers' self-efficacy for technology integration due to the influence of this intervention (see Alexander & Kjellstrom, 2014; Kinuthia, Brantley-Dias, & Junor Clarke, 2010; Ward & Overall, 2011). The third category is comprised of theoretical papers elaborating the role of teacher beliefs (including self-efficacy) for effective technology integration (see Chen, 2004; Galvis, 2012; Sherry, 1998). This category was the smallest, with only a handful of papers of this type. Thus, with so much of the existing literature related to self-efficacy for technology integration in pre-service teachers being either theoretical reviews, or else experimental or quasi-experimental in nature, the current study serves as a complement to this existing literature.

Searching the ProQuest Dissertations and Theses Global database with the search terms "pre-service teachers" and "self-efficacy" and "technology integration" resulted in over 1200 dissertations. Narrowing this search by adding the term "explanatory case study" resulted in 61 studies. Investigating these, many are reports of specific interventions, similar to the purely quantitative articles listed above. These are case studies articulating a particular teaching methodology or technology tool was added to a teacher preparation program, and the implications of those changes for the pre-service teachers. Only a few of the studies in this search were similar to the present study (e.g., Blakeney, 2014; McManus, 2014). These studies, however, were carried out at large, public universities. The present study was conducted to investigate the teacher preparation program at a private comprehensive college situated in a rural area. Thus, the present study serves as a complement to the existing literature, and fills a gap in the research that has been done to date regarding understanding pre-service teachers' self-efficacy for technology integration.

Chapter Summary

This chapter provided a review of the relevant literature for understanding the challenges of preparing pre-service teachers for technology integration. Beginning with an exploration of the challenges of integrating educational technologies into one's teaching practices an examination of two theoretical frameworks commenced. First, the TPACK framework was described as a way of describing the knowledge domains required for effective technology integration. Second, the role of technology self-efficacy was examined as a means of supporting pre-service teachers' implementation of technology integration. After a discussion of how these two theoretical frameworks complement each other, this chapter concluded by positioning this study within the body of existing literature related to preparing pre-service teachers for technology integration. In the next chapter, the methods of this study will be elaborated.

CHAPTER 3: METHODS

The primary goal of this convergent parallel mixed-methods case study was to understand pre-service teachers perceptions about how they are prepared to integrate technology into the classroom. To do so, this study provides a detailed description of how the Teacher Preparation Program at Dordt College functions to prepare pre-service teachers to integrate technology into their teaching practices. Surveys as well as semi-structured interviews were conducted to provide a comprehensive picture of pre-service teachers opportunities to learn about technology integration throughout the Teacher Preparation Program. A review of relevant institutional and program documents was also conducted. Two research questions guide the inquiry in this study:

1) What are pre-service teachers' perceptions of their ability to integrate technology into the classroom?
2) To what do pre-service teachers attribute their ability to integrate technology into the classroom?

This chapter begins with a brief explanation of the role of the researcher in case study research and the philosophical assumptions the scholar brings to this study. The remainder of the chapter elaborates on the research methods employed in this study to develop a clear description of this case. This elaboration includes the design of the study, the methods utilized to select participants, the instruments used for quantitative and qualitative data collection, the protocols for data collection, the procedures for data analysis, and mechanisms utilized to ensure trustworthiness.

Case Study Research and the Approach of the Researcher

According to Creswell (2013), “qualitative research begins with assumptions and the use of interpretive/theoretical frameworks that inform the study of research problems” (p. 44). He also explained a shift in the literature concerning qualitative methods through the past decade towards greater attention to the interpretive nature of qualitative methods, specifically the reflexivity and “presence” of the researcher in their research (Creswell, 2013, p. 45). Notably, Creswell exhorted his readers,

> Qualitative researchers need to ‘position’ themselves in their writings. This is the concept of reflexivity in which the writer is conscious of the biases, values, and experiences that he or she brings to a qualitative research study. One characteristic of good qualitative research is that the inquirer makes his or her ‘position’ explicit. (Creswell, 2013, p. 216)

Creswell (2013) modeled this approach himself, sharing his journey as a mixed-methods and qualitative researcher in his opening chapter (see pp. 6-7), and explaining his personal philosophical framework periodically throughout the text. With this encouragement and theoretical basis, here I will attempt to “place myself” in the design of this study, explaining my epistemological leanings—and how they connect to those of the seminal case study authors, Yin and Stake—because this will illuminate how they have impacted my case study design. In the section that follows, the epistemologies of these two prominent methodologists in case study research are briefly compared and contrasted.

Yin’s approach

Yin takes a generally positivist approach toward case study, emphasizing that the result of case study research will be established facts (Yazan, 2015). Yazan (2015) noted, however, that Yin does not specifically address his philosophical assumptions in his writing. Yin’s positivist epistemology is inferred by his statements about the high importance of validity and reliability and quality control in the research process (Yazan, 2015). These sorts of features would be essential for certainty about the results of a case study investigation, illustrating a positivist orientation. Yazan (2015) also highlighted that Yin does not distinguish between qualitative and quantitative methods in case study research, and rather looks for common ground between these two research traditions.

Stake’s approach

In contrast to Yin's thin treatment of epistemological issues, Yazan (2015) suggested that Stake takes deliberate care to explain his philosophical approach to case study research. Stake has embraced a constructivist and existentialist (non-determinist) approach to qualitative case study research (Yazan, 2015). Stake squarely identifies case study as a qualitative method, and appraises case study researchers as "interpreters, and gatherers of interpretations which require them to report their rendition or construction of the constructed reality or knowledge that they gather through their investigation" (Yazan, 2015, p. 137). Stake (1995) also expects the reader of a reported case study to make his or her own interpretation as well.

Placing Myself in the Research

Thinking through my philosophical assumptions as they apply to my research interests in educational technology, I believe my epistemological leanings are most in line with the perspectives espoused by Stake (1978, 2005). My approach to case study is informed by constructivism, which is more closely aligned to Stake's view than Yin's more positivist stance (Yazan, 2015). When I read, "most contemporary qualitative researchers hold that knowledge is constructed rather than discovered" (Stake, 1995, p. 99), this rings true for me. I conceive of my role as a researcher as collecting the pieces, and then fitting together the puzzle to interpret the situation of the case under investigation. However, even as I note that I align myself with Stake's constructivist approach, I do recognize that there are some elements of Yin's approach that are appealing to me as well. In particular, Yin's (2014) suggestion that both qualitative and quantitative data can be useful in developing a case study is valuable to me, along with some of the tools of inquiry Yin (2006; 2013; 2014) has laid out more specifically than Stake (1995).

The flexibility of Stake's (1995) design approach appeals to me so that I can adjust my research while in process as I learn more about the case under investigation. As Stake (2005) reminded case researchers, "One cannot know at the outset what issues, perceptions, or theory will be useful" (p. 456). Certainly, this study began with clear research questions and a planned approach to collecting data. However, as Stake (2005) noted,

> Case researchers usually enter the scene expecting, even knowing, that certain events, problems, and relationships will be important; yet they discover that some of them, this time, will be of little consequence. Case content evolves even in the last phases of writing. (p. 456)

Because I developed this case over time, I wanted to be able to be flexible enough to adapt to the data that emerged as the story unfolded.

Design of the Study

Case study is a complex research methodology, comprised of different methodological approaches that can be selected depending on the needs and goals of the researcher (Stake, 2005; Yin, 2014). Also, there are several general approaches to case study research that align to the researchers' underlying epistemological beliefs (Creswell, 2013; Merriam, 2009). In the next section, the specific design of this study is elaborated in light of the various types of case studies and the different approaches available for case study researchers.

Type of Case Study

I am interested in *how* people use technology for teaching and learning; as a teacher educator, I am concerned about my students' (pre-service teachers) abilities to integrate technology into their classroom practices. I conducted an instrumental case study (Stake, 1995) to investigate the issue of developing self-efficacy for technology integration for pre-service teachers in a teacher preparation program. This type of case study is intended to generate or confirm theoretical understandings illustrated by the case (Merriam, 1998). Instrumental case study designs are analytical in nature and aimed at understanding not just *what*, but *why*. My design for this research comprised a single-embedded case design (Yin, 2006; 2014), with the Teacher Perparation Program at Dordt College as the unit of analysis for my inquiry.

The Value of Mixed Methods in Case Study Research

While some authors have cautioned against mixing methods, there may be strengths to using both qualitative and quantitative data in crafting a case study (Pinto, 2010; Wilson, 2009). Case study is viewed by some authors as a purely qualitative methodology (Creswell, 2013; Eisner, 1991; Flyvbjerg, 2006; Stake, 1995). Yin (2014), however, advocated both qualitative descriptions as well as quantitative statistics as valuable data for case study research, reflecting his belief that case study may transcend the qualitative-quantitative duality. While I have gravitated towards the qualitative case study methods generally, Mardis, Hoffman, and Rich (2014) described the difference between quantitative and qualitative methods in the field of educational technology as a "slippery divide," noting that all methods have strengths and weaknesses.

It is becoming increasingly common for educational technology researchers to mix methods based on the needs of the study and the "real-world complexity" of the research context (Mardis et al., 2014, p. 175). Thus, I have incorporated both quantitative data collection in the form of a survey alongside the qualitative data collection conducted through interviews. While the qualitative and quantitative data in this study were collected independently, connections between the results from each data source were uncovered through the process of data analysis. At the interpretation stage, these data were compared and related through a process of triangulation of results in order to create a trustworthy, credible account of the findings (Creswell, 2012). This mixed-methods approach is illustrated in Figure 2.

This mixed-methods approach guided the particular tools and approaches for selection of participants, instrumentation, data collection, and data analysis, as described

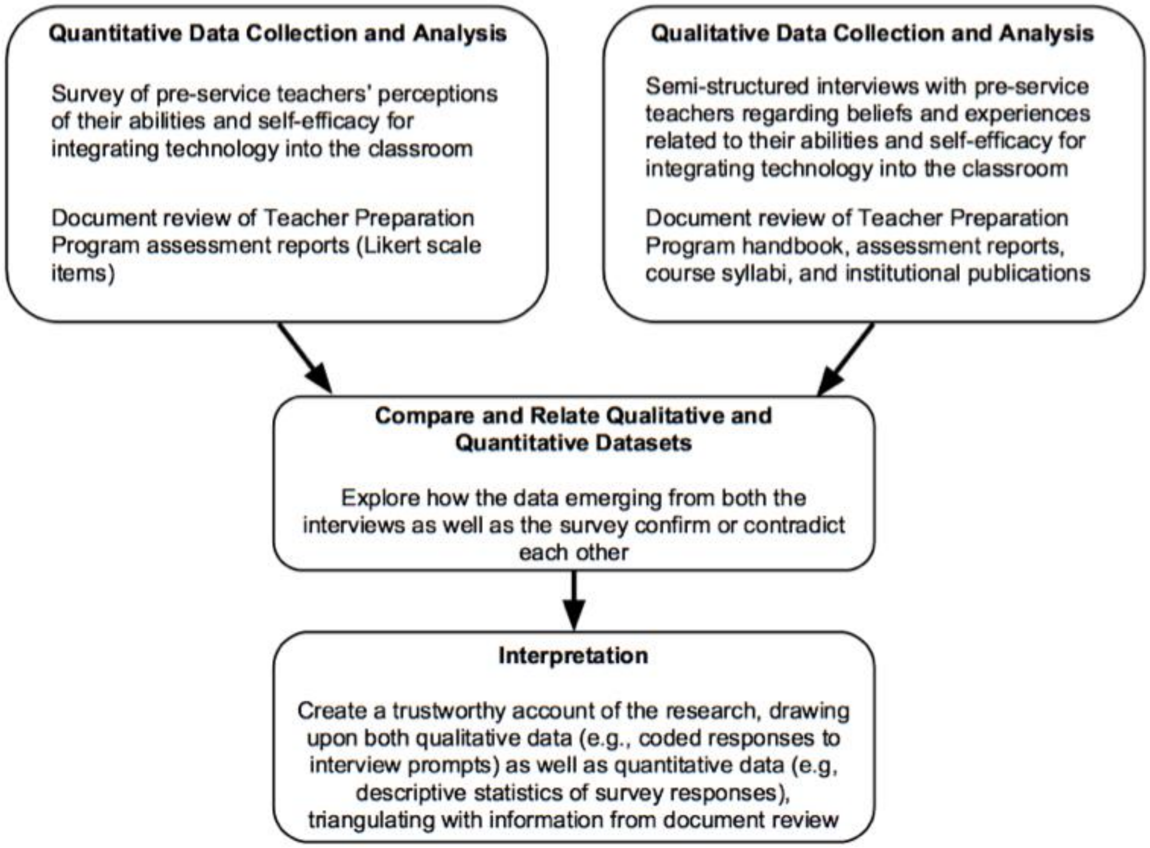

Figure 2 Approach for mixing methods in this case study

in the sections that follow. Table 2 indicates the research questions for the study, the methods for data collection, and the methods for data analysis. All of these elements of the study will be elaborated in the sections that follow.

Selection of Participants

Yin (2013) specifically notes that case studies, by design, are *not* randomly selected and that the participants must be thoughtfully chosen as well. Creswell (2013) advised case study researchers to use maximum variation as a sampling strategy. This sampling strategy involves purposefully selecting participants who can offer unique

Table 2 Research questions and methods of data collection and analysis

Research question	Data collection	Data analysis
Question 1: What are pre-service teachers' perceptions of their ability to integrate technology into the classroom?	Survey	Descriptive statistics and correlation analysis, pattern matching
	Semi-structured interviews	Pattern matching and memoing
	Document review	Pattern matching and memoing
Question 2: To what do pre-service teachers attribute their ability to integrate technology into the classroom?	Semi-structured interviews	Pattern matching and memoing
	Document review	Pattern matching and memoing

views from multiple perspectives on the case and thus provide a fuller picture of the situation. In light of these recommendations, several sampling strategies were used.

In the quantitative element of the study (i.e., a survey), three purposefully selected convenience samples of pre-service teachers were invited to participate and share their self-perceived knowledge and skills for technology integration and self-efficacy for technology integration. The three samples were comprised of intact class groups of three different courses, which are illustrated in Table 3. The pre-service teachers invited to participate included the members of a first-year Educational Foundations course enrolling 66 students (in two sections), the members of a second-year Curriculum and Instruction course enrolling 36 students (in two sections), and the members of an upper-level (fourth-

Table 3 Pre-service teachers invited to participate in the survey

Course	Status in program	N in this class section
Introduction to Education (1)	First course in the program	33
Introduction to Education (2)	First course in the program	33
Planning, Instruction, and Assessment (1)	Sophomore or Junior standing	19
Planning, Instruction, and Assessment (2)	Sophomore or Junior standing	17
Senior Seminar	Final semester prior to student teaching	40

year) Senior Seminar course enrolling 40 students. These class groups were selected because they represent participants at three different points along their progression through the teacher preparation program: One group is comprised of individuals just beginning their work as pre-service teachers, another is made up of students who have taken several courses in the program, and the third group of individuals have completed most of their work in the program and are readying themselves for their student teaching experience.

For the qualitative element of the study (i.e., semi-structured interviews), a maximum variation sample of the pre-service teachers who completed the survey was invited to participate. These pre-service teachers were invited to share in semi-structured interviews about their opportunities to learn about technology integration and the experiences they have had to help them learn how to integrate technology into the classroom. Along the recommendations of Creswell (2013) for maximum variation, pre-service teachers of different genders, various years in the program (i.e., members of the

Introduction to Education course; Curriculum, Instruction, and Assessment course; and the Senior Seminar), and a range of major or program emphasis (e.g., early childhood education, middle school mathematics, and K-12 music) were invited to participate. Creswell (2012) recommended keeping the number of participants in a qualitative inquiry small. A reasonable number of participants ensures that the data collection remains manageable for the researcher while also allowing for in-depth inquiry into what that participant has to offer for understanding the case.

I initially identified a list of twenty pre-service teachers among the survey completers that would provide a maximum variation sample based on the demographic characteristics listed above. This list included fourteen women and six men. It included ten pre-service teachers in the Senior Seminar class (because they had completed a majority of the program, and would be able to speak more specifically about their experiences throughout the TPP). The other ten were pre-service teachers in either the Introduction to Education class group or the Planning, Instruction, and Assessment class group. For the majors and endorsements, my initial list included eleven Elementary Education majors, six Secondary Education majors, and three K-12 Subject Area majors, which reflects the approximate distribution of these majors throughout the TPP. I also included three students with an Early Childhood endorsement (in addition to their Elementary Education major), and three with a Middle School endorsement (in addition to their Elementary or Secondary major.)

I initially invited ten of these to participate, but three of them declined. I proceeded with the first seven interviews, and afterward, I invited another four survey completers to ensure a maximum variation sample. Thus, for this study, eleven pre-service teachers were included in the qualitative inquiry to ensure that saturation was met.

Instrumentation

Instruments used to collect the data included semi-structured interviews with pre-service teachers that followed a survey of pre-service teachers.

Description of Survey

For the quantitative data collection, a survey instrument to measure pre-service teachers' self-perceptions of their knowledge and skills for teaching with technology and their self-efficacy for technology integration was adapted from two published instruments for this purpose. This adapted instrument was piloted during the spring of 2016, and is included in Appendix A. Subscales of this instrument were evaluated for reliability, and the survey was found to be reliable, with all four of the included subscales were in the acceptable range ($\alpha > .70$) (Nunnally, 1978, as quoted in Hatcher, 2011, p. 87). These reliability statistics are presented in table 4.

The first instrument adapted for use in this survey was an instrument aligned to the TPACK domains developed by Schmidt et al. (2009) to measure pre-service teachers' self-perceptions of their knowledge and skill for teaching with technology. Three subscales of this survey were selected for use in this project, comprising the TK, TPK, and TPACK domains of the TPACK framework. These subscales were selected because these three domains have the strongest impact on technology self-efficacy (Abbitt, 2011). The second instrument was created and validated by Wang, Ertmer, and Newby (2004) to measure pre-service teachers' self-efficacy for teaching with computer technology. Language from this instrument was adapted to broaden it slightly. The original survey by

Table 4 Subscales of survey, including reliability statistics

Subscale	Cronbach's Alpha	N of Items
Technological Knowledge (TK)	.902	7
Technological Pedagogical Knowledge (TPK)	.774	5
Technological Pedagogical Content Knowledge (TPACK)	.833	5
Self-Efficacy for Technology Integration (SE-TI)	.918	16

Wang and colleagues (2004) focused on computer self-efficacy; items were rephrased to indicate "technology" more generally. (For example, an item on the original survey was phrased, "I feel confident I can help students when they have difficulty with the computer." This was rephrased as, "I feel confident I can help students when they have difficulty with technology.") The adapted items from these two instruments (i.e., Schmidt et al., 2009; Wang et al., 2004) were combined into one instrument comprised of 40 items: 7 demographic items, 17 items related to TPACK knowledge domains, and 16 items related to self-efficacy for technology integration.

<u>Description of Semi-Structured Interviews</u>

The individual interviews were conducted following a model described in Richardson et al. (2008). Seven interview questions were developed to understand: 1) formal learning opportunities in the Teacher Preparation Program for developing knowledge, skills, and attitudes needed for effective technology integration, 2) informal technology learning opportunities, 3) development of self-efficacy for teaching with technology, and 4) beliefs about the best way for pre-service teachers to learn about technology integration. Survey questions asked of pre-service teachers are included in

Appendix B. Because these interviews were conducted in a semi-structured, conversational format, the specific phrasing varied slightly from one interview to the next. However, each of the questions was asked of each participant.

Data Collection

The proposal for this case study was submitted to the Institutional Review Board at Boise State University, and received approval on October 26, 2016. After this approval, the data collection process began. This study incorporated a convergent parallel mixed-methods design (Creswell, 2012). Creswell indicates that a convergent parallel design allows the quantitative data to “simultaneously collect both quantitative and qualitative data, merge that data, and use the results to understand a research problem” (Creswell, 2012, p. 540). Creswell (2012) also noted that the quantitative and qualitative data may play different roles in understanding the research problem, suggesting that a strength of this approach is that it, “combines the advantages of each form of data; …quantitative data provide for generalizability, whereas qualitative data offer information about the context or setting” (p. 542). In this study, the qualitative data was utilized primarily for elaboration of how pre-service teachers express their perceptions regarding their abilities to integrate technology into the classroom, and their experiences learning about technology integration. The quantitative data were used to understand how pre-service teachers self-assess their knowledge, skills, and self-efficacy for technology integration, and to triangulate the findings of the qualitative data.

Multiple data sources are necessary to arrive at a trustworthy understanding of how the Teacher Preparation Program is impacting the development of self-efficacy for technology integration. This study utilized both qualitative and quantitative data in the form of semi-structured interviews, document reviewing, and a survey administered to three groups of students at different stages in the Program. Many case study researchers—including both Stake (1995) and Yin (2014)—recommend triangulation from multiple sources in data analysis. Stake's depiction of triangulation is that it serves to "clarify meaning by identifying different ways that the phenomenon is being seen" (p. 444); this is why the multiple data sources (i.e., both surveys and interviews) were desirable in this proposed study. Table 5 illustrates the timeline for data collection in this study.

Table 5 Data collection methods and timeline

Data collection methods	Timeline
Document collection and analysis	October 10 – 25, 2016
Survey	October 28 – November 4, 2016
Semi-structured interviews (with students)	November 16 – December 2, 2016

Program Document Review

Document review provided contextual information relevant to this case study. Creswell (2012) noted that documents are a valuable source of information for qualitative researchers, as they can provide background information for comparison with other collected data. Documents have the benefits of being stable (i.e., able to be reviewed as needed), specific (i.e., containing exact details), and unobtrusive (i.e., not created as a result of the case study), which make them a valuable source of data (Yin, 2014). Yin (2014) also suggested that documents are one of the most important sources of corroborating evidence for comparison with other data sources.

Several types of documents were reviewed in the process of developing this study. Catalog descriptions of courses and syllabi for courses in the Teacher Preparation Program are publicly available and helped to illustrate the changes to the structure of the program over time. These were examined to understand the structure of the core courses of the TPP, and to determine which courses included instruction related to technology integration. Additionally, the TPP collects annual assessment data from graduating seniors as well as graduates with one, three, and five years of teaching experience. The survey used to create these annual reports includes items asking graduates to rate various aspects of the TPP on a five-point scale. Several of these items specifically address educational technology and technology integration. Additionally, graduates respond to open-ended prompts about the strengths and weaknesses of the program. These responses were explored for specific comments about graduates' experiences learning about educational technologies and technology integration. Thus, these annual assessment reports were used as historical data for building a background of the development to the present, and used for comparison to both the interview responses as well as the quantitative data collected in this study as a means of corroborating the findings from these other sources. A variety of other documents, including the Dordt College Faculty Handbook, the Dordt College Teacher Preparation Program Handbook, and information distributed through the Dordt College website were also utilized for explaining the context of this case study.

Survey

Wiersma and Jurs (2005) suggested that survey research is a valuable data collection tool for educational researchers conducting mixed-methods research. While most case studies tend to be qualitative in nature, including quantitative data collected via survey can provide another viewpoint into the situation (Mardis et al., 2014). Surveys are a useful tool in education research for describing data trends (Creswell, 2012) and Yin (2014) advocated their use in case study research.

The survey instrument was administered electronically using Boise State University's instance of Qualtrics, a software package designed to facilitate online survey distribution. A digital coversheet was included informing potential participants of their rights, and inviting them to continue if they agree and understand their rights. Links to the survey were distributed via email to the purposefully selected class groups identified (i.e., Introduction to Education; Planning, Instruction, and Assessment; and Senior Seminar) with an invitation to participate in the study. No students were required to participate, but all invited participants were encouraged to do so. The survey is comprised of seven demographic questions, seventeen items related to technology integration knowledge and skills, and sixteen items related to pre-service teachers' technology self-efficacy (Appendix A). The pre-service teachers were allowed to complete the survey in their own residences on their personal devices, and were given one week to complete the survey before the data collection period ended.

Interviews

Interviews are a common data-collection method in qualitative research, including case studies (Creswell, 2012; Yin, 2014). Semi-structured interviews provide an organization for the interview while still allowing the conversation to flow naturally (Merriam, 1998). Along the same lines, Creswell (2012) recommended asking open-ended questions prepared ahead of time, but being flexible to follow the responses offered by the interviewee. Recording the interview, with the permission of the interviewee, is considered a best practice for qualitative research (Creswell, 2013; Savenye & Robinson, 2004; Yin, 2014).

The semi-structured interviews were conducted according to the following protocol. Interviews took place in a quiet conference room where interruptions were unlikely, and the potential for good-quality audio recording was probable. Interviewees were asked to grant permission for the audio to be recorded; all eleven interviewees gave this permission. As such, the interviews were recorded using audio recording software and later transcribed for data analysis. Each interview participant was asked some ice-breaker questions initially to put them at ease and begin the conversation (Creswell, 2012), followed by several open-ended questions regarding the structure and practices of the Teacher Preparation Program for fostering the knowledge and skills for technology integration as well as self-efficacy for technology integration among pre-service teachers. Appendix B includes the questions pre-service teachers were asked in their interviews, but as these interviews are intended to be conversational in nature, the specific phrasing of the questions varied somewhat from interview to interview. During each interview, I also took notes on an interview protocol sheet that included the sample questions. Each interview lasted approximately half an hour, and each participant was interviewed only once. The interviews were conducted over an approximately two-week period during the fall of 2016.

Data Analysis

Among the case studies conducted in the field of educational technology, an interpretivist approach is regularly employed, in which the researcher seeks to interpret and explain the experience of an event or phenomenon from the participants' point of view (Mardis et al., 2014). Data analysis in this study was conducted flexibly, discovering themes that emerged (Stake, 1995). Triangulation was a key strategy for connecting themes that arose from the quantitative and qualitative datasets.

Quantitative Analysis

The quantitative data from the survey was analyzed with descriptive statistics, and examined for trends among the various subscales. Additionally, correlation analysis and MANOVAs exploring the subscales and demographic items were conducted. This approach for utilizing quantitative analysis as part of the development of a case study is advocated by Yin (2006; 2014), and is in line with what Creswell (2012) described as a convergent parallel research design. Yin (2006) argued for multiple data sources for a case study so that triangulation of results is possible. Utilizing multiple data sources—including both qualitative and quantitative sources—that point to the same finding can strengthen the overall reporting of the case.

For this study, particular areas of interest in the quantitative analysis were comparisons of gender, major/endorsement area, and year in the program, as well as correlations between the various subscales of the survey instrument.

Qualitative Analysis

Creswell (2012) encouraged qualitative researchers to think of data collection, data analysis, and report writing as interrelated tasks in the research process, and even suggested that they might go on concurrently in the research process. Thus, qualitative data analysis in this study, in fact, began alongside the data collection taking place through interviews with pre-service teachers and continued after the data collection was completed, and even through the process of composing analyses of the themes that emerged.

Transcription.

As indicated, interviewees were asked to consent to have their interview recorded. These recordings were transcribed by a transcription service to create easily readable documents that captured the totality of each interview. Upon receiving the transcriptions, each document was analyzed for completeness, and corrections were made based on my knowledge of the context, notes made during the interviews, and by reviewing the audio files. This process was an important part of the qualitative analysis as it represents a first pass through the data, and provided an opportunity to begin to develop themes that were already beginning to emerge.

Coding.

Pattern coding was an essential part of the approach to analyzing the interview responses. Creswell (2013) recommended beginning with a short list of five or six categories for the researcher to use in coding the data for analysis, though he also noted that other researchers recommend a greater number of code categories. The use of coding allowed for development of the themes as they emerged from the data (Creswell, 2013; Yin, 2014). The initial coding scheme was comprised of six categories: 1) technological knowledge, 2) technological content knowledge, 3) technological pedagogical knowledge, 4) TPACK, 5) informal technology learning, and 6) technology self-efficacy, as these were the primary interest areas from the outset of this study. However, as indicated by Stake (2005), qualitative research demands flexibility; as such, additional categories developed through the data analysis process. Through the coding process, six additional coding categories were identified as themes began to emerge.

Memoing.

Memos are short notes the researcher writes throughout the research process (Creswell, 2012). Memos are helpful for making sense of the data and the coded categories. The compilation of these memos is helpful for making sense of the data and the coded categories (Creswell, 2012; Savenye & Robinson, 2004; Yin, 2014). Memos were, therefore, noted throughout the data analysis process (and even the data collection process) to guide the development of the story of the research (Stake, 2005).

Creating a Trustworthy Account of the Research

Case study research may be compared to detective work, with the researcher sorting through the evidence and putting the pieces in place to create a believable, compelling story that accounts for all of the facts that have been uncovered (Eisner, 1991). This approach demands multiple sources of data to tell the most credible story possible (Creswell, 2013; Lincoln & Guba, 1985; Stake, 1995), and both qualitative and quantitative data are valuable for conveying a trustworthy account (Yin, 2014).

The case study researcher in the field of educational technology must be concerned about the trustworthiness of the research (Hoepfl, 1997; Ross, Morrison, & Lowther, 2010). Many authors recommend Lincoln and Guba's (1985) criteria for naturalistic inquiry as a framework for judging trustworthiness of case studies, admonishing the researcher to aim for credibility, transferability, dependability, and confirmability (Creswell, 2013; Hoepfl, 1997; Merriam, 1998; Ross et al., 2010; Stake, 1995). Lincoln and Guba (1985) link these criteria to familiar terminology from quantitative research, drawing comparisons between internal validity, external validity, reliability, and objectivity, respectively to the four previous. In his approach to data validation, Stake (1995) emphasizes *transferability* over "generalizability" and *credibility* over "external validity." The goal of this study was to produce a credible report of pre-service teachers' self-efficacy for technology integration as developed in one teacher preparation program; the hope is that the findings of this study may be transferable to other teacher preparation programs to inform their practices as well. Member checking, triangulation of data sources, and rich, thick description were utilized to ensure this study's findings are trustworthy.

Member Checking

Member checking is a technique in which the researcher returns to participants to affirm that the research accurately captured the participants' views and experiences (Creswell, 2013; Lincoln & Guba, 1985; Stake, 1995; Stake, 2005). Lincoln and Guba (1985) considered member checking "the most critical technique for establishing credibility" (p. 314). Stake (2005) advocated for member checking among other validation techniques to ensure the most credible interpretation possible. In this light, interview participants were invited to read and critique my depiction of their experiences and beliefs to confirm that their stories were accurately captured.

After transcription of the interviews and coding were complete, preliminary analyses were composed, highlighting the themes that emerged in the interviews. These analyses were shared with participants for their reaction and feedback, giving them the opportunity to fill in any gaps, add further information, and address my understanding of their experiences and beliefs. This approach is specifically encouraged by Creswell

(2013). The pre-service teachers had the opportunity to comment on my analysis of their contributions, and found it to be conducted soundly. The affirmation gained through the process of member checking adds additional trustworthiness to the results of this study.

Triangulation

Triangulation is broadly considered to be an effective approach for ensuring trustworthiness in case study research (Creswell, 2013; Eisner, 1991; Lincoln & Guba, 1985; Merriam, 1998; Savenye & Robinson, 2004; Stake, 2005; Yin, 2014). Triangulation is a process of drawing from a variety of different data sources and methods to generate corroborating evidence (Creswell, 2013). Eisner (1991) described triangulation as "structural corroboration," connecting multiple types of data from different sources and relating them to each other to support a particular interpretation of the data (p. 110). Triangulation from various data sources strengthens the case by demonstrating a “convergence of evidence” (Yin, 2014, p. 121). Comparison of results between interviews with pre-service teachers, and comparison between interviews and survey data were conducted, and all of these were held up against information located through document analysis with the goal of developing the most credible, trustworthy account possible.

Thick Description

Most qualitative researchers use the phrase “thick description” as a way of naming the reporting of the findings (Creswell, 2013; Eisner, 1991; Merriam, 2009; Mardis et al., 2014; Ponterotto, 2006; Savenye & Robinson, 2004; Stake, 2005; Yin, 2014). Merriam (2009) notes that the term is borrowed from the discipline of cultural anthropology, and this seems to be the case, as all of the researchers who use the phrase cite Geertz's *The Interpretation of Cultures: Selected Essays* (1973) as a source for this term. Creswell (2013) suggested that "rich, thick description" is a hallmark of trustworthy qualitative research, because, "With such detailed description, the researcher enables readers to transfer information to other settings and to determine whether the findings can be transferred" (p. 252). Thick description means that the author tells the story of the research in great detail, providing particular examples illuminating the themes that emerged from the data (Eisner, 1991; Stake, 1995). In his explanation of the development of the concept, Ponterotto (2006) distinguished between "thick" and "thin" description, with "thin" descriptions being superficial, while "thick" description

> accurately describes observed social actions and assigns purpose and intentionality to these actions, by way of the researcher's understanding and clear description of the context under which the social actions took place. Thick description captures the thoughts and feelings of participants as well as the often complex web of relationships among them. Thick description leads to thick interpretation, which in turns leads to thick meaning of the research findings for the researchers and participants themselves, and for the report's intended readership. Thick meaning of findings leads readers to a sense of verisimilitude, wherein they can cognitively and emotively "place" themselves within the research context. (p. 543).

Pontoretto (2006) admonished researchers utilizing interviews for data collection to include a thick description of the participants, procedures, results, and discussion. The reporting of this study was, therefore, composed with thick descriptions to ensure the most trustworthy and credible account possible.

Chapter Summary

Educational research is aimed at enhancing educational practices by suggesting possible improvements, offering new ideas, evaluating approaches, and building connections between practitioners and researchers (Creswell, 2012), and this is true within the subdomain of educational technology. Case study, while once a contested methodology for educational technology research (Mardis et al., 2014), has become an approach used widely in a variety of settings across the field of educational technology (Oliver, 2014; Ross et al., 2010). Many researchers advocate for case study research in education in general (Creswell, 2012; Maxwell, 2004; Merriam, 1998; Stake, 1995; Yazan, 2015; Yin, 2006).

This chapter explained the methodology used in this case study, elaborating the particular methods for selection of participants, instrumentation, data collection, data analysis, and promoting trustworthiness. The following chapter will illuminate the results of this study, utilizing thick description of the research context, the participants, and discussion of the participants' reported beliefs and experiences. These descriptions will shed light on how pre-service teachers in this case study are developing the abilities to integrate technology into their teaching practices.

CHAPTER 4: RESULTS

The purpose of this convergent parallel mixed-methods case study was to understand pre-service teachers' self-efficacy for successful technology integration in the classroom. This research was conducted during the Fall semester of 2016 at Dordt College and provides a snapshot of current students in the Teacher Preparation Program (TPP). In this chapter, I present a comprehensive description of the research context, the participants, the data analysis procedures, the findings, and a summary in which I explicitly relate the findings with the research questions. The findings are based on the analysis of survey data (N = 104) and semi-structured interview data (N = 11).

A detailed description of the setting, the participants, the procedures, and the results will be elaborated, following the suggestions provided by Ponterotto (2006) and Yin (2014). Therefore, this chapter begins with a description of the research context, which will be followed by an introduction to the researcher participants. After this, the data analysis procedures will be detailed. Finally, the findings of the study will be recounted in detail, to provide a comprehensive explanation of the experiences of the students in the TPP and the ways they have learned about technology integration.

Research Context

This study was conducted at Dordt College, a private, comprehensive college located in Sioux Center, Iowa. Dordt College is an institution that has played an important role in my life on both a personal and professional level; I am a graduate of the college, and I currently serve on the faculty. Creswell (2013) cautioned about the danger of conducting research “in one’s own ‘backyard,’” noting that while the site may be convenient and eliminate some obstacles to collecting data, the researcher must cautiously ensure that “multiple strategies of validation be used to ensure that the account is accurate and insightful” (p. 151). This sort of validation was my approach throughout the data collection and analysis, which I will describe in detail in this chapter. For example, the description of the research context that follows is based not only on my own observations of the college in general and the TPP specifically, but also thorough analysis of a variety of documents, including the Dordt College Catalog, the Dordt College Faculty Handbook, the Dordt College website, the Dordt College Education Department profile, the Dordt College TPP handbook for students, annual assessment reports of the Dordt College TPP, course syllabi archived in the Hulst Library at Dordt College, and the report of the Dordt College Year-long Student Teaching Pilot Study that TPP submitted to the Iowa Department of Education.

Dordt College has historically been affiliated with the Christian Reformed Church in North America. While the college is an institution with a strong religious orientation, it is not owned by any church or denomination. Instead, it is controlled by an incorporated free society and overseen by a board of trustees (Dordt College, 2015). Planning and development of the college began in the early 1950s, and classes began in 1955. The original building included four classrooms, and was located on land in Sioux Center, Iowa that had previously served as a mink farm, and was surrounded by farmland. (Dordt College, 2017a). The first class of 35 students were enrolled for training as future teachers, as the college was founded initially in response to the need for well-prepared teachers for Christian day schools in the area (Dordt College, 2015, 2017a). Over the next

60 years, the college grew in campus size, in enrollment, and in the number and diversity of programs being offered. Today, approximately 1500 students study at Dordt College across nearly 90 programs of study in the humanities, natural sciences, and social sciences (Dordt College, 2017c). The stated mission of the college is this: "As an institution of higher education committed to the Reformed Christian perspective, Dordt College equips students, alumni, and the broader community to work effectively toward Christ-centered renewal in all aspects of contemporary life" (Dordt College, 2017b). This mission guides the instruction, curricular programs, co-curricular programs, and campus atmosphere (Dordt College, 2015).

In keeping with the founding of Dordt College as an institution to prepare future teachers, Education continues to be the largest major. Approximately 250 undergraduate students are currently studying in the undergraduate Teacher Preparation Program, and approximately 120 graduate students are enrolled in the Master of Education program. Under the umbrella of the college's mission statement, the Teacher Preparation Program has its own mission statement that guides the work of the faculty and students: "The Dordt College teacher education program prepares students for service in diverse settings, equipping them with God-centered reflective and transformative skills, knowledge, and dispositions for teaching, learning, and leading" (Dordt College Teacher Preparation Program, 2017).

The Education department at Dordt College is comprised of nine full-time faculty members, two part-time faculty members, and about a half-dozen adjunct instructors (Dordt College Teacher Preparation Program, 2016). These faculty members have experience teaching in PreK-12 schools and bring their expertise to serve the needs of the pre-service teachers studying in the TPP. The TPP provides four major options for pre-service teachers, including 1) Elementary Classroom (all subjects), 2) Elementary Subject Area Specialist (art, music, physical education, Spanish, or special education), 3) Secondary Subject Area Specialist (with 20 different subject options, and 4) K-12 Subject Area Specialist (art, music, physical education, Spanish, or special education) (Dordt College, 2016).

All students majoring in Education take a shared core of ten courses, including the following: 1) Introduction to Education, 2) Learner Differences, 3) Learning Environments, 4) Lifespan Development, 5) Planning, Instruction, and Assessment, 6) Content Area Reading, 7) Applied Educational Psychology, 8) Philosophy of Education, 9) Service Learning Internship, and 10) Senior Seminar (Dordt College, 2016). Several of these courses have multiple options, depending on the grade level pre-service teachers are preparing to teach. For example, Planning, Instruction, and Assessment is differentiated into three different courses: one focusing on instruction at the elementary grade levels, one at middle school, and one at the high school level.

In addition to this common set of Education courses, all pre-service teachers in the TPP take one or more methods courses, along with a content major of approximately 12 courses to ensure appropriate content knowledge in the content area(s) they are preparing to teach (Dordt College, 2016). Also, pre-service teachers in the TPP at Dordt College can choose from among many additional endorsement options that can be added to these four major options. “Endorsement” is the term the Iowa Department of Education gives to a certification for licensed teachers (Iowa Board of Educational Examiners, 2017). For example, students completing the elementary education major at Dordt

College have the “K-6 Teacher Elementary Classroom” endorsement listed on their teaching license. Additional endorsement options include different academic subject areas (e.g., reading for elementary education majors, or chemistry for secondary biology education majors), early childhood education, middle school, teaching English as a second language, and athletic coaching. Each of the majors and endorsement areas require specified content and methods courses to ensure pre-service teachers’ competence to teach in these academic areas (Dordt College Teacher Preparation Program, 2016).

The capstone of the TPP is a professional semester comprised of student teaching internships in the content area(s) they have been prepared to teach. There are multiple options for the student teaching internships as well, which are designed to suit the diverse needs and interests of the different pre-service teachers in the program (Dordt College Teacher Preparation Program, 2016). Many students choose local student teaching, which involves being placed in a PreK-12 classroom within a 30-mile radius of the Dordt College Campus. Some students prefer a non-local student teaching placement. The TPP maintains several satellite locations in the Pacific Northwest and the Chicago area for cohorts made up of student teachers who wish to experience teaching in a very different context than the rural location of the Dordt College campus. Still other students choose to experience teaching internationally; the TPP maintains relationships with institutions in Indonesia, the Netherlands, and Nicaragua for this purpose. Finally, a growing number of pre-service teachers in the TPP are interested in extending their professional semester into a professional year by participating in the Professional Development School (PDS) program.

The PDS program merits special explanation because of the unique nature of this experience. The Dordt College TPP received a grant from the Iowa Department of Education to participate in a pilot study of year-long student teaching during the 2014-2015 academic year (Iowa State Board of Education, 2015). Based on the success of that pilot study, the PDS program has continued to be offered as an option for student teachers in the TPP (Dordt College Teacher Preparation Program, 2016).

Pre-service teachers who apply for a PDS internship are partnered with master teachers in local schools for a year-long student teaching experience. The PDS interns complete their service-learning internship during the mornings of the fall semester of their senior year, and return to campus for coursework in the afternoon. Then, in the spring semester, they continue full-time student teaching, working with the same mentor teacher and the same students. The great benefit of this approach is that PDS interns have the opportunity to experience the whole year, from the initial beginning-of-the-year planning, through parent-teacher conferences, the lead-up to the winter holiday break. After Christmas, they are able to immediately begin full-time teaching for the whole spring semester, unlike their peers in traditional student teaching placements, who typically spend the first few weeks observing and ease in to teaching one subject at a time (Dordt College Teacher Preparation Program, 2015). The intent of the PDS program is to place interns in a mentoring environment in which they co-plan, co-teach, and co-assess student work alongside an experienced master teacher. This arrangement has obvious benefits for the PDS intern, but the research conducted by the TPP indicates that both the mentor teachers as well as the PreK-12 students also benefit: the mentor teacher experiences a year of intensive professional development and support by the faculty from the Education department at Dordt College, and the students benefit by having a second teacher in the room with them throughout the year (Dordt College Teacher Preparation Program, 2015; Iowa State Board of Education, 2015).

Thus, although a relatively small program—in comparison to programs at large public universities—the TPP at Dordt College offers many options to pre-service teachers, both in terms of program options, licensure endorsements, and student teaching opportunities. These options are all supported by a strong core of coursework that all pre-service teachers complete, providing a foundation for all the other options. There is, however, one course typically included in a teacher preparation program notably absent among the list of courses required by all pre-service teachers studying at Dordt College. The TPP does not include a course about educational technology.

This was not always the case. Up until the spring of 2011, the TPP included a course titled "Media and Technology in Education," which was required of all Education majors. At that time, the curriculum of the TPP was under revision. The faculty determined that the Education major required too many credits, and were interested in reducing the total number of credits required by eliminating some courses. It was determined that the educational technology course was one that could be removed, by shifting some of the content of that course into other courses. The Education department targeted this course for two reasons. First, the faculty members decided that the separation of technology knowledge (i.e., learning how to use particular tools) from pedagogical knowledge (i.e., making instructional decisions) was ineffective, and perhaps even a disservice to the pre-service teachers. This idea has been borne out in the literature on teaching technology integration (see Gill et al., 2015; Kovalik et al., 2013; Mishra &

Koehler, 2006; Tournaki & Lyublinskaya, 2014). Secondly, the faculty recognized that different teachers have different needs in terms of their technology knowledge and experiences. For example, the technologies used by an elementary classroom teacher are likely to be very different from those used by a high school history teacher, which would in turn be quite different from a K-12 music teacher.

With the elimination of “Media and Technology in Education” from the program, the faculty committed to modeling and teaching technology integration in all methods courses throughout the program. This approach was intended to illustrate the connection between technology and pedagogy more clearly, and foster understanding of how different technologies can be effectively used within the various content areas. Different aspects of the role of technology in education were also included as topics on the syllabi of several of the core courses in the program, including Introduction to Education; Learning Environments; Planning, Instruction, and Assessment; and the Senior Seminar, among others.

Results of Program Review

When I joined the faculty in the fall of 2012, one of our first department meetings was spent examining the annual departmental assessment report from the previous year. The assessment report included surveys of graduating seniors from the program, as well as graduates with one, three, and five years of teaching experience. These annual surveys are comprised of five-point Likert-scale items that ask participants to rate their perceptions of how the Dordt College TPP helped them to develop in various areas related to teachers’ professional practices. I was very interested to note that among all of these groups of participants, survey items related to technology integration were among the lowest scores. The graduating seniors rated the statement, “The TPP helped me to understand current and emerging technologies and their effect on teaching,” at an average 3.59 out of 5, which was the lowest mean score of all of the survey items. They rated the statement, “The TPP helped me to apply educational technology appropriately to the teaching and learning process,” with an average score of 3.61 out of 5, which was the third lowest mean score of the survey items. In their written comments, 13 comments were related directly to technology knowledge or technology integration, and all of these were either critiques of the program (e.g., an elementary education major stated that a major weakness of the program is the “lack of technology training”) or recommendations to strengthen the program (e.g., a K-12 content area major suggested, “Increase the technology in your teaching us, and also help us know how to use it.”)

Similarly, the graduates of the program were asked, “Rate how the TPP helped you develop in your use of media and technology that is appropriate to the teaching and learning process.” Graduates with one year of teaching experience rated this item an average of 4.0, which was in the bottom 25% of the items on the survey. Graduates with three years of teaching experience rated this item 3.5 on average, also in the bottom 25%. Graduates with five years of teaching experience rated this item with an average score of 3.33, their lowest score out of the 20 areas surveyed. In their written comments, five experienced teachers commented on their preparation to teach with technology, mostly offering recommendations for improvements (e.g., a graduate with one year of experience suggested, “Technology has become such an important part of education in this last year. I work at a school that now uses iPads in the classroom, and it is quite difficult to wrap my head around how to use it properly. I would recommend more emphasis on technology since that is the center of most of the students' lives.")

I read these results and comments with great interest, because I recognized that these were students who had all taken Media and Technology in Education as part of their preparation for their classroom practices. It made me wonder about how students in future years—who would not have "the tech class" as part of their academic work would perceive their knowledge and skills for teaching with technology.

The assessment reports in ensuing years included similar ratings and comments to the 2012 report described here. Technology integration items remained among the lowest-rated aspects of the TPP, and students had suggestions for improving this—including several comments suggesting that the TPP should add a course in educational technology or technology integration. The most recent assessment report (i.e., reviewing the 2015-16 academic year) included six comments from graduating seniors that specifically recommended adding a technology course. Graduates from the program commented about the challenges of evolving technologies, and the need for more opportunities to learn to integrate technology throughout the TPP. For example, one prompt on the survey asked graduates to complete the sentence, "I would recommend that the Education Department consider the following to strengthen the Teacher Preparation Program…" In response to this prompt, a Secondary Education major suggested, "A full technology class would be great!" and an Elementary Education major elaborated, "Offer some sort of class on technology. I would have loved to be more familiar with the SMARTBoard, good iPad apps, etc."

Confronted with these results in the program's assessment data, I began to wonder about the realities of current students in the TPP and the seed for this study began to germinate. This study was developed to answer two research questions:

Q1: What are pre-service teachers' perceptions of their ability to integrate technology into the classroom?

Q2: To what do pre-service teachers attribute their ability to integrate technology into the classroom?

To understand their perceptions about their abilities to integrate technology and their opportunities to learn about technology integration, I surveyed a sample of the current pre-service teachers currently studying in the TPP at Dordt College. (142 students were invited, and 104 elected to participate, resulting in a response rate of 73.2%.) I followed up this quantitative inquiry by interviewing eleven of the survey-completers to discover the stories of their perceptions and experiences in their own words. In the next section I will describe the population of pre-service teachers at Dordt College, and explain how samples were selected for inclusion in this study.

Description of Participants

During the 2016-2017 academic year, 217 pre-service teachers and approximately 25 more students completed coursework in the TPP. This case study aims to understand how these pre-service teachers think about teaching with technology, and the experiences they perceive as relevant for developing the knowledge and skills needed for effective technology integration.

Survey Participants

Three purposefully-selected samples of pre-service teachers at different points in the TPP were invited to participate in the survey. These three samples were comprised of intact class groups of three different courses, representing three different points in the TPP. The survey participants, including the percentage of survey completion for each sample are illustrated in Table 6.

Table 6 Pre-service teachers who completed the survey

	N invited	N completed	Percentage
Introduction to Education (pre-service teachers in their first semester in the TPP)	66	42	63.6
Planning, Instruction, and Assessment (pre-service teachers in the middle of their coursework in the TPP)	36	30	83.3
Senior Seminar (pre-service teachers in final semester prior to student teaching)	40	32	80.0
Total	142	104	73.2

Sample One: Introduction to Education

The first sample was comprised of two class sections of Introduction to Education. Introduction to Education is the first course pre-service teachers take in the program. It is a survey course designed to introduce students to the field of Education, to induct them into the structure of the TPP at Dordt College, and to help them discern whether teaching is their vocational calling. Introduction to Education is a lecture and discussion-based course that incorporates a practicum in which all pre-service teachers have the opportunity to observe a cooperating teacher at work in a K-12 classroom. These classroom observations are used as discussion fodder for the course and help these pre-service teachers at the very beginning of their professional training start to make the switch from thinking like a student to seeing the classroom through teachers' eyes.

Introduction to Education addresses the topic of educational technology within a study of school reform initiatives of the past 20 years. In this portion of the course, students investigate a variety of topics under the umbrella of "school reform," including the range from the standards-based movement, to No Child Left Behind, to the Individuals with Disabilities Education Act. Along with these, various initiatives related to educational technology, such as the E-Rate program (see Federal Communications Commission, 2016), SpeakUp Day from Project Tomorrow (see Project Tomorrow, 2016), and the challenges of implementing a one-to-one technology program (see Great Schools Partnership, 2013) are included as possible research topics. Students conduct research to learn about a school reform initiative, and present their findings to their classmates through a digital video presentation as a summary to this research project. Each of the two sections of Introduction to Education was comprised of 33 pre-service teachers, and of these 66 potential participants, 42 completed the survey.

Sample Two: Planning, Instruction, and Assessment.

The second sample was comprised of pre-service teachers taking Planning, Instruction, and Assessment, which is usually taken by sophomores or juniors, depending on their major in the TPP. Two class sections of this course were invited to participate, one designed for elementary education majors, and one for students intending to obtain a middle school endorsement (which can be added to a major in either an elementary or secondary education.) A total of 36 pre-service teachers taking Planning, Instruction, and Assessment were invited to participate, and of these, 30 completed the survey.

Students must complete their educational foundations courses (Introduction to Education, Learner Differences, Learning Environments, and Lifespan Development) before they are allowed to enroll in this course. It is designed as a general teaching methods course examining the three key tasks undertaking by professional educators: planning for instruction, teaching, and assessing learning. Pre-service teachers in the TPP are generally expected to take this course before they are allowed to move into specialized methods courses for the different content areas. This course is divided up into three broad units corresponding to the three teaching tasks, “Planning,” “Instruction,” and “Assessment.” The topic of technology integration is addressed as part of this course in the unit on “Instruction.” In this unit of the course, pre-service teachers are assigned various technology tools to investigate and present to their classmates, including suggestions for how their tools might be integrated into the classroom. However, this whole project comprises only two days of the syllabus in a semester-long course. So, while the topic of technology integration is formally included in the Planning, Instruction, and Assessment course, it is a very small part of the curriculum.

Sample Three: Senior Seminar.

The third sample was comprised of seniors enrolled in the Senior Seminar. These pre-service teachers were preparing to enter their professional semester, and included a total of 40 participants. Of these, 10 were part of the PDS program, and were placed in internships in local schools for year-long student teaching experiences. The other 30 were preparing for traditional student teaching placements in the spring, whether locally, nonlocally, or internationally. The Senior Seminar includes a variety of content, but emphasizes professional skills such as effective communication, classroom management, motivation techniques, and legal and ethical requirements for teachers.

The topic of technology integration is a small part of this course, as issues related to management of technology in the classroom are addressed within the discussions of classroom management. The Senior Seminar is focused on practical skills, and several class meetings are devoted to discussions about effective classroom management techniques. One of these includes practical topics such as standing where you can see students' screens while they are working on laptops, and procedures for having the students check-out/check-in their devices. While not a major part of the course, this is one place in the TPP that some skills for technology integration are practiced. The pre-service teachers taking this course are in their final semester of coursework prior to their student teaching internship, and are concurrently taking one or more methods courses, Applied Educational Psychology, and Philosophy of Education, and a field experience. This field experience is either a placement in a PDS internship, or a 60-hour service learning practicum in which they have the opportunity to develop pedagogical skills by working with small groups of students, providing assessment and classroom management support, and presenting a few whole-class lessons while serving under the supervision of a qualified mentor teacher in a PreK-12 classroom. The 40 pre-service teachers taking the Senior Seminar were invited to participate, and 32 of these completed the survey.

In summary, a total of 104 pre-service teachers completed the survey, out of 142 who were invited to participate. This was a response return rate of approximately 73%, which is quite high. A participation rate of 50% is considered a very good response rate for a survey (Creswell, 2012). Also, the 104 survey responders represent nearly half of the 217 pre-service teachers in the TPP who have declared a major in Education. Because the samples were purposefully selected to illustrate pre-service teachers at the beginning, middle, and end of their studies in the TPP, the results credibly indicate a representation of the pre-service teachers in the TPP today.

Interview Participants

Of the 104 survey completers, I selected a sample for semi-structured interviews to uncover more about their beliefs about technology integration, their self-confidence for teaching with technology, and their experiences learning about technology integration. As I explored the demographic data of the survey completers, I was able to create a maximum variation sample of potential interviewees. I wanted to ensure that I included both male and female students, a variety of different majors within the TPP, and pre-service teachers at each point in the program. I initially created a list of 20 potential interviewees to ensure that I would reach saturation in the data collection, and I emailed ten of them to invite them to participate. Three of these potential participants decided they would rather not be part of the interviews, so I began with my initial seven interviews. After completing these, I reached out to four more survey completers who all agreed to participate in the interview process, which gave me sample of eleven pre-service teachers. In the next section, I will introduce the participants using pseudonyms to provide for anonymity. A summary of these participants can be found in Table 7.

Table 7 Semi-structured interview participants

Name	Gender	Year in TPP	Major/Endorsement
Andie	Female	Senior	Early Childhood
Bruce	Male	Senior	Secondary Education
Cleo	Female	Sophomore	Elementary Education
Drew	Male	Junior	Secondary Education
Elsa	Female	Senior	K-12 Subject Area
Fiona	Female	Junior	Middle School
Gary	Male	Senior	Elementary Education
Henry	Male	Junior	Middle School
Ivory	Female	Freshman	Early Childhood
Julie	Female	Senior	Elementary Education
Kevin	Male	Freshman	Elementary Education

Note. All names are pseudonyms to provide anonymity to participants.

Introducing the Interviewees.

These eleven pre-service teachers (five male and six female) were invited to participate in interviews approximately 30 minutes in length. These interviewees were selected because of their unique perspectives; each of them provides a personal snapshot of their beliefs and experiences. To be clear, while the five male participants, for example, may share this trait (i.e., male gender) in common, they should not be expected to speak on behalf of every male pre-service teacher in the TPP. That said, these eleven pre-service teachers give a window into the thinking and experiences of students with certain characteristics at different points in their journey to becoming professional educators.

The interviewees include participants at each point in the program. Ivory and Kevin are freshmen in their first semester in the TPP. They are taking Introduction to Education at the time of this interview, and are just discerning their calling to become teachers. Cleo, Drew, Fiona, and Henry are sophomores and juniors. They are in the middle of their journey in the TPP, having completed at least the first four courses of the program, and are taking Planning, Instruction, and Assessment, a course that includes some emphasis on the use of technology for classroom instruction. They are able to speak more knowledgeably about the TPP, because of the learning opportunities they have experienced in various Education courses and content courses up to this point. Andie, Bruce, Elsa, Gary, and Julie are seniors in the TPP, nearing the end of their journey toward becoming professional educators, and enrolled in the Senior Seminar. All five of them are also participating in a practicum in a local school. Andie, Bruce, and Julie are part of the PDS program and are interning in the classrooms where they will student teach in the spring semester, while Elsa and Gary are participating in a 60-hour service learning experience. All of these seniors are in their final semester of coursework before student teaching, and are able to speak about their learning from that vantage point.

I wanted to ensure that the interview participants reflected the different majors and endorsement areas offered in the TPP. Seven of the participants are elementary education majors (Andie, Cleo, Gary, Henry, Ivory, Julie, and Kevin), while three of them are secondary education majors (Bruce, Drew, and Fiona), and one is a K-12 subject area major (Elsa). Also, two of the participants are seeking endorsements in early childhood education (Andie and Ivory), and two are seeking a middle school endorsement (Fiona and Henry). Choosing a maximum variation sample allows for hearing from participants with particular viewpoints. The variety of individual stories is desirable because it makes it more likely that the sample will provide multiple perspectives (Creswell, 2013; Hoepfl, 1997).

Data Analysis Procedures

Survey Analysis

I used a survey to collect insights from pre-service teachers in the TPP to provide a backdrop for understanding their perceptions of their developing abilities to integrate technology (see Appendix A). After collecting the data using Qualtrics online survey tool, I exported the data sets and combined the de-identified data from the three samples into one Excel spreadsheet. I removed incomplete data records of pre-service teachers who started but did not complete the survey. From the Introduction to Education group there were five incomplete surveys, and from the Senior Seminar group there were two incompletes. Removing these seven incompletes gave the number of 104 complete surveys. I then used the find-and-replace feature in Excel to recode data from text strings to numerical ratings. For example, for the "Gender" demographic item, I recoded "male" to "1" and "female" to "2." I did this to allow for quantitative data analysis in SPSS.

I then imported the coded data into SPSS from Excel. In SPSS, I checked for gaps in the data, and found five missing values all together. I processed the data using Little's Missing Completely At Random (MCAR) test and found no statistically significant results (X^2 = 114.192; p = .212), which indicates that the data were indeed missing completely at random (Little, 1988). I used Expectation Maximization to impute values for these missing data, using subscales to impute the values for stronger validity (Allison, 2001).

I used SPSS to generate frequency tables of the demographic information the survey data. Table 8 illustrates the frequency of survey participants by gender. Table 9 illustrates the frequency of participants by year in the program. Table 10 illustrates the frequency of participants by major or endorsement area. Table 11 illustrates the frequencies with which participants described their comfort with computers, Internet tools, and technology in general.

Table 8 Survey participants by gender

	Frequency	Percent
Male	21	20.2
Female	83	79.8
Total	104	100.0

Table 9 Survey participants by year in the Teacher Preparation Program

	Frequency	Percent
Freshman	35	33.7
Sophomore	25	24.0
Junior	9	8.7
Senior	32	30.8
Graduate Student[a]	3	2.9
Total	104	100.0

[a] The three graduate students among the participants completed a bachelor’s degree in another discipline, and are now enrolling in the Sport Leadership emphasis in the Master of Education program. Each was taking a course in the TPP as a pre-requisite, and they were among those invited to participate in this survey.

Table 10 Survey participants by major or endorsement area

	Frequency	Percent
Early Childhood	7	6.7
Elementary Education	46	44.2
Elementary Subject Area	4	3.8
Middle School	12	11.5
Secondary Subject Area	19	18.3
K-12 Subject Area	16	15.4
Total	104	100.0

After tabulating these frequencies of the participants' demographic information, I went on to examine the reliability statistics for the subscales in the survey. The survey instrument was adapted from two previously validated instruments (Schmidt et al., 2009; Wang et al., 2004), and is comprised of four subscales designed to measure pre-service teachers' perceptions of their self-efficacy for technology integration. The first three subscales are aligned to several of the Technological Pedagogical Content Knowledge (TPACK) domains, TK, TPK, and TPACK, respectively, as these three domains have been found to have the strongest impact on technology self-efficacy among the seven TPACK domains (Abbitt, 2011). The fourth subscale measures participants' self-efficacy for technology integration (SE-TI). When I used SPSS to calculate alpha coefficients for each subscale, all four of the subscales were found to be in the acceptable range, with $\alpha > .70$ (Nunnally, 1978, as quoted in Hatcher, 2011, p. 87). Table 12 illustrates the reliability coefficients for each subscale.

Table 11 Survey participants' comfort working with various technologies

	Frequency	Percent
Comfort with computers:		
Not at all comfortable	0	0.0
A little comfortable	9	8.7
Fairly comfortable	64	61.5
Very comfortable	31	29.8
Total	104	100.0
Comfort with Internet tools:		
Not at all comfortable	0	0.0
A little comfortable	25	24.0
Fairly comfortable	58	55.8
Very comfortable	21	20.2
Total	104	100.0
Comfort with technology in general:		
Not at all comfortable	1	1.0
A little comfortable	21	20.2
Fairly comfortable	56	53.8
Very comfortable	26	25.0
Total	104	100.0

Having found the survey's subscale results reliable, I went on to calculate descriptive statistics for the four subscales. I calculated mean scores for each of the subscales, and found the minimum and maximum values, as well as the standard deviation for each subscale. These results can be reviewed in Table 13.

Table 12 Reliability statistics for survey subscales

Subscale	Cronbach's Alpha	N of Items
Technological Knowledge	.873	7
Technological Pedagogical Knowledge	.764	5
Technological Pedagogical Content Knowledge	.838	5
Self-Efficacy for Technology Integration	.892	16

Table 13 Descriptive statistics for survey subscales

	Min	Max	Mean	SD
Technological Knowledge	1.57	4.86	3.296	.7350
Technological Pedagogical Knowledge	2.0	5.0	3.692	.5738
Technological Pedagogical Content Knowledge	1.4	5.0	3.588	.6162
Self-Efficacy for Technology Integration	2.31	4.94	3.621	.5054

Finally, I used SPSS to calculate Pearson correlation statistics to examine the relationships between demographic categories and the four subscales. I also examined the relationships between the four subscales for any correlations. At $p < .01$, participants' level of comfort with computers was significantly positively correlated to TK ($r = .507$), TPACK (r = .265), and SE-TI (r = .346). Likewise, participants' level of comfort with Internet tools was significantly positively correlated to TK (r = .592), TPACK (r = .344), and SE-TI (r = .433). Comfort with technology in general was significantly positively correlated to all four subscales, with TK (r = .719), TPK (r = .301), TPACK (r = .480), and SE-TI (r = .527). Also, each of the four subscales demonstrated significant, positive correlations with the other three subscales. The summary of the r-values and p-values of these correlation tests are displayed in Table 14. The correlations between the comfort with computers, comfort with Internet tools, and comfort with technology in general items and the subscales illustrated generally small to medium effect sizes. The correlations between the subscales illustrated larger effect sizes.

Qualitative Analysis

I interviewed each participant independently in a quiet conference room near the Education faculty offices. This room was selected for both the comfortable seating to help put participants at ease, as well as the lack of background noise to improve recording quality. Having secured permission from each participant to record the interview, I used the GarageBand application on my MacBook to capture the audio. The interviews were semi-structured in nature; I had several questions prepared ahead of time that I asked to each participant (see Appendix B), but the interviews unfolded as conversations. Due to this conversational nature, the questions were not asked in exactly the same order or phrased identically to each participant, but I was able to raise the same topics (see Appendix B) in each interview. I ensured that the audio recordings were anonymous by assigning them file names that were numerical in nature, and I never used the participants' names in the recorded segments.

Table 14 Correlations between demographic items and subscales

		TK	TPK	TPACK	SE-TI
Comfort with computers	Pearson Correlation	.507**	.126	.265**	.346**
	Sig. (2-tailed)	.000	.202	.007	.000
Comfort with Internet tools	Pearson Correlation	.592**	.192	.344**	.433**
	Sig. (2-tailed)	.000	.051	.000	.000
Comfort with technology in general	Pearson Correlation	.719**	.301**	.480**	.527**
	Sig. (2-tailed)	.000	.002	.000	.000
TK	Pearson Correlation	1	.426**	.554**	.692**
	Sig. (2-tailed)		.000	.000	.000
TPK	Pearson Correlation	.426**	1	.682**	.563**
	Sig. (2-tailed)	.000		.000	.000
TPACK	Pearson Correlation	.554**	.682**	1	.703**
	Sig. (2-tailed)	.000	.000		.000
SE-TI	Pearson Correlation	.692**	.563**	.703**	1
	Sig. (2-tailed)	.000	.000	.000	

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

Following the completion of the interviews of all eleven participants, I exported the audio from GarageBand into mp3 audio format. I used a transcription service to have the digital audio files transcribed into text. At this point I read through the transcripts carefully, correcting any transcription errors and inaudible moments in the recording based on my knowledge of the TPP, and the participants, as well as notes I had taken longhand during the interview sessions. The data analysis process began as I was doing these transcription checks. As I read through the interview transcripts, I jotted memos about my initial codes that I anticipated using for their analysis. I was pleased to see evidence of all six of these initial codes present in my database of transcribed interviews: 1) technological knowledge, 2) technological content knowledge, 3) technological pedagogical knowledge, 4) TPACK, 5) informal technology learning, and 6) technology self-efficacy. Even at this stage of the analysis, I could tell that further codes would likely be needed. For example, I noted in a memo that most participants indicated that modeling (by college instructors, or PreK-12 teachers they observed) was a key way that they learned about technology integration. However, as Stake (2005) suggested, the addition of codes as the data analysis unfolds is normal, and an expected part of recursive analysis of qualitative data.

After ensuring that the transcriptions were accurate, I uploaded the text into NVivo. In NVivo, data sources can be created as "cases," and codes can be created as "nodes." I created a separate case for each interview transcript, eleven in all. I then created six initial nodes, corresponding to my six codes. With this preparation completed, I was ready to begin the process of coding the data.

Coding the data involved reading and re-reading the interview transcripts, highlighting sections in NVivo, and assigning them to various nodes. I was deliberate to only code any section of the transcript to one of the TPACK domains (i.e., a section coded as "TK" would not also be coded as "TPK" or "TPACK.") However, there were times that one section of the transcript might be coded to two or more different code categories. For example, one participant made this statement in an interview:

> GeoGebra, for instance, that I've referenced several times, [used by one of my math professors.] I've seen it very extensively working with it in my modern

> geometry class. Also, he uses it in other classes and a whole bunch of other math programs. He'll do it on his computer and show it on the screen and then like, 'Oh, look, that's really cool. You source them so I can use that one.' Desmos, I hadn't really heard of it until then. I was like, 'Oh, I can just graph things on here really nicely.' It actually has a lot of really other features and stuff like that.

This section of the interview transcript was coded with three different codes. I perceived this comment to be an expression of this pre-service teacher's self-efficacy, so it was coded "self-efficacy." At the same time, it serves as an example of his ability to describe technologies (i.e., GeoGebra, Desmos) used for teaching a specific content area (mathematics,) so it was also coded "TCK." Finally, it illustrates an example of modeling on the part of a professor, so it was also coded "modeling." This is just one illustration, but this approach for coding was utilized throughout the qualitative data analysis process. Further examples of selections from the interview transcripts for each of the code categories used in this study are included in Appendix C.

I read through each transcript at least five times, adding codes and writing memos as I read. After the second pass through the data, I realized that more codes were needed, and so I added additional coding nodes, including "modeling," "TPP," and "challenges for tech integration." Every time I added new codes, I went back through all of the transcripts and often found further examples from different participants. At the end of the coding process, twelve code categories had emerged, which are listed along with their frequencies in the database in Table 15.

Table 15 Code categories and frequencies

Code categories	N of participants coded with this category	Frequency of this code in database
Technological Knowledge	11	33
Technological Content Knowledge	9	26
Technological Pedagogical Knowledge	10	50
TPACK	11	28
Informal learning opportunities	11	85
Technology self-efficacy	11	110
Modeling	9	27
TPP	11	48
Challenges for tech integration	11	35
Lack of confidence	5	8
Resource list	4	6
Tech course	8	11

After coding the data, I read through each node in NVivo, and noted memos of emerging themes within those coded categories. Drawing upon these memos, I wrote a one-page initial summary of the general themes that had emerged. After this, I also composed a summary of each of the eleven interviews, each approximately one page in length, which recapped the comments given by that participant. These one-page summary documents were compiled for member checking. To each interview participant, I submitted both the initial themes document as well as the summary of his or her individual interview. For credibility, I asked each participant to review these documents for their feedback, providing them the opportunity to add further information or correct my understanding of their attitudes, beliefs, and experiences. All eleven participants responded favorably to the initial themes document, and each of them approved of my summary of their interviews. In fact, only one of the eleven participants had any words of correction for me. The error was a minor inaccuracy of interpretation on my part; I had mistakenly attributed a high school experience as something learned in a college course.

This process of analysis allowed me to examine the interviews in depth, and gave me confidence that I had accurately captured the interviewees' beliefs and experiences related to technology integration. Triangulation between the interview transcripts, and also with the survey results and what I discovered through document analysis have painted a picture of these pre-service teachers' perceptions of their abilities to integrate technology into the classroom.

Presentation of Findings

This case study was intended to understand pre-service teachers' self-efficacy for technology integration. The findings related below explain the beliefs and experiences of the pre-service teachers in the TPP at Dordt College related to technology integration. The data collected by survey and interviews provide evidence to support six major findings:

1) Pre-service teachers generally feel confident in their abilities to teach with technology, regardless of their gender, year in college, or major/endorsement area.

2) Pre-service teachers feel a sense of pressure or expectation to be able to integrate technology into their teaching practices.

3) Modeling effective technology integration is an important part of pre-service teachers developing the self-efficacy to integrate technology into their own teaching practices.

4) Both formal and informal learning opportunities positively impact pre-service teachers' confidence for working with technology.

5) Technological knowledge is an important component for self-efficacy in technology integration, but pedagogical knowledge and content knowledge are also necessary.

6) Pre-service teachers believe that a practical course in educational technology would help to prepare them to integrate technology in the classroom.

Triangulation among respondents in qualitative inquiry (Creswell, 2013) and between qualitative and quantitative data sources (Yin, 2014) provides trustworthy evidence for developing an understanding of a case. In the following pages, documentation from both the interviews responses as well as the survey results will be used to explain each of these six findings about pre-service teachers' beliefs related to technology integration.

Finding 1: Pre-service teachers generally feel confident in their abilities to teach with technology, regardless of their gender, year in college, or major/endorsement area.

While there are individual variations, the data collected in this study indicate that pre-service teachers are generally confident in their abilities to teach with technology. Both quantitative data and qualitative data will be used to illustrate this.

Survey participants were asked three demographic questions related to their level of comfort with computers, with using Internet tools, and with technology in general. The full responses of the participants were presented in Table 6. In summary, a solid majority (91.3%) reported feeling “fairly comfortable” or “very comfortable” with computers, a majority (76.0%) reported feeling “fairly comfortable” or “very comfortable” with using Internet tools, and a majority (78.8%) reported feeling “fairly comfortable” or “very comfortable” with technology in general. While comfort with computers, Internet tools, and technology in general is not the same thing as believing that one is capable of *teaching* with these tools, there was a medium to strong correlation between each of these demographic questions and each of the subscales related to participants’ beliefs about teaching with technology (i.e., TK, TPK, TPACK, and SE-TI.) These correlations were presented in Table 14.

The fours subscales are comprised of Likert-type scale items each having five levels, with 1 representing “strongly disagree,” 2 representing “disagree,” 3 representing “neither agree nor disagree,” 4 representing “agree,” and 5 representing “strongly agree.” Table 8 presented the descriptive statistics for the means of each subscale. In summary, the TK scale had a mean of 3.296, the TPK subscale a mean of 3.692, the TPACK subscale a mean of 3.588, and the SE-TI subscale a mean of 3.621. These results indicate that pre-service teachers report perceptions of general agreement that they have adequate technological knowledge, technological pedagogical knowledge, technological pedagogical content knowledge, and self-efficacy for technology integration to effectively integrate technology in the classroom.

Interview participants corroborated this finding, with most reporting that they felt quite confident teaching with technology. When asked, “How confident are you in using technology as part of your teaching practice?” seven of the eleven participants indicated a high level of confidence. Comments such as “I would be very confident” (Henry) or “[I am] pretty confident I could do it” (Cleo) were the norm for these participants. Drew responded, “On a scale of one to ten?...I’d say [I’m at] an eight.” These pre-service teachers exhibited a strong sense of self-efficacy, giving examples of the things they would be able to do as they integrated technology into their classrooms.

Four of the eleven interviewees suggested that they were still developing confidence for technology integration. Three participants indicated a moderate level of confidence. Elsa actually used that phrase, “I am moderately confident.” Other comments included Gary’s statement, “I could get by… (laughs),” and Fiona’s suggestion, “I would say…on the edge of being confident because I know that [technology] can be used [for] good, so I want to be able to use it that way.” Only one participant suggested that she was not very confident teaching with technology. Ivory, who is a freshman at the beginning of her studies in the TPP, described herself as “not super confident” with technology integration. She followed this statement up by exclaiming, “I feel like the kids would know more about it than I would!” (Ivory). Each of these four participants gave examples of things that they would still like to learn that would give them greater confidence. One pre-service teacher, for example, took a few moments of pause to reflect, and then shared,

> I guess just in general, I think that the scary thing about technology is that I don't want it to take over and be the biggest focus of the classroom, because I think sometimes it's a little questionable, like, ‘Hmm, does that actually have an educational value, or is that just fluff?’ I think that's maybe my biggest concern is being discerning about using technology that is actually helpful and has a point, and isn't just because it's cool. (Elsa)

Elsa’s thoughtfulness was matched by Fiona’s. When asked what could help increase her confidence, Fiona suggested that she would like more opportunities to work with other teachers to learn from each other about educational technologies. She also mused,

> [I have been] thinking about what technologies that I can bring in to either my lesson planning or to benefit the student, and to kind of bring it to their own level, because we are a very technology-based society. You should bring it into the classroom, just because the students are engaged with [technology] so much outside of school.

Fiona’s comment indicates that she is developing confidence through her course work. In her Planning, Instruction, and Assessment course that semester, she had opportunities to collaborate with classmates to investigate educational technologies appropriate for the grade level she is planning to teach. This developing sense of confidence was a common characteristic of ten of the interviewees. Some expressed that they already felt a sense of confidence to teach with technology. Others were thoughtfully positioning themselves as learners who were capable of mastering the things they needed to learn in order to be successful at integrating technology into the classroom.

While most pre-service teachers surveyed indicated that they were fairly confident in their abilities to teach with technology, an examination of the various demographic groups might provide a fuller picture of the survey data. Each of the subscales was investigated for variance according to gender, their current level in the program, and the major or endorsement area of the participants. The results will be presented in that order.

The four subscales were analyzed using a one-way MANOVA with "Gender" as the independent variable. With alpha set at .05, there was no statistically significant difference based on gender for any of the four subscales, F (4, 99) = 13.74, p = .078; Wilk's Λ = 0.919, partial η^2 = .081. Table 16 illustrates the descriptive statistics for the four subscales compared by gender, and Table 17 provides the MANOVA results.

Table 16 Descriptive statistics for Gender comparison

	Gender:	Mean	SD
MEAN TK	Male[a]	3.6752	.78414
	Female[b]	3.1994	.69453
	Total	3.2955	.73503
MEAN TPK	Male	3.781	.6161
	Female	3.670	.5643
	Total	3.692	.5738
MEAN TPACK	Male	3.810	.6737
	Female	3.533	.5920
	Total	3.588	.6162
MEAN SE-TI	Male	3.7719	.49905
	Female	3.5828	.50290
	Total	3.6210	.50549

[a] N = 21. [b] N = 83.

Table 17 MANOVA results for Gender

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Wilks' Lambda	.919	2.169	4.000	99.000	.078	.081

Next, the four subscales were analyzed using a one-way MANOVA with “Class” as the independent variable. The classes were the three samples: 1) the participants from the two Introduction to Education classes, 2) the participants from the two Planning, Instruction, and Assessment classes, and 3) the participants from the Senior Seminar class. Of the four subscales, no significant difference was found with alpha set at .05 (F (4, 99) = 1.610, p = .124; Wilk's Λ = 0.880, partial η^2 = .061.) Table 18 illustrates the descriptive statistics for the four subscales compared by class grouping, and Table 19 provides the MANOVA results.

Finally, the four subscales were analyzed using a one-way MANOVA with “Major/Endorsement” as the independent variable. There were six possible levels in this dataset, with major or endorsement options of 1) Early Childhood, 2) Elementary Classroom, 3) Elementary Subject Area, 4) Middle School, 5) Secondary Subject Area, or 6) K-12 Subject Area. Of the four subscales, no significant difference was found with alpha set at .05 (F (4, 95) = 1.309, p = .171; Wilk's Λ = 0.768, partial η^2 = .064.) Table 20 illustrates the descriptive statistics for the four subscales compared by major/endorsement area, while Table 21 provides the MANOVA results. The different majors and endorsement areas varied very slightly on the different subscales.

Among the data comparing different demographic items across all four subscales, no statistically significant relationships were found. Neither the pre-service teachers’

Table 18 Descriptive statistics for Class comparison

	Class	Mean	SD
MEAN TK	1[a]	3.4286	.54573
	2[b]	3.1710	.83763
	3[c]	3.2375	.83807
	Total	3.2955	.73503
MEAN TPK	1	3.824	.3980
	2	3.473	.6378
	3	3.725	.6580
	Total	3.692	.5738
MEAN TPACK	1	3.738	.5734
	2	3.467	.5390
	3	3.506	.7094
	Total	3.588	.6162
MEAN SE-TI	1	3.6774	.40589
	2	3.6050	.49554
	3	3.5619	.62707
	Total	3.6210	.50549

[a] Introduction to Education, N = 40.

[b] Planning, Instruction, and Assessment, N = 30.

[c] Senior Seminar, N =32.

Table 19 MANOVA results for Class

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Wilks' Lambda	.880	1.610	8.000	196.000	.124	.061

Table 20 Descriptive statistics for Major/Endorsement comparison

	Major or Endorsement:	Mean	Std. Deviation
MEAN TK	1[a]	3.3471	.60533
	2[b]	3.1180	.81647
	3[c]	3.2150	1.04927
	4[d]	3.6425	.54411
	5[e]	3.3768	.74775
	6[f]	3.4463	.47607
	Total	3.2955	.73503
MEAN TPK	1	3.857	.4721
	2	3.622	.5219
	3	3.700	.7394
	4	3.833	.6597
	5	3.653	.4937
	6	3.763	.7632
	Total	3.692	.5738
MEAN TPACK	1	3.600	.4000
	2	3.461	.6295
	3	4.250	.3786
	4	3.800	.4513
	5	3.537	.6768
	6	3.688	.6407
	Total	3.588	.6162
MEAN SE-TI	1	3.5371	.29820
	2	3.5876	.53941
	3	3.8900	.70057
	4	3.7883	.49090
	5	3.6089	.48472
	6	3.5750	.48834
	Total	3.6210	.50549

[a] Early Childhood, N = 7. [b] Elementary Classroom, N = 46. [c] Elementary Subject Area, N = 4. [d] Middle School, N = 12. [e] Secondary Subject Area, N = 19. [f] K-12 Subject Area, N = 16.

Table 21 MANOVA results for Major or Endorsement

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Wilks' Lambda	.768	1.309	20.000	316.029	.171	.064

gender, nor year in the program, nor their major or endorsement area had statistically significant impact on their beliefs about their abilities to integrate technology into the classroom. Overall, the pre-service teachers expressed confidence in their technological knowledge, their technological pedagogical knowledge, their technological pedagogical content knowledge, and their self-efficacy for technology integration.

Finding 2: Pre-service teachers feel a sense of pressure or expectation to be able to integrate technology into their teaching practices.

The pre-service teachers in this study report that they feel quite confident in their abilities to teach with technology. This does not, however, eliminate the pressure they feel to be viewed as members of the "tech-savvy generation" (Cleo). In fact, eight of the eleven interviewees mentioned feeling some sense of pressure or expectation for them to be able to teach with technology, often because of their age. While some seemed to take this as a fact of the matter, other participants raised questions about this.

Several participants expressed their belief that they are simply more tech savvy than veteran teachers because of their age and experiences. Take Cleo's comment, for example: "my generation knows a lot about technology and how other things work." She expressed her perspective that because she grew up in a technology-rich environment, and experienced a one-to-one technology program in her high school, she felt that she was naturally prepared to teach with technology. She summed up her thoughts on this matter by suggesting, “I would say that we are more tech savvy. I'm on my phone, my laptop majority of the time I'm awake, so just being comfortable using it in general” (Cleo). Similarly, Gary shared, “we just grew up with it. ...That's the norm, using technology.” Henry agreed, and also suggested that his generation is extremely connected to the technologies they have come to expect and rely upon. He shared a story of a class trip he took last summer and had to leave his phone behind. This was a challenge for him, he explained,

> When I was in Puerto Rico without a phone for two weeks, I almost had, well, not withdrawals, but…it was weird because I always pull out my phone to check the time. I would go and reach for it, and then it wasn't there. I finally got used to checking my watch, but [my phone] is something I've grown up with. It's something I'm used to. (Henry)

Henry expressed his opinion that his generation is simply more technologically savvy because he, like his classmates uses technology for both schoolwork and recreation. Regarding his personal technology use, he said “I’m on it all the time, whether that's my phone or my iPad or my computer. Whether that's socially, or grading, or working on papers too” (Henry). Drew summed up these expectations for young teachers to be adept at technology integration by suggesting, “Tech integration [is an expectation for us] in general, …You just learn it as you go [through school] and use what you can use” (Drew). These comments all point to a perspective held by many pre-service teachers: they are members of a generation that grew up saturated in technology, and some believe that they have learned to teach with technology by experiencing it as a fact of their lives.

Not all participants felt so positive about this generational assumption of technological savvy, however. In contrast to these previous comments, Ivory—who is a freshman in her first semester in the TPP—suggested,

> I definitely wish that I had had more experience with [technology] because I feel like this is the first year that it's really been super essential for me to have a computer. I literally use it all the time for different classes, but other than that ... I know it's kind of a new up-and-coming thing and it's happening, [but] I'm at the tail end of not having all of that technology. (Ivory)

Ivory expressed that she sometimes feels that she is “behind” her classmates when it comes to her technology knowledge, and fears that she will be left behind. On a similar note, Elsa brought up her concern that pre-service teachers are expected to be adept at technology integration, but she believes that they are not always as competent as they are expected to be. She commented, “We have grown up with that setting of we just had to figure it out because it's supposed to come naturally to us” (Elsa). In the course of this discussion, I asked Elsa, “Do you feel like there is a cultural expectation for people of your generation, like ‘Well, you guys are supposed to be good with technology?’” She replied, “A little bit. …[People expect] that someone my age *should* know how to do it. …Most of the time it's okay, but it's a little nerve-racking to realize that in like 20 years that won't be the case anymore. It’s like I better enjoy it while I can” (Elsa). Despite these concerns, Elsa also described herself as “moderately comfortable” with teaching with technology.

Other pre-service teachers felt a sense of pressure for exemplary technology integration, but took it as a challenge. Julie, for instance, noted that she did not have much technology integration in her elementary and high school experience, describing it as “chalkboards all the way through.” She thoughtfully reflected on her K-12 school experience by noting, “a lot of us didn't necessarily go through education with huge technology integration. A lot of us were right before that big wave came through” (Julie). Julie is a PDS intern, and commented that her mentor teacher and other colleagues expected her to be technologically savvy, and ready to help them learn more. She shared,

> Coming in, like you're the new [person in the school]... [More experienced teachers say things like] ‘Oooo, what did you learn at college with technology? Like, help me with my Smart Board. I don't know how to do this.’ That's part of the pressure I feel to get learning it, which is probably a good thing. If I went in feeling like I don't have to, I could, but I think it's better for me to have personal growth. If I feel like they're going to expect me to do that, I could just as well be up on it and then I can help and then that's a great way to increase those relationships between colleagues. (Julie)

Andie, another PDS intern made a similar observation. While describing her experiences with technology integration in her internship, she shared,

> It's interesting going into a school being the younger one… I know some [things about technology], but I've never felt like I was good at technology. Then I get there, and it's like, ‘Hey, can you fix this?’ Yeah, I can, and I can do it, but I didn't realize I could do it. I didn't ever think of myself that way, that I'd be the one…to say, ‘Yeah, I do.’ (Andie)

Andie seemed to have a moment of realization that she is more technologically savvy than she had previously given herself credit, and this was empowering for her. She took this as an ongoing challenge, to continue to learn more about teaching with technology, stating, “So now what's available for me, to be able to learn further?” (Andie). Being able to position herself as a learner was important to Andie, and Gary expressed similar ideas. At one point in his interview, Gary suggested, “When people don't know how to run certain technology stuff, I'm like, ‘Man, I'm never going to be like that. That guy is just old. He doesn't know what he's doing.’” After a moment of reflection, however, he had another thought, and went on to say,

> When my kids, if I have kids and they're 20, …am I going to look at whatever gadget they're using and be like, ‘What the heck is that thing? Is that a spaceship? What is that thing?’ I don't know. It'll be interesting what the smarter people in the world come up with. (Gary)

It seemed that Gary realized that he considers himself and his generation technologically savvy, for now, but he also realizes that there is some pressure on him; he will have to keep working at it to remain at the forefront of technology integration. Other pre-service teachers in this study were similarly reflective about their own learning, and how members of their generation may think differently about technology integration than previous generations.

For example, Henry, while reflecting on his classmates’ technological experiences and comparing them to older generations, grew thoughtful about his professors’ experiences learning about technology. He related, “Your generation didn't have that [level of technology], so then [some older teachers] probably aren’t going to change their ways to accommodate technology. ...It's kind of what I'm picking up on, I guess” (Henry). Henry went on to note his own desire to keep learning, so he would not fall into what he perceived as a shortcoming on the part of the older generation of teachers: stagnation. He wondered aloud about teaching in a one-to-one technology program, feeling pressure to be well-prepared to teach in such a setting:

> We talk about [teaching in a one-to-one environment in class], but we never really see what schools are using it for. We talk, 'Oh yeah, that school is one-to-one.' Great. What does that actually look like in a literacy classroom? What does that look like in a math classroom? How does that look in science? Yeah, we talk about it. It's great. (Laughs sarcastically.) Oh, yeah, most schools are going to [one-to-one], but it'd be neat to actually hear the teacher come in maybe sometime and say, 'Oh, this is how we use the one-to-one.' …That would be neat to, I guess, understand a little bit more about the one-to-one.

Henry shared that he is concerned about this because he feels pressure to be excellent in any classroom where he finds himself teaching, regardless of the level of technology available.

Summing up this finding, a majority of the interviewees expressed some sense of pressure or expectation that they must be able to integrate technology into their teaching practices. Some of these felt quite positive that they were able to do so simply due to their experience and background, growing up as members of a generation with widespread access to digital technologies. A smaller number of participants expressed some concerns about this, because they did not feel that they were prepared to meet the expectations placed upon them. Many participants recognized the need to continue learning about technology integration to be able to effectively meet these expectations.

Finding 3: Modeling effective technology integration is an important part of pre-service teachers developing the self-efficacy to integrate technology into their own teaching practices.

Modeling technology integration appears to be one of the most helpful ways to boost pre-service teachers' self-efficacy for technology integration. All eleven interviewees referred to learning by watching someone else use a technology, and eight of them gave specific examples from either their professors, mentor teachers in practicum experiences, or even their teachers in their K-12 schooling experiences.

Modeling by professors.

Seven of the eleven interviewees gave examples of how their professors modeled effective technology integration for them. Many of these commented on their professors' work with technology in class as helpful examples for them in thinking about how they too can teach with technology. Drew mentioned one of his content professors, and how the extensive modeling of technology integration in his science courses and labs helped him to picture himself teaching in a similar way. He shared this story:

> My professor, he has a lot of pretty cool technology we use for some of the experiments. He has this big probe that we did one lab, where he just dipped the whole thing in the water and left it there for five minutes. He has this big monitor and it says everything about the water, so it says flow rate and temperature, and amount of nitrogen in the water, and oxygen, so just cool things like that. … We also have things that we took in lab one day, you just held in the air, and it'd give barometric pressure. … It'd take wind readings and stuff like that, so that's kind of cool. I'd never seen that stuff before, neither. … It was kind of cool to use that for

> the first time. Yeah, it's really convenient, as the professor, just for a quick data collection. You send your students out to random places, and they're all collecting all this data at one time. Then, they can graph it all for you in one big graph, and stuff like that. … Now that I think of it, how convenient it is, both for the students and the teachers. I would definitely use that, if the school provided it, of course. (Drew)

Drew's story illustrates the importance of modeling by professors. His comment at the end of this passage demonstrates the impact on his own self-efficacy, that he can see himself doing the same thing with his own students if he had access to the technology. The statement, "I would definitely use that," provides evidence that Drew is developing greater confidence for technology integration through his course work. He perceives an increase in his abilities to integrate technology into the classroom, and the modeling by professors is providing a positive impact.

Four of the seniors who were interviewed gave examples from methods courses or content courses in which their professors demonstrated how to teach with particular apps, software programs, or hardware devices in ways that promoted self-efficacy for technology integration, in ways that sometimes directly carried over into their practicum experiences. These experiences are positively influencing their perceptions of their abilities to integrate technology into the classroom. As an illustration, Bruce shared several experiences about how his content professors naturally integrated technology tools into the way they taught the content. He related,

> GeoGebra, for instance…I've seen it very extensively working with it in my modern geometry class. Also, [my professor] uses it in other classes and a whole

> bunch of other math programs. He'll do it on his computer and show it on the screen and then like, ‘Oh, look, that's really cool. … I can use that one.’ Desmos, I hadn't really heard of it until then. I was like, ‘Oh, I can just graph things on here really nicely.’ (Bruce)

Bruce’s comments suggest that by observing his professor at work integrating technology into his teaching, he was encouraged that he could do the same thing with his own students. Bruce later mentioned these same technologies (i.e., GeoGebra and Desmos) as tools he was using in his PDS internship with his own students.

Julie shared a similar example, describing how one of her methods instructors did a think aloud when the SMARTBoard being used was not functioning properly, and how powerful this was for boosting her perceptions of her own abilities. She shared that the professor said, “‘Oh, look at that, our SMARTBoard just crashed. What are we going to do about that?’ and then just talking through [how to fix it]” (Julie). She went on to explain how this kind of modeling gave her confidence that even if things did not always go exactly according to plan, she knew that would still be able to use technology for teaching. She also shared how this kind of learning affected her teaching; in her PDS internship, she was teaching when “in a lesson the other day the SMARTBoard crashed, the YouTube video crashed, my notebook crashed. I restarted everything, and in the meantime we got kids going different directions and so it does not always work the way you're expecting it to” (Julie). The modeling she had experienced carried over into her own teaching.

<u>Modeling in practicum experiences.</u>

Pre-service teachers in the TPP have several practicum experiences as part of their preparation to teach, including observations in PreK-12 classrooms as well as service-learning opportunities to put what they are learning in their coursework into action with real students. Every pre-service teacher in the TPP has at least three practicum experiences that correspond to the courses surveyed in this study. Pre-service teachers in Introduction to Education have a brief (10 hour) observation practicum in a PreK-12 classroom as part of their coursework. Pre-service teachers in Planning, Instruction, and Assessment have a 25-hour practicum that includes tutoring students in local schools, giving them practice at assessing student learning and planning for lessons. Pre-service teachers in the Senior Seminar are all enrolled in either a 60-hour service learning practicum or a semester-long PDS internship. Every participant in this study, therefore, was involved in a practicum experience at the time the research was conducted. These practicum experiences give pre-service teachers occasions to observe mentor teachers at work with real students.

Six participants mentioned the modeling they had seen from PreK-12 teachers in their practicums as helpful for developing their confidence for teaching with technology. Examples include statements such as, “I think that's why I like observation type stuff so much, just because you're not just talking about it in a classroom, but you're actually seeing it being done” (Fiona) and, “I guess I've learned through seeing what other teachers do in the different practicum experiences that I've had, or just observations that I've been assigned…. I feel like observing other teachers has been one of the biggest ways that I've learned about how to use technology." (Elsa) Likewise, Gary shared this story from his service learning practicum:

> Over my practicum…I've seen some good technology stuff. I go to [my school] right now Tuesday and Thursdays. [My mentor teacher] uses some good technology not only with the SMARTBoard stuff, but these clickers that you can just punch in their answer and it comes up on your computer. It shows their answers and they have a certain number that's assigned to them. That's really handy. (Gary)

Gary suggested that observing his teacher working with the clickers made that seem like something that he wanted to do as well, and gave him the confidence that he could definitely use technology in this way for teaching.

The three PDS interns all indicated that they were tacitly learning from observing and working with their mentor teachers in their internships. When I asked Julie about this, she immediately gushed,

> She's awesome! [My mentor teacher] is top-of-the-line right there. We do laptops, we have a laptop cart, Chromebooks, and so once or twice a week in the mornings we get those for sure. …She does a lot of Smart Board stuff. On most days it's used just as more of like a PowerPoint, but then there are days where it's definitely interactive, like getting the kids up there working with different stuff and just showing them, like 'Okay, here's how you could do base-10 blocks.' (Julie)

Julie was describing the things her mentor teacher modeled for her, and she followed up this by talking about how much confidence this gave her for her own technology integration habits, explaining, “This is a good foundation…It all works together” (Julie).

Along the same lines, Bruce noticed his growth in managing a technology-rich classroom because of his experiences as a PDS intern. He described the ways he learned about technology in his content area, and in his methods courses as helpful, but he saw tremendous value in experiencing teaching with technology first-hand in a one-to-one technology environment, where he was able to observe how his mentor teacher taught in this setting. He commented,

> My cooperating teacher does a pretty good job of [setting expectations]. I guess the expectation that we set for them is that unless we ask you to take your laptops out, leave them in your backpack. Until they're working on their assignment or reading through something or asked to go on GeoGebra or write to learn or something like that, they'd take out their laptops. (Bruce)

When asked about the best way for pre-service teachers to learn about technology integration, Bruce suggested, “The best way I think …would be to have them placed in a one-to-one place. That would be ideal. I've learned so much just by observing about how you take care of people who are on their computers in class.”

Andie also had shaping experiences in her PDS internship. She noted that her mentor teacher both modeled how she integrates technology into the classroom, and also expected her to just jump in and teach, and that this made a big difference for her. She mentioned that she had recently realized that “[The other PDS interns and I] talk about how much more helpful our classes have been this semester because we're in the classroom so much more. …I have my kids every single morning, and I know how they're going to react and I know what they're doing." She related this to technology integration, stating, "You can learn SMARTBoard [in class], and that's great, and I can make a music thing that we do everyday is use our SMARTBoard thing to do our music, so I can do that, but until I can see if my kids actually like it, or if it's useful, then it's not real to me" (Andie). All of these comments suggest that the modeling and first-hand opportunities pre-service teachers have experienced in their practicums are positive influences on their confidence for teaching with technology.

<u>Modeling by K-12 teachers.</u> Four of the eleven interviewees described modeling by their elementary, middle, or high school teachers as shaping experiences for teaching with technology. Ivory described some of her technologically savvy teachers from high school, and their expectations for how the students would do their work, stating,

> Some of my teachers were really good about, 'Okay, here's your assignments. Email them to me or share them on Google Docs and then I can go through and proof read them for you before you just turn them in,' or they were like, 'Hey, if you need help doing whatever, I can help you out.' (Ivory)

She suggested that she knew she could do the same thing, based on her observation of this modeling.

Kevin had a similar example with a high school teacher learning to use a new piece of hardware. He shared, "I remember when I had my first classroom with a SMARTBoard in it and the teacher had spent a couple of weeks before school learning how to use that SMARTBoard so when the first day of classes came and they used it they knew what they were doing. …It was new to the students but…the teacher felt comfortable” (Kevin). Kevin indicated that this was the same sort of approach he would take as a teacher; he would definitely dedicate the time to learning how to use a new tool before trying it out with students, because, in his words, “That would be the worst thing. Whether you're teaching with a high tech tool or not, when you see students drifting away from you” (Kevin). So, while perhaps a less important influence for these pre-service teachers, modeling by PreK-12 teachers was an area of encouragement for their confidence for teaching with technology.

Overall, modeling was one of the most prevalent areas of commentary from the participants with regard to their confidence for teaching with technology. These pre-service teachers indicate that modeling by professors in class and mentor teachers in practicums are important influences on their self-efficacy for technology integration.

Finding 4: Both formal and informal learning opportunities positively impact pre-service teachers’ confidence for working with technology.

Participants described a variety of experiences that have helped them to develop the confidence for teaching with technology. These experiences largely fell into two categories: 1) formal learning opportunities that were connected to their course work (e.g., a professor demonstrating how to use a SMARTBoard, or a professor assigning students to “mess around” with the SMARTBoard and see what they can discover about how to use it), or 2) informal learning happening outside of class in their day-to-day lives (e.g., the students finding a tutorial on YouTube to learn how to use an unfamiliar technology tool).

Formal learning experiences. While there is not a specific educational technology course currently part of the TPP, this does not mean that there is no formal, course-related instruction in the program regarding teaching with technology. The catalog descriptions for some courses in the TPP indicate that technology integration is a component (Dordt College, 2016). Likewise, several of the syllabi for methods courses that were examined in this study demonstrate specific lessons on the semester schedule where technology integration within a particular content area was to be taught. Some pre-service teachers recognized the attempts their instructors are taking to integrate technology deliberately in their own teaching. One pre-service teacher who was taking Planning, Instruction, and Assessment noted that the "Instruction" part of the course included some encouragement for teaching with technology, stating, "[I'm learning] about what technologies that I can bring in to either my lesson planning to benefit the student, and to kind of bring it to their own level, because we are a very technology-based society" (Fiona).Julie, who was generally positive about her formal opportunities to learn about technology integration through her methods courses, had this to say:

> I think that [all of our professors] are starting to realize, 'We need to make sure they're ready for this,' and so [they say to themselves], 'Okay, I'm going to set aside this Wednesday on my syllabus to make sure that we talk about how to use the SMARTBoard,' which is great, but I think certain professors are also doing a really good job of along the way, like, 'You know what, time out. Here's a real life thing. Did you guys know that you can move your toolbox from the top to the side if you can't touch it?' (Julie)

Julie perceived the need for both deliberate, formal instruction in technology integration, as well as the more informal learning that can come when professors explain how they themselves are using the technologies.

While formal learning opportunities (i.e., a class presentation by a professor on how to use a particular technology) can be helpful for pre-service teachers, these are not the only way they learn about technology integration in their courses. Some "exploratory" learning activities were also included in their course work (i.e., the professor encouraging pre-service teachers to just "mess around" with a technology tool to learn about how it works.) Julie's comment above highlighted the just-in-time learning opportunities that come up in the moment, if faculty members are willing to "think aloud" to help their students understand what they are doing and why. This is one kind of informal technology learning, but there are others as well.

Several participants noted that some professors expect students to already know how to use educational technologies, or else learn to use technologies informally on their own. Comments such as "professors sometimes assume that about us [that we can just learn to use any technologies], like, 'You've grown up with this. You'll be fine. Just do it,'" (Elsa) and "[Professors] in the teacher prep program expect that you already have a good tech awareness, and I think that's good, just because yeah, we should know this stuff," (Drew) illustrate this perspective. Some pre-service teachers saw real benefits to this sort of informal learning, such as Kevin, who stated, "you want to go do something [with technology] or maybe create something using that program that we will some day use in a lesson."

Not all participants were so positive, however. Some interviewees had negative comments about these occasions for exploration-oriented technology learning that are part of the TPP. One participant was a little frustrated by some of what she perceived to be busywork related to technology learning, stating, "For one of my classes, we were required to download the SMARTBoard app, or go to a computer that had it downloaded, and then just mess around with it for an hour. You think, right away, ‘An hour? That's going to be forever’” (Andie). Another interviewee had a similar frustration come up in class; she related that one professor “gave us the chance to mess with the SMARTBoard for five minutes, I wanted to say, ‘Okay, teach me more and show me [how to use it],’…instead of a ‘hey-you-can-go-play-with-it-for-a-little-bit type of thing,’ because these things are relevant to our careers and to the students.” (Cleo) And another pre-service teacher, commenting on a course that required students to use social networks as a tool for professional learning, shared this anecdote:

> I've never been good at Twitter, Pinterest, and all those other things. All of the other people in my class were all excited about it. I'm like, ‘Oh, yeah. I can look up ideas on Pinterest.’ I type in my algebra activity on Pinterest. I tried it once. I was just overwhelmed. I was like, ‘Where do I even start?’ I click one and I’m like, ‘Hey, I don't like that one. That one's weird. That one works. I have already had that idea already.’ A little like, ‘This is just a crazy app.’ It overwhelms me a little bit, those sites like, Pinterest and Twitter. There's just so much going on. I'll just look up pictures of Calvin and Hobbes. (Bruce)

In relating this experience, Bruce suggested that while he could see some value in such activities, he did not feel they prepared him well for the challenges he would face in actually integrating technology into his teaching practice.

Conversely, others were quite positive about the combination of formal presentations and exploration opportunities to learn about technology integration within their coursework. Gary explained that he appreciated seeing professors both showing new tools and apps as well as explaining how they used familiar technologies in their teaching. He expressed some concern about not always being able to remember the tools, because there was not enough time to master them. He summed this thinking up, stating

> I can't always remember exact specifics of tools that [we used in class], but I just remember in general being like, ‘Oh, yeah. That's a cool website,’ or, ‘That's a cool…’ Something like that. Other classes…they're using the same technology that I would use if I had to teach. A PowerPoint, a Google Doc. (Gary)

Similarly, another participant appreciated the combination approach of modeling and self-directed learning a professor was using to teach students how to use a particular technology. He suggested, “it was good because we got the general idea of what this program is trying to do and then we got to figure it out for ourselves. Just clicking on that button, no that's not what I want, this is what I want.” (Kevin) Likewise, Fiona appreciated having a combination of modeling and hands-on learning. She described learning to use two different technologies (VoiceThread and Thinglink) in different courses. She shared,

> VoiceThread, I was able to figure that one out pretty well because actually [my professor] gave me a good enough description that I could figure it out from there, a good foundational so I wasn't going in there like, "What am I doing?" Others, it's more like I have to figure it out a little bit more. I've used Thinglink before, and when I first started using that I was confused on how to use it, but now that I understand it and figured out the basics, I've been able to figure out more with it. (Fiona)

Several participants then found confidence in the combination of some direct instruction from a professor about how to use a tool to help them get off to a good start, with the time to explore on their own to master a particular technology.

Informal learning experiences.

Participants also suggested that informal opportunities to learn about technologies were part of their day-to-day life, but also impacted their thinking about teaching with technology. When asked how they might learn about a new technology that they had heard of, but knew nothing about, participants had a variety of strategies that they suggested. Some suggested that they would learn by exploring firsthand. For example, Bruce stated, “I’d just spend time playing with it. That's how I figure things out.” Similarly, Cleo suggested, “I could probably figure [a new technology] out through messing around with it” and Ivory said she would “just mess around with it and see what I can do. Press buttons.” Julie shared that her high school was not a particularly technology-rich environment, so she has had to learn a lot on her own, but that she enjoyed learning by doing. She stated, “A lot of my basic tech skills were self taught. A lot of that kind of stuff, I just like it, so you dink around with it, you figure out how to do it” (Julie). While this might seem like a haphazard approach to becoming familiar with a technology, other interviewees had a range of deliberate strategies they said they would use to learn about a new technology in an informal way. Several participants mentioned that they use online resources to learn more about technologies. For example:

> I feel like you could learn so much on YouTube. I don't want to undermine going to school because obviously school is important, but you can almost learn just as much on YouTube as you can sitting in a day of class. (Gary)

> I'm pretty comfortable with using the internet to answer questions about things that I don't have someone right next to me to explain to me, so yeah, I'd probably go online and look up a tutorial, and maybe look up some things on Pinterest of how it's been used before by other teachers. (Elsa)
>
> [For a new tool,] I think immediately, I'll just Google it. That's just the first thing that comes to mind is just search Google or ask Siri. … If it's an Apple product, just go to Apple's website and see what's going on there. (Andie)

Other participants suggested that they would seek help from family or friends to help them learn. Examples include Bruce’s comment, “[I would ask] the person who told me about it, I'd be like, ‘Hey, how did you do this in this program?’” or Cleo’s suggestion, “I'd either ask my mom, because she's a teacher and might know how to use it, so I'd ask someone who knew [about it already.]” Likewise, Julie noted that she is developing a network of teacher friends who can help her when she has technology questions. She shared, “You know, I'd contact different teachers in the school, anybody that's used it. At this point I have a large network of teaching friends that are either already using it or looking at it themselves” (Julie). These comments suggest a range of informal approaches pre-service teachers use to support their learning about educational technologies in addition to course-related technology learning. Online tutorials and resources, as well as asking family or friends for advice and support, were approaches the pre-service teachers found helpful for there personal learning as a supplement to their formal and informal in-class learning opportunities.

Finding 5: Technological knowledge is an important component for self-efficacy in technology integration, but pedagogical knowledge and content knowledge are also necessary.

In order to meet the expectations of others—and themselves—when it comes to their ability to integrate technology, the pre-service teachers in this study overwhelmingly expressed that technological knowledge is an essential aspect. That is, to effectively integrate technology into the classroom teachers must understand how the technologies at their disposal function. However, the interviewees also strongly suggested that technological knowledge is not enough to integrate technology into the classroom.

The data collected through the survey of pre-service teachers illustrates these pre-service teachers' beliefs about their technological knowledge. The Technological Knowledge subscale of the survey, which is comprised of items 8-14, is designed to measure pre-service teachers' perceptions of their technological knowledge. The mean results for these items by class grouping are presented in Table 22. These results indicate that pre-service teachers in the TPP perceive their technological knowledge to be quite strong, both in the three samples, and across all samples when comparing the groups as a whole. In particular, item 9 ("I can learn technology easily") and item 13 ("I have the technical skills I need to use technology") were perceived to be very high among all participants, with mean scores of 3.90 and 3.71 respectively. Conversely, item 11 ("I frequently play around with technology") and item 12 were perceived to be weaker overall, with mean overall scores of 2.92 and 2.94, respectively. In fact, these were the two lowest overall scores (for all participants) of any of the subscale items; no other items had an overall mean score lower than 3.0.

For the purpose of comparison, subscale means were calculated for each of the four subscales by averaging each participant's scores for each subscale. These scores are presented in Table 23. Note that the mean score for the TK subscale is 3.296 with a standard deviation of .725, which is a lower mean score and a broader standard deviation than any other subscales in this survey.

It is worth recalling, however, that all of the subscales indicated statistically significant positive correlations with each of the others. Thus, technological knowledge is related to technological pedagogical knowledge, technological pedagogical content knowledge, and self-efficacy for technology integration. Table 9 illustrates these correlations. So, while technological knowledge is definitely a component for confidence in technology integration, it is not the only component. Pedagogical knowledge (connected to technological knowledge as TPK and TPACK) and content knowledge (connected to both technological and pedagogical knowledge as TPACK) are also essential components for self-efficacy for technology integration.

Comments from interviewees affirm this perspective. In response to the question, "How confident are you working with technology?" nine of the eleven interview participants described themselves as "pretty confident," "fairly confident," or even "very confident" with working with technology in their day-to-day lives. One freshman in the TPP commented,

> I would say I am growing more over the past couple years. I've gotten more comfortable with [technology]. I didn't do too much other than…school projects so I never really got too much into it but I definitely, I've gotten better working with it over the past couple of years. (Kevin)

Table 22 Mean scores for TK subscale by class grouping

	Introduction to Education[a]		Planning, Instruction, and Assessment[b]		Senior Seminar[c]		All participants[d]	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Q8 - I know how to solve my own technical problems.	3.12	.889	3.00	1.145	3.00	1.107	3.05	1.028
Q9 - I can learn technology easily.	3.79	.842	3.97	.718	4.00	.762	3.90	.782
Q10 - I keep up with important new technologies.	3.33	.846	2.80	1.215	3.16	1.051	3.13	1.040
Q11 - I frequently play around with the technology.	3.19	.890	2.73	1.258	2.75	1.164	2.92	1.103
Q12 - I know about a lot of different technologies.	3.02	.924	2.93	1.172	2.84	1.167	2.94	1.069
Q13 - I have the technical skills I need to use technology.	3.86	.566	3.57	.898	3.66	.971	3.71	.809
Q14 - I have had sufficient opportunities to work with different technologies.	3.69	.604	3.20	1.126	3.25	1.078	3.41	.951

[a] N = 42. [b] N = 30. [c] N = 32. [d] N = 104.

Table 23 Comparison of subscale mean scores

	N	Min	Max	Mean	SD
TK (subscale mean)	104	1.57	4.86	3.296	.735
TPK (subscale mean)	104	2.00	5.00	3.692	.574
TPACK (subscale mean)	104	1.40	5.00	3.588	.616
SE-TI (subscale mean)	104	2.31	4.94	3.621	.505

Note. Subscale means were calculated by finding the mean score for each subscale for each participant. This table displays the shape of that derived data.

Similarly, Gary, who is a senior, described his personal level of confidence by stating, “I think in day-to-day life, as a 22-year-old, I feel like I'm capable of using the technology that I need to use.” These comments are general illustrations of pre-service teachers’ self-perceptions of what it means to be confident in their technology use in daily life.

Teaching with technology, however, may look different to pre-service teachers than using technology in their day-to-day lives. Take Bruce, as an example. Among the interviewees, he has perhaps the highest level of first-hand experience working with technology; he even minored in Computer Science along with his Secondary Mathematics Education major. However, even with his knowledge of programming and hardware, he still describes his technological knowledge by stating, “I wouldn't say I'm an expert. I couldn't do tech support somewhere. I know enough about computers that I can find sources to fix the problems that I have” (Bruce). However, when asked about his confidence for *teaching* with technology, Bruce, described himself as “quite confident” and described his PDS internship teaching in a one-to-one technology environment in great detail, including a variety of technologies he uses to teach math. He is actively integrating technology into his teaching on a daily basis, making the connection between his technological knowledge and the pedagogies he is choosing for teaching the math content to his students.

Several other participants also shared comments about the intersection of technology and pedagogy, and the importance of this connection, even if they did not personally feel like an expert technology user. Gary, who described himself as comfortable enough working with technology, shared a story of working with a student one-on-one in his service learning internship. While he does not consider himself exceptionally technologically savvy, Gary described working with one student using technology to help her practice her math and literacy skills. He shared,

> One [student], she's in fourth grade but she's learning at a first grade level. She's using programs like Lexia or IXL. These are all programs online…I'll work with her on the computer. She'll work through simple addition and subtraction facts or filling in the correct word for the sentence with the vocab word. (Gary)

Gary's experience demonstrates that he has "enough" technological knowledge that he can see the value in finding tools to support his pedagogy.

In her PDS internship, Andie had a similar experience. She described a management problem: finding a way to call small groups of students back from working in the sensory room down the hall with a paraprofessional. She shared the story of how she thought of using the chat feature in Google Hangouts as a sort of silent intercom between the classroom and the sensory room. She installed the Hangouts app on both of their classroom iPads, and sent one along with the students to work with the paraprofessional. When it was time to call the kids back to class, she would just send a message between the iPads. She noted that there were community benefits for the whole class that came out of this innovation as well. She shared,

> Then it was fun because we got the kids involved, too, so they would remember, 'Oh, this kid is in the sensory room. We need to tell him to come back.' Then you show them what to do, and they would remind you every day. Then you just type it into them, and you'd see [the kids] come back [from the sensory room]. The kids [in the classroom] would be excited that it worked. (Andie)

It was clear that Andie was feeling proud of thinking creatively about her existing technology knowledge and using it as part of integrating technology into the classroom. Andie was one who described herself as "fairly confident" with technology in her daily life, but she also expressed that her practicum was giving her first-hand experience that increased her confidence for technology integration.

The interviewees suggested that they recognize that while they generally have an acceptable level of technology knowledge, they also know that they need to continue learning about technology. Nine of the eleven interviewees expressed that they recognized the need for ongoing technology learning, both now as pre-service teachers, as well as into the future when they will be the professionals. Some examples of comments about ongoing technology learning included:

> It's really important for teachers to be aware of what's going on technology-wise and development-wise to understand what's not necessarily the newest, most exciting thing, but the newest, most effective thing. … If there's something better that's come out, then use it" (Elsa).

> I do feel pretty equipped and confident. There are just some things like Prezi,…I don't *need* to know Prezi, but I'm also curious because I want to be well-rounded in that for my own sake, …If I have a toolbox, I want to have as many tools as I can going into teaching. (Cleo)
>
> I like getting to know new technology, interacting with it, and figuring it out, but at the same time, there's so much stuff that's changing, it's hard to keep up. (Drew)
>
> You fail sometimes and then you get it other times. …I think if I work towards it I can be successful with using technology. (Kevin)

The pre-service teachers in this study understand the need to continue to increase their technological knowledge. New technologies are constantly being developed, and existing technologies are often adapted to innovative new uses. Though they have not yet entered the professional ranks of teachers, these participants view continual learning about technology as a key for their careers.

All together, participants recognized the importance of technological knowledge for effective technology integration. While their individual levels of technology knowledge varied, they were able to see the value in using technology for teaching, and saw the connection between technology knowledge and pedagogical knowledge. Encouragingly, even the least confident interviewees expressed interest and willingness to learn more about technology to be best prepared for integrating technology into their teaching.

Finding 6: Pre-service teachers believe that a practical course in educational technology would help to prepare them to integrate technology in the classroom.

As previously discussed, the TPP does not currently include a course specifically devoted to learning about educational technologies. A majority of the interviewees (eight out of the eleven) commented about this, often wishing for a more deliberate—or perhaps a more obvious—opportunity for them to learn about the technologies that they will use in the classroom. I did not specifically ask them about a course related to educational technologies, but I did ask a somewhat broader question: “What do you think would be the best way for a pre-service teacher to learn about technology integration?” In response, eight of the eleven interviewees specifically brought up the idea that a course to help them learn about various classroom technologies would be a benefit, making comments such as, “I don't think it'd be a bad idea to have a whole course devoted to tech integration…A class that teaches about current technology and, maybe, how teachers are using it now, and how technology is changing,” (Drew) and “I think it would be more beneficial to have a class that is solely focused on technology. Then you can take that technology class and actually apply it to your methods courses.” (Gary)

Several participants noted that there are some formal opportunities to learn about educational technologies, but they also suggested that this learning is fragmented. For example, Bruce made the comment, “it surprises me that it isn't some course specifically called education technology…I think we have ‘technology in education’ as a little subsection of six different courses.” Two other pre-service teachers corroborated this view that technology learning was divided into a variety of courses:

> It's not something that is spent in depth on necessarily, but it's something that we definitely hit on in each methods course. We've talked about it in psych courses and such like that too. It's something we talk about all the time. (Henry)

> I know in multiple classes, I couldn't even name them necessarily, but we've just had a unit or a class that's been about technology, or we've been given a list of apps that are helpful, or just I feel like that's been at least brought up in most of my classes at some point. … I don't know that there's been whole lot of application. (Elsa)

Interestingly, most who thought a technology course was a good idea recognized that a one-size-fits-all course would actually be a poor-fit for pre-service teachers, due to the different age groups and content areas they would be teaching. This idea fits quite well with the TPACK framework: contextualizing technology use with different pedagogies and in different content areas. For example, in illustration of her technological content knowledge, one pre-service teacher suggested

> I think that for each subject area, tech integration is going to look a little differently, just because of the nature of the content. For science, I know there's online dissection type things, but of course a history class isn't going to have that type of thing. (Fiona)

Along similar lines but with regard to technological pedagogical knowledge, another participant recognized that teachers at different grade levels may use vastly different technologies with their students. In his thinking about how to best prepare for technology integration, one interviewee stated

> I think it will be cool to have a class, because each [pre-service teacher] in our class…we're going to teach very different things. [My friend] wants to teach high school history, there's no way I could ever teach high school history. If there would be a class for different majors or even high school, middle school, and elementary and just maybe modeling programs that we would use in a classroom and then letting us figure it out and try it for ourselves. (Kevin)

Thus, perhaps a better model for a technology course would be one differentiated for the different needs of a variety of pre-service teachers. Several participants had suggestions for how to make such an arrangement feasible, getting creative with the scheduling and thinking flexibly about the credit options, included the following:

> Maybe have a…one credit, or half semester class where you just dive into the different technologies that can be used in your content area, because I don't think it would necessarily need to be a three credit course, but a course that allows you to explore and have someone who's knowledgeable about the technology in your content area to be able to talk you through it. (Fiona)

> I don't know if it would be a once a week senior seminar type thing where it's Friday at eight a.m. (Gary)

> I think that would be the easiest way, [would be to] just spend a whole semester [learning about technology]…I suppose you could do three separate [segments] for the elementary, the middle, and the high school. Even if you broke it up into three terms or something, like you focused on elementary, if it was a one credit course or something like that even. You focus on elementary for four weeks and then middle for four weeks and high school for four weeks. If you want to go to

> all three, great. If you don't…it just depends what your credit level will allow you. (Henry)

These suggestions indicate their beliefs that learning about technology integration is important, and they are willing to be flexible to develop the knowledge and skills they believe they need.

Some of the participants however, had other ideas of ways to support pre-service teachers' learning about technology integration. One of Andie's comments is a telling contrast to those who recommended a technology course. She suggested, "I think prior to this year, I thought the best way would be to have a tech class, but I think I'm learning as I go that you naturally are just going to learn once you are in it" (Andie). It is important to note that being "in it," as she says, is referring to her experience as a PDS intern. She has the opportunity to practice technology integration under the supervision of and in collaboration with her mentor teacher on a day-to-day basis. She also suggested that it might be more helpful to just have a list of great technology tools for teaching different content areas, stating,

> I think one of the most beneficial things to improve would be to have a list. For math, if you want to learn geometry, here's my list. If you want to learn algebra, here's my list. Just to have a resource, like here's some awesome apps. I don't know if that's even possible for all of the different subject areas, but for science, if you're trying to learn about density, here's an app for that. (Andie)

Four other participants also recommended a resource list. Their suggestions included the following:

> I think it would be helpful just to maybe walk away with…five tools, five websites, five programs or five apps or whatever that you can be like, 'You know what? I'm going to use this.' (Gary)
>
> I would [just appreciate] some idea of what resources are out there to assist in integrating that technology into that subject matter. (Ivory)
>
> I can think of times that we've talked [in classes] about, 'What are some good ways to communicate with parents? Here's a list of communication apps that you can use.' That was so helpful. (Elsa)
>
> Today we had some [guest speakers] come into…Educational Psychology, and they're like, 'Oh, Classroom Dojo, blah, blah, blah' and they just keep going, and I'm like, 'Oh! Jot that down!' Throw that on my list of things. I've got apps, I've got websites, I've got, you know, just different technology resources, so I think that that's a really cool thing to compile. (Julie)

Both Gary and Ivory suggested that the combination of a course as well as a list of excellent resources could be helpful, and that the resource list would be a benefit because of its practicality. Other pre-service teachers also emphasized this need for practicality when it comes to technology integration, so if a technology course were to be offered, it would have to be "a practical course" (Henry), a course that emphasizes "first hand experience" (Ivory), a course that provides "some guideline…as to how we need to determine whether or not this [particular technology] is useful." (Bruce). Elsa offered an insightful comment that sums up much of the participants' ideas about a technology course, stating, "it's really important for teachers to be aware of what's going on technology-wise and development-wise to understand what's not necessarily the newest, most exciting thing, but the newest, most effective thing." These pre-service teachers are looking for wisdom in how to teach with technology.

Chapter Summary

Trustworthiness and credibility are always concerns in case study research (Creswell, 2012). By triangulating from both quantitative data and qualitative data (Yin, 2014) and among various perspectives within the qualitative data, (Creswell, 2013; Stake, 2005) a trustworthy, credible accounting of the case can be advanced. This chapter presented the results of the survey of pre-service teachers' beliefs about their knowledge and self-efficacy for technology integration, as well as interviews of a maximum variation sample of survey completers. After a thick description of the research context, the participants, and the data analysis procedures, the findings were presented. There were six major findings related to pre-service teachers' perceptions of their abilities to integrate technology into the classroom, and their perceptions of what contributed to the development of these abilities. These findings provide evidence answer the research questions for this study:

1) Pre-service teachers generally feel confident in their abilities to teach with technology, regardless of their gender, year in college, or major/endorsement area.

2) Pre-service teachers feel a sense of pressure or expectation to be able to integrate technology into their teaching practices.

3) Modeling effective technology integration is an important part of pre-service teachers developing the self-efficacy to integrate technology into their own teaching practices.

4) Both formal and informal learning opportunities positively impact pre-service teachers' confidence for working with technology.

5) Technological knowledge is an important component for self-efficacy in technology integration, but pedagogical knowledge and content knowledge are also necessary.

6) Pre-service teachers believe that a practical course in educational technology would help to prepare them to integrate technology in the classroom.

These findings suggest several important considerations for teacher educators intent on preparing pre-service teachers to integrate technology into their future classrooms. In the next chapter, implications of these results will be explored, and the limitations as well as what can be learned from the context-dependent knowledge (Flyvbjerg, 2006) that can be discerned from this case.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

In her explanation of the value of case study methods for educational research, Merriam (1998) suggested, "case study research in education is conducted so that specific issues and problems of practice can be identified and explained" (p. 34). This was very much the reasoning behind the development of this mixed-methods case study. I wanted to find an explanation for an issue I found in the data collected through the Dordt College Teacher Preparation Program's (TPP) annual assessment report: there were many comments from graduates of the TPP indicating that they felt unprepared to teach with technology. The TPP does not currently include a course in educational technology, and I wondered whether the lack of such a course in the program was a real detriment to their preparation to teach in today's technologically rich classrooms. Alternatively, I wondered whether it might be a problem of perceptions on the part of the pre-service teachers: perhaps it was the case that they perceived themselves unprepared to integrate technology into the classroom because they did not have a specific course related to educational technology. These reflections brought me to develop the present study, which is an instrumental case study investigating pre-service teachers' perceptions of their abilities to integrate technology into the classroom. Utilizing a convergent parallel mixed-methods approach to develop this case study, I sought to answer the two research questions for this study:

RQ1: What are pre-service teachers' perceptions of their ability to integrate technology into the classroom?

RQ2: To what do pre-service teachers attribute their ability to integrate technology into the classroom?

In this chapter, the implications of this research will be explored and a possible plan of action will be proposed. This chapter concludes with a discussion of the limitations of this research and suggestions for further topics of research related to this study.

Reviewing the Findings

There were six major findings related to pre-service teachers' perceptions of their abilities to integrate technology into the classroom, and their perceptions of what contributed to the development of these abilities. These findings provide evidence to answer the research questions for this study, and are corroborated by the existing literature related to pre-service teachers' self-efficacy for technology integration.

Research Question 1: Perceptions of Abilities for Technology Integration

The first research question for this study was, "What are pre-service teachers' perceptions of their ability to integrate technology into the classroom?" There are strong themes emerging from the data to answer this question. The first finding of this study is that pre-service teachers generally feel confident to teach with technology. This confidence was present regardless of their gender, their year in college, or their major or endorsement area; no statistically significant differences emerged based on any of these demographic categories (i.e., the first major finding.) The survey results indicated that pre-service teachers perceive themselves to have the ability to integrate technology into the classroom. The mean score on the TK subscale was 3.296. The mean for TPK was 3.692, the mean for TPACK was 3.588, and the mean for SE-TI was 3.621, all of these on a five-point scale (see table 8.) The subscales were significantly positively correlated, and also positively correlated with their expressed level of comfort with computers, with Internet tools, and with technology in general. All of this data taken together illustrates that they perceive that they are able to integrate technology into the classroom.

Another major finding connected to their perceptions of their ability to integrate technology in the classroom was that pre-service teachers feel a sense of pressure or expectation to be able to teach with technology (i.e., the second major finding.) Eight of the eleven interviewees expressed this sense of pressure. Several suggested that this was a personal pressure they put on themselves, while others indicated that, because they are members of the younger generation, they feel that older teachers expect them to have superior technological knowledge and skills. Several even gave specific examples from their practicum experiences of mentor teachers expecting them to be able to help with technology-oriented classroom activities. Participants responded to these expectations in varying ways. Some worried that their technological knowledge would be found lacking, that they are not actually as competent as they are presumed to be. Others took these pressures as a challenge, and determined to prepare themselves as best they can to meet the expectations.

A third major finding in this study also provides evidence to answer this first research question. Pre-service teachers ratings on the survey as well as their comments in interviews demonstrate that they understand that technological knowledge is an important component for technology integration, but pedagogical knowledge and content knowledge are also needed (i.e., the fifth major finding.) Pre-service teachers perceived that technology knowledge is, of course, necessary for effective technology integration.

They generally perceived themselves to have the abilities needed to teach with technology.

Thus, several of the major findings converge to provide further answers to the first research question. The current students in the TPP reported that they actually do feel fairly confident to integrate technology into the classroom. The survey results illustrate that pre-service teachers in the TPP feel confident using technology, regardless of their gender, their year in the program, or their major or endorsement area. Participants indicated that they feel a sense of pressure or expectation to be able to teach with technology. However, this sense of pressure did not diminish their general self-efficacy for technology integration. In the interviews with a maximum variation sample of survey completers, an overwhelming majority of participants (ten of eleven) expressed high levels of confidence for teaching with technology. At the same time, participants recognized that their abilities to integrate technology into the classroom are continuing to develop. A majority of the interview participants (seven of the eleven) spoke of the importance of continuing to learn about technology integration, both now as pre-service teachers as well as when they join the profession. By continuing to learn, they will be better able to meet the societal expectations for teaching with technology.

Research Question 2: Origins of Abilities for Technology Integration

The second research question guiding this study was, “To what do pre-service teachers attribute their ability to integrate technology into the classroom?” Several of the major findings in this study indicate that there are a variety of influences that converge to provide an explanation. Pre-service teachers in the TPP had clear ideas about what helped them develop confidence for technology integration. The interviewees noted that modeling by professors, by mentor teachers in practicums, and by their own K-12 teachers had provided positive influences on their perceptions of their abilities to teach with technology. They also expressed that both formal technology learning opportunities connected with their coursework, as well as informal learning opportunities arising through day-to-day life in a technology-rich society positively influenced their perceptions of their abilities to teach with technology. Both of these approaches (i.e., vicarious learning such as modeling, as well as enactive learning through direct experience) have connections to the literature on the development of self-efficacy (Bandura, 1986, 1997; Klassen & Usher, 2010; Woolfolk Hoy et al., 2006; Zimmerman, 1995).

One major finding in this study was that modeling of technology integration positively impacted pre-service teachers' self-efficacy for technology integration (i.e., the third major finding.) In fact, all eleven interview participants mentioned learning to use a technology by observing someone else using it. Pre-service teachers indicated that observing their professors, their mentor teachers in practicums, or their own K-12 teachers using technology gave them confidence to use technology in their own teaching practices. Observing a variety of models has been demonstrated to positively affect the observers' self-efficacy (Bandura, 1986; Kovalik et al., 2013; Mueller, 2009; Zimmerman, 1995). Bandura (1986) noted the importance of diversified modeling for fostering self-efficacy. Diversified modeling is comprised of multiple people demonstrating their mastery of difficult tasks (Mueller, 2009). Thus, having the opportunity to view multiple models including both professors as well as mentor teachers in practicum experiences modeling technology integration can increase vicarious self-efficacy over having just one model.

Additionally, the comments of several of the interviewees about the benefit of their professors thinking aloud about what they were doing as they modeled technology integration for the pre-service teachers are also notable. The approach of explicitly explaining one's thought process to observers has been named "cognitive apprenticeship," (Collins, Brown & Holum, 1991). The addition of cognitive apprenticeship to modeling skills can be a very effective means of reinforcing modeled behavior (Mueller, 2009). In a cognitive apprenticeship, a model "makes thinking visible" to the observer by explaining how and why the action was modeled in that way (Collins et al., 1991). This interaction between the model and the observer (e.g., between and instructor and a pre-service teacher) serves to foster the self-efficacy of the observer by helping him or her understand not only how to perform the action, but the conditions for success (Mueller, 2009).

Another major finding in this study connected with the second research question was that both formal and informal learning opportunities impact pre-service teachers' confidence for working with technology (i.e., the fourth major finding.) Participants mentioned that formal presentations by professors in class as well as hands-on exploration of technology tools alongside of their coursework provided positive benefits. They also indicated that they had many strategies for learning about technologies informally in their day-to-day lives, and these informal learning opportunities also positively impact their perceptions of their abilities to integrate technology into the classroom. The literature related to the development of self-efficacy indicates the importance of enactive learning experiences (Bandura, 1986; 1997; Kramarski & Michalsky, 2015; Zimmerman, 1995). These firsthand formal and informal opportunities to learn how to utilize various educational technologies are examples of such enactive experiences. The pre-service teachers taking advantage of direct learning opportunities in formal, course-based as well as informal, personal learning settings can thus be a benefit for boosting self-efficacy for technology integration.

There is a third major finding in this study that helps to answer the second research question. Pre-service teachers see technology knowledge as an important component for self-efficacy in technology integration, but it is not the only component (i.e., the fifth major finding.) Pre-service teachers in this study indicated that they also understand the importance of pedagogical knowledge, as well as content knowledge as essential components in technology integration. Participants expressed that their coursework in the TPP was providing them pedagogical knowledge and content knowledge that they needed to be successful at integrating technology in the classroom. It is important to remember that self-efficacy is task-specific and situationally-oriented (Bandura, 1997; Walsh, 2008; Woolfolk Hoy et al., 2006). This means that effective technology integration requires the self-efficacy to assess the needs of the particular situation (i.e., the pedagogical and content context) and make decisions accordingly.

When interviewees were asked, “How confident do you feel working with technology?” the majority indicated that they felt quite confident using technology, and were able to give examples from their day-to-day lives. Also, when asked, “How confident are you in using technology as part of your teaching practice?” ten of the eleven participants indicated that they felt “fairly confident,” or “pretty confident,” or even “very confident,” with only one participant (Ivory, who is currently a first-year student in the program) indicating that she did not currently feel confident to integrate technology in the classroom. The comments they offered following up their self-assessment suggested that they make the connection between their technological knowledge and the instructional methods they have been learning and practicing within different content areas they are preparing to teach. These pre-service teachers understand that they need to have technological knowledge in order to integrate technology in the classroom. However, their enactive experiences of actually working with the technology in a teaching and learning setting (i.e., as a part of their classes, or in practicums) made a difference for the way they believe they can use technology in their own teaching practices.

A successful experience teaching with technology will help to develop efficacy for technology integration (Abbitt, 2011; Wang et al., 2004). Combining technological knowledge with pedagogical knowledge within a particular context of content knowledge is the heart of the TPACK framework for understanding effective technology integration (Mishra & Koehler, 2006). Taking self-efficacy for technology integration together with the TPACK framework, then, it is critical for pre-service teachers to experience situation-specific opportunities to practice technology integration. Pre-service teachers need more than mere opportunities to learn how to use a variety of tools, as is often the case in the stand-alone technology course (Lambert & Gong, 2010). While this technological knowledge is important for effective technology integration in the classroom, they also need to experience opportunities to connect technology and pedagogy in task-specific ways. And, further, these technology-and-pedagogy connections must occur within particular content areas for pre-service teachers to develop self-efficacy for incorporating technology into teaching and learning within those content areas (Koehler et al., 2007; Kramarski & Michalsky, 2015; Perkmen & Pamuk, 2011; Schmidt et al., 2009). Perkmen & Pamuk (2011) emphasized that effective technology integration does not actually focus on the technology; rather "it concentrates on the learning that takes place through the use of technology" (p. 48). The focus on learning implies the essential role of other knowledge domains besides just the technological knowledge.

These findings combine to suggest that pre-service teachers perceive multiple influences that impact their abilities to integrate technology into the classroom. Modeling, formal and informal technology learning, and the enactive development of multiple knowledge domains are all important. While some individuals connected with one of these sources more substantially than the others, it is important to note that all of the participants noted at least two of these three sources of self-efficacy for technology integration, and several mentioned all three.

A Final Piece to the Puzzle: Desire for a Technology Course

These research questions have guided a process of uncovering answers to understanding pre-service teachers' perceptions of their abilities to teach with technology, as well as their perceptions of the sources of those abilities. However, there is one more piece to the puzzle. The sixth major finding in this investigation does not necessarily answer either of the research questions of this study, but it is an important finding that emerged related to both of them. The final major finding was that pre-service teachers believe that a practical course in educational technology would help to better prepare them to integrate technology in the classroom.

While pre-service teachers in this study did perceive themselves as having the abilities to integrate technology into the classroom, many participants also commented on the need for further development of their technological knowledge. Eight of the eleven interviewees specifically mentioned their desire for a course in educational technology. In order to teach with technology, pre-service teachers still need to learn about the technologies they will be using in the classroom. A course in educational technology has been found to be successful for providing pre-service teachers the knowledge, skills, and beliefs to integrate technology into their teaching (Kay, 2006; Lambert & Gong, 2010; Mishra & Koehler, 2006; Tournaki & Lyublinskaya, 2014). In spite of their expressions of self-efficacy for technology integration, the pre-service teachers in this study still perceived a need for formal technology learning, and for opportunities to connect their technological knowledge with pedagogical knowledge as part of their preparation.

Thus, a majority of the interviewees brought up the value of such a course to boost their knowledge of educational technologies, and provide them the opportunities to practice the skills that would make them better able to integrate technologies. A course in educational technologies was perceived to be a missing component of the TPP, one that would both increase their technological knowledge, and provide another formative experience that would increase their self-efficacy for technology integration.

Implications for Practice

In a 2009 article, Prensky introduced the term "digital wisdom." In Prensky's view, digital wisdom encompasses two meanings: wisdom arising *from* the use of digital technologies, as well as wisdom in *using* digital technologies (2009, p. 1). Both of these meanings may have implications for teacher educators striving to support pre-service teachers in the development of the abilities to integrate technology into the classroom. This study suggests several implications of the results of this study might inform wise practice for teacher educators such as promoting self-efficacy for technology integration, arranging learning opportunities according to the TPACK framework, and deliberate modeling of technology integration.

Promote Self-Efficacy

It seems wise for teacher educators to seek methods of fostering self-efficacy for technology integration among pre-service teachers. It is not possible to give pre-service teachers firsthand experience working with—let alone *teaching* with—every form of technology that might be present in their future classrooms. In fact, because technologies are constantly being developed or adapted for use in schools, there are likely to be technologies in their classrooms within a few years of beginning their careers that have yet to be imagined (Davies & West, 2014; Spector, 2016). Because of the likelihood that the technologies available will continue to evolve, teachers will be better served by learning how to learn about new technologies (Ertmer & Ottenbreit-Leftwich, 2010; Harris et al., 2010). Self-efficacy, the belief that one is capable of executing a course of action (Bandura, 1997), is essential for this type of ongoing learning. Professional educators who are have this capability to cast themselves as capable learners will be more adroit in their use of educational technologies (Ertmer, 2005; Gilakjani, 2013; Ruggiero & Mong, 2015). Teacher educators would do well to arrange their teacher preparation programs to provide a range of learning activities to help pre-service teachers develop self-efficacy for technology integration through enactive experiences connecting technology and pedagogy within content areas.

Several authors have noted that enactive experiences can have the strongest impact on the development of self-efficacy (Bandura, 1997; Zimmerman, 1995). Thus firsthand learning experiences are essential for pre-service teachers' development of self-efficacy for technology integration. Walsh (2008) suggested that undertaking moderately challenging tasks is an effective way to boost self-efficacy. The successful completion of a task is key, and if the task is too challenging, there is a greater risk of failure, which would actually diminish self-efficacy (Zimmerman, 1995). On the other hand, if the task is too easy, success only confirms prior success. Finding the right level of challenge then is the struggle for instructors (Walsh, 2008). However, putting students in charge of their own learning may be a helpful approach, because different teachers will have different areas of relative strength and relative weakness when it comes to technology integration (Hsu & Kuan, 2013). The results of this study indicate that pre-service teachers may have sufficient self-knowledge about their technological knowledge to judge their areas of relative weakness. These are the areas of technological knowledge that teacher educators should then target for further development.

Utilize the TPACK Framework for Structuring Learning Experiences

Teacher educators would be wise to arrange such enactive learning opportunities throughout the TPP according to the TPACK domains to foster technology integration abilities. Enactive experiences involving pre-service teachers successfully completing appropriately-challenging tasks have a strong, positive impact on their self-efficacy (Ertmer & Ottenbreit-Leftwich, 2010; Klassen & Usher, 2010; Lee & Lee, 2014). While there is still some debate about how the TPACK framework can best be used in a teacher preparation program, there is broad support for the use of the TPACK framework for conceptualizing pre-service teachers' learning about technology integration (Baran et al., 2011; Colvin & Tomayko, 2015; Graham et al., 2012; Harris et al., 2010; Kivunja, 2013; Koehler et al., 2014; Koh & Divaharan, 2011; Tournaki & Lyublinskaya, 2014). Koehler and colleagues (2014) recommended using the TPACK framework as a structure for designing technology learning opportunities throughout pre-service teacher preparation, and this view is corroborated by a variety of other authors as well (see Harris et al., 2010; Herring & Smaldino, 2015; Koh & Divaharan, 2011; Tournaki & Lyublinskaya, 2014). Connecting pre-service teachers' firsthand learning about technology with their learning about pedagogy and content is an important influence on their self-efficacy for teaching with technology (Koh & Divaharan, 2011; Kramarski & Michalsky, 2015). Kivunja's (2013) called for pre-service teachers to partake in a "lived experience" with the TPACK knowledge domains may provide a helpful way for them to develop their abilities to integrate technology. In this approach, pre-service teachers have both formal (i.e., course-related) and informal (i.e., personal, independent) opportunities to learn how to use technologies. These learning opportunities, however, are continuously tied back to learning about pedagogy and the development of content knowledge in their coursework in the TPP. This approach was found to be very effective by several researchers (Abbitt, 2011; Kovalik et al., 2013; Sadaf et al., 2016). These firsthand learning experiences must happen at multiple points in the program, not just in a single educational technology course (Abbitt, 2011; Perkmen & Pamuk, 2011) to have a strong impact on pre-service teachers' self-efficacy for technology integration.

Model Technology Integration

While enactive experiences are important, they are not the only way to foster the abilities for technology integration in pre-service teachers. It also seems wise that both TPP faculty and mentor teachers in practicums should model technology integration, and think-aloud for pre-service teachers to help them understand their deliberation in integrating technology into the classroom. Pre-service teachers in this study strongly indicated that this sort of modeling is a major positive influence on perceptions of their abilities to integrate technology. Modeling has been shown to have a strong, positive impact on pre-service teachers' self-efficacy for technology integration (Ertmer & Ottenbreit-Leftwich, 2010; Wang et al., 2004). Likewise, instructors' willingness to think aloud about their processes for integrating technology provides benefits for pre-service teachers' self-efficacy for technology integration. This kind of cognitive apprenticeship (Collins et al., 1991) can enhance pre-service teachers' development of self-efficacy through modeling (Mueller, 2009). Modeling by faculty members who teach methods courses is especially important for fostering self-efficacy, because methods courses are one place where pedagogy and content are explicitly linked (Janssen & Lazonder, 2016; Koehler et al., 2014; Mishra & Koehler, 2006). Additionally, the modeling of mentor teachers in field experiences is also a strong benefit for pre-service teachers learning to integrate technology in a program structured around the TPACK knowledge domains (Herring & Smaldino, 2015). The literature indicates that pre-service teachers experience increases in self-efficacy for technology integration by observing effective models (Koh & Divaharan, 2011; Perkmen & Pamuk, 2011).

Such modeling of technology integration across the teacher preparation program is an important part of helping pre-service teachers develop their own abilities. Nevertheless, it seems wise to offer a formal course in technology integration. Most teacher preparation programs include such a course (Kay, 2006; Lambert & Gong, 2010; Ottenbreit-Leftwich et al., 2010). However, several authors have called into question the value of a single, stand-alone educational technology course for truly developing the abilities to integrate technology, rather than just developing knowledge about technologies (Koh & Divaharan, 2011; Lambert & Gong, 2010; Lawless & Pellegrino, 2007; Wang & Chen, 2007).

Pre-service teachers interviewed in this study feel strongly that a formal course in educational technology would be a benefit for them. However, as the participants themselves noted, a one-size-fits-all technology course will actually fit few, because of different content areas and different age groups of students. Therefore, it also seems wise to differentiate a technology integration course into a variety of different options to better meet the diverse needs of pre-service teachers in the TPP. Participants suggested that providing options differentiated for the variety of age groups (i.e., elementary, middle school, high school) and multiple subject areas (e.g., mathematics, science, music) would be beneficial, and better prepare them for technology integration. This concept is supported in the literature related to fostering technology integration abilities in pre-service teachers (Harris et al., 2010; Koehler et al., 2014; Mishra & Koehler, 2006; Perkmen & Pamuk, 2011).

It may be helpful for teacher educators to rethink their own beliefs about technology and the purpose of a technology integration course in general. Teacher educators must consider the purpose of teaching technology skills for pre-service teachers, and also how these skills are to be taught. Perhaps a change in focus is required, a shift away from the perspective that we are teaching pre-service teachers how to use technology (Perkmen & Pamuk, 2011; Lambert & Gong, 2010). Rather, teacher educators should consider the role of the technology course as fostering the integration of technology and pedagogy, viewing technology as "a tool that helps students to learn content in different and effective ways" (Perkmen & Pamuk, 2011, p. 48). The technology course, in this perspective, still functions to boost pre-service teachers' technological knowledge, but always within the context of integration with pedagogical knowledge, and making deliberate connections to content knowledge.

A Plan of Action

Based on these suggestions of wise practices for teacher educators, a plan of action emerges to foster the abilities for technology integration among pre-service teachers. Instructors who are intent on supporting pre-service teachers as they develop the abilities for technology integration should consider incorporating the following four recommendations into their programs, which were developed as a result of this study and in connection with the literature on fostering technology integration in pre-service teachers.

First, pre-service teachers need training to learn about technologies and to develop their technological knowledge. But, because they have different needs with regard to the technologies they may need to know more about, the monolithic technology course is no longer a good fit. Instead, teacher educators should develop a menu of shorter courses tightly focused on particular technology skills that are appropriate for integration into different teaching situations or content areas. Topics for such courses should evolve over time to reflect ongoing development of educational technologies. Examples of contemporary courses that may provide benefits for pre-service teachers heading into today's classrooms might include offerings such as those described in table 24. These are just four examples based on current tools utilized in contemporary classrooms. Teacher educators should mindfully develop courses on an ongoing basis to best meet the needs of their students.

Table 24 Examples of Differentiated Technology Integration Courses

Sample Course Title	Possible Course Content
"Touchscreen Technology in the Classroom"	Emphasis on tools such as interactive whiteboards and tablet computers. Learning opportunities might include firsthand work developing materials that could be used in classrooms, and developing heuristics for determining which apps would be beneficial for teaching different content areas.
"Digital Storytelling for Teachers"	Emphasis on teaching and learning through the medium of storytelling, utilizing graphics, video, audio, and music. Learning opportunities might include both practical training in how to work with the tools as well as more theoretical learning about the craft of storytelling as pedagogy.
"The Internet for Educators"	Emphasis on the incredible array of resources available online to educators. Learning opportunities might include advanced search and research skills, learning about tools for creating online content, and utilizing tools for curating online resources.
"Google Tools for Schools"	Emphasis on the useful applications offered by Google, and how they can be implemented in the classroom. Learning opportunities might include exploring tools such as Google Drive, Google Sites, and Google Classroom, and understanding how to manage the use of such tools in a classroom environment.

Second, it is vital that each of these technology course options incorporate a strong TPACK structure. That is, they should not only emphasize how to use the technologies, but also foster pre-service teachers thinking about how to teach with the tools. Course requirements should include specific expectations that students will make explicit connections between the technologies with pedagogies, and the content area(s) to be taught. For example, an Elementary Education major with an endorsement in Early Childhood Education is likely to use a SMARTBoard in ways that are quite different than the ways a Secondary Mathematics major might. But both of these hypothetically might take the "Touchscreen Technology" course described above. In this example, the pre-service teacher preparing to teach Kindergarten might tailor her work in such a course toward the developmental needs of young children, and early literacy skills, while future high school mathematics teacher would focus on the needs of adolescents learning geometry. Thus, they might develop similar technological knowledge by taking the same course. However, because of the different pedagogical and content knowledge they would be preparing to utilize in their own classrooms, they would enact their technology learning in different ways as they prepare to teach in different contexts. Additionally, while they might develop their technological knowledge in their technology integration courses, pre-service teachers should be expected to put it into practice in all methods courses. Aligning methods courses to the TPACK knowledge domains will allow pre-service teachers to continue to develop facility with integrating technology and pedagogy in the various content areas.

Third, while a menu of technology course offerings will help to boost pre-service teachers' self-efficacy for technology integration through active learning experiences connected to the TPACK domains, modeling on the part of instructors remains an essential component. Thus, every course in the program should involve teacher educators modeling technology integration. This might mean that teacher educators themselves might need to boost their own self-efficacy for technology integration! If they expect their students (future teachers) to exhibit this mindset of learning, faculty members should also exhibit it themselves. Ongoing professional development and the creation of a culture of technology learning should become the norm for teacher educators to remain relevant and credible in their modeling of technology integration. Also, deliberate thinking aloud about technology integration should become a common occurrence in all methods courses, as should elaboration about the ways thoughtfully integrating technology can enhance the teaching and learning of the various content areas.

Finally, pre-service teachers should be expected to practice technology integration in their practicum experiences under the supervision and encouragement of mentor teachers. This is particularly true of student teaching, but other internship opportunities in PreK-12 classrooms should also include an expectation of pre-service teachers practicing their skills of teaching with technology. In a pre-student teaching service-learning field experience or other practicum, there should be a required technology integration task for all pre-service teachers. This task should involve a firsthand opportunity to develop a plan to address a curriculum, instruction, or assessment issue utilizing an appropriate technology tool. Because of the highly contextualized nature of a practicum (i.e., taking place in a particular school, a particular classroom, and particular students), pre-service teachers will be able to illustrate their proficiency with the integration of technology according to the TPACK framework. They will select appropriate technologies and pedagogies for the content area in which they are serving to address a real situation in a real classroom. A reflective written response to this task will provide the opportunity to elaborate their decision-making, and illustrate their self-efficacy for teaching with technology.

The implications of the findings of this study, in parallel with the existing literature on fostering pre-service teachers' abilities to teach with technology support this action plan. The four parts to this plan are intended to complement each other as a means of strengthening pre-service teachers' self-efficacy for technology integration. This will allow them to begin their teaching careers ready to face the challenges that technology integration might afford them, and thrive in this exciting classroom environment.

Limitations of this Study

As a mixed-methods case study, the qualitative data analysis in this study was influenced by my own beliefs and personal philosophy (Creswell, 2013; Merriam, 1998; Stake, 2005). Through member checking and triangulation of sources I have attempted to create the most credible account of the findings as possible. While I have attempted to tell the story of this study reflexively and with thick description, it is up to the reader to make up his or her mind about the transferability of the findings of this case study to other contexts (Stake, 1978).

This case study may have limited generalizability due to the highly contextual nature of the research (Creswell, 2013; Lincoln & Guba, 1985). Because it was conducted at a comprehensive college located in the upper Great Plains of the United States, the results may not transfer to other types of institutions, or to other geographic regions.

Another area of limitations on this study relates to the participants themselves. It is possible that the pre-service teachers in this study are not typical of pre-service teachers in general. Purposeful sampling of different groups of pre-service teachers was used to invite survey participants, and while there was a good response rate to the survey, it may be that survey responders and non-responders have different perceptions of their abilities to integrate technology into the classroom. Likewise, because the interviewees were a maximum variation sample of the survey completers, they are, by definition, not a random sample of the pre-service teachers in the TPP (Creswell, 2012). Additionally, this study relies on participants' self-reported perceptions of their abilities and self-efficacy. Observations of pre-service teachers' actual skill at integrating technology into the classroom were not included.

A final area of limitations is the nature of my relationship with the participants in this study. Because all of the participants in this study were part of the TPP where I serve as an instructor, this may have biased their responses. It is possible that their familiarity with me may have elicited more candid responses than an interviewer that they did not know personally. Alternatively, the fact that they already know me may have encouraged them to give responses perceived as "right answers." In the interviews in particular, I attempted to minimize the possibility of this effect by probing their responses to go deeper than their surface answers and find out more. The summaries I crafted for the purpose of member checking included these more intensive constructions of their perceptions. Each of the participants approved my synopses as appropriate summaries of their beliefs and experiences, and this approval demonstrates increased credibility of the results. However, the fact remains that while I have intended to provide the clearest, most credible and trustworthy accounting of the participants' perceptions, there is a limited possibility that they were biased in their interactions with me.

Recommendations for Further Research

Due to some of the limitations discussed above, further research should be conducted in future studies related to preparing pre-service teachers to integrate technology into the classroom. The context of this study was a private comprehensive college located in the upper Great Plains region of the United States. It would be valuable to replicate this study at other similar institutions for corroboration of the findings of this case. Likewise, it would be valuable to replicate this study in a variety of geographic areas for comparison across institutions.

This study relied on pre-service teachers' self-assessment and self-reporting. It would be valuable to include observations of pre-service teachers at work in the classroom, actually integrating technology into their teaching practices. This approach would give further insight into the ways in which pre-service teachers enact their beliefs about technology integration. Future research could include observations of pre-service teachers working with technology in their courses or practicum experiences to further corroborate the results of this study.

The plan of action outlined in this chapter may also indicate an area for further research. This study might serve as the analysis and exploration phase of a long-term design-based research investigation. Design-based research is "a genre of research in which the iterative development of solutions to practical and complex educational problems also provides the context for empirical investigation, which yields theoretical understanding that can inform the work of others" (McKinney & Reeves, 2012, p. 7). In other words, design-based research is an approach intended to address a contemporary problem in education, while simultaneously generating theoretical understandings. Future research could be conducted by implementing the proposed plan of action in this study through the course of multiple iterations to determine its effectiveness on boosting pre-service teachers' self-efficacy for technology integration.

Conclusion

Today's classrooms are brimming with educational technologies as schools have continued to adopt a wide variety of tools to support teaching and learning. Teachers are expected to be comfortable working with technology in all aspects of their vocation, and technology integration is now considered an entry-level skill for joining the profession. Pre-service teachers must, therefore, be prepared for the challenges of entering this ever-evolving environment. While training for working with technologies is valuable, fostering the self-efficacy for technology integration in the context of the TPACK knowledge domains is more promising. Understanding the intersection and interaction of technology, pedagogy, and content knowledge provides teachers entering the profession a better preparation for effective technology integration.

The findings of this study suggest that pre-service teachers perceive themselves as able to utilize technology, and able to integrate technology into the classroom. However, pre-service teachers also indicate that they recognize that they must continue to learn more about teaching with technology. Teacher educators, therefore, must plan both vicarious learning experiences to allow pre-service teachers to learn about technology integration through modeling, as well as enactive learning experiences to allow pre-service teachers to learn about technology integration directly. These learning opportunities will allow pre-service teachers to develop the self-efficacy necessary for successful technology integration both as they begin their professional work, and for a career of continued learning about technology integration. The teaching profession is challenging in many ways, but by positioning themselves as capable learners who possess knowledge of educational technologies, a variety of pedagogical approaches, and a strong grounding in the content they teach, technology integration need not be an insurmountable challenge for pre-service teachers.

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APPENDIX A

Technology Beliefs and Self-Efficacy Survey

This research was conducted under the approval of the Institutional Review Board at Boise State University, protocol #104-SB16-188.

Dear Student,

Thank you for considering to participate in this survey. This survey is a study researching college students' self-efficacy for technology integration. Participation is voluntary. The survey will take approximately 20 minutes or less to complete.

This study involves no foreseeable serious risks. We ask that you try to answer all questions; however, if there are any items that make you uncomfortable or that you would prefer to skip, please leave the answer blank. Your responses are anonymous.

If you would prefer not to participate, please do not fill out a survey. If you consent to participate, please complete the following survey.

Thanks!

Q1 Gender:
- ❍ Male (1)
- ❍ Female (2)

Q2 Age:
- ❍ 18-22 (1)
- ❍ 23-26 (2)
- ❍ 27-32 (3)
- ❍ Over 32 (4)

Q3 Year in college:
- ❍ Freshman (1)
- ❍ Sophomore (2)
- ❍ Junior (3)
- ❍ Senior (4)
- ❍ Graduate (5)

Q4 Major/Endorsement Area:
- ❍ Early Childhood (1)
- ❍ Elementary Education (General Classroom) (2)

- Elementary Subject Area (Art, Foreign Language, Music, Physical Education, or Special Education) (3)
- Middle School (4)
- Secondary Education (5)
- K-12 Subject Area (Art, Foreign Language, Music, Physical Education, or Special Education) (6)

Q5 Comfort with computers:

- Not at all comfortable (1)
- A little comfortable (2)
- Fairly comfortable (3)
- Very Comfortable (4)

Q6 Comfort with using Internet tools:

- Not at all comfortable (1)
- A little comfortable (2)
- Fairly comfortable (3)
- Very Comfortable (4)

Q7 Comfort with technology in general:

- Not at all comfortable (1)
- A little comfortable (2)
- Fairly comfortable (3)
- Very Comfortable (4)

Technology is a broad concept that can mean a lot of different things. For the purpose of this survey, technology is referring to digital technology/technologies—that is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions, and if you are uncertain of or neutral about your response, you may always select “Neither agree nor disagree.”

Q8 I know how to solve my own technical problems.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q9 I can learn technology easily.

- Strongly Disagree (1)

- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q10 I keep up with important new technologies.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q11 I frequently play around with technology.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q12 I know about a lot of different technologies.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q13 I have the technical skills I need to use technology.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q14 I have had sufficient opportunities to work with different technologies.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q15 I can choose technologies that enhance the teaching approaches for a lesson.
- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q16 I can choose technologies that enhance students' learning for a lesson.
- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q17 My teacher preparation program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.
- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q18 I am thinking critically about how to use technology in my classroom.
- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q19 I can adapt the use of the technologies that I am learning about to different teaching activities.
- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)

- Agree (4)
- Strongly agree (5)

Q20 I can teach lessons that appropriately combine content, technology, and teaching approaches.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q21 I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q22 I can select technologies that combine content, technology, and teaching approaches that I learned about in my coursework in my classroom.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q23 I can provide leadership in helping others to coordinate the use of content, technologies, and teaching approaches at my school and/or district.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q24 I can choose technologies that enhance the content for a lesson.

- Strongly Disagree (1)
- Disagree (2)

- ❍ Neither agree nor disagree (3)
- ❍ Agree (4)
- ❍ Strongly agree (5)

Below is a definition of technology integration with accompanying examples:

Technology integration: Using computers to support students as they construct their own knowledge through the completion of authentic, meaningful tasks.

Examples:

- Students working on research projects, obtaining information from the Internet.
- Students constructing Web pages to show their projects to others.
- Students using application software to create student products (such as composing music, developing PowerPoint presentations, or creating a digital video.)

Using the above as a baseline, please select one response for each of the statements. If you are uncertain of or neutral about your response, you may always select "Neither agree nor disagree."

Q25 I feel confident that I understand educational technologies' capabilities well enough to maximize them in my classroom.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neither agree nor disagree (3)
- ❍ Agree (4)
- ❍ Strongly agree (5)

Q26 I feel confident I can help students when they have difficulty with technology.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neither agree nor disagree (3)
- ❍ Agree (4)
- ❍ Strongly agree (5)

Q27 I feel confident that I have the skills necessary to use technology for instruction.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neither agree nor disagree (3)
- ❍ Agree (4)

- Strongly agree (5)

Q28 I feel confident that I can use correct terminology when directing students' technology use.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q29 I feel confident in my ability to evaluate educational technology for teaching and learning.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q30 I feel confident that I can successfully teach relevant subject content with appropriate use of technology.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q31 I feel confident I can mentor students in appropriate uses of technology.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q32 I feel confident I can effectively monitor students' technology use for project development in my classroom.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)

- Agree (4)
- Strongly agree (5)

Q33 I feel confident I can provide individual feedback to students during technology use.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q34 I feel confident I can consistently use educational technology in effective ways.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q35 I feel confident I can be responsive to students' needs during technology use.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q36 I feel confident about assigning and grading technology-based projects.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q37 I feel confident I can regularly incorporate technology into my lessons, when appropriate to student learning.

- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q38 I feel confident about selecting appropriate technology for instruction based on curriculum standards.
- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q39 I feel confident about using technology resources (such as spreadsheets, electronic portfolios, etc.) to collect and analyze data from student tests and products to improve instructional practices.
- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

Q40 I feel confident that I can motivate my students to participate in technology-based projects.
- Strongly Disagree (1)
- Disagree (2)
- Neither agree nor disagree (3)
- Agree (4)
- Strongly agree (5)

APPENDIX B

Interview Questions – Pre-Service Teachers

Questions for interviewing pre-service teachers included the following items. Because the interviews were semi-structured and conversational in nature, the specific wording of the question varied slightly from one interview to the next, but all participants were asked to respond to these topics.

1) Where have you learned about technology integration? (E.g., in a course, in a practicum experience, observing a teacher)

2) How confident are you working with technology? Please explain.

3) If there were a new type of technology that you wanted to know more about, how would you go about learning about it?

4) How confident are you in using technology as part of your teaching practice? Please explain.

5) What is your favorite subject—the one you would *love* to teach? How confident do you feel about integrating technology as you teach that subject?
    a. Follow up, if positive: How did you develop the knowledge or skills needed?
    b. Follow up: What would you need to know to feel more confident?

6) Has the Teacher Preparation Program helped you to learn about technology integration? Please explain.

7) What do you think would be the best way for a pre-service teacher to learn about technology integration?

APPENDIX C

Coding Examples

The table below provides examples of how the coding of the interview transcripts was conducted. For each coded category, a sample selection of text is provided to illustrate the sort of comments from participants that were coded to that category.

Code category	Sample of text from interview transcript
Technological Knowledge	I turn it off, and then I turn it back on again… If that doesn't work usually I just let it be off for a little while. Make sure the battery's charged all the way, and just other general maintenance things like that. (Ivory)
Technological Content Knowledge	I'm now learning LaTeX which is the official math writing language. It's almost a programming. Actually, I think it would be considered a programming language despite not actually having input, output thing. It's more a HTML or CSS thing. You write this and you have your slash and it'll say something and then it allow to put something else on your PDF document. I'm doing, actually, that for my abstract algebra test. Abstract algebra class, I have to write all of my assignments because it's a proof class. I write proofs in LaTeX. He can read and understand everything we say. It just takes a little more time to get to write up the assignments. It works out. Yeah, unless they have experience with something, one of those things, it's going to be really difficult for them. Even then, it still takes longer than X equals by something. (Bruce)
Technological Pedagogical Knowledge	One thing I did notice though, that's a little bit interesting in our preschool is since our kids are so short, they can't reach the top of the smart board, and so its something that you just don't think about, but we have to adjust a lot of our PowerPoint because the kids who are just three, are either having to jump way up high, or I don't know. They can't get it so they just have to point. Then it's a little bit frustrating for them. (Andie)
TPACK	There's a lot of great programs out there like IXL…The resources that they have there that line with the Common Core Standards that you can ... Especially since they're doing standards-based grading. That's also something that I really like, seeing those correlations and at least seeing that students are practicing and they're mastering, but then

	when they get to the assessment part of things and not mastering, it'd be nice to at least see, a comparison that way. If it's just the technology that's helping them out, if they're googling it or whatever they got to do or if it's really that they don't understand, I guess, is a program that I'd like to see used in my math classroom. (Henry)
Informal learning opportunities	I think if I was to say there's a new app out or new software out, I think I would probably turn to Twitter first. I would just search it in the search box and see what other people had to say about it or just type it in Google, see what other people had to say. Another resource that I really like to use is YouTube. I feel like you could learn so much on YouTube. I don't want to undermine going to school because obviously school is important, but you can almost learn just as much on YouTube as you can sitting in a day of class. There's so many educators, tech savvy people out there. (Gary)
Technology self-efficacy	A lot of my basic tech skills were self-taught. A lot of that kind of stuff, I just like it, so you dink around with it, you figure out how to do it. Integrating it into a classroom is definitely something that I would have wanted to do but didn't have a good basis on it because my background hasn't been a super wealthy school or one that has a lot of resources like that and so my personal education did not have a ton of technology in it. We had whiteboards and blackboards up until high school, and then all of a sudden stuff was coming out. Having that as my background, it's definitely something that I had to explicitly learn. (Julie)
Modeling	The way professors use technology, I guess, like the SMART Boards and stuff like that. The way they teach their lessons through the technology, just models how maybe we could use it. (Cleo)
Challenges for tech integration	I like getting to know new technology, interacting with it, and figuring it out, but at the same time, there's so much stuff that's changing, it's hard to keep up. (Drew)
Teacher Preparation Program	I know in multiple classes, I couldn't even name them necessarily, but we've just had a unit or a class that's been about technology, or we've been given a list of apps that are helpful, or just I feel like that's been at least brought up in most of my classes at some point. Not necessarily exhaustively, but I can think of times that we've talked about, 'What are some good ways to communicate with

	parents? Here's a list of communication apps that you can use.’ Just stuff like that I feel like. I don't know that there's been whole lot of, well, some application. Not as much application as just like, ‘Here's the information. Do with it what you want.’ Definitely presentations, we've been forced to use technology to do presentations. That's been good. I can remember doing PowToon for the first time, and that was a new experience, or just other Prezi, or other kinds of presentation software like that. (Elsa)
Lack of confidence	Interviewer: “How confident do you feel using technology as part of your teaching practice.” Participant: “Oh man, not super confident because I feel like the kids would know more about it than I would!” (Ivory)
Resource list	I think one of the most beneficial things to improve would be to have a list. For math, if you want to learn geometry, here's my list. If you want to learn algebra, here's my list. Just to have a resource, like here's some awesome apps. I don't know if that's even possible for all of the different subject areas, but for science, if you're trying to learn about density, here's an app for that. (Andie)
Tech course	I think that for each subject area, tech integration is going to look a little differently, just because of the nature of the content. For science, I know there's online dissection type things, but of course a history class isn't going to have that type of thing. Maybe have a, I don't know if it could be like a one credit, or like half semester class where you just kind of dive into the different technologies that can be used in your content area, because I don't think it would necessarily need to be like a three credit course, but a course that allows you to explore and have someone who's knowledgeable about the technology in your content area to be able to talk you through it. (Fiona)