A PHENOMENOLOGICAL STUDY OF PERCEIVED FACTORS INFLUENCING MATH TEACHERS' TECHNOLOGY SELF-EFFICACY

by

Jenna Marie Finnegan

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

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ABSTRACT

The purpose of this study was to explore how a teacher's technology self-efficacy influences decisions they make about the use of technology in their classrooms. The factors influencing teachers' technology self-efficacy were examined through a qualitative transcendental phenomenological research design. This study's theoretical framework was based on the combination of social cognitive theory and self-efficacy theory; both provide insight into how external and internal factors can influence a person's perception of their abilities. Using these theories helped identify and describe the self-efficacy experiences of high school math teachers. This research was conducted during the 2020-2021 school year using a qualitative approach to explore the technology self-efficacy of high school mathematics teachers from school districts in Virginia. The study was divided into two phases: interviews with teachers, document analysis and focus groups, and qualitative data aggregation. To collect a participant pool, an initial demographic survey was administered to all full-time, certified math teachers at five rural school sites. Next, a group of ten teachers with varying levels of technology self-efficacy were interviewed and participated in a focus group to better understand factors influencing their current level of self-efficacy. Document analysis was performed using a letter of advice from each participant to a teacher struggling with technology integration. The data analysis was completed using Moustakas' systematic steps to provide textural and structural descriptions that capture the essence of teachers' experiences with technology. The results of this transcendental phenomenological study showed that mastery experiences accounted for 47% of the codes that were given to statements made by participants. Participants shared that practicing before using new technology with students was a critical experience that teachers used to increase their self-efficacy.

Keywords: secondary teacher, self-efficacy, technology integration, classroom technology

Dedication

This dissertation is, first and foremost, dedicated to my daughter Ayla Marie Finnegan and my son, Ryan Michael Finnegan. You both have been with me through this process and shown me patience and understanding during the many hours I have invested in this process. Finally, I dedicate this work to my mother, Peggy Albanese, and her consistent support through my many deadlines.

Acknowledgments

First, I would like to thank Dr. Putney and Dr. Swezey for their guidance and kindness during the writing process; I was blessed to have them and their expertise to guide me in developing and finishing my dissertation. Second, I would like to thank the participants of my study who gave up their time during the summer to participate in my research. Third, I would like to acknowledge my family, who always believed in me. Finally, I would like to thank my friends for everything they have done to help me these last five years.

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List of Abbreviations

Science, technology, engineering, and mathematics (STEM)

Technological Pedagogical Content Knowledge (TPACK)

Specialized Technological and Mathematics Pedagogical Knowledge (STAMPK)

National Education Technology Plan (NETP)

The National Council of Teachers of Mathematics (NCTM)

CHAPTER ONE: INTRODUCTION

Overview

For secondary mathematics teachers to successfully prepare students for careers in science, technology, engineering, and mathematics (STEM), they must have a solid understanding of their content area and a working understanding of the technology available for use in the classroom (Mishra & Koehler, 2006). Successful technology integration in the mathematics classroom enables educators to create collaborative learning experiences that support 21st-century skills. Research has shown that existing technologies have increasingly become important in mathematics education because of their positive effect on students' acquisition of mathematical knowledge and skills needed for the 21st Century (Akayuure et al., 2013). Using technology in the classroom can assist in computation accuracy and a deeper understanding of the mathematical concepts (Murphy, 2016). Technology mustn't be limited in the math classroom due to teacher preference or insecurities (NETP, 2017).

Conducting qualitative research on the perceived factors influencing technology self-efficacy of math teachers will benefit teachers, students, and administrators. The first step in providing that support begins with understanding the average math teacher's comfort level with educational technology and what factors are tied to increases in their self-efficacy. Despite substantial progress in the classroom availability of technology, it remains underused, and its full potential is rarely taken advantage of as suggested by research and policy (Bretscher 2014; Drijvers 2019). It has become clear that the most crucial factor in the use of technology in the classroom is the teacher, who has to integrate content knowledge, pedagogy, and technology knowledge successfully (Drijvers 2019; Hegedus et al. 2017). In this chapter and the literature review, I will address the study's background, including theory, situation to self, problem statement, purpose statement, research questions, definitions, and summary.

Background

After a thorough study of the topic, it is evident that there is a need for a qualitative examination of math teacher technology self-efficacy regarding educational purposes when making curricular decisions. Successful technology integration in the mathematics classroom enables educators to create interactive learning experiences that support 21st-century skills (Mishra & Koehler, 2006). The National Council of Teachers of Mathematics (NCTM, 2014) points out the effectiveness of efficient technology use in empowering students' mathematics learning, suggesting a need for teachers to have a strong technology pedagogy. Technology has become increasingly important in mathematics education because of its positive effect on students' acquisition of mathematical knowledge and skills needed for 21st Century careers (Akayuure et al., 2013). However, to be efficient, one must be comfortable, and the majority of today's teachers did not grow up using technology in what is considered the formative years of K-12 (O'Neil & Krause, 2019). Understanding how teachers learn to use technology apart from specified professional development days will help align support (Morris et al., 2017). Therefore, it is necessary to explore teachers' needs and perceptions concerning technology pedagogy as it fits into the curriculum.

Researchers have studied teachers' self-efficacy and ability to effectively implement technology in the classroom (Birisci and Kul, 2019; Levin & Wadmany, 2008; Pan and Franklin, 2011). These studies have revealed that technology implementation in rural schools is extraordinarily complex due to less funding and internet access in remote areas (Kalonde, 2017a). However, the research lacks data for rural high school mathematics teachers. In addition, most studies on teachers' attitudes toward and use of technology have focused on urban schools, with little research on rural teachers' use of instructional technology (Kalonde, 2017a).

Historical

As the number of students grew during the 20th century, teachers needed new and more efficient instruction methods. Since the inception of the World Wide Web in 1990, communication has evolved into allowing instant connectivity. Teachers have been trying to ride the technology wave as a means of communication and instructional platforms to engage and reach more students. However, many teachers report feeling unprepared to use technology to support student learning (NETP, 2017).

Historically, the teacher knowledge base has focused on content and, more recently, pedagogy. The Technological Pedagogical Content Knowledge (TPACK), created by Punya Mishra and Matthew J. Koehler (2006), explains the skills required of teachers to teach a subject and use technology effectively. Educators must have content-specific pedagogy to support learning in the classroom. When technology is involved, teachers need to understand their technological pedagogical content knowledge (TPACK) to be the most effective in the classroom (Mishra & Koehler, 2006). Instructors in each discipline perceive TPACK differently, and mathematics teachers received some of the lowest scores in terms of variables affecting training in integrating technology with TPACK self-efficacy (Simsek & Yazar, 2019). However, Akayuure et al. (2013) found that mathematics teachers with TPACK successfully incorporated technology into the classroom.

The demand for technology use in the classroom has required school districts to provide technology for students and support for teachers. School leaders must thoroughly understand the technological pedagogical areas where teachers feel weak. When the administration knows where the weaknesses lie, they can tailor professional development to meet teachers where they are and help increase their self-efficacy. When provided with training and follow-up support, teachers experience significantly higher self-efficacy, or confidence, to integrate technology and use technology for learning than those who have not participated in training sessions (Levin & Wadmany, 2008).

Joo et al. (2018) used four factors, TPACK, teacher self-efficacy, perceived ease of use, and perceived usefulness as pre-cursors of the intention to use technology, and found that teachers with higher favorable attitudes toward technology increased their levels. Similarly, Kabakci-Yurdakul et al. (2012) developed the Technopedagogical Education Competency Scale with 33 items in four subdivisions: design, exertion, ethics, and proficiency. Finally, Birisci and Kul (2019) used the Technopedagogical Education Competency Scale in a correlational study model that concluded a positive and high-level correlation between the TPACK competency levels and technology integration self-efficacy beliefs.

Social

A social context relevant to this research is the insecurity in recruiting and maintaining certified, quality educators. There's a shortage of math teachers in grades 6–12 in rural Virginia, which means there's an operational need to attract and retain highly qualified individuals to teach this subject (Become a Math Teacher in Virginia, 2018). In response to the U.S. Department of Education's report on rural education, University Council for Education Administration (UCEA) has called for a need to stabilize the rural teacher workforce (UCEA, 2018). According to Sutcher et al. (2020), teacher shortages are on average more severe in the southern states than in other regions of the United States. Teacher shortages are a function of declining entrants into the profession and high teacher turnover rates, especially in low-income schools (Sutcher et al., 2016). In addition, there are alternate routes available to fast-track content professionals into the teaching profession, in turn leaving pedagogy deficits. Finally, teachers who are serious about a career in education must stay well informed of current and changing technologies.

The need for teachers educated in the use of technology will only continue to grow. The National Education Technology Plan (2017) described successful integration's critical elements: high-speed connectivity, available devices to teachers and students, digital content, and professional development. When teachers take the time to carefully design and apply the technology, they can accelerate, amplify, and expand effective teaching practice (NETP, 2017). To be successful with technology integration, teachers need help developing projects that meet curriculum standards, aligning the technology with the instructional practice (Ozdemir, 2018). Structured lesson planning allowed for more significant gains when using math educational software and not using the technology alone (Zengin & Tatar, 2017). Providing internet access and tools should not overshadow the importance of preparing teachers to teach effectively with the technology (NETP, 2017). Teachers must be able to select engaging and relevant digital learning content. There are features available such as speech to text, text to speech, color contrast, and enlarged font sizes that teachers can utilize to provide equity in the classroom. Teachers can use these features to support students when using technology or support the learning process during all classroom activities. The use of technology for this style of differentiation is just one example of the importance of preparing teachers for the exciting activities and programs that technology offers for their classrooms. When used effectively, these innovative technological pedogeological supports can help increase student achievement across the board (NETP, 2017).

Theoretical

The theory of self-efficacy developed by Albert Bandura (1977) provides key elements that influence the use and integration of digital technologies in the classroom. Four influences affect personal self-efficacy expectations: performance accomplishments, emotional and physiological states, vicarious experience, and verbal persuasion (Bandura, 1977). Bandura's self-efficacy theory focuses on the effects produced by one's actions and beliefs. People process information concerning their ability to handle situations and regulate their behavior and effort toward those situations accordingly. Self-efficacy affects how one approaches problems. According to Bandura (1977), the stronger the perceived self-efficacy of an individual, the more continuous their efforts to persevere until successful completion. Studies have identified teacher self-efficacy as a measurable component that influences teachers' decisions to integrate technology into their lessons (Akayuure et al., 2013).

Self-efficacy is an individual's belief in their ability to execute behaviors that will produce desired results (Bandura, 1977). Research has shown that teachers with greater self-efficacy are more successful in the classroom (Heath, 2017). However, teachers report having lower self-efficacy towards technology than they do with pedagogy or content alone (Guven & Yilmaz, 2016; Li et al., 2018; Thurm & Barbel, 2020). According to Akayuure et al. (2013), Bandura's (1977) self-efficacy theory suggests that confidence in being successful motivates people to act. The lower the self-efficacy, the more likely the teacher will not have a positive attitude or a favorable desire to use technology in the classroom (Pan & Franklin, 2011). These findings suggest that teachers with low technology self-efficacy will be less likely to use it in their classrooms. Heath (2017) did a phenomenological case study to explore teacher perceptions of technology integration. Heath (2017) found that even when teachers saw the positive reasons for using technology in the classroom, they can still fail to implement it regularly because of a lack of access and significant professional development to prepare them. Heath (2017) has shown that convincing teachers of the importance of technology integration is not enough; they need to have the training and support that builds their self-efficacy to levels that they will be willing to try independently.

Situation to Self

For this study, I sought to elucidate the factors that affect math teachers' levels of technology self-efficacy and why; thus, I chose a qualitative inquiry approach. Most educational researchers will have classroom experience using technology and carry some previously held beliefs or biases. According to the interpretivist paradigm (2020), the researchers' values are inherent in all research phases. Heath (2017) used an epoché method to encourage a suspension of judgment and acknowledge previously held beliefs, values, and experiences related to the research question. The deferral of assessment is essential for a qualitative review. The researcher, who has a history with the phenomenon, is not just looking at numbers and data but delving into interviews with participants.

The ontological assumption of my study was solely based on embracing the idea that multiple realities influence technology self-efficacy from the teacher's perspective. My epistemological assumption was that knowledge is gained through people's subjective experiences and, therefore, research must be conducted in the context in which the participants live and work (Creswell & Poth, 2018). Rhetorical assumption refers to the language used and writing structure, which followed the organization of this phenomenological study suggested by Moustakas (1994). I wrote the study in first person narrative as set by qualitative research standards (Creswell & Poth, 2018). I have undertaken an interpretive approach that assumes we cannot separate ourselves from what we know. As a high school math teacher, I have axiological assumptions about technology implementation in the mathematics classroom (Creswell, 2007). To fully integrate technology into the math classroom, teachers must understand the reasons for including technology instruction in lessons beyond simply because it is a mandated expectation. Additionally, I feel that successful teachers are comfortable with using technology as an instructional tool and are comfortable in their content area of mathematics. I must report those axiological assumptions through epoché as I obtain information from my participants.

Problem Statement

The problem addressed in this study is low math teacher technology self-efficacy and factors they perceive as influencing their technology use in the classroom. The NETP (2017) reported that more than two-thirds of teachers would like more technology in their classrooms, and roughly one-half say a lack of training is one of the most significant barriers to incorporating technology. While teachers use all three types of knowledge (technological, pedagogical, and content) to create learning activities for students, they struggle to combine pedagogy and technology (Kirikcilar & Yildiz, 2018). Technology has become an essential part of our country's education system. Teachers use email, electronic grade books, smartboards, and one-to-one devices, among other classroom tools, every day. Teachers must have self-confidence and technological pedagogy to successfully integrate technology into their curriculum. The TPACK framework has become an integral component of modern mathematics teachers and can influence their self-efficacy in technology integration (Akayuure et al., 2013; Simsek & Yaza, 2019). The developed TPACK model emphasized the importance and necessity of uniting the technological, pedagogical, and content knowledge (Birisci & Kul, 2019). There is a need for further qualitative research that reveals whether teachers' skills and professional development would help them become more effective in using technology in the classroom.

This qualitative study aims to bridge this research gap and provide educational stakeholders with a deeper understanding of teachers' self-efficacy while integrating technology into their teaching practices. Multiple factors influence tech integration, including teacher beliefs about technology, pedagogy, and access to technology (Heath, 2017). A qualitative discovery of teachers' perceptions of these influences will benefit schools. It is impossible to create better professional development and training for teachers without a thorough understanding of where the current status quo fails them in preparation (Tassell et al., 2019). This research will allow a more intimate knowledge of the specific factors that teachers believe affect their technology self-efficacy.

Purpose Statement

This phenomenological study aimed to explore what it means to be a secondary math teacher with technology self-efficacy. At this stage in the research, technology self-efficacy was defined as the belief in one's ability to successfully integrate technology into a lesson. The theory guiding this study was Bandura's (1977) self-efficacy theory, as it explains the factors that influence teachers' decisions to integrate technology into their lessons.

Significance of the Study

This study explored the perceived factors that influence high school math teachers' self-efficacy in technology. This study's transferability can contribute to research by identifying how technology self-efficacy is directly related to secondary mathematics teachers' use of technology in their classrooms and their perceptions in a rural school setting. This research can increase the understanding of this phenomenon. Conducting qualitative research on teachers' technology self-efficacy in the classroom will benefit teachers, students, and administrators. If teachers are provided appropriate content-specific professional development within their localities, their belief in their abilities to increase student achievement has the potential to improve (Tassell et al., 2019; Tyler-Wood et al., 2018). Successful technology integration can be a struggle for veterans and new teachers, suggesting that changes at the preservice and professional development levels will help increase success. This study will contribute to the research of teacher perceptions and their use of technology in the classroom, and their perception of training needs.

This study may lead to better training for teachers, thereby enhancing math classroom experiences. In the context of higher education, it may provide education professors with information to help them better prepare preservice teachers. The qualitative research should improve upon what the quantitative analysis has highlighted as a need for better technology pedagogical training. This study delved into the specific needs of rural high school mathematics teachers. It is incredibly beneficial for the school systems to understand how to provide their staff with training to support technology integration and increase their teachers' technology self-efficacy. The theoretical significance of the study lies primarily in Bandura's self-efficacy theory. Teachers who have a heightened sense of self-efficacy quickly recover from setbacks and disappointments (Bandura, 1994). High self-efficacy is an essential skill for teachers in rural counties where less funding significantly influences technology support and access (Tyler-Wood et al., 2018). School systems will benefit from the research, as it will provide them with specific issues to offer guidance during faculty training and professional development (Kalonde, 2017a; Tyler-Wood et al., 2018).

Research Questions

The following questions will guide this study:

CQ1. What are the self-efficacy experiences of high school math teachers?

SQ1. What are the mastery experiences of teachers with technology self-efficacy?

The research questions seek to provide educational stakeholders with a deeper understanding of teachers' self-efficacy while integrating technology into their teaching practices. According to Murphy (2016), "educators recognize the need for different methods, strategies, curricula, and professional training that may be necessary to help meet the need in the pedagogy of students in mathematics" (p.1). In addition, Bandura states that performance accomplishments are the most influential of the four sources of self-efficacy (Bandura, 1977).

SQ2. What are the vicarious experiences of teachers with technology self-efficacy?

Vicarious experience can generate expectations in observers that they can be successful and is one of the easiest of the four sources of self-efficacy to influence human behavior and can be utilized in professional developments by having teachers share success stories (Bandura, 1977). Understanding how teachers identify factors related to professional development will help administrators create future staff developments that cater to teachers' needs to have higher technology self-efficacy. School districts must provide the hardware and software in the classroom for teachers, but they need to support teachers in using it effectively (NETP, 2017).

SQ3. What are the emotional and physiological experiences of teachers with technology self-efficacy?

By identifying the factors that influence self-efficacy, the researcher can delve into what provided these factors to the teachers, such as professional development, mentors, teacher preparation programs, and student inclination and preparation. According to Levy and Wadmany (2008), factors that they found to influence self-efficacy included a need for external legitimacy, reinforcement, encouragement, power, and emotional support from authority figures such as superintendents and principals. Teachers' emotional and physiological experiences can increase or decrease their self-efficacy (Bandura, 1977).

SQ4. What are the verbal persuasion experiences of teachers with technology self-efficacy?

Verbal persuasion is one of the easiest of the four sources of self-efficacy to influence behavior (Bandura, 1977). A verbal appraisal can come as positive feedback or bolstering a teacher's classroom management skills in preparation for using new technology. Teachers use verbal persuasion when they seek the advice of their coworkers to help guide their classroom technology integration (Morris et al., 2017).

Definitions

1. *Technological Pedagogical Content Knowledge (TPACK)*- explains the set of knowledge that teachers need to teach a subject and use technology effectively in the classroom (Mishra & Koehler, 2006).
2. *Self-efficacy* - refers to an individual's belief in their capacity to execute behaviors necessary to produce specific performance attainments (Bandura, 1977).
3. *Instructional Technology*- Instructional technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning (LSU, 2020)

Summary

Most research has reported on preservice teachers, leaving a gap in the research data available concerning current teachers and their technology self-efficacy (Li et al., 2018). There is a need for further qualitative research on this topic, explicitly employing interviews and observations to gather more data about technology integration self-efficacy (Birisci & Kul, 2019). After finding that self-efficacy influences teacher implementation of technology, Hatlevik and Hatlevik (2018) suggested that further research should delve into teacher preparation and support inadequacies in this area. The National Council of Teachers of Mathematics (2014) points out the efficient use of technology in enabling students' mathematics learning. However, it is not enough to encourage technology use in the classroom; researchers should study teachers' needs and perceptions regarding technological pedagogy (Birisci & Kul, 2019). This qualitative study aimed to fill this research gap and provide educational stakeholders with a deeper understanding of in-service teachers' technology self-efficacy.

CHAPTER TWO: LITERATURE REVIEW

Overview

In this literature review, I present an analysis of the current literature related to high school teachers' technology self-efficacy. The first section reviews the theories relevant to the study, including Bandura's social cognitive theory related to self-efficacy, followed by a synthesis of recent literature regarding teacher self-efficacy concerning technology. Next, I examined how teacher self-efficacy affects the successful implementation of technology in the classroom. The analysis included the recurring perceived factors that influence success: TPACK, experience, beliefs, self-efficacy, school, and contextual characteristics. The purpose of this chapter was to build a foundational understanding relating to factors influencing technology use in secondary classrooms, emphasizing teachers' self-efficacy to utilize technology for educational purposes. A qualitative analysis of teacher self-efficacy regarding technology may assist educators in making informed curriculum decisions.

Theoretical Framework

Productivity beliefs impact academic motivations and goals, the levels of interest in intellectual and educational achievements, and academic persistence (Bandura, 1997). This study's theoretical framework was based on the combination of social cognitive theory and self-efficacy theory. Both provide insight into how external and internal factors can influence people's perception of their abilities.

Social Cognitive Theory

A fundamental principle of social cognitive theory is that people learn through their own experiences and by observation of the actions and inevitable results of others (Bandura, 1989). Bandura's (1989) social cognitive theory (SCT) explains human behavior as a cyclical and inverse interaction between internal (personal), behavioral, and environmental influences. These three elements can be segmented into smaller parts. Personal influences can be reduced to four components: self-efficacy, motivation, anxiety, and experience (Bandura, 1977). Behavioral influences can be subdivided into three parts: cognitive strategies, metacognitive strategies, and feedback to others (Bandura, 1977). Environmental effects can be divided into modeling, achievement, and input from others (Bandura, 1977). These elements influence each other producing a persuasive force (Bandura, 1977).

Bandura (1989) contended that social environments cause different reactions in people according to their physical characteristics. Bandura's (1989) SCT provides a valuable framework for understanding, predicting, and changing human behavior. Acknowledging this influence from uncontrollable variables, exerted through the teacher's physical appearance and personality, exposes the need for a qualitative study allowing for a deeper understanding of individual experiences. The classroom environment, which influences students (Bandura, 1989), is created by demographics, teacher qualities, district expectations, and curriculum requirements. Following this theory, teachers design their classroom procedures according to the environment their students create, and at the same time, the students react according to the atmosphere their teacher constructed.

Self-efficacy

This literature review provided a theoretical understanding of self-efficacy, specifically teachers' self-efficacy in classroom technology. Self-efficacy is a subset of Bandura's (1977) social cognitive theory, on which he explains that an individual's belief in their ability to execute behaviors will produce desired results. Bandura (1977) delineates between two components of self-efficacy as efficacy expectations and outcome expectations. An outcome expectation is the person's estimate that a particular behavior will bring about a specific outcome (Bandura, 1977). An efficacy expectation is a conviction that one can successfully execute the action required to bring about the desired product (Bandura, 1977).

This theory entails critical elements that directly influence the use and integration of digital technologies in the classroom. Using a new technology tool in a classroom full of students can be a high-pressure situation where teachers need preparation (NETP, 2017). The ability to be confident in specific technology skills is helpful when teachers first introduce new technology. Studies have identified teacher self-efficacy as a measurable component that influences teachers' decisions to integrate technology into their lessons (Akayuure et al., 2013). Personal efficacy expectations develop through four significant information sources: performance accomplishments, emotional and physiological states, vicarious experience, and verbal persuasion (Bandura, 1977). Bandura's theory focuses on the effects produced by one's actions and beliefs. People process information concerning their ability to handle situations and regulate their behavior and effort toward those situations accordingly. Self-efficacy affects how one approaches problems and influences their perseverance (Bandura,1977). The stronger the perceived efficacy an individual has, the more perseverant that person becomes.

Performance Accomplishments

Performance accomplishments are the most influential of the four sources of self-efficacy. Performance accomplishments refer to an individual's successful experiences attempting to perform a task or accomplish a goal through direct action (Bandura, 1977). Success increases mastery expectations, while failures diminish them (Bandura, 1977). When applied to the educational setting, repeated success with technology can create strong self-efficacy, reducing the occasional technology failure's impact on the teacher's overall perception of their efficacy (Bandura, 1977). When failure occurs after multiple attempts, they can strengthen self-motivated perseverance; supporting the initial undertaking is crucial for long-term success and persistence (Bandura, 1977). Consequently, the effects of failure with technology use tend to be more severe early on, and teachers will need more generous support during these first endeavors.

Emotional and Physiological

This self-efficacy source references an individual's arousal level, which can be positive or negative, thereby inducing an enabling or debilitating effect. For example, a newly learned technology can evoke excitement, especially when deployed in what the teacher feels is a safe and supportive environment; this will likely result in positive encouragement (Bandura, 1977). However, implementing new technology in a classroom that is already poorly managed or has other extraneous variables will likely result in feelings of anxiety-producing negative arousal.

Vicarious Experience

A vicarious experience is the observation of others accomplishing a task. Witnessing others' successful completion of activities without adverse consequences can generate expectations in observers that they too will improve if they persist in their efforts (Bandura, 1977). All vicarious modes of influence, modeling, symbolic modeling, recorded modeling, or cognitive modeling enhance self-efficacy (Bandura, 1997). To achieve a positive impact when observing the successful implementation of technology, the observing teacher must feel that they relate to the model's nature and level (Bandura, 1997; Barton & Dexter, 2020). Observing colleagues' instruction motivates teachers to integrate technology into their classrooms much more than a formal professional development where they are passive learners (Liu et al., 2015; Barton & Dexter, 2020). According to Willis et al., (2016), vicarious experience can teach new skills and enhance self-efficacy. Vicarious experience can be a safe way for a teacher who has yet to experience mastery or has adverse emotional reactions to trying new technology in their classroom on their own. Barton and Dexter (2020) point out that different teaching philosophies render the vicarious experience less useful. When teachers are exposed to modeling effective practices, innovative technology teaching, and learning use improve (Barton & Dexter, 2020; Willis et al., 2016).

Verbal Persuasion

Verbal persuasion is one of the easiest of the four sources of self-efficacy to influence human behavior, although it is not as strong as the other sources (Bandura,1977). Verbal persuasion can impact the ability of people to master difficult situations. When provided with temporary aids for effective action, teachers are likely to demonstrate more significant effort than those who receive only the performance aids (Bandura, 1977). A verbal appraisal can even come in the form of positive feedback or bolstering the teacher's classroom management skills in preparation for implementing new technology. Morris et al. (2017) found that teachers would use specific technology based upon the recommendation of their colleagues and relied heavily on the mentor's experiences. Morris et al. (2017) also found that teachers sought their coworkers' opinions and advice and relied on their success stories to help guide their classroom integration. Barton and Dexter (2020) found that when a teacher has little to no experience with innovation, verbal persuasion is critical in creating beginning levels of positive self-efficacy. Verbal persuasion and vicarious experience can be gained through groups formed at the building level (Barton and Dexter, 2020; Willis et al., 2016).

Effects on Teaching

According to Bandura (1995), the factors affecting teachers' self-efficacy include mastery experience (performance accomplishments), vicarious experience, social persuasion, physiological state. Mastery experience is acquired directly through the successful performance of one's tasks (Bandura, 1995). Vicarious experience is indirectly achieved by observing others' successful behaviors enforcing teachers' beliefs that specific teaching methods will bring positive outcomes (Wu, 2021). Finally, social persuasion refers to others' support, enhancing, or weakening teachers' self-efficacy (Wu, 2021). Current research finds that teachers' self-efficacy is a crucial factor that primarily affects teachers' classroom practices students' learning outcomes (Tongchai, 2021).

Related Literature

Technology in the classroom is not new, but it is a continuously evolving practice with new methods for incorporating new technology types available every day (de Koff, 2020). To guide and support mathematics teachers, the National Council for Teachers of Mathematics (NCTM) put out a position statement in 2015 concerning technology integration in the mathematics classroom:

> Strategic use of technology in the teaching and learning of mathematics is the use of digital and physical tools by students and teachers in thoughtfully designed ways and at carefully determined times so that the capabilities of the technology enhance how students and educators learn, experience, communicate and do mathematics. Technology must be used in this way in all classrooms to support all students' learning of mathematical concepts and procedures, including those that students eventually employ without the aid of technology. Strategic uses support effective teaching practices and are consistent with research in teaching and learning. (p.1)

There are several forms of technology available to assist or complement traditional teaching methods, which can include: the use of applications such as social media and mobile communication systems, mobile classroom response systems, and video technology (de Koff, 2020). The best predictors of how teachers will integrate technology in their classroom are their pedagogical beliefs, self-efficacy, and perceived value to student learning (Hsu, 2016). Through numerous studies on the barriers of integrating technology, time investment needed, effects on student achievement, and teacher effectiveness, researchers revealed the best predictors of success (Barton and Dexter, 2020; Morris et al., 2017; Hsu, 2016; Liu et al. 2015; Willis et al., 2016). These three predictors are themes throughout the literature and will help form the literature review framework. The related literature will detail the TPACK, teacher characteristics, and school and contextual characteristics.

TPACK

Learning in the 21st century requires new skills, tools, and knowledge on the part of the student. Integrating technology according to the content material is expected to make abstract concepts more concrete so that students can better understand concepts in-depth, and the ideas can be achieved with minimal misconceptions (Nurhadi & Darhim, 2021). To keep up with these new requirements for students, educators must invest time learning how to interweave the knowledge and skills required for their content area with those that lead to technology success (Mishra & Koehler, 2006). Shulman (1987) built a foundation for teaching reform on the concept of pedagogical content knowledge as one of seven knowledge types required by teachers. Shulman (1987) outlined the seven categories needed to promote comprehension through teaching as:

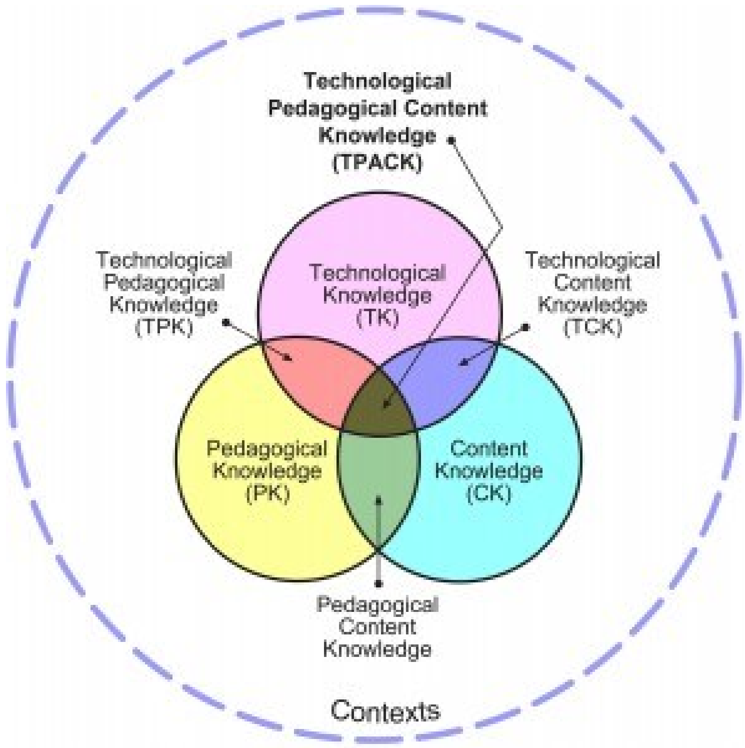
- content knowledge;
- general pedagogical knowledge, referencing broad principles of classroom management and organization that transcend subject matter;

- curriculum knowledge, with a precise grasp of the materials and programs that serve as "tools of the trade."
- pedagogical content knowledge, that mixture of content and pedagogy that is unique to teachers;
- knowledge of learners and their characteristics;
- knowledge of educational contexts, ranging from the workings of the classroom, financing of the school, to the character of the community and cultures; and
- knowledge of educational ends, purposes, and values

Teachers and students must have regular access to technologies supporting and advancing mathematical reasoning, problem-solving, and communication (NCTM, 2017). Mishra and Koehler (2006) framed TPACK on Shulman's seven knowledge types framework, including the present-day requirement for pedagogy knowledge in technology integration, as shown in Figure 1.

Figure 1.

Technological Pedagogical Content Knowledge (TPACK)



Note. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A Framework for Teacher Knowledge. *Teachers College Record*, *108*(6), 1017–1054. 10.1111/j.1467-9620.2006.00684.x; Reproduced by permission of the publisher, © 2012 by tpack.org

Technology is a tool that, when used daily in the classroom, requires a teacher's knowledge base that has three components: content, pedagogy, technology (Mishra & Koehler, 2006). To provide students with authentic learning experiences, Mishra and Koehler (2006) suggested asking teachers what technology will support and engage student understanding, why it is appropriate, and how they will incorporate all three elements (content, pedagogy, technology) into their lesson. Educators must have content-specific pedagogy to support learning in the classroom. Teachers need to understand their technological pedagogical content knowledge (TPACK) when assessing their effectiveness (Mishra & Koehler, 2006). The Technological Pedagogical Content Knowledge (TPACK), created by Punya Mishra and

Matthew J. Koehler (2006), explains the knowledge that they suggest teachers need to teach a subject and use technology effectively.

Pedagogical Content Knowledge

Historically, the teacher knowledge base has focused on content and, more recently, pedagogy. Pedagogical content knowledge requires teachers to understand how their subject matter is best organized and represented for optimal learning experiences (Mishra & Koehler, 2006). The pedagogy involves the use of illustrations, examples, and demonstrations to make the material more accessible to students; technology now plays a critical role in this pedagogical undertaking as now the illustrations, models, and demonstrations can be more precise and reach a broader range of students (Mishra & Koehler, 2006). A teacher must have strong content pedagogy to pre-emptively facilitate successful redirection where misconceptions or misapplications of prior knowledge are likely to occur (Mishra & Koehler, 2006).

Technological Content Knowledge

Through a case study where quantitative and qualitative methods were used to collect and analyze data**,** Kirikcilar and Yildiz (2018) found that teachers could successfully combine content and technology knowledge but lacked a pedagogical component to complete the tripod. Kirikcilar and Yildiz (2018) were mindful of previous research regarding pre-service teachers' technology pedagogy, so they concentrated on in-service teachers in their study. Technology brings imperatives to the lesson, thereby constraining certain instructional moves so that when introducing technology to faculty, there should always be a pedagogical and content connection (Mishra & Koehler, 2006). Furthermore, with so many available options for technology integration, teachers need to have the robust technological content knowledge to quickly weed out programs that do not add to the learning of the content (Mishra & Koehler, 2006).

Technological Pedagogical Knowledge

Understanding the technology and its use is not enough to warrant successful integration; using technology to increase student learning is vital for all teachers (Ruggiero & Mong, 2015). To successfully integrate technology into the classroom, teachers need to have solid content pedagogy knowledge to make informed technology hardware and software integration decisions to teach their concepts (Mishra & Koehler, 2006). Teaching is a highly complex skill that requires flexibility and in-depth knowledge of the content, pedagogy, student audience, and new technology. Teachers struggle with combining pedagogy and technology (Kirikcilar & Yildiz, 2018). For example, some mathematics concepts lend themselves to technology integration (polygons, circles, transformations, linear equations, etc.). In contrast, some ideas are more limited, such as roots and factorization, and it would not be beneficial for a teacher to try to push technology into the latter group (Guven & Yilmaz, 2016). Training can help teachers understand how technology and learning mathematics interact, specifically how technology can enhance certain mathematical concepts (Hill & Uribe-Florez, 2020). Professional development training for technology implementation should fall heavy on the pedagogy to focus on the content and build on the mathematical concepts through the use of the technology, so the technology use and the pedagogy are in concert (Hill & Uribe-Florez, 2020).

Technological Pedagogical Content Knowledge

TPCK provides a practical framework for the skills required to teach with technology: an understanding of the visual representations through technology; pedagogical techniques that use technology in innovative ways; knowledge of student understanding and how to use technology to support or increase that knowledge (Mishra & Koehler, 2006). When teachers believe in their capabilities to organize and execute TPACK, they report stronger self-efficacy in technology integration (Simsek & Yaza, 2019). According to Akayuure et al. (2013), the TPACK framework is essential for the proper implementation of technology. Therefore, there is a necessity for TPACK based organization in all stages of a lesson to ensure appropriate technology integration to enhance content knowledge through better pedagogy application (Birisci & Kul, 2019).

STAMPK

Professional development that focuses on the pedagogical use of technology effectively gets teachers to make changes in their instruction and develop the skills required to use the technology in teaching (Kalogiannakis, 2010; Schibeci et al., 2008). Building upon the suggestions of Koehler and Mishra, Getenet (2017) and Hassler et al. (2015) focused on developing a context-driven professional development program to facilitate technology-integrated mathematics teaching. Hassler et al. (2015) researched the most effective strategies for interactive education and the external support required to implement a successful continuing professional development program. Video recordings, lesson planning, and review meetings were critical elements in the professional development process (Hassler et al., 2015). The strategies focused on professional developments and encouraged the teachers to shift their attention from teaching to student learning (Hassler et al., 2015). One effective strategy the teachers gained during the reflection process was an insight into the value of peer interaction among students. Several students who did not understand the teacher's directions for the technology in the lesson were successful after receiving help from another student (Hassler et al., 2015).

Getenet (2020) developed a context-driven professional development program with guidelines to support mathematics teachers using technology in their instruction. Specialized technological and mathematics pedagogical knowledge (STAMPK) is used to understand teacher educators' understanding of technology-integrated mathematics teaching (Getenet, 2020). Using the suggestions of Mishra and Koehler (2006) and the findings of previous researchers, including Hassler et al., (2015), Getenet (2020) illustrates how the STAMPK framework might help analyze the knowledge needed for teaching certain mathematical concepts and the contextually relevant professional development that would be required to support teachers in this endeavor. Effective integration of technology requires the understanding of the relationship between technology knowledge (TK), specialized pedagogical knowledge (SPK), and specialized mathematics knowledge (SMK) (Getenet, 2020). Getenet (2020) used the integration of these three knowledge types to analyze teachers' perceived proficiency in the knowledge required to integrate technology into their lessons. Getenet (2020) measured the knowledge necessary for mathematics teachers to use technology in their math lessons through a 41-item survey evaluating their agreement with STAMPK items and offered open-ended questions where they could describe professional development programs they had attended and characteristics of ones they would like to attend.

Framework. Four themes emerged from Getenet's (2020) study: lack of professional development programs on the pedagogical use of technology, lack of required knowledge, lack of experience and awareness, and lack of technology resources. The teacher educators especially mentioned the missing aspect of specialization use of technology in their professional development programs. The teachers reported knowing pedagogy and mathematics knowledge but showed limited knowledge concerning specialized technology pedagogy, technology knowledge, and technical technology mathematics pedagogy knowledge (Getenet, 2020). Context-based scenarios should be at the root of the framework for technology professional development (Getenet, 2020). Professional development should focus on the pedagogical use of technology and strengthen teachers' positive beliefs (Getenet, 2020). Finally, professional development should be available as an informal arrangement that enables teachers' participation based on their availability and continuous opportunities without physical appearance (Getenet, 2020).

Teacher Characteristics

The use of technology allows teachers to free up time to carry out other activities independent of their professions (Fernández-Batanero et al., 2021). However, incorporating technology may also become a focus of tension and anxiety among teachers as it is often demanded despite a lack of technical resources and professional training (Fernández-Batanero et al., 2021). When teachers delve into the use of technology, they bring to the table a host of personal experiences that shape their perceptions of their digital proficiency (McDaniel, 2020). Teachers' prior technology experiences to the classroom impact their profession (Steven, 2019). Those who have not had positive experiences and lack proper training can feel that the technology is onerous, leading to more negative experiences (Steven, 20019). Four specific characteristics encompass these aspects of teacher confidence about their meaningful integration of technology into their instruction: experience with technology, teacher experience, teacher beliefs and comfort, and teacher self-efficacy.

Experience with Technology

Studies indicate that teacher educators often use technology for non-pedagogical purposes suggesting that their technical knowledge may not include pedagogical technology knowledge (Getenet, 2017; Schibecci et al., 2018). However, it is not enough for teachers to have only pedagogical and content skills; they also must have adequate technological skills (Yulianti et al., 2021). Current curriculum standards and administrative requirements will act as outside influences on teacher decision making while the past encounters teachers have experienced with technology act as internal influences (Bandura, 1989). With the presence of educational technology standards, availability of conferences and workshops, and digital and print media opportunities and experiences, it could be assumed that "technology integration knowledge and skills would be ample among professions" (Krause et al., 2017, p.176). However, technology use continues to be a problem among teachers outside of the computer technology integration subset (U.S. Department of Education: Office of Educational Technology, 2017). Through past experiences, people will plan for likely consequences and set goals for themselves based upon these preconceived beliefs (Bandura, 1989). Teachers who have encountered technical problems during a lesson reported wasted time and decreased classroom management (Guven & Yilmaz, 2016). Teachers who experience technical issues throughout several tasks are often less likely to use technology again without the support of a school technology specialist (Guven & Yilmaz,2016). During the COVID-19 pandemic, many K-12 teachers lacked digital competency or online teaching abilities as they transitioned to virtual education (Ogodo et al., 2021).

Teacher Experience

A teacher's years of experience are a factor that can influence their integration of technology. The more removed teachers are from the university setting, the less they adopt new practices into their teaching methods (Syvanen et al., 2016). Baek et al. (2008) conducted a study where more experienced teachers responded negatively to external pressures to implement technology than less experienced teachers. Barton and Dexter (2019) found that external persuasion toward new technology is more welcomed by other teachers in a professional learning community. Concerning content ability, tenured teachers would likely report a higher self-efficacy regarding their teaching ability than their younger counterparts due to their extended time and practice in their field (Saltan & Arslan, 2017). Bandura (1989) can explain the reported higher self-efficacy in pedagogy knowledge for veteran teachers as the theory that middle-aged people have created routines and self-appraised their efficacy in the areas they routinely live in (Saltan & Arslan, 2017). However, life is not stationary, and outside influences continue to change, such as the rapid technological and social changes that call for continuous learning (Bandura, 1989). Liu et al. (2017) reported that years of teaching had an inverse effect on classroom technology integration. In this regard, the veteran teachers with more than ten years of experience are finding their years working against them. They report significantly lower technology use than teachers with three years of experience or less (Li et al., 2019). Saltan and Arslan (2017) noted teachers with 6-15 years of experience had higher technology knowledge scores than those with 20 years of experience. Mongillo (2016) suggests that novice teachers who would generally replicate the veterans' classrooms could offer guidance in reforming the veteran teachers' traditional classrooms through collaboration and shared knowledge.

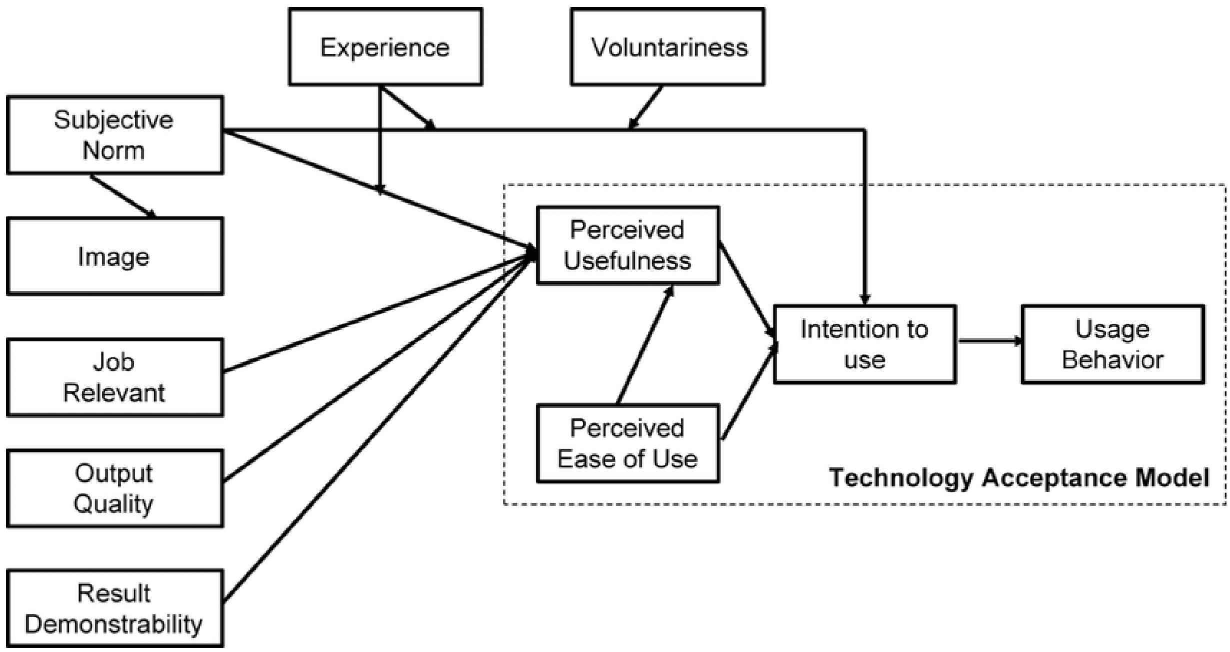
Teacher Beliefs and Comfort

Teachers' pedagogical belief is often defined as a holistic conception relating to multiple dimensions of teaching, such as instruction, curriculum, and the teaching profession in general (Wu, 2021). Although the current online experience will impact education, trust in these technology tools' effectiveness may not be incredibly significant or long-lasting (Tartavulea et al., 2020). To support effective technology use, which is not only the result of adequately tailored instructional and assessment tools, teachers' beliefs and comfort with the technology must be supported, which begins with a technological willingness and the overall confidence that the system is functioning towards the intended objectives (Tartavulea et al., 2020). Teaching with technology can be an arduous undertaking, and teacher competencies such as knowledge and beliefs are a decisive factor, according to Thurm and Barbel (2020).

Teacher beliefs about the effects of their actions influence their choice in instructional methods even when those beliefs are unfounded or inaccurate. Teachers' technology self-efficacy has been related to the more frequent use of technology in the classroom (Li et al., 2018). Hsu (2016) found a direct correlation between teacher beliefs and practice, whereas the more a teacher believes in technology as a beneficial tool, the more likely they are to use it. When ideas about the impact of actions differ from reality, the behavior is strongly controlled by this false belief until repeated experiences instill realistic expectations (Bandura, 1989). Multiple factors influence tech integration, including teacher beliefs about technology, pedagogy, and building-level access to technology (Heath, 2017). Gavora (2010) also found that teachers' personal beliefs in their ability to plan instruction and accomplish instructional objectives can lead to success. Teachers who demonstrate a positive attitude and perception toward technology usage may be more likely to implement technology in their lessons (Holden & Rada, 2011). Lack of time and personal beliefs, and attitudes toward teaching methods and technology are the biggest obstacles in direct control of the practicing teacher (Salleh, 2016). Research-based evidence suggests that teachers' beliefs about and readiness for technology integration have the most robust relationship with integration and are influenced by external support (Inan and Lowther, 2010; Petko et al., 2018). Salleh (2016) proposed that external variables, perceived usefulness, and ease of use all shape the teacher's attitude, influencing their intention to use technology. Using social cognitive theory, Salleh's ideas were derived from Davis's Technology Acceptance Model (1989), as shown in Figure 2.

Figure 2.

Technology Acceptance Model



Note. Davis, F. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly, 13*(3), 319-340. doi:10.2307/249008

Davis (1989) describes an individual's intention to use a system as regulated by perceived usefulness and ease of use. Joo et al. (2018) used four factors, TPACK, teacher self-efficacy, perceived ease of use, and perceived usefulness as the pre-cursors of the intention to use technology. Joo et al. (2018) confirmed that perceived ease of use significantly affected perceived usefulness. Cardullo et al. (2021) used this model to examine the relationship between perceived usefulness and teachers' remote teaching self-efficacy. When teachers believe that technology is easy to use, they tend to find it more useful. To integrate technology in their teaching and develop adequate skills and beliefs, teachers need the support of their schools and beyond (Petko et al., 2018).

Teacher Self-efficacy

Researchers have studied teachers' and preservice teachers' self-efficacy and ability to successfully implement technology in the classroom. Tassell et al. (2019) used the Mathematics Teaching Efficacy Belief Instrument (MTEBI) to measure teachers' efficacy beliefs. During this research, Tassell et al. (2019) found that teacher efficacy had the most considerable impact on student achievement beyond other factors such as teacher-student relationship, home environment, or parental involvement. According to Akayuure et al. (2013), Bandura's (1977) self-efficacy theory suggests that confidence in success motivates people to act. The lower the self-efficacy, the more likely the teacher will not have a positive attitude or a favorable desire to use technology in the classroom (Pan & Franklin, 2011). Liu et al., (2017) found that technology self-efficacy was a significant predictor of teacher technology use when background variables were controlled.

Self-efficacy suggests that when a person becomes good at something, they will feel more comfortable (Bandura, 1977). Morris et al. reported that individuals who used adaptive rather than avoidant coping strategies were more likely to describe decreases in stress and increases in teaching self-efficacy. In addition, Morris et al. (2017) reported that teachers with higher teaching self-efficacy were more likely to engage in adaptive stress-coping strategies.

Kabakci-Yurdakul et al. (2012) developed the 33 items Technopedagogical Education Competency Scale (TECS) with four subdivisions: design, exertion, ethics, and proficiency. Birisci and Kul (2019) used this scale in a correlational study that concluded a positive and high-level correlation between the TPACK competency levels and technology integration self-efficacy beliefs. Birisci and Kul (2019) did a correlation study using the Technology Integration Self-Efficacy scale developed by Wang (2004). The calculated Cronbach's alpha internal consistency coefficient was.94 (Birisci & Kul, 2019, p. 79). A high Cronbach's alpha internal consistency coefficient is .94 reflects a robust correlation between technopedagogical education competency levels and technology integration self-efficacy beliefs. The correlation Birisci and Kul (2019) found can be clarified by Katz and Stupel (2016). They explain that teachers with high pedagogy technology efficacy invest time planning and collaborating with coworkers to ensure the best use of the technology in their lessons.

School and Contextual Characteristics

Although teachers differ in technology-related skills and beliefs, these characteristics are influenced by the schools' social and cultural context (Petko et al., 2018). Therefore, to support the teachers, it is imperative to provide digital tools and deliver strategic and goal-oriented planning with regard to educational technology integration, head-teacher support, and formal and informal exchange with fellow teachers (Petko et al., 2018). Technology is an essential 21st-century skill for students that teachers can develop to build upon their technical skills to succeed in the future. According to the U.S. Department of Education (2018), technology helps expand course offerings experiences, builds 21st-century skills, increases student motivation and engagement, accelerates learning, and supports learning 24 hours a day. A study by Petko et al., (2018) shows that the use of educational technology in classrooms is dependent on teacher readiness, which, in turn, is strongly influenced by school readiness. Despite the data that supports the use of technology in the classroom, some schools still fall behind in implementation despite the research that shows teachers in schools with an emphasis on technology tend to share this emphasis themselves (Petko et a., 2018). Lack of technology implementation is often due to not all schools having the same computer hardware, software, and technology staff support, thereby creating digital divides that can disadvantage some students' acquisition of 21st-century skills. Public school funding is based on student enrollment, and rural areas receive less funding

(Gutierrez, 2016). Therefore, the access, technical support, and technology education opportunities are lowest for urban and rural schools, with rural schools dealing with the most limited access to technology resources (Tyler-Wood et al., 2018). To achieve school readiness, as conceptualized in the study by Petko et al., (2018), there needs to be perceived importance of educational technology in the given school, universal understanding of expected outcomes, a supportive school principal, good technological infrastructure (including hardware, software, content, and support) and formal and informal professional learning communities.

COVID-19.

During the current COVID-19 pandemic, schools were underprepared for the emergency transition into virtual learning (Ogodo et al., 2021). The COVID-19 pandemic caused a significant shift in education, moving all teaching remotely in just days (Cardullo et al., 2021). Numerous districts purchased mobile hotspots, retrofitted their buses and community locations with Wi-Fi, and worked with their Internet providers to narrow the digital divide in their communities (Casserly, 2020). Suddenly, all schools had to find ways to offer distance learning to their students without national guidelines and funding, highlighting the vast differences among school systems in the United States (Casserly, 2020; Prampling et al., 2020). According to a study by Gerber (2020), many school districts were unprepared for the transition to virtual learning, and 85% of the sample had no existing plan for teachers' work expectations. Gross and Opalka (2020) also reported that low-income rural districts didn't communicate expectations on how teachers should provide instruction during the COVID-19 pandemic.

Teachers had to consider several aspects during this shift: the need for the platform, features of the platform that fit the need, assessment, responsive learning and application, and the customization of the learning management system (LMS) (Cardullo et al., 2021). Pramling et al.,

(2020) reported the preparation time of some kindergarten teachers to be days for just a twenty-minute virtual lesson as they now needed to create not only a virtual lesson but detailed lesson plans that the parents could follow at home and often these first lessons evolved into controlled chaos. One of the biggest challenges for schools across the United States has been to provide equitable educational experiences for children who do not have computers or access to the Internet (Pramling et al., 2020). Not all the pandemic effects are harmful; COVID-19 has sparked exploration of new approaches to assessment and greater availability of some educational technology products; some companies have made their tools freely available (Wyse et al., 2020).

School Technology and Support

Availability of support often gives teachers peace of mind and relieves some anxiety around technology integration; technical support makes an enormous difference in technology integration (Morris et al., 2017). Utilizing technology support specialists may motivate teachers to incorporate different technology-enhanced teaching strategies (Morris et al., 2017). School technology support was one of the influencers of classroom technology integration, reported by Liu et al. (2017). For teachers who do not have high self-efficacy regarding technology use, one failed technology experience can negatively influence their perspective, hindering future endeavors with technology integration (Liu et al., 2017). Quality support staff who are available on-demand to resolve technology issues as they occur are vital to teachers' positive experiences (Liu et al., 2017). Delgado et al. (2015) suggest supporting technology in the classroom through software and hardware training and integrating the technology to improve student skills where the standards have changed. The support for technology use and proper TPACK integration can derive from collaboration with colleagues, supplementing support from technical support personnel (Liu et al., 2015). According to Morris et al. (2017), researchers Tschannen-Moran and McMaster (2009) discovered that teachers experienced the highest self-efficacy in a professional development format that embed instructional coaching, compared to other professional development formats.

The COVID-19 pandemic pushed this advancement from 1:1 in school to 1:1 at home (Pramling et al., 2020). During the COVID-19 pandemic, teachers may feel uncomfortable teaching remotely, especially if other technology factors compound the lack of training, such as limited technology available at home, defective equipment at school, or technical problems faced in technology-assisted teaching are (Tartavulea et al., 2020). On the other hand, the COVID-19 pandemic may have been the catalyst to move technology integration forward by forcing districts to provide reliable technology to all their students. Cardullo et al. (2021) reported that participants in their study associated many elements of equity of access in their responses: "some students do not have enough access to [a] device and Internet reliably during class time. And no technology support from family" (p.38).

Professional Development

Previous studies have indicated that teachers need professional development that emphasizes the pedagogical use of technology in teaching; this could help facilitate an understanding of the relationship between pedagogy, technology, and the mathematical concept (Getenet, 2017; Koehler and Mishra, 2009). Professional development would have been beneficial to the teachers during the COVID-19 pandemic; however, Gerber (2020) found that only 42% of districts in their study reported providing any professional development to increase familiarity with digital platforms. Teachers have indicated that a lack of in-service training negatively affects their technology investment (Ruggiero & Mong, 2015). Heath (2017) did a phenomenological case study to explore teacher perceptions of technology integration. He found that even when teachers saw the positive reasons for using technology in the classroom, they can still fail to implement it regularly because of a lack of access and effective professional development to prepare them. Training provided to teachers, and continued support after training, significantly increases higher self-efficacy, or confidence, to integrate technology and use technology for learning than those who have not participated in training sessions (Levin & Wadmany, 2008). Delgado et al. (2015) reported that 80% of teachers stated that their attitudes about technology improved tremendously after participating in professional development. Mathematics teachers benefit from learning within a community of practice, explicitly using the time to discuss their practices and ways to incorporate technology into their classes with their specific content and teaching philosophies (Kelley et al., 2020). Therefore, teacher colleges and school administration must provide training and professional development to acquire technological, pedagogical, and content knowledge (TPACK) (Tondeur et al., 2017). Unfortunately, rural districts may not have the funds in their budget to provide adequate technology training (Kalonde, 2017a; Tyler-Wood et al., 2018). In the study conducted by Kaonde (2017), middle school math and science teachers responded to a survey reporting that most of them had received less than 10 hours of educational software training.

Thurm and Barzel (2020) conducted a quantitative study over six months to investigate the efficacy of a professional development program on mathematics teachers and found the most substantial impact on teachers' technology-related beliefs. Professional development is an essential tool supporting teachers in the iterative learning process to incorporate practical technology tools into their classrooms (Thurm & Barzel, 2020). Thurm and Barzel (2020) reported that their control group, who did not receive professional development training while incorporating the technology, developed more negative technology views. Bandura (1977) would suggest that ideally, these problems would be seen as part of the natural growth process, but control group teachers seemed to attribute these problems to the technology itself. The teachers in the experimental group who received professional development achieved higher self-efficacy, which gave them the internal motivation to persevere as suggested would happen to those with high self-efficacy by Bandura (1994). The professional development studied by Thurm and Barzel (2020) "either reduced the experience of a severe implementation dip or helped to frame their negative experience as a natural part of the implementation process" (p.1420). Teachers' self-efficacy in the experimental group did not advance much more than the control group, which Thrum and Barzel (2020) attribute to the lack of follow-up coaching described by Petko et al. (2018).

Kalonde, G. (2017b) explored how rural schools provide students with enhanced teaching through technology integration through a mixed-methods design using quantitative data to support or refute the corresponding qualitative data. Kalonde, G. (2017b) found that the teachers used iPad technology for instruction less than 30% of the time. The students were found to use the iPads more than the teachers, which indicated they were more comfortable with the technology suggesting a need for further professional development (Kalonde, G. (2017b). Professional opportunities that address teachers' competencies are essential in supporting knowledge, beliefs, and practices (Clark-Wilson et al., 2014; Hegedus et al., 2017; Sztajn et al., 2017). Hill and Uribe-Florez (2020) suggest that professional development should include time for teachers to learn to use the technology and practice implementing it in the classroom to troubleshoot any problems that may arise before implementation with students.

Teachers have identified training as the most effective when it occurs in their classroom (Ruggiero & Mong, 2015). Morris et al. (2017) reported concurring themes with teachers relying on their coworkers and mentors for guidance. Sometimes time is the only barrier for teachers to learn about technology tools. Ruggiero and Mong (2015) reported that approximately 60% of their respondents used outside research, reading, the internet, and professional development. Creating an individualized professional development plan for teachers might improve their technology integration success (Ruggiero & Mong, 2015). School leaders need to model the technology use through professional development. For instance, professional development on Zoom's positive effects would be much more effective if the session was held through Zoom.

Principal Support and Leadership

School leaders are adjusting to a world where technology has crept into many aspects of the profession through technology innovation due to the COVID-19 pandemic in Spring 2020, where digital learning and leadership have become the new norm (Sterrett & Richardson, 2020). In some cases, inconsistent directives from school administration during the pandemic may have created some learning loss (Ogodo et al., 2021). The call for technology use in the classroom has created further support and inspiration requirements for principals and leaders in schools. Leaders in school districts are responsible for providing continuous support for teachers throughout the school year on technology, including professional development and daily support through technology liaisons (Hill & Uribe-Florez, 2020). Principals play an essential role in supporting teachers' work by supporting professional development efforts (Sterrett & Richardson, 2020). Leadership goals and a desire to drive change are critical for successful technology integration (Tyler-Wood et al., 2018). Tassell et al. (2019) followed a three-year initiative where teachers worked as leaders in their community of learners sharing ideas at state and local conferences due to increased confidence in planning and implementing technology-laced high-quality mathematics lessons. School leaders should find ways to motivate teachers so that they want to integrate technology, and they are not using low-level integration methods to simply comply with a district requirement (Kelly, 2015). A principal's beliefs, actions, and involvement contribute to the teachers' success, which in turn must be recognized and rewarded to help spur a culture of technology use (Tyler-Wood et al., 2018). Principals can strengthen teachers' best practices through relevant, timely, and individualized professional learning opportunities (Sterrett & Richardson, 2020). Morris et al. (2017) report that many teachers have attested to the importance of early modeling experiences, claiming that early involvement with masterful mentors was imperative to their confidence development because those experiences armed them with content knowledge and pedagogical strategies. Principals need to support teacher leaders in their school and recognize them as the best resource to encourage coworkers through informal discussions, coaching, and formal professional development training (Kelly, 2015).

Principal support of technology use in the classroom is not as simple as it appears from the outside. Sterrett and Richardson (2020) conducted a qualitative study of principals who had won an award for being “digital principals” awarded by the National Association of Secondary School Principals. Their findings illuminated three themes: first, these digital leaders engaged teachers in purposeful professional development; second, they engaged in digital professional learning networks themselves; finally, they empowered their teachers to become leaders in technology in the classroom and the school (Sterrett & Richardson, 2020). For example, one principal in the study described how using an online newsletter that encouraged responses through Padlet stimulated the use of Padlet by teachers in their classrooms (Sterrett &

Richardson, 2020). Another principal in Sterrett and Richardson's (2020) study created short tutorial videos and directional screenshots for his teachers to use new technologies such as Kahoot. Through targeted purposeful training and modeling, the principals could inspire their teachers to gain confidence in their abilities to use instructional technology (Sterrett & Richardson, 2020).

Principals are also responsible for their schools' behavior social and academic management. Dodson (2020) studied school principals in eight states regarding their social media perceptions and classroom smartphone use. Over 90% of the respondents to Dodson's (2020) survey believed that schools should have a strict guideline for student smartphone use during school hours, with 85% reporting that they have strictly enforced policies in place at their schools. While these principals believe that smartphone use should be strictly regulated, 80% believe that schools should issue computers to all students; still, only about 25% issue computers to all students (Dodson, 2020). Dodson showed a relationship between the state rankings of schools and their policy on issuing laptops to students. The top three ranked states were among the top four states whose principals reported that computers were issued to all or some of their students (Dodson, 2020). Technology through student devices will continue to bring new situations that teachers and principals must learn to regulate. Sterrett and Richardson (2020) found that principals who embrace change, continued learning, and innovation create a trickle-down effect where the teachers are comfortable not having all the answers and feel comfortable looking for them with their students.

Student Engagement

According to research, YouTube, Facebook, Instagram, and Snapchat are the top social media platforms for teenagers, 95% of whom have access to smartphones (Chang, 2016;

Anderson & Jiang, 2020). Students utilize social media regularly in their daily lives, and by incorporating this technology into the classroom, instructors can meet students where they are and where they are comfortable (de Koff, 2020). Implementing social media within a traditional teaching structure creates a more learner-centered environment (Chawinga, 2017), leading to closing learning gaps (Wong, 2021). In addition, technology can foster autonomy and develop student responsibility for specific learning goals; this may be done in digital environments through synchronous videoconferencing systems or asynchronous learning management systems (Wong, 2021). Despite this data, nearly 86% of teachers have not integrated social media into their classrooms (Chang, 2016).

Along with the potential to support a deeper understanding of mathematics through technology, unmotivated students in a traditional classroom setting may become more motivated when technology is involved (Morris et al., 2017; Thurm & Barzel, 2020). Studies by Koff (2020) and Liu et al. (2017) suggest that teachers know that technology integration will engage more students in learning, citing the immediate feedback and positive affirmation students receive through technology programs. Positive effects on student achievement have been correlated to technology and result in students taking a more active role in their learning (Liu et al., 2017). In a study reported by de Koff (2020) on the effects of Twitter on student motivation, students said that using a mobile app instead of email to communicate outside of class had several positive attributes, including more significant interaction with the instructor, greater interaction with students in the class and it was more fun to use.

Another example of technology use in the classroom includes classroom response systems (CRS); these systems have primarily moved from purchasing required classroom sets of clickers to mobile-based systems using smartphones (de Koff, 2020). Technology integration has provoked positive classroom environment changes such as increased differentiation and student engagement (Courts & Tucker, 2012). According to Courts and Tucker (2012), technology-savvy students are more likely to learn through instructional methods that are comfortable and familiar. This learning style suggests that teachers need to invest the time to become proficient in using technology. Engagement is the key to successful technology integration that increases the effectiveness of the lesson (Murphy, 2016).

Zengin and Tatar (2017) suggest that passive use of technology will not create a more effective task than without any technology; technology lessons should be dynamic and interactive with a clear purpose. Ruggiero & Mong (2015) suggest that technology can be highly motivating for students and the teachers reported that its use could be a successful motivation and engagement tool. However, technology cannot stand alone as a motivator and must be engaging so that the students do not quickly lose interest (Zengin & Tatar, 2017; Ruggiero & Mong, 2015). For example, technology allows students to work at their own pace or create more expressive work providing more opportunities for all learners to stay engaged in the lesson (Zengin & Tatar, 2017; Ruggiero & Mong, 2015).

However, due to the COVID-19 pandemic and at-home learning, students are now required to be engaged through the use of technology, and one of the challenges for teachers is to help students achieve the necessary skills to balance the management of technology with their mental health (Fernández-Batanero et al., 2021). In addition, student engagement is now dependent upon another variable, that of parental assistance. The parental help is likely highly varied depending on the student's age and other social, economic, and family-related factors (Wyse et al., 2020).

Summary

A thorough review of the literature revealed that high self-efficacy, quality support, principal modeling, and professional development followed by teacher collaboration and reflection positively influence teachers' intent to use technology (Liu et al., 2017; Liu et al., 2015; Starrett & Richardson, 2020). The social cognitive theory views humans as proactive capable of self-reflection, self-regulation, and self-organization before adopting certain behaviors (Bandura, 1989). The theory also suggests that personal, behavioral, and environmental factors affect efficacy. The social cognitive theory considers multiple types of factors that may play a role in influencing one’s decision to adopt or carry out a specific behavior and can provide support to the factors affecting self-efficacy. The current pandemic and its influences on education were considered. For teachers to teach effectively with technology, a framework is known as Technological Pedagogical Content Knowledge (TPACK) has been identified (Koehler & Mishra, 2009). People who doubt their ability to accomplish complex tasks see these tasks as threats and give up quickly, leading to task avoidance, positivity, lack of engagement, and resignation that failure is inevitable (Bandura, 1994). However, people who have a heightened sense of self-efficacy quickly recover their self-efficacy following setbacks and disappointments (Bandura, 1994). Teachers with higher self-efficacy are more likely to use technology and invest time learning new technology skills (Branntley, 2017; Joo et al., 2018). Research suggests that developing technological and pedagogical support systems to accommodate teacher technology skills and a strong focus emphasized by the school division with clear goals may help teachers integrate technology more effectively (Li et al., 2019; Petko, 2018). Professional development for technology use should allow for individualization, be modeled, when applicable, by school leadership, and support continuous reflection through learning communities (Morris et al., 2017;

Kelly, 2015; Murphy, 2016; Starrett & Richardson, 2020). Once a better understanding of secondary math teachers' perceptions of technology integration is collected, professional development instruction can be advanced to include the technology and the pedagogy.

The effect of the current pandemic on education was taken into consideration. The success of remote teaching and remote learning is impacted by the teachers' perceived teaching self-efficacy and attitude toward the remote LMS (Cardullo et al., 2021). The COVID-19 crisis abruptly disrupted teaching and learning's status quo and pushed school leaders into the digital world overnight (Starrett & Richardson, 2020). During the current COVID-19 pandemic, schools were forced into virtual learning. Numerous districts purchased mobile hotspots, retrofitted their buses and community locations with Wi-Fi, and worked with their Internet providers to help narrow the digital divide in their communities (Casserly, 2020). The schools improved by looking to the digital leaders in their educational communities (Starrett & Richardson, 2020). To continue to improve upon the now mandatory use of technology, there is a need for research concerning the perceptions of rural high school mathematics teachers' technology self-efficacy (Hill & Uribe-Florez, 2020; Tassell et al., 2019). There is also a necessity, as several researchers suggest, for qualitative research on this topic (Li et al., 2019; Liu et al., 2017; Salleh, 2016; Saltan & Arslan, 2017). Educator of this digital revolution has a story to tell, and their lived experiences should inform the field for practice, research, and leadership preparation (Starrett & Richardson, 2020). Tartavuluea et al. (2020) argue that the current pandemic has forced academic stakeholders to quickly accept some online tools, which will continue to be used to some extent once the educational system returns to a traditional format. This qualitative study aimed to provide educational stakeholders with a deeper understanding of high school mathematics teachers' self-efficacy regarding integrating technology to facilitate informed decision-making. I intended to consider the novel education setting due to the COVID-19 pandemic throughout the study.

CHAPTER THREE: METHODS

Overview

The purpose of this transcendental phenomenological study was to develop a description of perceived factors influencing secondary mathematics teachers' technology self-efficacy in Virginia. Since secondary school teacher perceptions were the basis for the study, quantitative and mixed-methods study designs were not selected; the rationale for this decision will be explained later in the chapter. This study was qualitative because it aimed to analyze participants' experiences to obtain a comprehensive picture and detailed understanding of the phenomenon. It is vital to provide math teachers with content-specific technology support through professional development and building-level support (Liu et al., 2014); this is especially true for teachers who report low self-efficacy. A lack of support for teachers to learn how to combine pedagogy, content, and technology in a time when technology integration is essential to a complete curriculum created this problem (Akayuure et al., 2013; Birisci & Kul, 2019; Kirikcilar & Yildiz, 2018; Simsek & Yaza, 2019;).

The focus was to collect data from the perspectives of secondary mathematics teachers. The research questions were explored using phenomenological research methods. I chose a qualitative methodology to explore teachers' experiences and understand what factors influence their technology self-efficacy. Throughout this study, I used the theoretical framework of Bandura's (1989) social cognitive theory and Bandura's (1977) self-efficacy theory. Because the focus of this study was to identify factors that influence teachers’ technology self-efficacy, it was appropriate to use Bandura’s Social Cognitive Theory. It considers multiple types of factors that may play a role in influencing one’s decision to adopt or carry out a specific behavior. In addition, I conducted qualitative research using a transcendental phenomenological design to examine this phenomenon to understand teachers' personal experiences. Moustakas's (1994) approach provided the methodological framework for a systematic qualitative data collection and analysis approach. Described in this chapter are the research design, research questions, setting, participants, data collection process, and data analysis procedures of the study.

Design

Transcendental phenomenology was an appropriate design for my research study because of the parameters and the qualitative nature of this specific case study. A qualitative study allows the researcher to explore the story's meanings and gain detailed firsthand accounts of the experiences (Creswell & Poth, 2018). A qualitative approach was favored over a quantitative approach since it allowed me to delve into the phenomenon's complexity by "searching for meaning and essences of experience rather than measurements and explanations" (Moustakas, 1994, p. 21). The purpose of this transcendental phenomenological study was to develop a complex and detailed understanding of secondary mathematics teachers' experience with technology in rural Virginia public schools. The research design was phenomenological, as it enabled the researcher to describe shared meaning and themes for several individuals of their lived experiences (Creswell & Poth, 2018). A phenomenological design focuses on determining a rich meaning of the phenomenon by describing what all participants have in common as they experience the phenomenon (Moustakas, 1994). Phenomenology is defined as all that comes from consciousness serves as the basis for all knowledge (Moustakas, 1994). To examine the essence of the participants' experience, I used a transcendental phenomenological design. Perceived ease of use and perceived usefulness of technology are the most critical concepts influencing the intention to use technology; thus, qualitative research questions can elucidate external variables affecting these two concepts (Joo et al., 2018). I defined the phenomenon as the perceived factors influencing technology self-efficacy for mathematics teachers at rural high schools in Virginia.

Phenomenology is based upon a familiar or lived experience that multiple people have experienced, creating a phenomenon between them (Creswell & Poth, 2018). In phenomenological research, the researcher has a personal interest in the research phenomenon (Moustakas, 1994). As a high school math teacher, I have a personal investment and interest in my study phenomenon. However, I was careful not to let my beliefs influence the study's outcome. For my high school math teacher self-efficacy study, I was looking to determine what the experiences mean for the teachers who have lived the phenomenon (Moustakas, 1994). I planned to use a transcendental approach to phenomenology, identify the problem, bracketing out one's experiences, collect data from people who have lived the phenomenon, and analyze the data by combining the statements into themes (Moustakas, 1994).

Researchers who use a phenomenological approach seek to explain the essence of the experience from those who have lived it by setting aside preconceptions about the phenomenon and allowing the qualitative data to reveal meaning (Smith, 2016). Epoché is a process where the researcher takes steps to set aside judgments and knowledge to revisit the phenomenon from a pure perspective (Moustakas, 1994). The epoché process requires the researcher to abandon all prior biases when analyzing the data collected. This process provided the researcher with an open perspective to collect data that will serve as a basis for further reflection (Moustakas, 1994). Noema and noesis involve the physical experience and the perception and judgment of the experience, respectively (Moustakas, 1994). In carrying out the study, I considered each of these elements of phenomenology to obtain reliable results. I recorded my perceptions and judgments regarding technology implementation in the mathematics classroom before collecting data so that

I was ready to objectively observe, record, and analyze the participants' experiences.

Research Questions

The following research questions helped to guide the study:

CQ1. What are the self-efficacy experiences of high school math teachers?

SQ1. What are the mastery experiences of teachers with technology self-efficacy?

SQ2. What are the vicarious experiences of teachers with technology self-efficacy?

SQ3. What are the emotional and physiological experiences of teachers with technology self-efficacy

SQ4. What are the verbal persuasion experiences of teachers with technology self-efficacy?

Setting

The setting for this phenomenological study was five rural public high schools in Region 8, Southside, Virginia. I chose the five rural public high schools due to their proximity. I chose this setting because I had easy access to the participants because of my current employment in the region and connections in the math teacher community. The region's school districts have technological resources available to teachers. I gave the five school districts pseudonyms, and they are as follows: Alpha High School, Beta High School, Delta High School, Zeta High School, and Theta High School. Alpha High School has 613 students enrolled for the 2020/2021 school year with a demographic make-up of 45% Caucasian students, 43% African American students, 4% Mixed-race, 8% Hispanic, 13% with disabilities, and 54% economically disadvantaged (Virginia School Quality Profiles,2020). Beta High School has 679 students with a demographic make-up of 68% Caucasian, 20% African American, 8% Multi-racial, 3% Hispanic, 11% with disabilities, and 46% economically disadvantaged (Virginia School Quality

Profiles,2020). Delta High School has 574 students enrolled with a demographic make-up of 52% Caucasian, 36% African American, 6.3% Multi-racial, 4% Hispanic, 14% with disabilities, and 12.7% economically disadvantaged (Virginia School Quality Profiles, 2020). Zeta High School has 564 students enrolled with a demographic make-up of 61% Caucasian, 30% African American, 5% Multi-racial, 3% Hispanic, 17% with disabilities, and 49% economically disadvantaged (Virginia School Quality Profiles, 2020). Theta High School has 382 students enrolled with a demographic make-up of 46% Caucasian, 45% African American, 5% Hispanic, 5% multi-racial, 14% with disabilities, and 46% economically disadvantaged (Virginia School Quality Profiles, 2020). Individual schools within the district have the freedom to provide teachers with various types of professional development opportunities on technology. The push to incorporate technology in math education in this area has been new within the last ten years. The expectation is that the site would provide a mixture of teachers who have and have not used technology for math instruction regularly. In a phenomenological study, participants' location can vary, but most importantly, they must have experienced the phenomenon (Creswell & Poth, 2018).

Participants

Three considerations went into the purposeful sampling approach: selecting participants, the sampling strategy, and the sample size (Creswell & Poth, 2018). From the participating schools in Region 8, the researcher selected a convenience sample of 10 high school math teachers to participate in the study. The participants were full-time, certified math teachers chosen from the five chosen school districts in Region 8. I informed all participants of the study's nature, obtained informed consent, ensured their confidentiality, and described my responsibilities and the participants’ responsibilities (Moustakas, 1994). Pseudonyms were used for all participants to protect their privacy and ensure minimal risks. A convenience sample was used to identify participants with the qualifications from a local geographic region to create a population sample representing the larger sample pool (Creswell & Poth, 2018).

Procedures

In his book *Phenomenological Research Methods*, Moustakas (1994) describes the procedures and methods for designing transcendental phenomenological research. These steps include finding a topic that has both social meaning and significance and conducting a thorough literature review, careful selection of participants, informing participants about all aspects of the study, developing interview questions, performing and recording interviews, and organizing and analyzing data to provide detailed descriptions that capture the essence of the experience (Moustakas, 1994). Before any data collection began, approval was submitted to be granted by both Liberty University's Institutional Review Board. The high school principals and all participants gave permission to conduct the research. A convenience sample was collected by selecting the first two participants to respond to the email from each school. Participation in the study was voluntary, so if a respondent was contacted and declined, the researcher reached out to the next teacher to participate. This process continued until the researcher secured a minimum of ten teachers. Teachers who chose to participate in the study were given a twenty-dollar gift card for their participation and were entered to win one of three fifty-dollar gift cards at the conclusion of the study.

I contacted the teachers through email to participate in the study. As evidence of their endorsement of the study, the researcher first sent the email to the principals. I then emailed their mathematics teaching staff. The email included an introductory letter to teachers with information that provided an overview of the study and an informed consent letter to explain the survey's purpose and study. Teachers who wished to participate in the study then clicked a link to a demographics survey.

I collected the survey results and discarded incomplete or invalid surveys. Next, I sorted the surveys by school division. The survey did not answer any of my research questions. Still, it did allow me to collect demographic information about the teachers and organize them by the school district to gather participants from several districts. After securing the participants, I scheduled meetings using virtual conferences outside of regular work hours, lasting approximately one hour. Finally, I recorded the sessions using Zoom recording. The interviews began with controlled questions and allowed for open-ended responses and discussion to explain personal experiences with technology integration in the classroom. The sessions were recorded and transcribed with signed participant permission.

I also conducted a document analysis of letters of advice written to a teacher struggling to incorporate technology into their math classroom. I collected the documents to understand and corroborate the information provided by the teachers to get at the essence of what contributes to a teacher's technology self-efficacy. Reviewing these documents allowed me to compare the participants' advice to the interview answers. According to Creswell and Poth (2018), journaling can create additional field issues, but providing specific instructions with leading questions and ensuring all participants are comfortable with journaling can reduce the problems to a minimum. As with the requirements suggested by Creswell and Poth (2018) for journaling, I provided specific instructions for the letter of advice regarding the person needing the advice and their academic setting.

The Researcher's Role

I am a high school mathematics teacher employed by one of the districts in region 8 in Southside, Virginia. I am the department chair for my school's math department and am interested in understanding the perceived factors influencing teachers' technology self-efficacy levels. This deeper understanding can help increase their technology self-efficacy by creating better professional development for math teachers in region 8. I believe in the benefits of successful technology integration and want to help mathematics teachers in rural areas increase student achievement through technology integration.

The transcendental method requires that the researcher suspend their beliefs to focus on the participants' experience of the phenomenon and objectively report its essence (Neubauer et al., 2019). Moustakas (1994) suggests that the researcher set aside prejudgments regarding the phenomenon to free the study from preconceived ideas or interpretive influences. Following Heath's (2017) suggestion to use blocking or epoché to help acknowledge previously held beliefs, this researcher set aside their experiences by describing my own experiences with the phenomenon. Epoché or bracketing involves the researcher setting aside their own experiences and allowing for freedom of suppositions to look at the phenomenon (Creswell & Poth, 2018; Moustakas, 1994). I am a public high school math teacher with ten years of experience in the classroom. I have experience using technology in the classroom to enhance student achievement. The technology I have used includes hardware and software, with the students using Chromebooks. I would revisit my epoché regularly using a spiraling technique reflecting throughout the data analysis process.

Data Collection

The data collection in a phenomenological study should include interactive interviews using open-ended comments and questions to create a relaxed and comfortable atmosphere for the participant (Moustakas 1994). Following Moustakas's (1994) suggestion, I obtained the descriptions of the experiences through first-person accounts with informal and formal conversations and interviews. First-person reports of experiences make phenomenological research valid (Moustakas, 1994). Groenewald (2004) suggests that the researcher direct the questions to the participant's experiences, feelings, beliefs, and convictions about the phenomenon in question. Data collection for this study involved face-to-face interviews, focus groups, and document analysis. As the researcher, I must participate in these activities to better understand the teachers' perspectives. This data collection method was less intrusive than classroom observations that could potentially change the teaching environment's dynamic.

Interviews

I used interviews in this phenomenological study to gather data on each of the twelve participants' opinions, beliefs, and feelings of perceived factors that influence their technology self-efficacy in the classroom. Creswell and Poth (2018) recommend that a phenomenological study relies on data collection, including single or multiple interviews with participants. Self-efficacy is one of the four components of Bandura's Social Cognitive Theory; therefore, I must understand the participants' thoughts toward the factors they perceived as influencing their ability to implement technology in the classroom. The interview questions were developed with the literature connected to social cognitive theory and self-efficacy in mind. The interviews consisted of 20 interview questions, which I developed. I designed the interview questions with the influential undertones of the literature connected to self-efficacy theory. According to

Bandura (1977), personal, environmental, and behavioral factors affect efficacy. Given this information, several interview questions addressed the participants' perceived emotional, environmental, and behavioral factors. Other interview questions spoke to participants' experiences with technology through mastery experiences or performance accomplishments, emotional and physiological experiences, vicarious learning experiences, or verbal persuasion as sources of self-efficacy (Bandura, 1994; Bandura, 2000). Interview questions were peer-reviewed by the dissertation chair and committee members, and suggested revisions were made. All interviews took place through Zoom, and each participant completed one interview. The interviews were recorded and lasted 18 to 66 minutes in length. Each interview used semi-structured, open-ended questions. Interviews are a valid data collection method for use in a phenomenological study as they seek to gather information about a participant's lived experience with a phenomenon (Moustakas, 1994).

The interviews were conducted after participant selection and the retrieval of their consent to be in the study. The primary recording device was Zoom, and the backup device was Screencastify. Temi online software was used to transcribe the interviews. Field notes were taken during each of the interviews. The following interview questions were used as the starting point for all participant interviews:

Please introduce yourself to me as if we just met one another.

Participant Background Interview Questions:

1) How long and in what capacity have you been in education?

2) What role did technology play in your undergraduate/graduate degree?

3) What subject and grade level do you teach?

4) What type(s) of technology do you have access to at work?

5) What technology do you enjoy using outside of work?

Focused Interview Questions:

Table 1

Interview Questions as Related to Self-Efficacy or Social Cognitive Theory

Interview Question	Related Aspects
6. How would you describe your attitude toward instructional technology in regard to education as an instructional aid?	Personal
7. What professional development opportunities have you participated in that targeted the use of instructional technology?	Mastery, Vicarious
8. How do you perceive the professional developments you have attended in the last year have affected your implementation of technology in the classroom?	Mastery, Vicarious
9. What, if anything, challenges you/scares you about using technology in the classroom?	Personal
10. How does your district encourage technology use in the classroom?	Verbal Persuasion
11. How important do you think technology is to the mathematics classroom?	Emotional, Physiological
12. How does your comfort with technology influence your students' success during a lesson that integrates technology?	Emotional, Physiological
13. What factors have influenced you to use technology more frequently in the mathematics classroom?	Mastery, Vicarious, Verbal, Emotional Physiological, Environmental, Behavioral
14. How would you describe the role of technology in education?	Personal
15. Describe the amount of time you have available to learn about technology to use in your classroom through other avenues such as professional development, seminars/workshops, conferences, and summer sessions?	Behavioral

Interview Question	Related Aspects
16. What effect do you see that technology has on student engagement?	Personal
17. What factors would you identify as increasing your intention to use technology?	Personal, Environmental, Behavioral
18. How would you describe the learning opportunities you have been provided regarding instruction and professional development on technology integration in the math classroom?	Mastery, Vicarious
19. How does your school leadership model the use of technology?	Vicarious
20. What more can you tell me about your experiences with instructional technology concerning your teaching practice?	Mastery, Vicarious, Verbal, Emotional Physiological, Environmental, Behavioral

Questions one through five are background questions that provide the researcher with data about personal factors influencing the participant's self-efficacy. These questions are intended to be straightforward and help develop a rapport between the participant and myself.

Questions six through nineteen are designed as focus questions to help the participants reflect on their technology integration and influential factors. Using focusing questions is a reflective process that leads to specific data that can better qualify the knowledge in a field of study (Agee, 2009). Questions six, nine, eleven, twelve, fourteen, and sixteen invite the participant to reflect on their attitude, challenges, and influences with technology in the classroom. These questions focus on the effects produced by one's actions and beliefs. People process information concerning their ability to handle situations and regulate their behavior and effort toward those situations accordingly. Self-efficacy affects how one approaches problems; the more robust the perceived self-efficacy of an individual, the more active their efforts will be to persist until successful completion (Bandura, 1977). Bandura (1977) suggests that the basis for personal efficacy expectations is from four significant information sources: performance accomplishments, emotional and physiological states, vicarious experience, and verbal persuasion.

The Technological Pedagogical Content Knowledge (TPACK), created by Punya Mishra and Matthew J. Koehler (2006), explains the set of knowledge that teachers need to teach a subject and use technology effectively. First, educators must have content-specific pedagogy to support learning in the classroom. Second, teachers need to understand their technological pedagogical content knowledge (TPACK) when assessing the technologies effectiveness (Mishra & Koehler, 2006). Questions seven, eight, fifteen, and eighteen seek to elicit the participants' perceived feelings of the technological pedagogical content knowledge training.

Questions ten, thirteen, and seventeen looks at the participants' perceived feelings of support or perceived influence on technology use in the classroom. The National Education Technology Plan (2017) describes successful integration's critical elements: high-speed connectivity, available devices to teachers and students, digital content, and professional development. Providing technology should not overshadow the importance of effectively preparing teachers to teach with technology (NETP, 2017). Question nineteen provides the participant time to reflect on the technology practices being modeled by their school leadership. Starrett and Richardson (2020) report that the quality of principals with exceptional technology leadership skills influences teachers. Questions twenty ensures that the participants fully express their feelings and experiences with technology. A teacher can go through all the training and understand the importance but still fail to use the technology effectively. Question twenty provides them an opportunity to express that situation. Heath (2017) found that even when teachers saw the positive reasons for using technology in the classroom, they can still fail to implement it regularly because of a lack of access and significant professional development to prepare them.

Document Analysis

I used document analysis to understand factors that may influence participants' perceived factors that influence their technology self-efficacy level. The document for this study includes letters of advice from each participant to a teacher struggling to incorporate technology effectively in their secondary math classroom. Participants were given an information sheet on the teacher working to integrate technology in the classroom to write a letter of advice to influence the struggling teacher's technology use. The researcher asked that each participant write a 300-400-word letter to a teacher. The hypothetical teacher receiving the letters had been teaching for fifteen years and had effectively been teaching with high self-efficacy in content knowledge and teaching pedagogy but struggled with technology during the COVID-19 pandemic. The participants chose their top three go-to technology sources to share with the struggling teacher and explained why they were valuable. The participants were encouraged to write the letter directly after the interview with the researcher, so the conversation from the interview was still fresh in their minds. I used the letters to verify teacher responses through multiple sources' triangulation (Creswell & Creswell, 2018).

Focus Groups

I conducted a virtual meeting for a focus group. The focus group met using a virtual conference, and the researcher recorded the session using Zoom recording and Screencastify as a backup recording device. I took field notes during the focus group interview. The recording was transcribed using an online transcription service, Tami. This method is a valid data collection technique for this study as it seeks to gather information from a group of individuals who have had a shared experience (Moustakas, 1994). The focus groups consisted of participants who taught virtual or hybrid using an online platform for the 2020-2021 school year. The focus group participants did not take part in the individual interviews. The focus group interview lasted 30 minutes and took place after I had completed all the individual interviews. The semi-structured format began with several prompts before expanding into other areas of relevant discussion brought forward by the participants. Although I had preselected several questions as the focus group starting point, I reserved the right to modify any of the following prompts based on the initial analysis and feedback from the one-on-one interview sessions. The following questions were used as the starting point prompts for the focus group:

Table 2

Focus Group Questions as Related to Self-Efficacy or Social Cognitive Theory

Focus Group Prompts	Related Aspects
1. Please introduce yourself and tell the group what subject(s) of mathematics you teach.	Background
2. What technology do you use every day in the math classroom?	Personal
3. What would describe as the most effective professional development you have received on technology use?	Mastery, Vicarious
4. What, if anything, challenges you/scares you about using technology in the classroom?	Personal
5. How does your district encourage technology use in the classroom?	Verbal Persuasion
6. How important do you think technology is to the mathematics classroom?	Emotional, Physiological
7. What factors have influenced you to use technology more frequently in the mathematics classroom?	Mastery, Vicarious, Verbal, Emotional Physiological, Environmental, Behavioral

Questions one is a background question that provides the researcher with data about personal factors influencing the participant's self-efficacy and introducing them to the group.

This question is straightforward and helps develop a rapport between the participant, the group, and myself. Question two focuses on the technology that the teacher uses daily. Question three requires the participants reflect on professional developments they have attended and how they have affected their technology integration. Successful professional developments should lead to mastery accomplishments. Question four should shed light on any specific hindrances the teachers perceive affect their technology use regarding teaching in a rural school district. For example, Tyler-Wood et al. (2018) suggested that rural districts may not have the funds for hardware maintenance and technology specialists that urban and suburban communities can afford. Question five addresses the effects of verbal persuasion from the district on teacher technology use. Questions six is designed to focus on the emotional and physiological state of the teacher concerning the emphasis they place on technology integration.

Data Analysis

I analyzed the data using the following computer applications: Temi and Word. Temi was used to transcribe all the audio files recorded during the interviews and focus group sessions. The Word program was used for all documents that required word processing, including coding and sorting. Qualitative research creates a pool of information for the researcher to organize to allow themes to emerge and divulge valuable information. I utilized member checks to validate that each participant's main ideas were in line with what they had planned on communicating. According to Stake (2006), member checking is vital for field researchers. After completing the interviews and transcribing, I asked the interviewees to read their statements to check for accuracy and possible misinterpretations. Participants were provided with the opportunity to review a summary of their interview transcripts and were allowed to provide feedback as to the accuracy of their interview transcripts.

Transcendental phenomenology uses analytical steps for data analysis which include a deeper reading of the data, identification of significant statements called horizonalization, grouping or clustering into themes, composing individual textural and structural descriptions, creating composite textural and structural descriptions, and synthesizing the textural and structural descriptions (Moustakas, 1994). I assigned codes to the participants' responses, combined with their pseudonyms, to identify the variables associated with each teacher. The major components of the transcendental phenomenological design include epoché, phenomenological reduction, imaginative variation, and synthesis of composite textural and composite structural descriptions.

Initially, I bracketed (epoché) my personal knowledge and experience with technology integration to establish a clear lens from which to view the data collected. After bracketing my personal knowledge and experience, all interviews and focus groups were transcribed verbatim. Once the transcription process was complete, the transcripts were read from beginning to end several times to immerse myself in each participant's lived experience. Horizonalization will assign equal value to each statement, representing a segment of meaning (Moustakas, 1994). After reading the transcripts numerous times, I began to list every statement relevant to the phenomenon in the study since all statements carry the same weight at the beginning of the analysis (Moustakas, 1994). The phrasing and how the participants tell the stories give a deeper meaning to the experience. As the statements were gathered and collected, the horizons were identified. The irrelevant and repetitive statements are identified and omitted so that only the "textural meaning and invariant constituents of the phenomenon" remain (Moustakas, 1994, p. 97). Each invariant constituent was examined to see if it could be labeled as a lived moment of experience or clustered meaning unit. If the statement met the criteria, it was considered a grouped meaning unit and moved to the next step, clustering statements and identifying themes. As the statements were continuously reviewed and compared, the significant-shared experiences began to emerge concerning the phenomenon in the study.

Once these meaningful statements have been identified, similarities across the participants' stories were identified, so clusters of overlapping meanings were created (Moustakas, 1994). The segments were clustered into themes; segments and themes were then synthesized into the core theme of the study, the textural description. From the clusters, two individual descriptions are created for each participant: a textural description regarding the specifics of what happened and a structural description of the setting or context that influenced how the phenomenon was experienced (Creswell & Poth, 2018). The textural description was examined, and a textural-structural description will emerge representing the meaning and essence of the experience (Moustakas, 1994). A textural-structural description was produced for each participant by repeating the above steps. The descriptions were developed into a universal description of the essence of the experience (Moustakas, 1994). All participants' textural descriptions and structural descriptions were analyzed and "put back together for a cohesive synthesized description of the essence of the situation" (Moustakas, 1994, p. 14). The composite textural-structural description integrated all the descriptions "into a universal description of the experience representing the group as a whole" (Moustakas, 1994, p. 122).

The transcripts for the interviews provided the data for "reflective analysis and interpretation of the research participant's account or story" (Moustakas, 1994, p. 13). I first coded the transcripts from the interviews individually for themes about self-efficacy sources. After coding each transcript, they will be re-coded a second time to look for perceived sources that influenced self-efficacy. The second coding will cluster the themes into Bandura's (1997) framework (mastery, verbal, vicarious, physiological). Next, I began to develop a thick narrative of the participants' lived experiences. I included relevant, verbatim examples from the interview and focus group transcripts to make the lived story apparent to ensure the participants' voices were heard.

Trustworthiness

I addressed credibility and dependability using several methods. First, by collecting three separate data sources, interviews, focus groups, and letters of advice, I triangulated the findings to ensure that evidence collected from one source is confirmed in another source. Both member checks and peer feedback are appropriate techniques to address credibility (Lincoln & Guba, 1986).

Credibility

The first step toward credibility included the process of triangulation, which occurred through multiple data sources, including Zoom interviews, letters, and focus groups. Using triangulation, I was able to provide credibility to the research findings. Triangulation is a process by which the researcher can guard against the accusation that a study's findings are simply an artifact of a single method, a single source, or a single investigator's biases. The triangulation function is to locate and reveal the phenomenon under investigation from various empirical reality aspects (Erlandson et al., 1993). The inevitable vulnerability of qualitative research leads to subjectivity profits from triangulation to ensure the study's credibility. Credibility was established through member checks conducted after participant interviews and the focus group interview.

Dependability and Confirmability

I ensured dependability and confirmability through the auditing process. Second, I developed detailed and thick descriptions of the collected data to ensure confirmability and dependability (Moustakas, 1994). Third, I made sure the interview questions, directions for letters, and focus group questions were fair and not leading to address dependability. Finally, I created a document log to collect the data as prescribed by Creswell and Poth (2018) to outline the researcher's thoughts as they collect and code research.

Transferability

Throughout the study, thick and rich descriptions are reported to transfer the findings between the researcher and the participants (Creswell & Poth, 2018). Transferability was established by providing thick and rich descriptions of the settings where participants teach their high school mathematics courses (i.e., number of students, co-teacher, technology access). In addition, focus groups and zoom interviews assisted in transferability. Another method of trustworthiness within the study was member checking. After data analysis, I ensured that the research participant could confirm that the information matched what they intended to share. Member checking supports the study's credibility and respects the research participant (Creswell & Poth, 2018).

Ethical Considerations

The researcher must foresee any ethical issues that may arise during the research process and prepare for those issues accordingly (Creswell & Poth, 2018). All data collected was saved and stored in well-secured locations to which only I had access to ensure the confidentiality of all participants' data and identification. I password protected all electronic files, and I stored paper copies in a locked cabinet, and only I have the password and key to both locations. I will keep the data for a minimum of three years. I used pseudonyms in place of participants' real names and school names. Participation in the study is strictly voluntary. Participants were made aware that the participant could choose to terminate the interview process at any time during the interview. Participants were asked to sign a letter of informed consent outlining the study's nature and the possible risks of participating in the study.

Summary

The purpose of this transcendental phenomenological study was to develop a complex and detailed understanding of secondary mathematics teachers' experience with technology in classrooms in rural Virginia. By taking a qualitative approach, the researcher examined the perceived factors influencing feelings, reservations, and teaching successes with today's pressures and expectations to integrate technology. I intended to investigate and report the perceived factors affecting teacher self-efficacy to improve technology integration in the classroom and increase student achievement. The methodology and theoretical framework have been described. The details for the method used, including site selection, participant selection, and data collection processes, were discussed. The procedures were outlined and will be handled ethically. The qualitative data analysis details and built-in validity strategies such as triangulation, member checks, and peer feedback are included. The researcher took safeguards to ensure the confidentiality of the participants and the schools remained intact.

CHAPTER FOUR: FINDINGS

Overview

This phenomenological study aimed to explore what it means to be a secondary math teacher with technology self-efficacy. Participants provided rich and descriptive data that described their technology self-efficacy. I conducted qualitative research to understand teachers' personal experiences. I used a transcendental phenomenological research design that involved collecting information from all participants to consider how the participants described their experiences as related to the phenomenon being studied. Data were reduced, categorized, coded, and analyzed following Moustakas' (1994) steps.

The gap in the research that this study was designed to address was high school mathematics teachers' technology self-efficacy their use of technology in the classroom. This qualitative study aimed to bridge this research gap and provide educational stakeholders with a deeper understanding of teachers' self-efficacy while integrating technology into their teaching practices. Therefore, the focus of the research was to describe the characteristics of math teachers with technology self-efficacy. This chapter presents the key findings from seven in-depth interviews, one focus group with three participants, and letters of advice from five interview participants. In addition, this chapter includes a narrative of the participants and an account of the theme development process that generated the themes. The research questions for this study were:

CQ1. What are the self-efficacy experiences of high school math teachers?

SQ1. What are the mastery experiences of teachers with technology self-efficacy?

SQ2. What are the vicarious experiences of teachers with technology self-efficacy?

SQ3. What are the emotional and physiological experiences of teachers with technology self-efficacy?

Participants

A total of ten secondary mathematics teachers who taught during the 2020-2021 school year were included in this study. In phenomenology, the number of participants can range from one to over three hundred. It is recommended to study three to ten participants (Creswell & Poth, 2018). Included in this research were participants from five different high schools who taught high school mathematics during the 2020-2021 school year. Twenty-two teachers were asked about their interest in taking part in this study. Eleven participants responded with an affirmative, but only ten were able to work with the logistics and time constraints of the research. Seven of the participants participated in the interviews, and five of those contributed a letter of advice, while three separate participants participated in the focus group. Nine of the participants were female, and one of them was male. Eight of the nine female participants were white, and one was African American. The male participant was also white. The participants' classroom experience ranged from one year to thirty-five years.

The participants agreed to zoom interviews, and each participated fully and responded freely to the interview questions. No one declined to answer any of the questions; each appeared impassioned to talk about their experiences. The participants divulged their concerns as well as their professional accomplishments and triumphs.

Sophia

Sophia was a white female teacher who taught Algebra and Algebra II. During my interview, she revealed that she was the department chair for the math department this past school year. During my conversation with her, I found that Sophia was very excited about teaching and learning new things even after finishing her 35th year of teaching. Although she stated that she didn't know what Zoom was before this school year, she understood that technology is something that you have to keep learning and be open to learning.

Throughout her interview, Sophia demonstrated a deep understanding of the effectiveness of technology for differentiation. She stated, "some technology will reach some students, but then you have to maybe use other technology to reach other students". Sophia also expressed that "technology is wonderful so long as it's working properly." She suggested that county-wide lack of reliable Wi-Fi was the biggest obstacle to having access to her students this school year.

Rose

Rose was a white female teacher who taught geometry and pre-calculus. She said that she loves teaching geometry and usually gets that course because most other teachers don't want it. She also revealed that she "hadn't taught pre-calculus in about fifteen years, so that was a challenge to do remotely". Rose was easy to talk to and took a moment before answering the interview questions, carefully choosing her words. She stated that the school "has been outstanding, supplying us with all sorts of new technology toys that we've come to depend on during this quarantine time." Rose's optimism and soft-spoken guidance were demonstrated in her letter of advice. Rose suggested that the teacher should not expect perfection and amend the lesson based on the first trial use with technology. Rose recommended, "If you see value in the new site or hardware, stick with it for at least three trials, increasing the time used in class each time and checking for student feedback."

Dorothy

Dorothy was a white female teacher who held a position teaching Algebra and Geometry with twenty years of experience in education. Dorothy was easy to talk with, and her outgoing personality filled the session with detailed examples of her experiences. Dorothy admitted to not having a positive feeling toward technology starting in her high school years "somebody told me to take a computer programming class, and apparently that person didn't know me well, and that was a disaster." Despite her stated discomfort with technology, Dorothy had a great sense of humor and regularly made jokes about her technology ability and comfort with technology. During the interview, Dorothy described a technology software that she came to enjoy using, the Desmos calculator. Dorothy was impressed with the Desmos calculator's ability to help her with precision in drawing and its ability to "make Algebra infinitely more conceptual for kids."

Margaret

Margaret was a white female teacher who taught Algebra and one inclusion Algebra with a co-teacher. She has had a position at her current school for thirteen years and stated that she taught younger grades for about a year prior to that. Margaret revealed during the interview that she did get a master's degree in curriculum and instruction in 2017. Margaret displayed an overall positive attitude toward technology use, especially regarding differentiation, "It allows you to differentiate in the classroom. I think it has made learning more enjoyable because of the different tools and the different resources we have". Margaret stated the only obstacle she sees with technology use is "not knowing what to expect, but once I start using it, then it gets much better."

Blanche

Blanche was a white female teacher who had just finished her first year of teaching. She taught geometry and Algebra Functions. At the beginning of the interview, I learned that Blanche was a math major with a computer science minor and didn't go to school for an education degree. She is currently taking the education classes she needs to be a fully licensed teacher.

When talking about her undergraduate courses, Blanche said, “I had a minor in computer science, so I did a lot with computers with my minor; for my math degree, we had labs where we ran programs.” Blanche talked about the importance of practicing with technology before using it with the students. Blanche shared what a trepidation she has when using technology, “The scariest thing is like not doing the research and just like wanting to like show the technology to my class and me not knowing it fully and not being able to answer questions.” Blanche shared her excitement at the prospect of teaching a computer math class next year and the necessity of technology in that course. Blanche's letter of advice shared, “technology keeps the classroom interesting, and students love technology.”

Robert

Robert was a white male teacher who taught dual enrollment pre-calculus, trigonometry, and statistics. Robert just finished his 23rd year of teaching and has been the department chair for about 18 of those years. Robert has also been the school’s senior class project coordinator for the last nine years. Robert had a very laid-back demeanor and seemed very comfortable talking about technology and his role in the classroom. Robert spoke very highly of his school system’s ability to provide technology and encouragement of technology use, “They want to see as much technology as possible.” When reflecting on this past year, Robert stated, “with COVID having to teach from home, if you couldn’t incorporate technology into your lessons, then you pretty much couldn’t teach.” In his letter of advice, Robert suggested that “if the first time is not successful, then keep trying because the next time will get easier.”

Carolyn

Carolyn was a white female teacher who had just completed her third year of teaching. She taught Algebra, Geometry, Algebra Functions, and a computer math course. During the interview, I found Carolyn to be very friendly and easy to talk to during our discussion. She gave vivid details of her classroom experiences. Carolyn stated she feels comfortable saying that she is confident in her technology abilities in the classroom and strongly encourages students to use their technology. Carolyn shared that daily practice increased her technology self-efficacy “daily practice, there is nothing that I go through in a day that doesn’t help me feel more confident in my technical abilities.” In her letter of advice, Clara repeated the importance of practice “practice with a resource before introducing it to the students; you will better your confidence.”

Vivian

Vivian was a white female teacher who had just completed her sixteenth year of teaching. She has had experience at the elementary, middle, and high school levels. Vivian is currently teaching Algebra. Vivian took part in the focus group and shared that she did not use technology much in the past. Although Vivian remarked that the implication of the pandemic did force her to use more technology, “this past year has been my biggest technology year because, I guess coming from an originally elementary background, a lot of my stuff that I did with my ninth graders was just hands-on.”

Lucy

Lucy is a white female teacher who taught Algebra and Algebra Functions. Lucy is licensed to teach high school mathematics, and she has her master’s degree in special education. Lucy just finished her third year of teaching. Lucy was easy to talk to and eager to answer the questions with great detail and insight into using technology in her classroom. For example, Lucy mentioned she preferred software such as Desmos that allowed her to try activities in a student mode before she used them in the lesson, “I know some Wiser activities when I sent it to the kids, it wasn't as user friendly as I thought it was because I couldn't have that access to play around with it beforehand where the Desmos activities you can and you can customize and everything."

Ethel

Ethel is an African American female teacher who taught Algebra II and Geometry. Ethel worked with mostly the advanced students and took on coverage for the pre-calculus and calculus students second semester. She said that Delta Math was a program that worked well for advanced students. In respect to technology issues in the classroom, Ethel stated that "it would glitch and like it'll work for one class than within the next lesson wouldn't, and then it is like okay, now it's trying to think on the spot, what can I do in place of tech to still get this lesson across."

Results

The purpose of this study was to explore how a teacher's self-efficacy regarding the use of technology influences decisions they make about the use of technology in their classrooms. This study consisted of a convenience sample of 10 teachers who taught high school math courses in rural Virginia during the 2020-2021 school year. The sampling criteria were: being a high school mathematics teacher at a rural Virginia public school and teaching during the 2020-2021 school year. As explained verbally and written in the informed consent form signed by the participants before data collection, participation in this study was completely voluntary. Data collection was conducted through the video conferencing software Zoom. Sophia, Rose, Dorothy, Margaret, Blanche, Robert, and Carolyn, were interviewed individually. Interviewees Rose, Dorothy, Blanche, Robert, and Carolyn also submitted letters of advice. Interviewees Vivian, Lucy, and Ethel were interviewed as a focus group. During the analysis, six distinct themes emerged from the participants' discussions. The themes that answered the research questions were: (a) practice, (b) networking, (c) student feedback, (d) efficiency, (e) teacher characteristics, (f) student engagement. The following section will present the theme development, descriptions, and excerpts from the data.

Theme Development

I attained the themes for the formal study after a thorough and lengthy review of the letters of advice, individual interviews, and focus group transcripts. The major components of the transcendental phenomenological design include epoché, phenomenological reduction, imaginative variation, and synthesis of composite textural and composite structural descriptions. Through the four-step process, I identified meanings and the essence of the lived experience of the participants (Moustakas, 1994). Moustakas (1994) noted that the steps should follow a sequential order: First, one must gather a thorough description of their understanding of the phenomenon. I did this through the interview process and following transcription. Using the transcript, I analyzed each statement for its implication toward describing the lived experience. I extracted each relevant description from the 10 participants' narratives. I coded the text-based data using the comment application in Word, not repeating or overlapping any remarks, and pulled them to a new document using Macros. I then began to cluster and thematize the codes. As I analyzed the data, I found several words and phrases repeated in the transcripts. These words and phrases were coded, grouped, and developed into meaning units which were later developed into themes of the study. I have provided an example of some of the repeated words and phrases in Table 3.

Table 3

Repeated Words and Phrases Mentioned by Participants

Repeated Words and Phrases	Data Source	Code
No time	Interview	Professional Development
Desmos Calculator	Interview, Focus Group, Letter of Advice	School Technology
Technology more critical in higher math	Interview	Importance of Technology
Technology is great	Interview	Emotional
Poor internet connection	Interview	Technology Issues
Support from other teachers	Interview	Vicarious Experience
Scary not knowing	Interview	Emotional
Practice	Interview, Letter of Advice	Mastery Experience
Emails from Administration	Interview	Verbal Persuasion
Pandemic	Interview, Focus Group	Pandemic
100% necessary this year	Interview	Pandemic
World with technology	Interview, Letter of Advice	Importance of Technology
More engaged	Interview, Letter of Advice	Student Engagement

This process allowed for a thorough review of the data to develop a composite textual description of the meanings and essence of the phenomenon. Based on the coded texts, codes with similar meanings were grouped. The coding process involved phenomenological reduction, in which I identified small units of meaning relevant to the phenomenon of high school math teachers' technology self-efficacy. Creating the invariant meaning and themes into a textural description of the experience with the phenomenon followed. Using imaginative variation, I described the structures of the experience. Finally, I was able to design a textural-structural analysis of the essence of the experience. The essence of the participant's experience with the phenomenon is the continual need to adapt their teaching methods through deep and meaningful self-reflection based on student feedback, trial, and error, and colleagues shared experiences. Through this process, their development as educators has empowered them to embrace their discomfort and adapt to teaching in a virtual classroom. These experiences led them to develop technology self-efficacy. The six dominant themes that emerged relating to the experiences of high school math teachers with technology self-efficacy were: (a) practice, (b) networking, (c) student feedback, (d) efficiency, (e) teacher characteristics, (f) student engagement.

Theme One: Practice

Participants were asked what factors they would identify as increasing their technology self-efficacy. All ten participants agreed that the pandemic had forced them to utilize technology in their classroom daily to communicate with and instruct their students, which led them to secure more practice and experience with technology. Therefore, the practice theme emerged throughout the interviews and was marked as a recurring statement. As noted in Chapter Two, Bandura proposed that mastery experience is acquired directly through the successful performance of one's tasks. The participants all independently suggested that the best predictor of a lesson going well with technology was the practice or prior experience a teacher employed.

Blanche shared a tactic she uses as a first-year teacher who doesn’t have any previous experience or practice to fall back on, “I would like practice, before the class, I would get up there and make sure everything would run smoothly, that it just worked. So I would lecture to like nobody, but just to make sure it would go smoothly”.

Margaret, a veteran teacher, also believed that practice was valuable, “Just knowing step-by-step how to assist them is definitely helpful; I have to do it myself first. I always have to do things ahead of time to make sure that I can explain it to the students or practice using one of their devices to make sure that I can do it”.

Dorothy reflected upon the preparation for the new school year and missed opportunities for practice before the school year started. During the interview, she recalled wondering, “Why didn’t I come in June when I could practice?”.

During the focus group session, when the participants discussed the Desmos calculator and its applications, Lucy remarked on an attribute of the software she found helpful. In addition, Lucy described how the Desmos activities have a built-in practice version to go through the activity as a student.

Theme Two: Networking

Another theme that emerged from the question regarding factors that influenced self-efficacy was support from the district, other teachers within their school, and social media networks. Lucy, Dorothy, Margaret, Carolyn, Robert, Sophia, and Rose, contributed to this theme. Networking and learning from colleagues both in person and virtually are forms of vicarious experience and a principle of social cognitive theory. According to Bandura (1977), the vicarious experience can generate expectations in observers that they can be successful and is one of the easiest of the four sources of self-efficacy to influence human behavior.

Robert discussed the in-school network of support for technology use provided by his school district. They provided training and worked to acquire any technology that the teachers requested. Robert described the availability of training as “Our school did a really good job of providing multiple professional developments on technology.” In addition, he was pleased with the ability to acquire technology, stating, “If a teacher needs some type of equipment or technology, usually our administration will figure out some way to get it.”

In the interview, Carolyn, one of the younger teachers in the study who just finished her third-year teaching, revealed that she has been on the experienced end of networking. She recalled several times when she would be stopped in the hallway by another teacher asking her to come by their room and help them with a technology issue. When talking about this during the interview, she stated with a smile, “It makes me feel good that I am the go-to tech person. Yeah, I love that.” When talking about the school district and its influences on technology use, she stated, “the school district strongly, strongly, strongly encourages it. As a matter of fact, it was through email that we would frequently be told that they encourage the use of Chromebooks, and students need to be on them throughout the day”.

Two interviewees described the virtual community of teachers as another avenue of support, especially during the first semester when everyone was teaching from home, and they were not in the same building as their colleagues. Rose said she found “support in the virtual community,” specifically citing Facebook teacher groups. When describing how she learned about Desmos activities from another teacher, Rose said she Googled Desmos activities and, “that’s where it just exploded with all these possibilities and people, and other teachers who were in the same situation…there was support amongst the virtual community”.

Sophia talked highly about online teacher groups and all she learned from reading through the posts. Sophia noted that technology gave her so much more access to other teachers and recalled, “So many more connections are available online…it is reassuring to know that someone else had some of the same issues I had…I am not alone”.

Theme Three: Student Feedback

Regarding content and instructional material, Rose put value in her students' feedback and gathered their input frequently. She said, "They didn't enjoy using Kami, and when given a choice, they preferred Desmos for showing their work. When introducing new software like the Desmos calculator for activities, she suggested "using the software for fifteen minutes during the class and then getting some feedback from the students but make sure you stick with it for at least three times always checking for student feedback."

Sophia collected student feedback on different teaching methods she tried throughout the year and found that they preferred when she posted material early. Carolyn's input from the students came more in tune with their needs due to the increased screen time. "I would look over, and you know half of them are zoned out, so we would go outside and get some fresh air and then come back. "She said the students reported using their Chromebooks constantly in the previous classes, and it just became too much.

Blanche received positive feedback from her students when she used interactive software games for formative assessments. She said, "It was fun instead of sitting there working on a worksheet, and it was another way to assess how well they were doing with the subject or if they needed more practice. It was a lot of fun, and my students loved it."

Theme Four: Efficiency

With the pandemic requiring all teachers to work from home during the school year, the teachers pointed out the efficiency of several software programs and hardware available to them. Vivian felt that the immediate feedback that her students receive from technology helped her be a more effective teacher. In addition, the efficiency of the immediate feedback was a positive attribute of technology relayed by most of the teachers. "I think sometimes technology makes it quicker to get what you're looking for. That way, you don't let mistakes go for too long too."

Ethel followed up on Vivian's input by relaying that her students really enjoyed that immediate feedback.

The Desmos calculator is a software program available for free online that all the teachers talked about during their interviews. Carolyn shared that the Desmos calculator made her students much more efficient at graphing. "The Desmos graphing calculator specifically has been a great resource for students who struggle with graphing as it color coordinates all of the graphs and ordered pairs." In her letter of advice, Carolyn also recommended using Google Classroom so that "the students who were working at school to have the same notes, assignments, tests, and activities as the students at home."

Theme Five: Teacher Characteristics

An enthusiasm for learning and excitement when mastering a new tool was apparent among all the teachers. In addition, they described different experiences they had during virtual instruction and using technology in the classroom. One crucial characteristic these participants had in common was their willingness to listen to and take advice from their students. Rose, for example, praised one student's idea for changing out her earbuds so each one would have a chance to charge as "a great idea." The participants in the focus group were very enthusiastic in sharing their experiences with the Desmos calculator. Lucy described a teacher mode in Desmos "where you can try it out as a student beforehand where some, like, I know some Wiser.me activities when I sent it to the kids, it wasn't as user friendly as I thought it was because I couldn't have that access to play around with it beforehand".

During his interview, Robert explained that "we can get our hands on any of the technology; the biggest problem here is getting more teachers to use the technology more so than having access to the technology." There in developed the fifth theme of enthusiasm; those teachers who are enthusiastic about learning new methods and are excited to try them in their classes. The technology was available, and as Robert pointed out, the interested teachers used it. Robert discussed taking over a statistics class after twenty-two years of teaching. “I would never have used any kind of statistical software ever. But this past year, I am knocking it out with the technology. You just have to get your hands dirty and just use it and work with it until you feel comfortable”.

Theme Six: Student Engagement

When asked what effect technology had on student engagement, eight participants reported a positive response or increased student engagement. During the focus group, Vivian remarked on how she noticed the students appreciated the immediate feedback that technology provided, stating, “I think the more immediate the feedback is, the better it is for the kid and the better it is for you.” Ethel mirrored Vivian’s comments with, “the kids really enjoy it, immediate feedback.”

Robert expressed that he believes that the students are more engaged whenever technology is involved. He spoke several times throughout the interview about increased student engagement. At one point, Robert said, “I think they just, they are more engaged, kind of more into the lesson and then more willing to learn and do the work.” Robert suggested that “To be successful in the classroom, you have to be able to incorporate some technology.”

Dorothy, who spoke with the most apprehension toward technology, observed that the technology allowed for more one-on-one interactions with the students as they realized their teachers were more accessible. She described situations in which “They might not have joined a group chat, but they would reach out and communicate concerns and ask for one-on-one help and really thrive from that.”

Margaret, who teaches Algebra and inclusion, really focused on the gains she saw with students who typically struggle to do math with just paper and pencil. When talking about the Desmos calculator, she said, “So many things they couldn’t remember, and now they can understand the material, which is great.” Margaret recalled several online software programs that she found to keep the students engaged. Although Margaret suggested that not all technology is engaging, she said, “They will be more engaged, especially if you are incorporating some kind of game or activity they want to be involved in.” When speaking about Quizlet live, she reported, “Students have to work in collaborations. They all have to work together and talk about it. Only some people have the answer, so they are engaged in that.”

Sophia spoke at length during our interview about the positive effects on student engagement from technology and how it has helped her build relationships with her students. When working with new technology, Sophia said, “My students are always willing to help…I feel like it is a partnership”. When discussing the types of software that she uses with the students, she spoke about the Desmos calculator, “they can interact a whole lot more with the Desmos activities.” She said that the students use the technology to check their grades too. She did recognize that “some technology will reach some students, but then you have to maybe use some other technology to reach other students”.

The Desmos activities were described by all the teachers during the interviews and focus groups. Rose said, “students look forward to Desmos activities,” and said, “I have had a lot of success with Desmos activities.” She described the anonymity feature that the Desmos activities provide and how the students enjoy that feature and the technology. In her letter of advice, Rose explains how the Desmos activities engage students from the beginning by getting them to join the activity. From there, they can “graph, calculate, draw, type or write answers and explanations." To ensure students stay engaged, she details how the teacher can monitor student progress in real-time by "viewing all their responses in live time, display individual student screens, or display a grid showing student progress."

Five of the teachers described scenarios when the technology did not increase student engagement but instead hindered it. These teachers then discussed actions they took to rectify the situation. For example, Sophia reported decreased engagement due to the technology requirements induced by the pandemic. Sophia recalled telling parents of students who were failing, "they are not attending Google meet…they are not contacting me…they are not coming to school…and they are telling me they don't check their email. So I don't know what else I can do as a teacher because those were the main ways for me to help students".

Dorothy spoke at length regarding how quickly technology can become overwhelming for students. She recalled a staff meeting when the principal said, "These kids are overwhelmed. You know, you want to give them everything. I know your intentions are good, but they are overwhelmed".

In their interviews, Carolyn and Rose both mentioned that the students did not like Kami when responding about student engagement. Kami is a software that allows people to write over pdfs. Carolyn shared that her students would frequently come to class from another subject that utilized Kami as its primary software, and "after staring at a computer for three hours I look over and, you know, half of them are zoned out or tapping their foot or whatever."

Rose said that Kami was one of her school's first software pieces to get back student responses. But she said, "the students didn't like it. They were expected to be able to write on that little teeny tiny mouse pad with their finger, and yeah, it's terrible". However, rose said that was when she started delving into the Desmos activities, and soon she had moved away from Kami, and her students were much happier, "Desmos was the winner."

Finally, each statement marked as a theme was relabeled as one of the four elements of self-efficacy: mastery experience, emotional and physiological, verbal, and vicarious. The following table shows the number of occurrences for each element of self-efficacy for the interviewees, including their letter of advice and the focus group session.

Table 4

Occurrences of Influences

Influence	Carolyn	Robert	Margaret	Dorothy	Blanche	Sophia	Rose	Focus Group
Mastery	31	23	24	32	13	28	32	14
Emotional/ Physiological	13	5	18	29	12	13	18	0
Verbal	18	13	11	3	2	13	9	3
Vicarious	7	1	8	6	2	11	7	1

Out of the 420 statements labeled as influential toward technology, self-efficacy mastery experience appeared 47% of the time, making it the most significant of all internal and external self-efficacy sources based upon the participants in this study. Emotional and physiological experience ranked second in occurrences throughout the study at 26%. Verbal and vicarious experiences were reported the least, with percentage occurrences at 17% and 10%, respectively.

Research Question Responses

The purpose of this transcendental phenomenological study was to develop a complex and detailed understanding of secondary mathematics teachers' experience with technology in classrooms in rural Virginia. To answer this study's research questions, the data collection included face-to-face interviews, focus groups, and document analysis. Participants provided rich and descriptive data that described their technology self-efficacy. The data was reduced, categorized, coded, and analyzed following Moustakas' (1994) steps. Finally, the research questions were answered through the themes developed from the data collected.

Sub-Question 1: What are the mastery experiences of teachers with technology self-efficacy?

Themes one was used to answer this question. Theme one was *practice*. Theme one indicated that all the participants felt the pandemic forced them into using technology in their classroom. Teachers reported using technology to communicate with and instruct their students. Using technology for all their interactions with their students, including instruction, caused some teachers to begin practicing their craft before interacting with the students. The teachers reported that the more they used the technology, the more comfortable they became.

Robert put in the first paragraph of his letter of advice, "Ultimately, the best way to become more comfortable with using technology with your students is simply to use it! The more you use it, the more you will master it, and if the first time is not successful, then keep trying because the next time will get easier".

Rose did not share that she practiced before her students arrived but stated she only used new technology in short sprints at first. "I'll try it for, say, ten minutes out of the 90 minutes or something. I don't ever write it off the first time it doesn't work well we're going to try it at least two more times before I say it is a wash". Rose included her students in what she considered her practice sessions.

Sophia didn't mention practicing without the students or introducing new technology slowly like Rose. However, she did note that the pandemic pushed her to use new technology during the first semester of this school year. Sophia recalled, “Fortunately, the second semester when it rolled around, I already had taught the classes and had experience. . . so that helped quite a bit”.

Carolyn didn’t speak about specifically practicing before teaching a lesson with new technology. Still, she did say that the daily use of technology led to her feeling more confident in her abilities. “Daily practice, there is nothing that I go through in a day that doesn’t help me feel more confident in my technology abilities.” She added later in the interview that “every day that I have used technology, I felt more confident in using it.”

Sub-Question 2: What are the vicarious experiences of teachers with technology self-efficacy?

Theme two was used to answer this question. Theme two was *networking*. Data from this theme indicated that teachers who utilized social networks had positive vicarious experiences. These networks came in support from teachers within their school, region, and through online social networks for teachers. This networking gave teachers a leg up in the learning curve for technology use as they could bypass mistakes that were already made and shared with them through their peers.

In his letter of advice, Robert wrote the importance of seeking out fellow teachers for support in gaining self-efficacy with technology. He wrote, “Seek out other teachers who are proficient with technology in the classroom and ask to observe them using technology in the classroom or have them come to your classroom to demonstrate how to use technology to enhance your instruction.”

Margaret was another teacher who had experience with sharing information with her coworkers. Margaret’s experience was similar to Carolyn’s, but the teacher would see the technology she was using and become interested in her example. “I have had other teachers come up this year, and they are like oh, what are you using…oh, you are using that…you are doing that?"

During the focus group, the interviewees described leaning on the people in their department to share successes and failures with technology. Lucy specifically shared, "Sitting together and sharing what we found that worked and didn't…collaborating as a math department that is what really got us through".

Sub-Question 3: What are the emotional and physiological experiences of teachers with technology self-efficacy?

Theme four, five, and six were used to answer this question. Theme four was *efficiency*. Theme five was *teacher characteristics*. Theme six was *student engagement*. The emotional and physiological effects of quarantine during the 2020-2021 school year were sometimes quite emotionally isolating and detrimental to the physical health of people. Teachers were not exempt from this and reported feelings of isolation during virtual instruction. On the other hand, there were times when they felt relief and joy with the efficiency of the technology and software that they had to get through and excitement for their students through this challenging process.

Robert was relieved to have google meets paired with his document viewer so that "I could actually show the kids how to do work; I did enjoy that, and that helped a lot." In addition, he was impressed with the efficiency of the google meet and its ability to create a setting in which he could work out problems in real-time for his students.

Carolyn exemplified an avid learner and was very enthusiastic and suggested that teachers keep their excitement and interest flowing by switching up the resources they use. "This will help improve your self-efficacy and keep your teacher brain happy." Carolyn modeled the excitement of an enthusiastic teacher when talking about her excitement over using the Desmos calculator. “I get so excited because Desmos does the order of operations for you, and then the students get excited about it as well.” She went on to say, “I feel like my attitude is pretty positive toward technology in the classroom.”

Blanche felt strongly that technology increases student engagement and compared a school she had worked at for a short time that didn’t have much technology. Blanche described when she worked at this prior school district for two months, “I had like no technology in my classroom what so ever so my students didn’t enjoy it.” Blanche spoke about several software programs she used and said, “my students loved it this past year.” Overall, Blanche said, “I feel like if you have more technology going on, they get engaged more.”

. During quarantine and hybrid teaching Rose described with sadness the feelings of isolation when virtual students wouldn’t turn on their computer cameras. Rose described her feelings on virtual learning, “It has got to have the human touch. You have got to be able to read the kids. That’s what I miss this time is seeing their expressions, seeing their frustration when we were in Google meetings, they would not turn their screen on. So it was very isolating”.

Sub-Question 4: What are the verbal persuasion experiences of teachers with technology self-efficacy?

Theme three and theme six were used to answer this question. Theme three was *student feedback*. Theme six was *student engagement*. The teachers described a partnership with the students as a way to effectively wade through the seemingly unlimited software options and choices for instruction during the 2020-2021 school year. The teachers frequently asked for informal feedback from their students to better understand what was working for them through virtual learning and what was not. Sometimes the students would offer help and feedback to the teachers without prompting, creating a more trusting partnership between the teacher and their students where the students' verbal opinions were valued and considered frequently.

Rose recalled struggling to use earbuds while doing hybrid learning because they wouldn't stay charged. She said that "my student suggested I don't have to have them in both ears…just put on in one ear, and you know that will work for that class and then let that one charge and use the other one for the next class".

Sophia was very impressed and proud of the positive response and help she received from her students during class when she needed guidance with the technology. "The students taught me a lot about technology," Sophia said several times throughout the interview.

Robert stated that his school and school board verbally encouraged the use of technology, saying, "They want to see as much technology as possible."

Central Question: What are the self-efficacy experiences of high school math teachers?

The answer to this question is a summation of the sub-question responses and other data assembled from the letters of advice, interviews, and focus group. Teachers' mastery, emotional and physiological, verbal, and vicarious experiences shaped their beliefs. They influenced their existent approaches to teaching with technology, but the confidence with which teachers taught using technology and their believed efficacy was impacted primarily by mastery experiences. Throughout the interviews, focus group, and letters of advice, the math teachers shared in common the importance of mastery experience. This confirms that mastery experiences are the most influential of the four sources of self-efficacy, according to Bandura (1977).

Summary

This chapter addressed the six significant themes throughout the participants' interviews and the focus group. Data collected from the teacher interviews revealed the research subjects' experiences with their use of technology and the effects of integrating technology into their pedagogical practices in their classrooms. Direct quotations were used throughout the chapter to allow the researcher to communicate the participants' lived experiences in the most natural way possible, as is required for a qualitative study. The data analysis of individual interviews, letters of advice, and a focus group revealed six themes associated with teacher technology self-efficacy: practice, networking, student feedback, efficiency, teacher characteristics, and student engagement. The themes formed a foundation of understanding that permitted the research questions to be explored and answered by participants' lived experiences during this study.

The first theme, practice, was a derivation of mastery experiences. Participants discussed the various software and hardware they utilized during the 2020-2021 school year to facilitate virtual instruction. They provided varying viewpoints on what forms of practice benefited their teaching. The most prominent practice the teachers described was achieved before using the software or hardware for instruction with the students. This revealed that teachers took the initiative to practice independently before using new software or hardware for teaching. In turn, they described it as having a positive effect on their self-efficacy. Practicing in a "student mode" was also deemed beneficial to predict any students' issues during the lesson while using the software or hardware from a student's point of view. A drawback described by the participants was the lack of time provided for them to practice before virtual learning ensued due to the pandemic.

The second theme, networking, delved into the influences of other educators on the participants and their technology use and choices of software and hardware. The prominent understanding that emerged from this theme proclaims that collaborative practices can increase teacher technology self-efficacy. During the interviews, two networks were revealed: district or school and social media. Teachers shared that they would look for guidance from other teachers in their building or department for support when they were frustrated or needed help with technology. The participants also remarked on the convenience of social media networks for teachers and how the shared difficulties left them feeling less alone during the isolation of teaching virtually during quarantine.

The third theme, student feedback, explained students' role during the learning curve the participants encountered navigating virtual instruction. Overall, the transition to virtual instruction affected both teachers and students in delivering and producing content in the virtual education setting. The understanding that emerged from participants’ stories highlights teachers' emphasis on student feedback. The participants reported building a solid connection with their students who came to class, seeking their feedback on new software, and valuing their advice on hardware and software that the teacher could try to increase effectiveness. In addition, the participants reported getting positive feedback when their technology integration was interactive and user-friendly for those on small Chromebooks or game-based learning tools.

The fourth theme, efficiency, was derived from the benefits teachers reported finding when using specific software programs or hardware during instruction. The type of technology used by teachers was said to be based on the ease of use, availability, and external pressures. For example, different learning platforms such as Schoology for some and Google Classroom for others were required depending on the school district. The transition to virtual instruction was difficult, but the participants described several technology programs or devices that they found helpful and would continue to use in years to come when they are back in person.

The fifth theme, teacher characteristics, highlighted the shared enthusiasm of the participants as they spoke about their experiences navigating through the uses of new technology. One participant correlated her excitement over a new software to her students' excitement during the lesson. The teachers who had the most positive attitudes toward technology were the ones who mentioned the most successful experiences. The teacher's personal beliefs and biases were carried with them throughout the school year and influenced their technology self-efficacy. Some teachers worked hard to overcome previously held beliefs about technology during this school year. Dorothy, for example, was not as comfortable with technology as the other participants. Still, this year having no choice but to use it daily, she began to find redeeming qualities in certain software and new confidence in her abilities.

The sixth theme, student engagement, was developed in response to the effect participants saw technology have on student engagement with assignments and communication. Several participants described the positive effects they experience when using technology in terms of student achievement and communication. Dorothy, for example, mentioned during her interview that she felt students reached out to her more for one-on-one tutoring and questions during the virtual school year. On the other hand, several teachers described times when technology did not increase student engagement and their steps to rectify the situation. For example, Sophia recalled, "when I was learning Kami, I had a lot of students that were having trouble submitting their work and saving it in Kami, or even just saving their work to their Google drive." Sophia said she would often have to teach them those technical skills to turn in their math work at the beginning of the virtual school year. Rose began coding the answers in the Desmos activities to let her students know with a thumbs up or down if they had completed a slide correctly or not. This was her way of keeping the students engaged through a virtual activity that was self-paced.

Self-efficacy plays an essential role in using technology as an instructional tool in the mathematics classroom. The participants' experiences showed evidence that practice, networking, student feedback, efficacy, teacher characteristics, and student engagement deeply influenced their decisions on using technology in the classroom. All participants believed they could effectively use technology in their mathematics classroom. In addition, all participants believed in the positive influence of practice on their ability to effectively implement technology in the classroom. The most influential theme from this study, confirming Bandura's (1977) assertion, was found to be mastery experience.

CHAPTER FIVE: CONCLUSION

Overview

This phenomenological study aimed to explore what it means to be a secondary math teacher with technology self-efficacy. Discussions of lived experiences in this study presented emerging themes that describe the factors that participants perceive as influencing their technology self-efficacy. Through focus groups, interviews, and letters of advice, I found firsthand what factors teachers perceived influenced their technology self-efficacy. According to the qualitative data, nine of the teachers in this group of ten participants all had a relatively strong sense of technology self-efficacy. They did reveal what factors contributed to and impacted their personal feelings of technology self-efficacy.

Summary of Findings

This study examined how ten central Virginia mathematics teachers described the factors that influenced their technology self-efficacy. Themes evolved from data provided through individual interviews, letters of advice, and a focus group interview. The following section describes the themes relative to the central research question and four sub-questions.

Central Question

The central research question was, what are the self-efficacy experiences of high school math teachers? There are four sources of self-efficacy that can influence the development of efficacious beliefs: mastery experiences, vicarious experiences, verbal persuasion, and emotional and physiological states (Bandura, 1997). In addition, themes of practice, networking, student feedback, efficiency, enthusiasm, and student engagement emerged as influential sources that develop the technology self-efficacy of mathematics teachers.

Sub-Question 1: What are the mastery experiences of teachers with technology self-efficacy?

Mathematics teachers reported that mastery experiences contributed to increased self-efficacy regarding technology use for instructional purposes. Mastery experiences accounted for 47% of the codes that were given to statements made by participants. Practicing before using new technology with students was a critical experience that teachers used to increase their self-efficacy. “I have to do it myself first,” a statement provided by Margaret reiterated throughout the other interviews. Carolyn reported, “I would like practice, like before the class, I would get up there and make sure everything would run smoothly, that it just worked.”

Sub-Question 2: What are the vicarious experiences of teachers with technology self-efficacy?

Sharing the success and failures of colleagues in their departments and social media networks provided math teachers with vicarious experiences that gave them the confidence to try specific technology software or avoid it. However, the vicarious experience represented only 10% of the coded statements throughout the study; the lowest represented out of the four self-efficacy sources in this study. The participants in this study shared vicarious experiences through colleagues in their district, students, their children, and teachers' social networks. Rose felt very strongly about the positive effects social media groups had on her self-efficacy, sharing that “…searching the internet and then I got on Facebook, Facebook had a group for Desmos. And that's where it just exploded with all these possibilities and people, other teachers were in the same situation”. Margaret had a more local vicarious experience to share regarding technology tips provided by her administrator, “she learns new things and then she tries it out, and she'll share it with us.” Lucy in the focus group recalled that her math department meetings and her direct colleagues were a vital source of vicarious experience for her stating, “us sitting together and saying oh, hey, I found this, and like us collaborating as a math department, I think is the only way we made it because we would be like, why to use this and there was someone we trusted there to tell us."

Sub-Question 3: What are the emotional and physiological experiences of teachers with technology self-efficacy?

Emotional and physiological experiences accounted for 25% of the codes created throughout this study. Math teachers experienced negative emotional experiences due to the lack of rapport developed through virtual learning when students would not turn on their cameras or show up for class. Rose described what the other teachers confirmed often happened to them, "And then when we were Google meeting, they would not turn their screen on. So, it was, it was very isolated". Positive emotional experiences were a source of efficacy when the teacher was excited about the effects of technology on student achievement and engagement. Rose liked the ability she was afforded through virtual learning to see her students working in real-time, "I can see what they're doing and when they are stuck, and individually give aid." Margaret was one of the teachers who really embraced technology and had mostly positive experiences stating, "I absolutely love it."

Sub-Question 4: What are the verbal persuasion experiences of teachers with technology self-efficacy?

District persuasion to use technology in the classroom was the most referenced verbal persuasion for math teachers. Verbal persuasion coded at 17% and ranked in the lower represented self-efficacy sources. It is noted that the teachers never reported receiving specific feedback regarding their use of technology in the classroom, only generalized mandates through email and faculty meetings. Verbal feedback was acquired from the students, influenced the teachers' use of specific technologies, and was a source of their technology self-efficacy. Ethel, one of the participants in the focus group, stated, “If I'm being honest, our professional development with technology was not good.” Apart from the student feedback, the teachers did not share receiving any verbal feedback from the administration regarding their use of technology.

Discussion

The purpose of this transcendental phenomenological study was to describe perceived self-efficacy related to the use of technology for instruction by high school mathematics teachers. Bandura’s (1997) self-efficacy theory and social cognitive theory (1989) served as the theoretical frameworks of this study. This study brought about a connection between the theoretical and empirical literature discussed in chapter two. This section continues the discussion of Bandura’s (1997) theory of self-efficacy related to mathematics teachers' use of technology for instruction. The findings of this study of the perceived experiences of 10 high school mathematics teachers in Virginia should benefit educational stakeholders and policymakers to better understand how to support math teachers using technology in the classroom.

Theoretical Findings

Two influential theories established the theoretical framework for this study of perceived self-efficacy and persistence in technology use in the math classroom. Bandura’s (1977) self-efficacy theory and Bandura’s (1989) social cognitive theory described the technology self-efficacy related to persistence high school math teachers. Bandura's (1977) self-efficacy theory served as the primary guide in this study. It related to the participants' belief in their pedagogical ability to incorporate technology in their instruction through persistence, not merely behavioral self-control.

Social Cognitive Theory

Bandura (1991, 2012) theorized that three factors, or determinants, influence learning. They include the environment, behaviors, and personal factors. The virtual learning environment influenced the participants in this study and the behaviors of their students. This study demonstrated evidence supporting Bandura's (1989) social cognitive theory. The participants were proactive in their teaching methods for this school year, capable of self-reflection, self-regulation, and self-organization before adopting particular teaching methods. A fundamental principle of social cognitive theory is that people learn through their own experiences and by observation of the actions and inevitable results of others (Bandura, 1989). Teachers' changes to their approach to technology based on student feedback is an example of social cognitive theory at play in the classroom. The participants adjusted their teaching style and changed the technology software they used based on trial and error, student feedback, and colleagues' shared experiences.

Self-efficacy

Research in self-efficacy in teaching can greatly influence teachers because when a teacher has high self-efficacy, they will be more willing to continue learning new technology software to keep their curriculum engaging (Morris et al., 2017). The participants who showed enthusiasm spoke of the importance and described minimal limitations to the use of technology also suggested the value in continually researching and trying new technology through the school year. Self-efficacy expectations develop through four significant information sources: performance accomplishments, emotional and physiological states, vicarious experience, and verbal persuasion (Bandura, 1977). There appears to be a strong belief in the importance of mastery experiences among the participants from the data. This study found that the participants learned through mastery experiences 47% of the time and utilized the experiences and influences of others a total of 27% of the time when combining verbal and vicarious influences.

Empirical Discussion

As examined in Chapter Two, the existing literature explored factors that influence math teacher technology self-efficacy. Previous research revealed that high self-efficacy, quality support, principal modeling, and professional development followed by teacher collaboration and reflection positively impact teachers' intent to use technology (Liu et al., 2017; Liu et al., 2015; Starrett & Richardson, 2020). This study extended this research and built upon the factors that were previously found to influence math teacher technology self-efficacy.

TPACK

The data findings supported the TPACK model suggested by Mishra and Koehler (2006). The participants used their content knowledge and pedagogy knowledge to narrow down the vast amount of software available. The Desmos activities described by the participants involve using illustrations, examples, and demonstrations to make the material more accessible to students; the illustrations, models, and demonstrations were said to be more precise and reach a broader range of students according to the participants in the study. For example, Dorothy speaks specifically to the use of Desmos for drawing graphs, "the students always remark on how straight my lines are now that I use Desmos." Perceived ease of use was an influential factor for teachers in this study and had been a recurring theme in previous studies to influence teacher use of technology (Davis,1989; Joo et al., 2018; & Salleh, 2016). The perceived ease of use is a part of the technology pedagogy that a teacher uses within TPACK to make decisions regarding technology use in the classroom.

STAMPK

According to Getenet (2020), effective technology integration requires understanding the relationship between technical knowledge, specialized pedagogical knowledge, and specialized mathematics knowledge. The participants in this study showed clear discernment regarding the technology they used. All the teachers spoke of using the Desmos activities and favored them for the specific qualities they afforded to math students over other applications such as Kami. The math teachers in this study wanted technology that could display the math visually with an increased aesthetic. Dorothy shared her reason for using wizer.me, "The Wizer. me, I found, to be engaging, especially with the freshmen, because it was like a lot of sorts and stuff with that vocab do you could do with that". Participants used their knowledge of the technology and then evaluated its effectiveness on mathematical instruction using their pedagogical knowledge.

A clear example was the overwhelming dismissal of the use of Kami and its replacement with Desmos as the year progressed. Rose explained her reasoning for using Desmos instead of Kami, "And they knew that Desmos was the winner when, precalculus had tests and exams on Desmos because it allowed them to show their work on the screen and allowed them to do the math type, which they liked better than having to try and scribe on the little mouse pad. So, for me, that was a clear winner". Getenet (2020) suggested professional development be available as an informal arrangement that enables teachers' participation based on their availability and continuous opportunities without physical appearance. The participants in this study confirmed this with the credit they gave to the importance of online social media networks in supporting their technology self-efficacy.

Teacher Characteristics

The incorporation of technology can cause tension and anxiety among teachers as it is often demanded despite a lack of technical resources and professional training, according to

Fernández-Batanero et al. (2021), precisely how the participants described the start of their 2020-2021 school year. Most participants in the study conveyed a positive and excited attitude toward technology in general; however, there were moments relayed from several participants where technology was the cause of stress. Anytime technology would unexpectedly stop working was a stressful memory for the participants; these included: loss of internet access, technology not working, student frustration with technology, and most common lack of charged Chromebooks. This concession supports the findings of Steven (2019), where negative experiences can lead to more negative feelings and experiences toward technology.

Carolyn had a positive attitude throughout the interview. She felt very strongly about the importance of technology, but she did say, “On a rainy day in the middle of April, technology use makes the students so sleepy.” Therefore, she had to have a creative way to combat this and would change the activity for the day or get the students up out of their seats for a while. Carolyn’s attitude and creative teaching methods endorse the findings of Tartavulea et al. (2020), who suggested technological willingness, confidence, and overall understanding of technology integration toward teaching objectives.

Mastery experience was the leading factor that participants referenced throughout the interviews in the context of practice. Carolyn and Margaret, two participants who were the most comfortable with technology, specifically stated that they would practice with new technology before introducing it during a lesson with the students. This supports the suggestion of Katz and Stupel (2016) and Yulianti et al. (2021) that teachers with high pedagogy technology efficacy invest time planning to ensure the best use of technology in their lessons, and they plan their learning carefully and restructure instructional and management routines more often.

School and Contextual Characteristics

The participants in this study all taught in rural public schools in Virginia, and the main issue they reported with technology was the lack of internet access for their students. This supports the limited access to technology resources reported for rural schools by Tyler-Wood et al. (2018). Additionally, the participants shared that they all had access to any required technology. Still, most of their students' lack of reliable internet became a handicap that was unsurpassable at times throughout the year.

Technology support staff often gives teachers peace of mind and relieves some anxiety around technology integration; (Morris et al., 2017). In the face of this research claim, only one participant mentioned technology support staff during this study, despite the suggestion from research that they should be an essential support for teachers utilizing technology in the classroom. Liu et al. (2015) suggested that the support for technology use and proper TPACK integration can derive from collaboration with colleagues, supplementing support from technical support personnel. This study finds that all participants described collaboration as taking place throughout the school year.

COVID-19. The participants in the study were all affected by the COVID-19 pandemic as it pushed their classrooms into a virtual setting. Casserly (2020) discussed the implication that virtual instruction across the country had on school districts as they struggled to provide internet access to their students. The participants in this study were not an anomaly, and they too reported struggles with internet access for their students and the adverse effects it had on their ability to teach. Sophia, for example, proclaimed during her interview that lack of reliable Wi-Fi was the most detrimental factor in her ability to teach during the 2020-2021 school year. This finding is in line with the research conducted by Cardullo et al. (2017), where they found that students without stable access to devices internet would not guarantee remote learning was taking place through remote teaching, thus creating an inequity. All participants in this study were from rural school systems, and all participants mentioned the lack of reliable Wi-Fi as an issue. Robert and Margaret commented that the hot spots provided for students often were not strong enough or compatible with the number of students in the home trying to access their video sessions with their teachers.

School Technology Support. School technology support gives teachers peace of mind and is vital to teachers' positive experiences (Morris et al., 2017; Liu et al., 2017). Carolyn and Robert were the two participants who spoke the most about receiving quality support from their school technology support team. Robert described the technology support as provided through generic professional developments. Carolyn reiterated this with her technology support coming in generic emails with helpful technology tips and software suggestions. Although the two participants found this helpful, it does not support the claim of Morris et al. (2017) that interventions are more effective when they are included in coaching sessions that provide teachers with specific and individualized support.

Professional Development. Previous studies indicated that teachers benefit from professional development that emphasizes the pedagogical use of technology in teaching and that a lack of in-service training negatively affects technology use (Koehler and Mishra, 2009; Ruggiero & Mong, 2015). However, Robert was the only participant to speak at length about the effectiveness of professional developments provided to him during the 2020-2021 school year. Thurm and Barzel (2020) suggest that professional development is an essential tool supporting teachers in the iterative learning process to incorporate practical technology tools into their classrooms. However, this study found that the school districts did not take advantage of the positive advantages that can be accrued through professional development. Again, Robert was the only participant to speak about the positive effects of professional development provided by his district. The findings of this study run concurrently with the conclusions from Gerber (2020), where professional development for teachers was not a priority.

Principal Support and Leadership. Sterrett and Richardson (2020) claim that principals play an essential role in supporting teachers' work. This study found that only one teacher, Margaret, reported any support from the administration. These findings are conclusive with the findings of Gross and Opalka (2020), who reported a lack of communication of expectations and support from school districts. Margaret commented on the emails her administrator would send out that utilized software the teachers could also use in their classroom, thereby modeling effective strategies. According to Sterrett and Richardson (2020), effective principals engage teachers in purposeful professional development, engage in digital professional development themselves, and empower their teachers to become leaders in the classroom. Margaret's principal showed evidence of using one of these three themes: engaging in digital professional development by learning about new technology and then communicating with the teachers. None of the teachers reported receiving any feedback, positive or negative, from their administration on their use of technology as a teaching tool during the 2020-2021school year.

Student Engagement. Low student engagement was a theme that all participants in the study reported. Rose described having few students showing up for online sessions and those who did rarely turned on their cameras. She described the 2020-2021 school year as very isolating. When used in a traditional classroom setting, previous research found that technology creates a more learner-centered environment (Chawinga, 2017). However, the participants in this study reported a decrease in overall student engagement during the 2020-2021 school year when the classroom was utterly dependent on technology use. During this school year, Sophia found that technology software that worked to engage some students may not work for others, and she had to work to find the right technology to keep students engaged.

Implications

The findings of this transcendental phenomenological study suggest implications for implementing more individualized and focused technology support for mathematics. These implications will be addressed through empirical, theoretical, and practical perspectives. This section will conclude with a summary.

Theoretical Implications

The data for this study indicated that participants all held positive beliefs about the importance of mastery experiences to increase self-efficacy. In addition, teachers repeatedly recommended practice and personal experience as the most effective way to increase their comfort level with technology as a teaching tool. The continued reference to practice lends evidence to a need for a change in professional development from presenter-led with the teachers as passive learners to allowing the teachers a more active role in the professional development.

Empirical Implications

The participants all felt as though they were doing the best they could to meet the needs of the students through technology during the 2020-2021 school year. The teachers all reported using their planning period and personal time to prepare for classes. The preparation included finding resources taking the time to practice them from the student's perspective. For example, Blanche said, “I think my time that I have to learn about the new technology is a big factor; I want to be comfortable with it to be able to use it in front of the class. So, I don't have any like problems and am prepared for the students who have a question. So, I think the biggest thing would be time to figure out the technology well enough to use it in the classroom". This would indicate that the districts would benefit from more intensive and practical training to build on models such as the technological pedagogical content knowledge (TPACK), created by Mishra and Koehler (2006), which explains the skills teachers need to teach a subject and use technology effectively. This study supports Heath's (2017) finding that convincing teachers of the importance of technology integration are not enough; they need to have the training and support that builds their self-efficacy to levels that they will be willing to try independently.

Practical Implications

Building on the implications offered above, the practical implications of this study are significant because they will provide stakeholders with concrete ways to effect change in the math classrooms. It would appear that due to the minimal reliance on school technology support staff, school districts would be better advised to allocate funds to support qualified teachers who demonstrate strong TPACK skills and develop them into the technology leaders of their schools. A more systematic approach to staff development in supporting technology use in the math classroom would be highly beneficial. Universities and large-scale policymakers should consider the need for training for pre-service teachers in a more intensive approach. As previously reported in other studies, lack of district support through professional development and guidance was a critical factor in student learning loss (Gerber, 2020; Gross & Opalka, 2020).

Recommendations. Several participants in this study were well-versed in finding quality technology software, which technology best blended the content with pedagogy, and the experiential learning process involved. Still, overall, most of the participants would benefit from structured training on this entire process. Therefore, one recommendation of this study is for districts to provide math teachers with specific pedagogical-based technology professional development that involves hands-on learning opportunities for teachers and continued support throughout the school year.

Another recommendation of this study is for the school districts to provide time for math teachers to have regularly scheduled time to meet with other math teachers built into their schedule during the school year and over the summer. Dorothy's experience in this study echoed the findings of Morris et al. (2017), where low confidence participants seek out their coworkers' opinions and advice. This lack of time was reiterated by several participants and is, therefore, a consideration that building and district administration need to consider. The participants in this study followed advice from other math teachers in their department and social networks. This can be attributed to the findings of Bandrua (1997) and Barton and Dexter (2020), who found that for vicarious experience to be effective, the observing teacher must feel that they relate to the model's nature and level (Bandura, 1997; Barton & Dexter, 2020).

The final recommendation of this study is for rural districts to find a way to address the inequality of internet access among the students. Hot spots were made available, but participants described the reality of their effectiveness to be less than ideal and not sustainable for long-term use.

Delimitations and Limitations

This phenomenological study was designed to fill the gap in the literature by describing the self-efficacy experiences of high school math teachers. The researcher made certain delimitations to determine the essence of the phenomenon and ensure the participants had experienced the situation studied. The first decision was that of research design. A transcendental phenomenology was utilized because of the desire to hear the participants' voices while bracketing researcher bias. Additionally, all participants had experience with the phenomenon, as required by phenomenological studies (Creswell & Poth, 2018). Therefore, the delimitations included limiting the study to high school mathematics teachers who taught during the 2020-2021 school year. I created this requirement to ensure that participants had a level of experience suitable for answering the interview questions and would all have experience teaching during the pandemic, requiring all teachers to utilize instructional technology.

There were also limitations to this study. First, the geographic location of the participants limits the generalizability of this study. The participants came from rural central Virginia school districts with similar school demographics. A second limitation was that data collection occurred during the COVID -19 pandemic, and therefore interviews were conducted through Zoom. Virtual interviews did allow for more flexible scheduling and the possibility of the participants being more relaxed in their environment but did make it more challenging to read whole body language. Finally, this study explored the lived experiences of ten people, which, for phenomenology, is an acceptable number of participants for research. Still, it should not be generalized to larger populations because of the small research sample. Because of this, the study results are not entirely generalizable, but the findings can help improve teachers' self-efficacy in the future.

Recommendations for Future Research

In consideration of the study findings, limitations, and the delimitations placed on the study, several recommendations are made for future research. The restrictions related to the COVID-19 pandemic greatly impacted the knowledge and experience of the participants' technology use, as all participants were required to utilize technology during the 2020-2921 school year. A similar study should be completed now that teachers are back in the physical classroom. One of my concerns with this study is that without the COVID-19 restrictions, the participants would be free to go back to less frequent technology use for instructional purposes. A current study might show that virtual teaching required during the COVID-19 quarantine only caused a temporary increase in the lived experience selected for this research study.

The participants in this study spoke highly of virtual networks and coworkers for support, but only one mentioned technology support staff; therefore, further research should look into why teachers feel more comfortable utilizing social networks and coworkers over school technology personnel. In addition, other phenomenological studies should be conducted in different regions of Virginia to create an in-depth description of the phenomenon of technology self-efficacy of math teachers. Administrators and school technology personnel included in one of these studies might offer a different view of pedagogical approaches to technology use in the math classroom.

Summary

The purpose of this transcendental phenomenological study was to explore how a teacher's self-efficacy regarding the use of technology influences decisions they make about the use of technology in their classrooms. Bandura's (1977) self-efficacy theory provided the theoretical framework for this study. Five research questions focused data collection on the participants' lived experiences that influenced their technology self-efficacy, leading to the development of themes in this research study. Ten high school mathematics teachers were asked to participate in interviews, written letters of advice, and a focus group interview with questions relating to using technology in the math classroom during the 2020-2021 school year.

The data for this study added to the research of technology self-efficacy of mathematics teachers. The themes that emerged as influential sources of self-efficacy were practice, networking, student feedback, efficiency, teacher characteristics, student engagement. These themes were then re-coded into the four sources of self-efficacy: mastery experience, emotional and physiological experience, verbal experience, and vicarious experience. These experiences and feelings directly influenced math teachers' technology self-efficacy and their use in the classroom. The most critical implication of this study is that all participants held positive beliefs about the importance of mastery experiences to increase self-efficacy. Teachers repeatedly recommended practice and personal experience as the most effective way to increase their comfort level with technology as a teaching tool. I expect this research will support the body of knowledge that will encourage policymakers and administration to understand the type of support that math teachers require to support the increased need for technology use in the classroom.

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Appendix A

IRB Application

4/19/2021

Institutional Review Board

Campus North Suite 1582

1971 University Blvd.

Lynchburg, VA 24502

Dear Institutional Review Board:

As a graduate student in the Department of Education at Liberty University, I am conducting research as part of the requirements for a Ph.D. in Higher Education Administration degree. The title of my research project is A Phenomenological Study of Perceived Factors Influencing Math Teachers' Technology Self-Efficacy. My research aims to explore the technology self-efficacy of mathematics teachers at rural high schools in Virginia.

I am writing to request your permission to conduct my research at Amelia County Public Schools, Appomattox County Public Schools, Buckingham County Public Schools, Charlotte County Public Schools, Cumberland County Public Schools, and Nottoway County Public Schools.

Participants will be asked to respond to an email and short demographic survey if they are interested in taking part in the study. In addition, participants will be presented with informed consent information prior to participating. Taking part in this study is entirely voluntary, and participants are welcome to discontinue participation at any time.

As specified in the consent form, at the conclusion of the study, participants will have the option to go to a Google Form and enter their email address to be included in a raffle for three $50 gift cards. As specified in the consent form, all participants will each receive a $20 gift card. Participants will still be able to enter the raffle even if they choose to end the study early. Participants who are interviewed will still receive the full gift card amount even if they choose to end the study early.

Thank you for considering my request. If you choose to grant permission, please provide a signed statement on official letterhead indicating your approval. A permission letter document is attached for your convenience.

Sincerely,

Jenna Finnegan

Ph.D. Candidate Liberty University

Appendix B

Consent
A phenomenological study of perceived factors influencing math teachers' technology self-efficacy
Jenna Finnegan
Liberty University

You are invited to participate in a research study. In order to participate, you must be a high school mathematics teacher employed at a public school in rural Virginia. Taking part in this research project is voluntary. Please take time to read this entire form and ask questions before deciding whether to participate in this research project.

Jenna Finnegan, a doctoral candidate in the School of Education at Liberty University, is conducting this study. The purpose of this phenomenological study is to explore the technology self-efficacy of mathematics teachers at high schools in Virginia.

If you agree to be in this study, I would ask you to do the following things:

1. Respond to this email by completing the Google Form link below.
2. Participate in virtual interviews that will last approximately 30 minutes outside of school hours.
3. Participate in one focus group session that will last approximately 60 minutes outside of regular school hours.
4. Write a 300-400-word letter to a teacher struggling with technology self-efficacy offering them advice and your top three technology resources.

At the conclusion of the study, participants will have the option to go to a Google Form and enter their email address to be included in a raffle for three $50 gift cards. As specified in the consent form, all participants will each receive a $20 gift card. Participants will still be able to enter the raffle even if they choose to end the study early. Participants who are interviewed will still receive the full gift card amount even if they choose to end the study early.

Participants should not expect to receive a direct benefit from taking part in this study.
The study may indicate participant perceptions of computer use and technical support in their school division. A final report will be submitted to the participating schools' administration.

The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Liberty University will not provide medical treatment or financial compensation if you are injured or become ill as a result of participating in this research project. This does not waive any of your legal rights nor release any claim you might have based on negligence.

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records. Data collected from you may be shared for use in future research studies or with other researchers. If data collected from you is shared, any information that could identify you, if applicable, will be removed before the data is shared.

- Participant responses will be kept confidential through the use of pseudonyms. Interviews will be conducted in a location where others will not easily overhear the conversation.
- Data will be stored on a password-locked computer and may be used in future presentations. After three years, all electronic records will be deleted.
- Interviews and focus groups will be recorded and transcribed. Recordings will be stored on a password-locked computer for three years and then erased. Only the researcher will have access to these recordings.
- Confidentiality cannot be guaranteed in focus group settings. While discouraged, other members of the focus group may share what was discussed with persons outside of the group

Participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Liberty. If you decide to participate, you are free not to answer any question or withdraw at any time.

If you choose to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should you decide to withdraw, data collected from you, apart from focus group data, will be destroyed immediately and will not be included in this study. Focus group data will not be destroyed, but your contributions to the focus group will not be included in the study if you choose to withdraw.

The researcher conducting this study is Jenna Finnegan. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at _______. You may also contact the researcher's faculty sponsor, Dr. Putney, at ________.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA 24515 or email at irb@liberty.edu

By signing this document, you agree to be in this study. Make sure you understand what the study is about before you sign. You will be given a copy of this document for your records. The researcher will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

☐ The researcher has my permission to audio-record/video-record me as part of my participation in this study.

Printed Subject Name

____
Printed LAR Name and Relationship to Subject

____ ________________
LAR Signature
Date

Appendix C

Interview Protocol

Date:

Time:

Place:

Interviewee:

Script prior to the interview:

I would like to thank you once again for being willing to participate in this study. As I have mentioned to you before, my study seeks to explore what it means to be a secondary mathematics teacher with self-efficacy.

Before we begin the interview, do you have any questions? [Discuss questions]

If any questions (or other questions) arise at any point in this study, you can feel free to ask them at any time. I would be more than happy to answer your questions.

Let's review the informed consent form together. The form has an outline of the purpose of the study, your role in the study, and your rights as a participant. (The consent form follows.)

Once consent is given, continue by saying the following:

If the participant gives permission to be recorded, say the following:

Please let me know if, at any point, you want me to turn off the recorder or keep something you said off the record.

If the participant does not agree to be recorded, say the following:

I will only take notes of our conversation.

Let's begin, please:

Please introduce yourself to me, as if we just met one another.

Participant Background Interview Questions:

1) How long and in what capacity have you been in education?

2) What role did technology play in your undergraduate/graduate degree?

3) What subject and grade level do you teach?

4) What type(s) of technology do you have access to at work?

5) What technology do you enjoy using outside of work?

Focused Interview Questions:

6) How would you describe your attitude toward instructional technology in regard to education as an instructional aid??

7)What professional development opportunities have you participated in that targeted the use of instructional technology?

8) How do you perceive the professional developments you have attended in the last year have affected your implementation of technology in the classroom?

9) What, if anything, challenges you/scares you about using technology in the classroom?

10) How does your district encourage technology use in the classroom?

11) How important do you think technology is to the mathematics classroom?

12) How does your comfort with technology influence your students' success during a lesson that integrates technology?

13) What factors have influenced you to use technology more frequently in the mathematics classroom?

14) How would you describe the role of technology in education?

15) Describe the amount of time you have available to learn about

technology to use in your classroom through other avenues such as professional development seminars/workshops, conferences, summer sessions?

16) What effect do you see that technology has on student engagement?

17) What factors would you identify as increasing your technology self-efficacy?

18) How would you describe the learning opportunities you have been provided regarding instruction and professional development on technology integration in the math classroom?

19) How does your school leadership model the use of technology?

20) What more can you tell me about your experiences with instructional technology concerning your teaching practice?

Appendix D

Focus Group Protocol

Date:

Time:

Place:

Interviewee:

Script prior to the interview:

I want to thank you once again for being willing to participate in this study. As I have mentioned to you before, my study seeks to explore what it means to be a secondary math teacher with high technology self-efficacy. I am going to ask you some questions about your experiences teaching using technology. I hope that these questions will generate discussion amongst you. My purpose here is to moderate the session and keep track of time. There are no wrong answers but rather different points of view. Please feel free to share your point of view even if it differs from what others have said. Keep in mind that we're just as interested in negative comments as positive comments, and at times the negative comments are the most helpful. This session will be recorded. We will be on a first-name basis today, but I want to remind you that I won't use anyone's name in the study. You may be assured of complete confidentiality.

Before we begin the discussion, do you have any questions? [Discuss questions]

If any questions (or other questions) arise at any point in this study, you can feel free to ask them at any time. I would be more than happy to answer your questions.

Opening Question (round-robin)

Let's find out some more about each other by introducing ourselves. Tell us your name and what you taught during the 2020-2021 school year. Tell us how long you have been in education and what type of technology you have access to at work.

Introductory Prompts

1. Please introduce yourself and tell the group what subject(s) of mathematics you teach.
2. What technology do you use every day in the math classroom?
3. What would describe as the most effective professional development you have received on technology use?
4. What, if anything, challenges you/scares you about using technology in the classroom?
5. How does your district encourage technology use in the classroom?
6. How important do you think technology is to the mathematics classroom?
7. What factors have influenced you to use technology more frequently in the mathematics classroom?

Final Prompt - Remind participants the purpose of the study is to explore what it means to be a secondary math teacher with high technology self-efficacy.

Then ask:

7. Have we missed anything?

Thank you again for your participation in this study.

(Assure him/her that their responses are confidential and a pseudonym will be used)

Appendix E

Letter to Superintendent

Dear Superintendent,

I am a doctoral candidate at Liberty University. My doctoral study is on perceived factors influencing math teachers' technology self-efficacy. I am writing to ask for permission to conduct this study. I am interested in interviewing secondary mathematics teachers with varied years of teaching experience. A written report of my work will be provided to you at the conclusion of the study.

Should you have any questions regarding this study, I would appreciate the opportunity to speak to you personally to answer those questions for you. Otherwise, I am asking for your permission to conduct the study. Please let me know of your decision as soon as possible at ________. I appreciate your consideration of this request.

Sincerely,

Jenna Finnegan

Ph.D. Candidate Liberty University

Appendix F

Email to the Principal

Dear Principal,

I am a doctoral candidate at Liberty University. My doctoral study is on perceived factors influencing math teachers' technology self-efficacy. I am writing to ask for permission to conduct this study at your school. I am interested in interviewing secondary mathematics teachers with varied years of teaching experience. A written report of my work will be provided to you at the conclusion of the study. I would appreciate the opportunity to speak to you personally to describe the research proposal further, to ask for your permission to conduct the study in your school, to contact your teachers to participate, and to answer any questions you might have. Please let me know of a meeting time that will be convenient for you by emailing me at ________.

I look forward to speaking with you about this study and appreciate your time.

Sincerely,

Jenna Finnegan

Ph.D. Candidate Liberty University

Appendix G

Email to Teachers

[Insert Date]

Dear Teacher:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree. My doctoral study is on perceived factors influencing math teachers' technology self-efficacy, and I am writing to invite you to participate in my study.

If you are a secondary math teacher who has taught this year and is willing to participate, I ask that you participate in an individual interview, focus group, and submit relevant documents, which include a letter of advice to a teacher struggling with incorporating technology in the classroom. It should take approximately 10 minutes to complete the demographic form linked below. Your name and/or other identifying information will be requested as part of your participation, but the information will remain confidential.

To participate in this study, please click the link at the bottom of the page. A consent document is provided as the first page you will see after you click on the survey link. This letter will be given to you for you to sign at the time of the interview or focus group. The consent document contains additional information about my research. Please click on the questionnaire link at the end of the consent information to indicate that you have read the consent information and would like to take part in the study.

At the conclusion of the study, participants will have the option to go to a Google Form and enter their email address to be included in a raffle for three $50 gift cards. As specified in the consent form, all participants will each receive a $20 gift card. Participants will still be able to enter the raffle even if they choose to end the study early. Participants who are interviewed will still receive the full gift card amount even if they choose to end the study early.

Thank you for taking the time to consider participating in this study.

Sincerely,

Jenna Finnegan

Doctoral Candidate Researcher

Teacher Demographics Survey

What is your name?

What is the name of the school in which you teach??

What is your teaching assignment?

Have you taught during the 2020-2021 school year?

How many years of teaching experience do you have?

APPENDIX H

Interview Transcript Approval Letter

Dear [Recipient]:

Thank you for volunteering to be a participant in my research study. In this email, you will find an attached copy of the transcript of your one-on-one interview. I ask that you please review this document within the next two weeks and let me know if you have any questions or comments. If I do not hear back from you within the next couple of weeks, I will assume that you are satisfied with the transcribed document.

Thank you again for your help!

Sincerely,

Jenna Finnegan

Ph.D. Candidate Liberty University