RELATING MILLENNIAL TEACHERS' AGE TO FREQUENCY AND VARIETY OF INSTRUCTIONAL TECHNOLOGY USE IN ELEMENTARY MATH

by

LaDonna Marie Tate

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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2019

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ABSTRACT

Mathematics instruction continues to be of immediate concern in the United States. The availability of technology has become commonplace in today's classrooms. However, the integration of technology-assisted instruction involves a paradigmatic shift in traditional mathematical practices. Instructional technology, such as interactive whiteboards, handheld tablets, laptops, software, and desktop-based devices, serves as a tool to aid students in communicating mathematically and conceptualizing mathematical reasoning. Research posits that when teachers can personally adapt to the use of innovation, instructional technology in the classroom can be a rigorous tool used for the development of individualized, student-centered learning. As generational shifts of power take hold, Millennial teachers are rising to become the most dominant group of educators in America. The purpose of this quantitative, correlational study is to relate Millennial teachers' age to the frequency and variety of instructional technology used during math instruction at public K-5 elementary schools in Texas. A Spearman's Rank Correlation Coefficient was computed to assess the hypothesized relationship between Millennial teachers' age and their use of technology. The instrument used in this study was a modified version of the Use, Support, and Effect of Instructional Technology (USEiT) Teacher Survey The theories guiding this study include Rogers's Diffusion of Innovation and Constructivism. Results indicated no significant relationship between Millennial teacher age and the frequency subscales for technology use during math instruction. Additionally, no significant relationship was found between Millennial teachers' age and the variety of technology used during math.

Keywords: digital natives, early millennials, recessionist, innumerate, instructional technology, elementary mathematics

Dedication

This dissertation is dedicated to the little girl still lurking in the mind of every abused and abandoned woman striving to overcome childhood adversity. As the words of discontentment continue to loom and stifle your progress, just know that you are more than your circumstance. Keep pushing toward all that the Lord has destined for you. The chains are broken, and Girl, you are free.

Acknowledgments

The submission of this dissertation would not have happened without the unwavering support from my husband, Kenneth. Thank you for the quiet morning inspiration, tough love, and laughter to relieve my tears of frustration. This is my last degree, I promise. I love you more…

To my babies, Dwain and Alivia, thank you for your patience as your mommy worked diligently to be an example for you. It is my prayer that you will understand that hard work and dedication pay off in the end, and I want nothing but the complete best for you.

Dr. Paynter, words cannot express how much I thank and appreciate the person that you are. Thank you for your words of encouragement, and the detailed feedback required to strengthen my research during this process. I am a firm believer that the Lord places the people we need in our lives specifically. He sent you to guide me through this process; I would not have been successful in this endeavor without you.

Finally, I would like to send a special thank you to my committee, Dr. Kirk, Dr. Thomas, and Dr. Watson. I appreciate your feedback, and all that you have done to assist me on my quest to earn this degree.

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CHAPTER ONE: INTRODUCTION

Overview

As of 2017, 42 states, four territories, and the Department of Defense Education Activity (DoDEA) have adopted Common Core State Standards (CCSS) (Common Core State Standards Initiatives, 2017). In response to such initiatives, many schools have had to restructure their curriculum, strengthen their teachers' content knowledge, and refocus professional learning (Kane, Owens, Marinell, Thal, & Staiger, 2016). As a means to address such needs, researchers correlate the use of instructional technologies with student academic success and improved teacher pedagogy in mathematics (Borba et al., 2016; Delialioglu, 2012; Wang, 2011). This study seeks to identify relationships between Millennial elementary teachers' age and the frequency and variation of technology used during math instruction.

Background

Mathematics instruction continues to be of immediate concern in the United States (Bertram, 2014; Eddy et al., 2014; Hartsell, Herron, Fang, & Rathod, 2010; National Center for Education Statistics [NCES], 2015; National Education Technology Plan, 2010; Organisation for Economic Co-operation and Development [OECD], 2013). A Harvard University study presented by Hanushek, Peterson, and Woessmann (2012) cited gains in academic achievement by the United States to be "middling, not stellar" (p. vi.). Twenty-four countries trail the United States academically. Unlike these countries, however, the U.S. has failed to demonstrate an expedited rate of progression significant to compete with growth among leaders of the industrialized world (Hanushek, Peterson, & Woessmann, 2012). For example, in 2016 the United States awarded 568,000 bachelor degrees in Science, Technology, Engineering, & Mathematics (STEM) related fields. This statistic is staggeringly low when compared to countries such as China and India, which produced, respectively, 4.7 million and 2.6 million STEM graduates in the same year (World Economic Forum, 2016). Growth in U.S. STEM education is needed to maintain economic stability (Bertram, 2014; Olson & Riordan, 2012). If America plans to retain its historical pre-eminence on the world stage, the 2012 President's Council of Advisors on Science and Technology (PCAST) projected a need for one million more STEM graduates over what the United States is currently producing annually (Olson & Riordan, 2012). Wagner (2008) expressed the importance of STEM careers but found the prerequisite skills of critical thinking and problem solving to be deficient at the elementary, middle, and secondary levels in math, science, and technology education in the United States.

For students to meet pillars of success in college sciences, advanced mathematical study is required at the high school level (Bertram, 2014; Jordan & Kaplan, 2009). Regrettably, American students are failing to master the foundational standards in elementary and middle school required for success in advanced math courses in high school and college. As a result, opportunities are limited for a variety of STEM-related careers in the future (Bertrum, 2014; Jordan & Kaplan, 2009; Watts, Duncan, Siegler, & Davis-Kean, 2014). Olson and Riordan (2012) cited a need for the development of academic environments that "include methods courses that inspire and provide assistance for students with challenges in math" (p. i).

To redirect the current course of mathematical decline in education, teachers must adopt innovative practices that foster deeper learning, critical thinking, problem solving, collaboration, and communication (Darling-Hammond, Wilhoit, & Pittenger, 2014). Researchers have argued that the use of technology prepares future scientists, inventors, and engineers with a competitive edge in the ever-growing global market (Bertrum, 2014; Darling-Hammond et al., 2014; Hanushek et al., 2012; Wagner, 2008; West, 2013).

One causal variable cannot address the challenge of identifying the basis of this irregular pattern of mathematical success within the American educational system. Instead, the disjointed nature of learning in America stems from its historical purpose and various definitions of effective teaching and learning models (Christensen, Horn, & Johnson, 2011, Wagner, 2008; West, 2013; Wimberley, 2016). For centuries, formalized education in America has utilized a teacher-centered industrialized approach where instruction was designed to distribute information uniformly (Wimberley, 2016; Horn & Staker, 2015) to maintain a society capable of functioning interdependently (Christensen et al., 2011).

The emergence of the concept of digital natives (Prensky, 2001; Prensky & Berry, 2001) brought with it a generation which required a differentiated approach to instruction (Gu, Zhu, & Guo, 2013; Hicks. 2011; Joiner et al., 2013; Prensky, 2001; Prensky & Berry, 2001). Digital natives, as defined by Prensky (2001) are those who have spent their entire lives surrounded by and using digital technology. The reformation of American schools and closing of the global achievement gap requires educators to accept the increased impact of media and technology on digital native learners and to redefine what rigorous learning looks like in a modern educational environment (Christensen et al., 2011; Wagner, 2008, Wimberley, 2016). A number of authors have sought to refute Prensky's theory of digital natives, citing that variation in technological experience exists within the identified age group, thereby preventing age from being an isolated predictor of an individual's knowledge of technology (Hargittai, 2010; Jones & Cross, 2009; Kennedy, Judd, Churchward, Gray, & Krause, 2008; Margayah, Littlejohn, & Vojt, 2010). Twenty-first century learners require not only foundational literacy and mathematical knowledge, but also crucial life skills such as an ability to reason, analyze, weigh evidence, solve problems, and communicate efficiently utilizing innovative practices (Christensen et al., 2011; Gu et al., 2013; Hicks, 2011; Joiner et al., 2013; Wagner, 2008).

Patrick and Sturgis (2015) described technology as a means to address increased globalization and the technological advancements required for future competitiveness. The last two decades have seen an increase in available digital resources in the classroom (Zhonggen, 2015). The No Child Left Behind Act of 2001 included an initiative designed to develop students who would be technology-literate by the 8th grade (No Child Left Behind Act [NCLB], 2002). Under the administration of President Barack Obama, goals were developed to narrow the achievement gap by targeting the academic concerns prohibiting the acquisition of technology-based 21st century learning skills. The enacted initiatives' goals projected an increase in the percentage of American college graduates from 41% to 60% by 2020 (U.S. Department of Education, 2010).

The implementation of technology in education creates learning environments that promote individualization and student engagement (Handy & Braley, 2012; Poon, 2013) and influence student preparedness for the 21st century workforce (Saritepeci & Çakir, 2015). Researchers have identified math achievement as the most influential predictor of post-secondary academic success (Dossey, McCrone, & Halvorsen, 2016; Eddy, Hankel, Matelski, Cluff, Hunt, & Murphy, 2014). Despite the exponential growth of available technologies in schools in response to substantial budgets over the years (Horn & Staker, 2015; Padron, Waxman, Yuan-Hsuan, Meng-Fen, & Michko, 2012), the United States continues to lag behind other countries (The National Center for Education Statistics, 2015). The 2017 National Education Technology Plan [NETP], stated that the "digital use divide continues to exist[s] between learners who are using technology in active, creative ways to support their learning and those who predominantly use technology for passive content consumption" (U.S. Department of Education, 2017, p. 7).

A teacher's role includes developing connections with students through exceptional educational experiences that prepare them to enter the fast-paced world (Horn & Staker, 2015; Staker & Horn, 2012). The 2010 NETP emphasized the need for increased integration of state-of-the-art technology instructional practices that enable, motivate, and inspire student learning (U.S. Department of Education, 2010). Digital technology, when used innovatively, develops "weavers of zeitgeist" that enhance cognitive preoccupations and habits of thinking (Cavanaugh, Giapponi, & Golden, 2016, p. 377). To promote effective technology integration, educators' focus cannot be solely on the use of a specific technology, but also on developing an understanding of the complex relationships between the user, technology practices, and the tools themselves (Koehler & Mishra, 2005). The integration of technology merges traditional instructional methods such as lecture with digital and online technologies that produce learning through a variety of approaches (Al-Ani, 2013). Within this instructional design, teachers provide opportunities for student learning that are independent, personalized, and sustainable (Graham, 2006; Heinze & Procter, 2004).

Data presented by Bennett (2017) predicted the two youngest generations currently in the workforce–Millennials and Generation Z–will comprise roughly 70% of the global employment market within the next 4 years. Generation Z includes individuals born after 2000 (Bennett, Beehr, & Ivanitskaya, 2017). This generation will continue to shape the continuum of technological change in the classroom. Although Generation Z has entered the workforce, it is important to note this demographic group is still too young to populate the field of education as employees. Due to this fact, Generation Z has been excluded from comparisons in this study.

Two genres of teachers emerge within the technological and pedagogical realm of classroom instruction: Millennials and pre-Millennials. Millennials, often categorized as *digital natives*, share a variety of titles that include *NextGen, GenY, C Generation, M Generation, and Echo Boomers*. Millennials include individuals born in the 1980s and beyond (Houck, 2011; Smith, 2013). This generation grew up surrounded by technology and utilizes it instinctively to perform personal daily functions (Gu et al., 2013; Hicks, 2011; Houck, 2011; Joiner et al., 2013; Lee & Delli Carpini, 2010; Prensky, 2001; Prensky & Barry, 2001; Smith, 2013). Millennials make up roughly 44% of all teachers (Organisation for Economic Co-operation and Development OECD], 2017) and have been described as digitally conscious and comfortable with the use of technology as a tool for instruction (Attard & Orlando, 2014; Kubiatko, 2013). Also, Millennials understand that the integration of technology is critical for teaching the current generation of students (Flanagan & Shoffner, 2013; Kubiatko, 2013).

In contrast, pre-Millennials include individuals born before 1980 who grew up in an era when print, television, and radio news dominated information (Lee & Delli Carpini, 2010). As a result of their inexperience with digital technology, the term *digital immigrants* (Prensky, 2001) is an appropriate way to describe the teachers who require a shift in pedagogical and instructional practices to include the use of technology. Pre-Millennial teachers make up approximately 56% of all teachers in both private and public education (OECD, 2017).

As pre-Millennial teachers retire, Millennial educators move toward becoming the dominant group of educational professionals in the field. Within this generational group, descriptive sub-markers can be assigned to define Early Millennials as those born between 1980 and 1987; and Late Millennials, or Recessionists, as those born between 1988 and 1995 (Bridgeworks, 2017).

Gaining knowledge on teachers' use of technology is critical to relating students' overall academic success (Teo, 2006) with how disruptive and innovative instruction is utilized in the classroom (Christensen et al., 2011; Horn & Staker, 2015; Huang & Liaw, 2005). With pre-Millennial teachers exiting the profession at rapid rates, there is a need to identify if differences exist within the Millennial generation of teachers' variation and frequency of technology use as it relates to age.

Problem Statement

"The delivery system in mathematics education—the system that translates mathematical knowledge into value and ability for the next generation—is broken and must be fixed" (NMAP, 2008, p. 11). Heid (1997) noted that the use of technology in mathematics results in student-centered instruction in which learners associate themselves as mathematicians, thereby inviting opportunities for reflection and independence in their learning. Despite data supporting the use of technology in mathematics (Aydin, 2005; Crompton, 2015; Li & Ma, 2010; Yuan-Hsuan, Waxman, Wu, Michko, & Lin, 2013), and substantial monetary investments for technology integration in American schools, less than half of all fourth- and eighth-grade students meet basic proficiency levels in mathematics (Bertram, 2014; NAEP, 2013; NCES, 2013, 2015; Organisation for Economic Co-operation and Development [OECD], 2013a).

The availability of technology has become commonplace in today's classrooms. However, the integration of technology-assisted instruction involves a paradigmatic shift in traditional mathematical practices (Aydm, 2005). Framed in constructivist ideology, technology integration challenges educators to grow through the expansion of three frames of knowledge—content knowledge, pedagogy knowledge, and technology knowledge (Koehler, Mishra, & Cain, 2013; Paily, 2013). Instructional technology, such as interactive whiteboards, handheld tablets, laptops, software, and desktop-based devices serve as a tool to aid students in communicating mathematically and conceptualizing mathematical reasoning (Henrie, Halverson, & Graham, 2015; National Council of Teachers of Mathematics [NCTM], 2014). Despite grandiose financial investments in technology, Bhat (2016) argued that educators'use of these tools in the classroom have maintained a teacher-centered, monolithic approach to instruction that merely eases traditional administrative tasks. Within a monolithic approach, teachers utilize a single instructional practice for all students, such as lecturing to a classroom using the same textbook (Christensen et al., 2011). This continued retention of conventional math instruction repudiates an opportunity for disruptive student-centered approaches to teaching (Ball, 2012; Christensen et al., 2011; Harris & Hofer, 2011; Kumari, 2013; Zhao, Tan, & Mishra, 2001).

The problem this study seeks to address focuses attention on the stagnant nature of math achievement in American schools. Research supports the use of instructional technology in math as a means to address the discontinuity of progression. Educators are not effectively implementing technology using strategies that promote disruptive student-centered learning opportunities. The body of research is rich with data on the generality of teachers' use of technology among teachers in the pre-Millennial generation. Each year as more pre-Millennial teachers retire, current data related to technology use become less relevant to the representation of educators in the field. There remains a significant gap in the literature specific to Millennial teachers in all content areas, especially math. To understand the role technology plays in the instructional realm of 21st century learners, it is imperative that data is collected regarding Millennial teachers as they move closer to becoming the projected dominant group of educators. In studying Millennials, researchers have identified sub-generation descriptors that must be explored within this population of teachers. Finally, the literature presents limited data associated with the variety of modern technologies used by Millennials within an elementary math learning environment.

Purpose Statement

The purpose of this quantitative, correlational study is to relate Millennial teachers' age to the frequency and variety of instructional technology used during math instruction at public PreK-5 elementary schools in Texas. For this research, the target population adhered to the Bridgeworks (2017) report descriptors, which define Early Millennials as those born between 1980 and 1987 and Late Millennials, or Recessionists, to include those born between 1988 and 1995.

Significance of the Study

Application at the Local Level

The results of this study aid in focusing mathematical instruction at the elementary level. Research has suggested that in many classrooms technology is used as a substitution for traditional learning activities such as projecting assignments, or using a word processing program to type a research paper (Bebell, Russell & O'Dwyer, 2004; Kumari, 2013; Teo, 2006). Teachers have identified barriers due to a lack of resources and training, insufficient time, attitudes, beliefs, and resistance to change as reasons for the lack of adequate integration of technology (Hixon & Buckenmeyer, 2009; Wozney, Venkatesh, & Abrami, 2006). Educational leadership at the school and district levels may utilize the data provided as a tool in the development of professional learning opportunities that address the needs of Millennial teachers specifically. In the identification for a possible resistance of use, districts can be proactive in treating the concern.

Professional Application

Teachers play a pivotal role in equipping today's students with the technical skill necessary for their future careers (Bertram, 2014; Christensen et al., 2011; Wagner, 2008; Wimberly, 2016). Teachers may use this study as a reflective tool for how their age and professional experience may correlate with the types of technology used during math instruction. From a contemplative nature of their analysis, teachers may seek ways to improve their current use of instructional technology during math instruction. There is a need to sharpen the focus of elementary math educators' ability to provide direction with tools designed to meet student needs. By targeting possible correlating factors that may affect implementation, and seeking support proactively, student populations will be positively impacted on a grander scale. There is no doubt that Millennial teachers will become the dominant group of educators. Therefore, it is imperative that Millennials take note of traditional approaches to instruction that have proven effective, and use them to birth new innovative strategies that incorporate skills necessary for the success of 21st century learners in math.

Research Question(s)

RQ1: To what extent, if any, does a relationship exist between millennial teacher age and the frequency of instructional technology used during PreK-5 math instruction?

RQ2: To what extent, if any, does a relationship exist between millennial teacher age and the variety of instructional technology used during PreK-5 math instruction?

Definitions

1. *Millennials*—Individuals born between 1980 and 2000 (Houck, 2011; Smith 2013). For this research, the target population will adhere to Bridgework's (2017) report descriptors, which

define Early Millennials as those born between 1980 and 1987 and Late Millennials, or Recessionists, as those born between 1988 and 1995 (Bridgework, 2017).

2. *Instructional Technology*—"The theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning" (Seels & Richey, 2012, p. 1), specifically those processes and resources that use computer-based technologies.
3. *Technology Integration*—The process of merging face-to-face instruction with online technologies to facilitate teaching and learning in the classroom (Al-Ani, 2013; Phillips, Kennedy, & McNaught, 2012).

Summary

This doctoral study has attempted to correlate teachers' age with the frequency and variation of technology integration during math instruction at the elementary level. Chapter 1 has offered background knowledge for the problem, a statement of the problem, the purpose of the study, and the significance of this research from the local and professional application. The chapter concluded with operational definitions utilized throughout the dissertation. Chapter 2 will offer a review of the literature related to the research. Chapter 3 will focus on the Methodology for this study, followed by Chapter 4 in which the results will be analyzed. In conclusion, Chapter 5 will offer a discussion of the findings and recommendations for further research.

CHAPTER TWO: LITERATURE REVIEW

> *"It is hard to think about computers of the future without projecting onto them the properties and the limitations of those we think we know today. And nowhere is this more true than in imagining how computers can enter the world of education."* (Papert, 1980, p. 5)

The state of mathematics in the United States remains a point of concern for educators (Bertram, 2014; Eddy et al., 2014; Hartsell et al., 2010; National Center for Education Statistics [NCES], 2015; Organisation for Economic Co-operation and Development [OECD], 2013; US Department of Education, 2010). With the adoption of Common Core State Standards (CCSS) in states and territories around the United States (Achieve, 2013; National Governers, 2017), schools have been forced to restructure their curriculum, strengthen teachers' content knowledge, and refocus professional learning (Kane et al., 2016).

A historical reflection supports the use of instructional technology in the context of a constructivist-learning environment for student academic success and improved teacher pedagogy in mathematics (Borba et al., 2016; Delialioglu, 2012; Wang, 2011). As Baby Boomers and Generation X teachers retire, a generational shift in power has begun within the professional realm of education. The number of Millennials entering the teaching profession each year has increased, thereby initiating the need for research aimed at understanding the professional traits of this dominant group. This chapter will review the literature and offer theoretical and historical perspectives of instructional technology use in the classroom while analyzing research on the benefits of technology use for instructional purposes within a constructivist, student-centered learning environment. It will further discuss Millennial traits and seek connections in the literature to support differentiated perspectives toward technology use based on age.

Theoretical Framework

The use of technology in the classroom proves ineffective without a theoretical foundation driving instructional practice (Gilakjani, Lai-Mei, & Ismail, 2013; Nanjappa & Grant, 2003). Similarly, a dissertation must also have a guiding theory. Two theoretical perspectives are used for this research: Rogers's Diffusion of Innovation Theory and Constructivism.

Rogers's Diffusion of Innovation

The adoption of instructional technology requires the acceptance of innovation by the stakeholders. Rogers's Diffusion of Innovation Theory (DoI), is an appropriate theoretical frame to explore the adoption of technology by Millennial teachers in an elementary learning environment (Sahin, 2006). Also, the DoI offers a comprehensive framework for addressing factors associated with users' technological motivation and adoption behaviors (Chang, 2010). The historical foundation for the Diffusion of Innovation Theory began with the original plot of an S-shaped diffusion curve by French sociologist Gabriel Tarde in 1903 (Toews, 2003). Adopter categories, which would later be popularized by Everett Rogers, took root from the investigation into the diffusion of hybrid seed corn in Iowa by B. Ryan and N.C. Gross in 1943 (Ryan & Gross, 1943).

Innovation is defined as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12). In comparison, diffusion is the manner in which the innovation is communicated between members of a social system over time (Rogers, 2003). According to Rogers (2003), technology serves as the basis for knowledge during the decision process of innovation acceptance, thereby reducing the uncertainty associated with the cause-effect relations involved in achieving an outcome. Embedded within the DoI are two elements of technology: hardware and software. Rogers (2003), defined hardware as "the tool that embodies technology in the form of a material or physical object," and software as "the information base for the tool" (p. 259).

Innovation-Decision Process. The Diffusion of Innovation-Decision Process involves the accumulation of knowledge and information processing in determining the motivation and reduction of uncertainty regarding the advantages and disadvantages of innovation adoption (Sahin, 2006). This process involves the composition of the following five stages (Rogers, 2003):

(1) *Knowledge*. During the knowledge stage, individuals seek cognitive understanding of the innovation and define its critical "what," "how," and "why" associations. Three sets of knowledge are obtained during this phase: Awareness knowledge, How-to knowledge, and Principles knowledge.

(2) *Persuasion*. The persuasion stage is where individuals create their opinion of the innovation and develop a negative and positive perspective. This stage offers an affective approach to determine how an individual feels about the innovation.

(3) *Decision*. In the decision stage, individuals decide if they will accept or reject the innovation. Two forms of rejection are displayed: active or passive. Active rejection involves the individual trying the innovation and then rejecting it. In passive rejection, an individual shows no interest in the innovation at all.

(4) *Implementation*. Implementation involves individuals using the innovation and determining if they require assistance. It is during this stage that individuals experience levels of uncertainty and, in turn, may discover they are in need of technical assistance from change agents.

(5) *Confirmation*. During the final stage of the Diffusion of Innovation Process, individuals seek support and determine if they will keep the innovation. When uncertainty goes unresolved, rejection of the innovation may occur. Replacement Discontinuance occurs when the innovation is replaced with one that is deemed better. Disenchantment Discontinuance happens when an individual is dissatisfied with the innovation (Rogers, 2003; Sahin, 2006) and rejects it.

The theory of DoI proposes that "the individuals or other units in a system who most need the benefits of a new idea (the less educated, less wealthy, and the like) are the last to adopt an innovation" (Rogers, 2003, p. 295). The DoI theory applies to two groups: early adaptors and late adaptors. Early adaptors include innovators, early adaptors, and the early majority. The late adaptors include the late majority and laggards.

Innovators. Rogers (2003) described innovators as those willing to take the risk to experience new ideas. With this risk comes the coping ability to handle the terms associated with a possible loss in the incidence of unprofitable or unsuccessful innovations (Sahin, 2006). This group is also responsible for introducing innovations to the mass community.

Early Adaptors. In this category of diffusion innovation, individuals are more apt to seek advice or information related to the innovation before fully committing. Early adaptors are often leaders who have set parameters preventing them from taking the initial risks associated with innovation (Sahin, 2006). This group is seeking to find precursors to unprofitable risks related to the innovation before trying it (Rogers, 2003). Many Millennials fall into the category of early adaptors. Once this group has obtained enough information on the technology, either through formal or informal channels, they are more apt to decide to accept or reject an innovation (Blackburn, 2011).

Early Majority. Similar to early adaptors, the early majority has a vital role in the delivery of the innovation to the social system. However, unlike the early adaptors, the early majority does not possess leadership qualities necessary to maintain the initial push of the innovations. They tend to linger in the center of the diffusion process, neither initiating nor ending the process of innovation assimilation (Rogers, 2003; Sahin, 2006).

Late Majority and Laggards. The final two categories of diffusion include the late majority and laggards. The late majority are those who wait for each of the preceding groups to adopt the innovation before they feel it is safe enough to try (Rogers, 2003). Laggards are less likely to adopt the innovation until they have witnessed its success in the social environment. Rogers suggests that laggards tend to be those who may experience a more significant risk for a failed innovation, such as those from a low socio-economic setting (Rogers, 2003; Sahin, 2006).

Constructivism

Constructivism is a theory "based on the conception that we learn by relating new experiences to our prior knowledge and construct new understandings based on what we already know" (Kurshan & Sherman, 2005, p. 10). For educators, it is a challenge to measure and tailor instruction to a student's prior knowledge. Rooted in the works of Bruner (1962, 1979), Piaget (1970), and Vygotsky (1962, 1979), constructivism offers a complementary perspective advocating the use of instructional technology during classroom instruction. Its philosophical and psychological approach is based on the social cognitivist ideology that assumes individuals' behaviors, and environments interact in a communal nature (Nanjappa & Grant, 2003).

Gupta (2008) described constructivism as a "theory about knowledge and learning" (p. 382). In the ascription of constructivist ideas, learning involves a mental construction garnered through discovery and investigation. Isolated from age and developmental restrictors, constructivism utilizes concrete examples, discussion, and reflection to promote self-regulated processes designed to address collaboration, primitive activity and exploration, the practice of respecting multiple points of view, and authentic problem solving (Gilakjani et al., 2013; Gupta, 2008). Effective constructivist learning environments involve the construction of learning by the student rather than the delivery of information by the teacher. In comparison, the incorporation of constructivist practices and the use of technology in the classroom produce similar outcomes toward the goal to engage learners (Gilakjani et al., 2013). Van De Walle (2004) suggested that constructivism provides educators with insight as to how children learn mathematics, therefore guiding educators' instructional practice toward the development of student-centered learning opportunities rather than teacher-centered common practices.

The teacher plays a pivotal role in student performance within a constructivist classroom. A teacher grounded in constructivist ideologies creates "learning environments that are invigorating, interactive, immersive, and informative" (Gilakjani et al., 2013, p. 50). Pichat and Ricco (2001) suggested that the process of learning is structured within a tertiary framework that includes knowledge, the student, and the teacher. With Vygotisan ideals in mind, mathematical mastery requires not only the acquisition of knowledge of procedures, but also an understanding of when to employ these said procedures. This process involves the guidance of a teacher whose instruction is influenced by Vygotsky's zone of proximal development (Pichat & Ricco, 2001).

Related Literature

Educational Reform and the Progression of Math Education in America

Addressing the challenge of educational reform in the United States has sparked discourse among political and professional leadership since the 19th century (Stanic & Kilpatrick, 1992). Often driven by a political agenda, the call for educational reform gained strength during the 1980s and 1990s and continues to influence the manner in which mathematics is taught in the 21st Century (Klein, 2003). This reformation period included efforts to develop standard curriculum, but disputes continued between stakeholders about best practices for mathematics instruction (Klein, 2003). By exploring the historical development of mathematics education in the United States, this section will paint a picture of the progression of math education and its relation to technology integration (Klein, 2003).

Historically, mathematics was not viewed as a point of importance in schools during the colonization of the New World. As European settlers inhabited the land, the motivation for their presence varied considerably. While some entered in search of fortune, others sought religious freedom and/or the opportunity to convert indigenous people to Christianity. As a result, colonial education in the New World chose less institutionalized instruction that focused on grammar-based contents such as reading, writing, and spelling. Arithmetic and ciphering were generally omitted entirely from elementary education (D'Ambrosio, Dauben, & Parshall, 2014). In 1639, Dutch authorities in Europe required that their colonies begin teaching children reading, writing, ciphering, and arithmetic, in addition to Christian religion and salvation (D'Ambrosio et al., 2014). Initially, Quakers were not convinced that mathematics education was necessary, but after some time, began incorporating curriculum that emphasized the four Rs of "religion, arithmetic, writing, and reading" (D'Amrbosio et al., 2014, p. 177).

In 1789, an Education Act passed in Boston requiring that boys ages 11-14 learn a "standardized course of arithmetic through fractions" (Cohen, 1982, p. 131, as cited in D'Ambrosio et al., 2014). It was not until the end of the 18th century that North American educational values began to institutionalize a consistent standard for elementary mathematics education. As the 19th century began, the demand for primary education grew, and approximately 90% of all children in the United States enrolled in public primary schools. This dramatic increase in students presented a challenge for educators. As students continued to fail to demonstrate mastery in math, the urgency to develop curriculum reform persisted during the 20th century (Stanic & Kilpatrick, 1992).

The 1950s and 1960s brought hope for curriculum reform as federal funding was granted for research and training in mathematics. The United States government sought to produce scholars, teacher educators, and highly prepared mathematicians who would help the country become more competitive internationally by shorting the gap between math and science development (Woodward, 2004). During this time, concerns grew that K-12 curriculum was out of date and not adequately preparing students for collegiate-level math instruction. This concern prompted large-scale curriculum development projects introduced by various research groups over the next few decades (Woodward, 2004).

In 1983, the U.S. government released *A Nation at Risk* (National Commission on Excellence in Education [NCEE], 1983). This report highlighted the weak stance of American schools, referring to the "rising tide of mediocrity" (NCEE, 1983, p. 15). A demand for rigor increased across the country as educators scrambled to remedy the shortcomings detailed in the report. Despite efforts for improvement, concern continued regarding the poor state of educational matters.

No Child Left Behind (NCLB) (2002), is a term too familiar to educators in the public school system in the United States. Since NCLB's inception, educational culture has changed dramatically in response to schools' attempts to fulfill the requirements of high-stakes testing. Under NCLB, goals were introduced that required states to test students in reading and math in grades 3-8 and once in high school. The expectations were that all students would meet or exceed state standards in reading and math by 2014 (U.S. Department of Education, 2002). Some years after the inception of NCLB, there is little convincing evidence to indicate significant improvement in student achievement occurred under this program (Ladd, 2017). Research from the National Assessment of Educational Progress (NAEP) (2013; 2015) showed that there has been no substantial increase in scores, nor have the achievement gaps between the higher and lower socioeconomic communities narrowed (Berliner & Nichols, 2008).

Current State of Mathematics in the United States

The National Assessment of Educational Progress (NAEP) reported in 2013 that 26% of 12th grade students in the United States scored at or above proficient levels in math. The same study concluded that 35% of high school seniors failed to meet basic college- and career-ready mathematical concepts (NAEP, 2013). In 2015, scores decreased to 25% of American seniors demonstrating proficiency in math. A comparison of quadrennial and biennial NAEP math scores for the current trend line found no significant growth between scores from the initial assessment in 2005 and the most recent scores in 2015 (NAEP, 2015).

The National Mathematics Advisory Panel (NMAP) (2008) linked elementary concepts, such as number competence, to student difficulty mastering middle and high school math content. A 2013 NAEP report found 34% of fourth-grade students in the United States to be proficient in mathematics (NAEP, 2013). To visualize these statistics, in 2013, one in every five fourth-grade students in the United States failed math (Bertram, 2014; NAEP, 2013). This trend continued as the release of the 2015 NAEP reported a continued decrease in overall math scores in grades 4 and 8, when compared to 2012 scores (NAEP, 2013, 2015).

Geary, Hoard, Nugent, and Bailey (2013) reported that in 2007, 22% of American adults were functionally innumerate due to a failure to master mathematical concepts expected by eighth grade (NCES, 2007). A decade later, data collected from the same measure suggested a decrease in success rates, with 25% of the students unable to demonstrate mastery of mathematical concepts (NCES, 2017) in grade 12. The lack of mastery in mathematics has led to adults being unable to meet the qualifications necessary for jobs that require routine quantitative tasks (Geary, Hoard, Nugent, & Bailey, 2013). In a K-9 longitudinal study of mathematical development, Geary et al. (2013), found that "children who begin first grade with low number system knowledge are at heightened risk for low functional numeracy scores in seventh grade" (Geary et al., 2013, p. 5). The call for early identification and remediation of knowledge deficiencies is required to ensure long-term risks of innumeracy remain at bay.

Trends in low academic readiness in mathematics, such as reported by NAEP, link to deficiencies in concept mastery in grades as early as kindergarten (Bertram, 2014; Jordan & Kaplan, 2009). For example, a longitudinal study conducted by Watts, Duncan, Siegler, and Davis-Kean (2014), observed 1,364 children from birth until the age of 15, in search of mathematical and literarily correlations over time. Data from this study suggested that even with the adjustment of moderate variables (e.g., academic skill, home environment, and cognitive ability), correlations existed between the mastery of mathematical concepts in preschool and first grade and math achievement through the age of 15 (Watts et al., 2014).

Educational Standards Adapt to Meet 21st Century Skills

To address inconsistency in educational standards in the United States, the National Governors Association (2010) developed Common Core State Standards (CCSS) for voluntary use by the states. As of 2017, 42 states, four territories, and the Department of Defense Education Activity (DoDEA) have adopted the CCSS (National Governers, 2017). The response to this initiative has prompted institutions to restructure their curriculum to meet the demands of 21st century learning goals (Kane et al., 2016).

In 2009, President Obama signed the American Recovery and Reinvestment Act (ARRA) of 2009, which included 4.35 billion dollars, dedicated to the Race to the Top (RttT) initiative. To date, RttT remains the most substantial federal competitive investment in educational reform in the United States (U.S. Department of Education, 2009). Through this program, states were offered an opportunity to compete for federal funding in exchange for the incorporation of reform efforts within their educational agenda (Howell & Magazinnik, 2017). A pivotal component of RttT included the focus on early education literacy and STEM development through the Resources for the Early Learning program. The curriculum focused not only on children between the ages of 3 and 5, but also targeted children from birth to 33 months in the areas of physical and social-emotional development (Keith, 2015).

The competitive program incentives of RttT required the incorporation of NCLB reforms and encouraged states to support educational innovations in exchange for additional school funding (Howell, 2015). Race to the Top focused on the following four areas for improvement:

1. The adoption of internationally benchmarked standards and assessments that would prepare the student for success in college and the workplace;
2. Aid in the development, retention, and reward of effective teachers and principals in high needs areas;
3. The development of data systems that would measure student success while providing information to teachers and principals on strategies for improving instruction; and
4. Turn-around of low performing schools (U.S. Department of Education, 2009).

A common myth suggests CCSS was developed in response to NCLB and enforced through RttT. However, developers of Common Core cite that development of CCSS existed before the initiation of ARRA and RttT (National Governors Association, 2010).

Defining Instructional Technology

April Chamberlin stated that “we cannot teach our students in the same manner in which we were taught. Change is necessary to engage students not in the curriculum we are responsible for teaching, but in school. Period” (Techbytes, 2012, para 12). Straightforward in thought, the time has come for change, a disruption in the way children are taught in today’s schools (Christensen et al., 2011). The 2012 Census reported 86% of school-age children in America had computer access in their home. Technology has modified the way in which interactions occur and is reciprocally related to the necessary approach for acquisition of the 21st century skills. A unifying operative definition is required for this research to address the use of technology by teachers. Varied definitions exist for instructional technology. However, it is commonly defined as the tools for the preparation of instruction, such as lesson planning, collaboration, and creating digital resources. For this research, instructional technology will be considered as “the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning” (Seels & Richey, 2012, p. 1).

The Evolution of Instructional Technology

For centuries, formalized education in America utilized a teacher-centered approach set to achieve the desired goal. Currently, teacher learning models continue to direct learning outcomes in schools across the country. Historically, the United States’ educational foundation derived from a teaching system designed to distribute information uniformly (Wimberley, 2016) to fulfill the specific task of maintaining a society capable of functioning interdependently

(Christensen, 2011). According to Christensen, Horn, and Johnson (2011), the teaching environment was historically developed to meet the following four goals: (1) preserve democracy; (2) provide something for every student; (3) maintain global competitiveness, and (4) eliminate poverty. Unfortunately, the modernization of goals has been a slow process, and current goals are stifled by the remains of these foundational expectations within American education through the sustaining of innovations (Christensen et al., 2011).

The past three decades have revealed a transformation in math education regarding the incorporation of educational technology. Overall computer accessibility in public school has seen marked increases since the 1980s. In 1984, the computer to student ratio sat at 1:125, as compared to the most recent published account wherein every 1 in 0.15 students have access to a computer (NCES, 2008). During the 1980s the use of standard calculators reflected progressive learning. However, as noted by Connell and Abramovich (2016), today's students have access to a plethora of electronic devices, some of which include pocket computers like Smartphones, which far exceed the basic uses of the calculators from decades past.

Inan and Lowther (2009) found that technology use in the classroom could be categorized into three groups: technology for instructional preparation, technology for instructional delivery, and technology as a learning tool.

Technology for Instructional Preparation. Technology for instructional preparation is the most common use by classroom teachers (Bhat, 2016; Christenson et al., 2011; O'Dwyer, Russell, & Bebell, 2003). However, according to Kopcha (2012), a gap exists between the amount of technology available in schools and the frequency with which teachers use it for instructional purposes. Technology is frequently used as administrative tools to complete tasks such as searching for materials for a lesson, grading, and attendance (Bebell et al., 2004; Bhat, 2016; Kopcha, 2012). More recent data collected from Houghton Mifflin Harcourt's 2017 Educator Confidence Report indicated that 98% of educators used digital materials to complete work tasks such as peer communication and collaboration, instructions and interactions with students, and communication with families.

Technology for Instructional Delivery. Teacher use of technology in the classroom has a significant effect on classroom technology integration (Liu, Ritzhaupt, Dawson, & Barron, 2017; Miranda & Russell, 2012). Lei and Zhao's (2008) mixed-methods study found student use of instructional technology tools such as laptops is most frequently limited to performing tasks such as note taking, searching the internet, and research. Nearly a decade later, minimal changes have occurred in reference to student and teacher use of instructional technology. A progression of the literature on technology integration suggests that teachers' level of confidence plays a significant role in technology integration within an academic setting (Hernandez-Ramos 2005; Inan & Lowther 2010; Kreijns et al., 2013; Lim & Chai 2008; Liu et al., 2017; Mueller et al., 2008; van Braak et al., 2004; Wozney et al., 2006; Zhao & Frank 2003).

According to Liu, Ritzhaupt, Dawson, and Barron (2017), teachers' years of experience have a significant influence on their comfort level and confidence with the use of technology. Decades of research on teacher self-efficacy levels for learning and teaching with technology have shown a direct link to the level of technology they use in the classroom (Hernandez-Ramos, 2005; Inan & Lowther, 2010; Kreijns et al., 2013; Lim & Chai 2008; Mueller et al., 2008; Overbaugh, 2015; van Braak et al., 2004; Wozney et al., 2006; Zhao & Frank 2003). Albion (1999) argued that teachers' confidence serves as a strong indicator of their ability to work effectively with technology and the degree they integrate it into classroom instruction. Additionally, an educator's amount of experience working with technology, computers specifically, plays a role in the frequency and variety of digital resources utilized in the classroom (Houghton Mifflin Harcourt, 2017). For example, 62% of teachers with 11 or more years of classroom experience report using technology more often than teachers with less experience and for a variety of purposes. Such reported use included digital versions of print materials, online assessments, and digital communications for interactions with parents (Houghton Mifflin Harcourt, 2017).

Technology as a Learning Tool. The exponential growth of technology initiatives in K-12 schools can be attributed to the increased availability of resources, such as reduced costs, lightweight laptops, and expanded availability of wireless connectivity accessibility (Harper & Milman, 2015; Penuel, 2006). The use of technology assists teachers with time management and allows for immediate and focused feedback on the current topic of study (Kurshan & Sherman, 2005). In a review of technology use in K-12 instruction, three themes emerged from the literature: (a) student achievement, (b) changes to the classroom environment, and (c) student motivation and engagement (Harper & Milman, 2015).

In a quantitative study on 1:1 laptop use by fifth-grade students in low socioeconomic status (SES) communities, Shapley, Sheehan, Maloney, and Caranikas-Walker (2010) found that a correlation exists between student use for homework and educational games with achievement scores. An introduction of technology into the classroom environment invites opportunities for more in-depth learning experiences, new instructional approaches by teachers, and active interactions between the students and teacher (Harper & Milman, 2015).

Barriers to Technology Integration

The past 20 years have brought exponential growth in the variety and frequency of technology use in the classroom. Most teachers recognize the importance of instructional technology; however, for some, negative technology self-efficacy prevents them from utilizing it beyond the traditional purpose of accessing model lesson plans and research (Bhat, 2016). The review of the literature links teachers' minimal use of technology integration during instruction to a lack of resources and training, insufficient time, attitudes, beliefs, and resistance to change (Hicks, 2011; Hixon & Buckenmeyer, 2009; Wozney et al., 2006). In a study of educational technology use by teachers, Bhat (2016) concluded that 20-39% of classroom teachers refrain from using technology out of fear of embarrassment, classroom management concerns, a personal view that a computer is a complicated device, or a lack of training. In this same study, the author found there to be no difference between the attitudes of experienced and new teachers as it relates to technology use for instruction.

Instructional Technology Use and the 21st Century Classroom

As Deye (2015) stated, "Today's students are immersed in technology in nearly all aspects of their lives, except when they are in school" (p. 1). Bhat et al. (2016) argued that in today's classroom, it is difficult to communicate without the use of technology. Despite billions of dollars spent for educational reform, there remains a deficiency in instructional improvement. Falck, Mang, and Woessmann (2018) proposed that the specific use of computers to perform traditional applications offered the potential for more effective conventional teaching alternatives. For example, data collected on fourth-grade students found using computers to practice skills and procedures had a positive impact on their overall math achievement (Falck, Mang, & Woessmann, 2018). Thus, it is not the tool that solidifies student academic success, but rather the targeted activities that are employed through the use of specific electronic devices (Falck et al., 2018). Statistically stated, the overall null effect of technology use, computers specifically, is relatively the sum of positive and negative effects (Falck et al., 2018).

The acquisition of 21st-century skills continues to dominate the discussion in education. However, the definition of such skills remains varied in the literature (Donovan, Green, & Mason, 2014). The lack of a consistent operational definition for 21st-century skills makes it difficult to determine if authentic 21st-century instruction is taking place in today's classrooms. Within the system of technology integration lies the interconnectedness of the machine, materials, media, men/women, and methods all working succinctly toward meeting the educational objective (Bhat, 2016). For technology to be useful, the pedagogy associated with it must be effective itself. Researchers have argued that the use of computer-assisted learning tools in the classroom produces more effective use of time, opportunities for individualized instruction, more efficient monitoring of student progress, and improved access to international information (Bulmam & Fairlie, 2016; Christensen et al., 2011; Falck et al., 2018). Instructional technology does not serve as the cure-all for the woes of the educational system, but it is merely a necessary tool that will aid in the delivery of instructional material appropriate for the development of skills required for 21st-century student success (Bhat 2016; Deye, 2015; Donovan et al., 2014).

According to Christensen (2009), educators are approaching the needs of students from the wrong perspective. The use of a 21st-century teacher model requires educators to identify the individual needs of students and relay a product that will incite relevant situations that tap into their unique intelligence (Christensen, 2009). Technology plays a pivotal role in supporting schools' desired learning goals, learning processes, and learning outcomes toward the development of 21st-century scholars (Kong et al., 2014). Within a constructivist learning environment, technology-based interactivity relevant to the students' social communities facilitates learning and dialogue that promotes authentic learning experiences.

Researchers Donovan, Green, and Mason (2014) sought to develop an innovation configuration map that would measure the use of 21st-century skills in the classroom. In their map, derived from the 2011 Partnership for 21st Century Skills (P21) framework, the authors argued that to develop in students appropriate 21st-century skills, those students require opportunities for creativity and innovation, collaboration, critical thinking, and communication.

Mathematical Rigor, Educational Technology, and Student Success in Mathematics

The acquisition of foundational math concepts is critical to continued academic success in high school and college (Bertram, 2014; Jordan & Kaplan, 2009). In response to the adoption of Common Core Standards, the National Council for Teachers of Mathematics (NCTM) (2014) released *Principles to Actions*. This publication provided teachers with guidance for successful implementation of the Common Core standards (Cosby, Horton, & Berzina-Pitcher, 2017). NCTM used the latest research to outline six principles required of educators to aid in the integration of CCRS in the classroom (Cosby et al., 2017). Included in these principles was the call for teachers and students to use tools and technology for instructional purposes (National Council for Teachers of Mathematics, 2014).

The skills gleaned in childhood have been shown to have a direct correlation with SES, into adulthood (Kutner et al., 2007; Ritchie & Bates, 2013; Watts et al., 2014). The skills acquired in high school predict positive outcomes in the areas of college degree attainment, job quality, and health care choices (Watts et al., 2014). More recent data on the topic indicate that students' knowledge of number systems (Geary et al., 2013) and whole number knowledge (Bailey Siegler, & Geary, 2014) in kindergarten and first grade were highly predictive of their mathematical ability, fractional conceptual understanding, and fraction arithmetic skills in middle school (Watts et al., 2014).

Ritchie and Bates (2013) found that an individual's level of mathematics at age 7 has a substantial and positive impact on the SES of that adult at the age of 42. In this study, the researchers hypothesized and concluded that correlations existed between elementary mathematics and reading skills in four ways. First, persons able to demonstrate higher academic skills are prone to be more successful in an occupational context, thereby having improved chances of career development (Ritchie & Bates, 2013). Next, a lack of numeracy skills is associated with poor financial decision making (Agarwal & Mazumder, 2013; Ritchie & Bates, 2013). Third, research has shown that poor numeracy and reading are linked to a misunderstanding of medical information and ill health decisions (Anker & Kaufman, 2007; Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011; Ritchie & Bates, 2013). Finally, an individual's capacity for reading is positively associated with his or her self-esteem (Kiuru et al., 2012; Ritchie & Bates, 2013), which in turn predicts economic prospects and negative associations with delinquency (Ritchie & Bates, 2013). Thus, the researcher posits that the skills children learn during their elementary years can either serve to benefit or stifle their academic attainment as they progress through high school, matriculate through college, and go into their adult careers.

As the revolution toward a student-centered learning environment continues to disrupt institutions across the country, the role of the teacher remains at the center of dialogue. For learning to occur in a classroom, quality teachers are required (Gilakjani et al., 2013). The quality of teaching is measured best by its impact on student achievement by way of assessed learning (Coe, Aloisi, Higgins, & Major, 2013). As the learning needs of students change, teachers must also transcend from the traditional "directive" approach to that of a consultant approach to instruction (McCarthy, 2015).

Research has further posited that the use of technology for instructional practice has increased over the years (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). The United States is challenged with balancing the learning sciences with modern technology to create engaging, relevant, and personalized opportunities for learners (U.S. Department of Education, 2010). Millions of dollars have been spent by schools cramming computers into classrooms. Students, however, have reported use to be sparse and inconsistent (Christensen et al., 2011). Constructivism serves as a framework to guide the use of instructional strategies that motivate student learning in mathematics (Van De Walle, 2004). Although teachers support the idea of technology integration through a constructivist approach to mathematical instruction, research finds that many are unsure of where to begin (Gilakjani et al., 2013).

In an evaluation of teachers' interaction, it is essential that the discussion include the topic of mathematical rigor and its connection and importance to the use of instructional technology in elementary mathematics. Rigor, from an educational standpoint, refers to "a condition that encourages creative problem-solving in new exciting contexts, yielding perseverance and satisfying growth in knowledge and skills" (Carlson, 2016, p. 18). The incorporation of technology during math instruction opens the window for flexible, creative, yet challenging opportunities for growth and inspiration, all of which are components of rigorous instruction (Carlson, 2016; Christensen et al., 2011). A student engaged in rigorous learning opportunities demonstrates a complex cycle of growth that generates deeper thinking and increasingly complex problem-solving skills (Carlson, 2016).

Traditional instructional tools can be categorized by the "specificity" and "stability" of their use (Koehler & Mishra, 2009, p. 61). For example, a pencil is used to write, a microscope is used to view objects too minute for the naked eye, and the whiteboard is to be used for the passage of knowledge to learners (Koehler & Mishra, 2009; Majocha, 2015). Today's society finds tools such as laptop computers and software applications as mechanisms for everyday tasks, thereby redefining their label as technology. Teachers play a crucial role in the integration of technology in the classroom (Ertmer et al., 2012; Lui et al., 2017). Educators are tasked with creating extensions that transform instructional technology tools into relevant models for instruction that meet the needs of 21st-century learners in the classroom (Majocha, 2015).

The brain science behind the use of visual representation supports the use of technology in the classroom. The human brain consists of distributed networks that work in a communicative nature to disseminate knowledge across the ventral and dorsal pathways (Boaler, Chen, Williams, & Cordero, 2016). It is through this widely distributed network that mental processing of mathematics knowledge occurs. When learners are engaged in visual representations in math, increased comprehension of skills occurs (Boaler et al., 2016). Effective mathematics teachers incorporate visuals, manipulatives, and motion to enhance a student's understanding of mathematical concepts (Boaler et al., 2016). As children grow, the brain becomes more interactive and begins to connect the visual and visuospatial knowledge of symbolic number forms. From this, it can be suggested that the use of visuals developed for instructional purposes with technology in elementary mathematics, will in turn yield increased improvement in overall numeral proficiency (Boaler et al., 2016).

The use of technology for learning can be modeled through examples such as educational digital game software. Digital games are plentiful in the realm of education. Recent years have found digital games to include those aligned with teachers' standards integrated into the curriculum (Callaghan et al., 2018). Most of the educational digital resource games are expected to supplement rather than supplant effective instruction. Digital games provide students with relevant, rigorous opportunities for increased content learning reflective of instructional goals (Callaghan et al., 2018; Wouters & Oostendrop, 2013). An example of such is the Spatial-Temporal, (ST Math) program (Coulson, Wendt, Rice, & Nakamoto, 2018).

ST Math is an interactive resource in which learning is made assessable through visual game-based learning. Widely popular in elementary schools across the country, ST Math moves from traditional modes of math drills and tests to encourage learning through discovery and trial and error. Students begin to build conceptual understanding of math skills required for mastery all while inspiring creativity, problem solving, and the transference of knowledge (Carlson, 2016). In the most comprehensive research on educational technology math programs to date, WestEd's quasi-experimental study assessed mathematics outcomes in elementary schools utilizing the ST Math program with fidelity (Coulson et al., 2018). The researchers collected data from 150,000 students in grades 3-5 at 474 treatment schools in the United States. Included in the data set were standardized test scores from the 16 states that participated in the study (Coulson et al., 2018; Mind Institute, 2018). WestEd concluded that the use of game-based math programs such as ST Math to supplant instruction, when used with high fidelity, yielded significant academic growth in math. Campuses who utilized the program consistently demonstrated marked growth on statewide assessments, exhibiting an average increase in rankings of 14 percentile points (Coulson et al., 2018).

A quasi-experimental study conducted by Eyyam and Yaratan (2014) proposed that instructional technology has a positive impact on student success and attitude toward math lessons. This same study found students who engaged in math instruction using technological tools to have significantly higher posttest results than those who were taught using traditional teaching methods (Eyyam & Yaratan, 2014). Rather than using computers as an adaptive tool for improving current instructional practices, instructional technology should be utilized as a primary instructional mechanism for customized student learning (Christensen et al., 2011, p. 81). The capacity of computer software lends itself to a system of self-paced instruction often restricted within a whole group instructional model (Bulman & Fairlie, 2015). Advancements in technology now support different objects of mathematical reasoning. A noted example of the transformative use of technology in elementary math education is the use of the National Library of Virtual Manipulatives. Virtual manipulatives afford the opportunity to mimic hands-on manipulation of materials essential to elementary math instruction (Connell & Abramovich, 2016).

Understanding the Millennial Educator

The Millennial Generation, also referred to as Generation Y (Monaco & Martin, 2009) and the Net Generation (Tapscott, 2009), describes a densely populated demographic who have shifted the psychological ideologies that have dominated the society in which they dwell. Cited as being the most diverse generation (United States Census, 2015), it makes up approximately 38% of the U.S. workforce, and the majority of newly hired teachers (Hodges, 2016). Millennials sparked a shift in societal expectations when they surpassed the Baby Boomers to become the largest living generation in the American workforce (Fry, 2016; Smilansky, 2016; United States Census, 2015). Despite their broad presence in the workforce, there is a scarcity of literature focused on Millennial teachers and their direct correlation to technology use for instructional purposes. This reality is even more evident for Millennials teaching in the elementary setting. With the influx of Millennials entering the workforce annually, the essentiality of understanding generational differences has become a priority for organizational leaders in the recruitment and retention of this group of workers (Farrell & Hurt, 2014).

Generational Technological Differences in the Workplace

Walker (2011) reported that Millennial teachers often demand more attention than Generation X and Baby Boomer teachers do. Such habits create a generational expectation gap in which one generation purportedly “holds forth a best (or only) way of being or doing something like an expectation” (Williams et al., 2017, p. 109). To garner an understanding of the technological relationships that exists among educators, and the use of technology in a 21st century learning environment, a comparison of generational predecessors, is required. Currently, three generations comprise the educational employee market: Baby Boomers, Gen Xers, and Millennials (Hansen & Quintero, 2017; Houck, 2011).

Baby Boomers include individuals born between 1946 and 1964 (Houck, 2011). This generation is often characterized as being idealistic, optimistic, and materialistic. Boomers self-focused and competitive nature tends to feed into their overwhelming need for success (Lancaster, 2004). Until recent years, Baby Boomers dominated the workplace in America (Fry, 2016), including a significant number postponing retirement to remain in the workforce. This generation values work security and stability and often finds it difficult to adjust to flexible work policies (Brack & Kelly, 2012; Pollack, 2017). The innovation of television during this generation greatly influenced a communication revolution that aided in shaping the views of Baby Boomers (Tapscott, 2009). This age group would also be generalized as digital immigrants (Prensky, 2001) because they did not grow up with technology (Pollack, 2017) as it is utilized today. Despite this characterization, many Boomers have embraced technology in the workplace to improve personal productivity (Houck, 2011).

Generation Xers, born between 1964 and 1980 (Houck, 2011), are categorized as independent and adaptable, and include the pioneers of the technological revolution (Lancaster, 2004; Pollack, 2017). This generation has been greatly influenced by the dominant nature of the Boomer generation and views education as a means to an end (Houck, 2011). As one of the smaller generations historically, Gen Xers often felt alienated and unimportant in comparison to their Boomer predecessors (Pollack, 2017). This group can be characterized as the "most entrepreneurial generation" (Pollack, 2017, para. 12) and one that values the balance between work and life (Houck, 2011). Their creative nature is often seen as an attribute and detriment (Houck, 2011; Lancaster, 2004). Gen Xers are often skeptical of authority and prefer working independently to complete tasks. Their aggressive communication style (Tapscott, 2009) often leads to structured succinct interactions that are straightforward (Bennett et al., 2017; Houck, 2011). Gen Xers were introduced to technology in school and believe that it plays a pivotal role in work efficiency (Houck, 2011). Although Gen Xers did not grow up with technology, they are a technologically literate generation (Bennett et al., 2017) whose internet and computer skills mimic those of the Millennial generations (Tapscott, 2009). Gen Xers "view radio, TV, film, and the internet as nonspecialist media" (Tapscott, 2009, p. 15) that is an available resource for everyone to use.

The Millennial Generation

Generational research is inconsistent in defining specific age identifiers for the Millennial generation. However, a consistent trend found in the literature establishes this group as those born during the years 1980-2000 (DeVaney, 2015; Meyer, 2016; Fry, 2016; Stewart et al., 2007; U.S. Census, 2010). Millennials have been generalized as optimistic, civic-minded, impatient, and team-oriented (DeVaney, 2015) individuals whose childhood has been influenced by defining moments such as the O.J. Simpson trial, Columbine school shooting, September 11, and the war in Iraq. This generation has grown up with close parental involvement (DeVaney, 2015), and is often characterized by older generations as being entitled, demanding, and in need of constant feedback. This desire for consistent feedback derives from the extensive attention and coaching received from their Boomer and Gen Xer parents (Meyer, 2016; Pollack, 2017; Tapscott, 2009). Walker (2011) referred to Millennial teachers as “the ‘Baby on Board’ generation who have worn helmets, knee, and arm pads, been given awards and recognition just for participating in school and activities, and been overscheduled in a myriad of pursuits” (p. 74).

In 1983, 7% of average households owned computers. By 2004, this average had increased to 44% of American homes with access to a computer, with 60% of these being households with children (Tapscott, 2009). Researchers have argued that Millennials assimilated to technology in response to their direct exposure to it as children (Prensky, 2001; Tapscott, 2009). Comparative to the nonchalant manner in which Boomers viewed the innovation of television and its impact on their childhood; Millennials are not amazed by technological advancements, but rather “breathe them in, like improvements in the atmosphere” (Tapscott, 2009, p. 19). Having experienced the world with the comforts of technology, Millennials often find it difficult to adapt quickly when placed in a situation where they are forced to be without it (Walker, 2011). For Millennials, the use of technology in learning environments is not wanted, but an expectation (Williams, Medina, Medina, & Clifton, 2017).

The inundation of data into their everyday lives has led Millennials to be very “matter of fact” and a generation that questions everything (Williams et al., 2017 p. 110). Millennials have served as active participants in their household and expect authority figures to partner with them working collaboratively to define tasks that are meaningful. This group is often resistant to traditional leadership styles, thereby leading them to question rules and procedures more frequently. This group of individuals has been encouraged to express their opinions openly, and has no qualms challenging leadership when they cannot ascribe ownership to the projects at hand (Williams et al., 2017).

In an empirical study conducted by Stewart, Oliver, Gravens, and Oishi (2017), Millennials, when compared to Boomers and Gen Xers, did not find job satisfaction to be a motivating factor for employee loyalty. A study conducted by Kuron, Lyons, Schweitzer, and Ng (2015), sought to determine if work values vary across different life and career stages among Millennials. Utilizing a sample of Millennials born between 1980 and 1994, the researchers found variations among the work values of pre-career and working Millennials (Kuron et al., 2015). Millennials entering a career are drawn to organizations that emphasize collegial work environments and possess a socially responsive culture. This generation thrives on flexibility and prefers work environments where they can take a hands-on approach and make a more significant impact on the organization (DeVaney, 2016). Once in their career, retention of Millennials involves working in an environment that provides "interesting work, work-life balance, job security, and the information workers need to do their job successfully (Kuron et al., 2015, p. 991).

Millennials: The Digital Native vs. Digital Immigrant Conundrum

The generational differences between Millennial teachers and their predecessors are present and illuminate within the confines of technological differences. In the scope of literature, a synonymous relationship exists among the age indicators for digital natives and Millennials (DeVaney, 2016; Houck, 2011; Joiner et al., 2013; Meyer, 2016; Prensky, 2001; Zhu & Guo, 2013). Prensky (2001) coined the terms "digital immigrants" and "digital natives" to categorize the technical discrepancies present between generations of learners based on their exposure to technology. Since the release of this ideology in 2001, however, researchers have challenged the idea that age alone can serve as a determining factor in defining a generation's technological abilities (Margaryan, Littlejohn, & Vojt, 2011). Meyer, 2016; Teo, 2016) based on their direct experience with technology.

According to Prensky (2001), all individuals born after 1980 are considered Digital Natives. He argues that Digital Natives have "spent their entire lives surrounded by and using computers and video games, digital music players, video cams, cell phones and all other toys and tools of the digital age" (p. 1). In recognizing their advanced skills in technology, Prensky (2001a; 2001b) hypothesized that once digital natives take over the field of education, the problem from the lack of digital use in the classroom will cease.

The literature on digital natives has characterized this group as innovators who are eager to adopt new technologies (Lei, 2009). However, current research has presented the positive and negative impact on these characterizations of digital natives. According to Cavanaugh, Giapponi, and Golden (2016), Digital Natives have "advanced cognitive skills such as multitasking, divided attention, spatial observation, and spatial visualization" (p. 376). In contrast, the same study found that the "continual manipulation of digital technology alters the structure of the brain implicating the learning process itself" (Cavanaugh et al., 2016, p. 375). Digital natives exhibit factors such as decreases in the following areas: depth of processing, mindful knowledge acquisition, inductive analysis, critical thinking, and imagination, as a reflective consequence by excessive exposure to digital technology (Cavanaugh et al., 2016).

Despite the generalized defining properties of this dominant group, concerns persist. Within the Millennial generation there are differentiated characteristics, influenced by life experiences, that reject the one-size-fits-all perspective postulated in Pensky's research (Bridgework, 2017; Joiner et al., 2013). Wang, Hsu, Campbell, Coster, and Longhurst (2014) found that digital natives navigate their entertainment and communication technologies fluently but require guidance with technology that needs sophisticated cognitive problem solving. Using such a succinct perspective to describe Millennials has pigeonholed this group of individuals into the digital native conundrum wherein all are expected to meet the above expectations.

The life experiences of an individual dramatically impact the way he or she interacts with technology. Millennials also include Digital Immigrants. For example, individuals who have grown up without access to technology either by circumstantial hardships or by choice would be considered Digital Immigrants (Meyer, 2017). Digital Immigrants seek immediate and relevant learning tasks and aim to be stewards of their learning (Ransdell, Kents, Gaillard-Kenny, & Long, 2011). When placed in an online learning environment, digital immigrants are more likely to contribute pieces of work that are more original, earn higher grades in class, and demonstrate more critical thinking skills than that of digital native students. This same study found digital immigrants' acuity for rote memorization and critical thinking disposition on tests to be superior in learning to that of digital natives (Ransdell et al., 2011). For this research, the use of Digital Native, or Digital Immigrant is not sufficient as descriptors of the subjects to define the Millennial generation.

Millennial Characteristics

Millennials are generally early adaptors (Rogers, 2003) who are willing to implement a technological product early on rather than seeking confirmation of its relevance from outliers (Blackburn, 2011). Seventy-one percent of Millennials get their information from the internet (Gallup, 2016). Research has suggested that 20% of Millennials began using computers as early as 5 years old and the use of technology and media have been intricately connected to their daily lives and impact their keen ability to multitask (Blackburn, 2011; Connaway, 2008; DeVaney, 2015). Where the majority of Americans use desktops to surf the internet, Millennials are more likely than any other generation to use their smartphones (Gallup, 2016). Much of the research presented regarding Millennials in the workplace has sought to debunk stereotypes put in place in response to Prensky's (2001) digital native comparatives.

A Gallup (2016) report surveying how Millennials seek to live and work found that Millennials generally fall within the following four summarized descriptors below:

- **Unattached**: This generation is more likely than any other generation to move jobs frequently. These higher mobility rates may be in response to the idea that 55% of Millennials are unengaged in the workplace. Compared to other generations, Millennials are less likely to be engaged in the workplace and prefer to remain ambivalent about workplace politics. It is common for Millennials not to ascribe to traditional affiliations such as political parties or organized religion.
- **Connected:** The majority of Millennials have experienced technology throughout their life; this generation of workers seeks to modify the way information is accessed as well as the development of social networks. Millennials are less likely to watch conventional news programming to get their news. Preferably, this generation relies on the internet for the majority of the information. Ninety-three percent of Millennials report using social media to maintain communication with family and friends. In doing so, smartphones play a major role in Millennials' management of their social media.
- **Unconstrained**: Millennials challenge the status quo. It is uncommon for Millennials to accept the way things are in the workplace just because it is the customary way. Unlike older generations, Millennials feel an interconnectedness between their personal and work lives.

- **Idealistic**: Millennials are highly educated and seek employment that connects to their purpose for life. They want to feel valued, and seek managers who care about their employees as individuals (Gallup, 2016).

When seeking employment, Millennials seek leaders who ascribe to their individual needs for the purpose by promoting the individual strengths and prioritizing the needs of their employees. Additionally, Millennials pursue ongoing developmental coaching in a team atmosphere where others are motivated to participate. Communication and feedback regarding tasks are crucial for the Millennial generation in the workplace. Finally, employers must recognize that Millennials often align their identities and lifestyle with the organization to which they work. If they are unable to engage within this organization, Millennials are more likely to move on (Gallup, 2016).

Researchers argue that the sub generational behavioral descriptors exist, and therefore generalize those within this age bracket, thereby creating unrealistic expectations related to technology and social interactions (Bennett, Maton, & Kervin, 2008; Kennedy et al., 2008; Meyer, 2016). The process of defining characteristics for the Millennial generation requires the need for sub-categorical descriptors to describe this group. Based on their varied characteristics, Bridgework (2017) categorized this generation into two segments: early and Late Millennials.

Millennial Sub-Cohorts

Sub-generational identifiers are present within the Millennial cohort. For this research, the target population will adhere to Bridgework's (2017) report descriptors, which define Early Millennials as those born between 1980 and 1987 and Late Millennials, or Recessionists, as those born between 1988-1995 (Bridgeworks, 2017).

Minimal literature is available that differentiates between Early Millennials and Late Millennials, also known as Recessionists. Early Millennials are the pioneers of social media. This group was the first to experience preliminary association with the World Wide Web and build network friendships through online communications such as chat rooms. Haunted by the sounds of a dial-up modem, Early Millennials spent their formative years playing Oregon Trail on the original candy-colored iMac G3 desktop computers. Often the guinea pigs of technology integration, Early Millennials are familiar with the ever-changing cycle of technology upgrades. As a result, this group is consistently looking for the next best thing (Bridgeworks, 2017). Descriptive traits for Early Millennials include collaborative, optimistic, flexible, efficient, technologically savvy, and self-sufficient.

The recessionist Millennial is the category of individuals born between 1988 and 1995. The term Recessionist derives from the fact that the Great Recession directly impacted many of the individuals in this genre of Millennials. The Great Recession began in 2007 when many Late Millennials were entering and/or graduating from college. Many recessionists are greatly concerned with debt, and financial gain drives many of their decisions in the workplace. This conscientious financial awareness may be in part due to the fact that many in this group exited college at the heart of the recession. Sixty-five percent of recessionists surveyed consider themselves to be technologically savvy as compared to only 40% of Early Millennials (Bridgeworks, 2017). Traits of the recessionist include realistic, financially conscious, questioning, impatient, and connected.

The Millennial Teacher

Most of the new teachers entering the field of education are Millennials (Hodges, 2016). Taking into consideration the above mentioned Millennial traits, it comes as no surprise that the research has supported the idea that Millennial teachers require increased contact, quality time with people, and successful experiences in the workplace. Millennial teachers are optimistic and seek to make valuable contributions to their students and within the professional community (Walker, 2011). The drive for professional success within the Millennial generation echoes throughout the literature. Leadership finds that working with Millennials can present its challenges.

Summary

American students are failing to meet pillars of success in college sciences and advanced mathematics because of their inability to master the foundational standards in elementary and middle school (Bertram, 2014; Jordan & Kaplan, 2009;). The literature presented in this chapter hones in on the need for a direct study of Millennials and how their presumed technological advances will impact the manner in which they approach elementary math instruction. The historical implications of math and technology in education are a factor that has inhibited progress within the current system of innovative practices in the United States. With blended learning environments, Millennial teachers can provide instruction utilizing research-based strategies that the literature suggests apply to them as the teacher, as well as to the students they serve in the classroom. Chapter 3 will discuss the methodology related to this study.

CHAPTER THREE: METHODS

Overview

This study sought to determine if a significant relationship existed between PreK-5 Millennial teachers' age and the frequency and variety of technology used during math instruction. This quantitative, correlational study was conducted using a sample of Millennial teachers in an urban public school district in Texas. Participants in this study responded to a modified version of Use, Support, and Effect of Instructional Technology (USEiT) Teacher Survey (Russell, Bebell, & O'Dwyer, 2004) to determine if Millennial teachers' age relate to how often, and to what variation, technology utilization occurs during math instruction.

Design

For this quantitative study, a correlational research design was used. Gall, Gall, and Borg (2007) indicated correlational research was appropriate to describe the degree of relationships between two or more variables. A Spearman *r* was used to examine the strength of the relationship between elementary Millennial teachers' age and the frequency and variety of instructional technology used during math instruction. The study included teachers' age as the predictor variable and the frequency and variety of technology use during math instruction as the criterion variables. Teacher technology frequency and variety were determined using the Modified Use, Support, and Effect of Instructional Technology (USEiT) Teacher Survey (Russell et al., 2004). The data collected derive from Likert-type scales and self-reported results, obtained from the participants (Gall et al., 2007).

Research Question(s)

RQ1: To what extent, if any, does a relationship exist between millennial teacher age and the frequency of instructional technology used during PreK-5 math instruction?

RQ2: To what extent, if any, does a relationship exist between millennial teacher age and the variety of instructional technology used during PreK-5 math instruction?

Null Hypotheses

The null hypotheses for this study are:

$H_0$1: There is no statistically significant correlation between millennial teachers' age and the frequency of instructional technology used during elementary math instruction as determined by the Modified USEiT Teacher Survey.

$H_0$2: There is no statistically significant correlation between millennial teachers' age and the variety of instructional technology used during elementary math instruction as determined by the Modified USEiT Teacher Survey.

Participants and Setting

The participants for this study derived from a convenience sample of PreK-5 certified Millennial teachers recruited from a large urban district in south central Texas. The sample included a percentage of the district's 90 schools, which serve approximately 54,000 students. There was a high concentration of poverty and low educational attainment within the district, wherein 40% of all students between the ages of 5-17 lived in poverty. Eighty-seven percent of the families within the community earned less than $35,000 annually. The vast majority (92%) of the student population were eligible for free or reduced lunch and additional public assistance programs. Of the population of students, 91% were Hispanic, with one in five identified as an English-language learner.

The district selected had a large teacher demographic employing over 3,200 teachers, 1,609 of whom serve PreK-5 students. The target population included teachers born during the years 1980-1995, employed at 46 of the elementary school campuses. The number of teachers sampled was 153, which met the minimum requirement to maintain a medium effect size at an alpha level of 0.05 and a statistical power of 0.8 (Warner, 2013). The participants included 75 teachers between the ages of 23 and 30, and 78 teachers between the ages of 31 and 38. Female teachers (*n* = 137) made up the majority of the sample, along with a few (*n* = 15) male teachers. There was one participant who did not report their gender. Demographic information collected found the grade levels taught by the participants included a uniform distribution between PreK and grade 5.

The target district had documented utilization of bond and Title One funds, including the implementation and upgrade of technology resources at 68 of their campuses in 2010. In 2016, voters approved the issuance of bonds that would provide funding to enhance technology and learning environments to meet necessary 21st-century skills across a number of their campuses. A total of 48 elementary campuses serviced K-5 students within this district. Although each of the elementary schools varied in the level of instructional technology integration, most campuses were equipped with digital technology at some level. Two elementary schools were eliminated in response to pending significant technology upgrades and infrastructure renovation projected in the wake of the 2016 bond victory.

Campuses selected for the study met the necessary criteria by possessing a computer projection system with a document camera and/or a SMART/Promethean board, teacher laptop and/or iPad, and access to online digital curriculum resources for both the teacher and students. The district provided professional development opportunities, at no charge for teachers, related to the integration of technology.

Instrumentation

The instrument used in this study consisted of 55 items taken from select questions on the

Use, Support, and Effect of Instructional Technology (USEiT) Teacher Survey created by Russell, Bebell, and O'Dwyer (2004). Creators of the USEiT Teacher Survey worked with 22 school districts in Massachusetts over 3 years to examine educational technology use by teachers and students, factors that influence this use, and the impact of technology on student learning (O'Dwyer et al., 2003). This instrument was appropriate to address the research questions in this study because it included survey items explicitly focused on the variety and frequency of technology used by teachers. Permission was obtained and granted by the author to use and modify the original instrument and tailor the tool specific to math instruction (See Appendix A). Modifications focused on replacing dated technologies with current tools available since the creation of the instrument. With minimal, unsubstantial changes applied to the original USEiT survey, existing reliability and validity coefficients remained intact.

The Modified USEiT Teacher Survey began with the collection of demographic information, such as the number of years the teachers have taught at their current campus as well as in their career. It further asked for the teacher's gender, age, and grade level taught. No identifiable information, such as names or school, was collected for analysis. For the purpose of this study, the researcher omitted demographic information related to the teacher's school's state assessment scores. Additionally, question items in the age, subject, and grade level sections were modified to meet the target population. For example, rotary items for ages 41-61+ were removed because the subjects for this research did not fall under these descriptors. Under grade level taught, grades 6-12 were also omitted as an answer choice.

Russell et al. (2004) performed a principal component analysis and combined closely related survey items to form individual scales that measured teachers' use of technology in a variety of educational settings. The USEiT study developed three sets of measurement scales—

Teacher Scales, Student Scales, and District Scales. Twelve scales were used to measure teachers' interactions with technology. The current research examined the following five scales:

- Teachers' use of technology for delivering instruction (single item).
- Teacher-directed student use of technology during classtime (0.73)
- Teacher directed student use of technology to create products (0.84)
- Teacher use of e-mail for professional purposes (0.86)
- Teachers' use of technology for preparation (0.80)

O'Dwyer, Russell, and Bebell (2004) noted that because the outcome measure for teachers' use of technology for delivering instruction was a single item, no reliability measure was reported. Reliability indices for the remaining scales, as indicated above, ranging between 0.73 to 0.86 (Cronbach α), suggested appropriate reliability of this instrument for use in this study.

Data for the study were collected via an online survey. Participants responded to 55 items using the Modified USEiT Teacher Survey. The following list indicates modifications made to the original instrument for use in this study:

- Under the demographic questioning, number 6 was removed. The collection of teachers' state assessment scores is of no utility for the current research.
- This research focused on Millennial teachers. Therefore, number 5 included the ages represented in the study: 20-30 & 31-40.
- The target population was comprised of PreK-5 teachers, so number 9 excluded the option to choose grades 6-12. The option to select PreK was added.
- Number 10 included an additional line to add *SMART board or Promethean board*. The term *DVD* replaced *VCR*, and *scanner* was replaced with *Document Reader/Elmo*.

- This research focused on math instruction, so number 11 was changed to “During classtime, how often did students perform the following activities IN MATH?”
- Number 11 changed its seventh item to “students use a computer or portable writing device for RECORDING MATHEMATICAL REASONING.”
- Number 11 removed the item “students learn keyboarding skills.”
- Number 12 now reads, “How often do you perform the following IN RELATION TO MATH?”
- Number 13 now reads, “How often do you ask students to produce the following using technology IN MATH?”

Procedures

At the onset of the study, the researcher prepared consent forms detailing the intent of the survey for all participants. Initial IRB review resulted in conditional IRB approval from Liberty University. The researcher requested and obtained approval from the school district’s Accountability, Research, Evaluation, and Testing Department. Official IRB approval was received from Liberty University, initiating the beginning of the data collection phase. A courtesy email was sent to principals at the participating campuses notifying them of pending survey requests to their teachers. The surveys were administered online via Survey Monkey. Participant input was completely voluntary, and the researcher did not obtain any identifying information such as name, campus, or the collection of IP addresses for analysis.

A week before the distribution of the surveys, the researcher provided an email to the principals at the campuses reminding them of the forthcoming contact with their teachers and solicited their assistance in encouraging their teachers to participate. On the designated date, participants received the survey via their district email. At the onset of the survey, participants found a link to the electronic consent (Appendix B) granting permission to utilize their submission in this study. The consent page noted that their participation was voluntary and the study might be published, and their information would not be identified. The next section included the demographic information followed in the modified USEiT Teacher Survey (Russell et al., 2007).

After the survey, participants were provided the option to enter a drawing to win a $25 gift card. The release of participants' name and campus for the incentive was optional and was in isolation of the survey questions. The researcher was the only person with access to both the consent forms and survey submissions.

Two weeks after the survey was sent to teachers, there had been zero participation in the study from the prospective participants. Contact with the district revealed that the original invitation email entered the teachers' spam boxes. The researcher resent the survey using an email generated in Survey Monkey. The new invitation resulted in some participation, although minimal. As surveys were submitted, the researcher noticed a pattern of submissions from participants who did not fit the criteria for the study. In response, the researcher contacted the district for an updated list to include the correct demographic for the study. Additional contact with the district concluded that the original list submitted included all teachers for the district rather than Millennial elementary teachers only. The researcher obtained a corrected list and distributed a new request for participation to the correct demographic via email in Survey Monkey. A follow-up email was sent 2 weeks later and once each week for the next 4 weeks until the desired sample size was reached.

Data Analysis

The modified USEiT Teacher Survey included 55 Likert-type questions that participants answered via an online survey generated in Survey Monkey. The data collection phase was completed at the end of 9 weeks once the required number of participants had responded. The raw data were organized using Survey Monkey and exported to SPSS for analysis.

Educational literature has noted the common use of Pearson's product moment correlation in education-related studies due to its small standard of error and use of continuous data (Gall et al., 2007). A Pearson's *r* was the original statistical test selected for the study due to the transformed continuous Likert-type data collected from the participants (Gall et al., 2007). However, initial assumption testing determined that the use of a Pearson's *r* for analysis would be inappropriate due to a violation of normality and the presence of outliers among the variables. A review of alternative tests resulted in the decision to test the data utilizing a non-parametric, Spearman's rank correlation coefficient (Spearman's *rho*) test. Spearman's *rho* is the preferred test when assumptions for Pearson's *r* are violated (Warner, 2013). Additionally, Spearman's *rho* is an appropriate analysis when data consist in ranks, such as Likert-type data, and when scores have extreme, nonnormal distribution shape, as was the case discovered for this data set during the initial assumption testing for a Pearson's *r* (Warner, 2013).

The two null hypotheses were tested using Spearman rank correlation to determine the measure of the relationship, if any, between teacher age and frequency and variety of use of technology (Gall et al., 2007). The sample size of 153 met the requirement necessary for a correlational research design (Warner, 2013). The non-parametric measure of Spearman's *rho* was appropriate to examine the null hypothesis at an alpha level of .05 and statistical power of 0.8 which maintained a medium effect size (Warner, 2013).

A Spearman's *rho* was used to evaluate **$H_0$1** and determine if a relationship existed between Millennial teachers' age and the frequency of instructional technology used during elementary math, as determined by the Modified USEiT Teacher Survey.

A Spearman's *rho* correlation was used to evaluate **$H_0$2** to determine if there was a relationship between PreK-5 Millennial teachers' age and the variety of technology use during math instruction as determined by the Modified USEiT Teacher Survey.

Summary

This chapter has detailed the methodologies used to determine if a significant relationship exists between PreK-5 Millennial teachers' age and the frequency and variety of technology used during math instruction. It further explained the process for development of the Modified USEiT instrument that was used to collect data from participants in this study. Chapter 4 will provide a detailed analysis of the findings highlighted in this section of the text.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this quantitative, correlational research was to relate elementary Millennial teachers' age to the frequency and variety of instructional technology utilized during math instruction in PreK-5 elementary schools from a public district in Texas. The population used for this study adhered to Bridgeworks' (2017) descriptors, which defined Early Millennials as individuals born between 1980-1987, and Late Millennials as those born between 1988-1995. The predictor variable, age, was divided into two subcategories: Early Millennials between the ages of 31 and 40, and Late Millennials between the ages of 23 and 30. The criterion variable, frequency, and the variety of technology used during math instruction were measured using the Modified USEiT Teacher Survey (Russell et al., 2004).

Research Question(s)

RQ1: To what extent, if any, does a relationship exist between millennial teacher age and the frequency of instructional technology used during PreK-5 math instruction?

RQ2: To what extent, if any, does a relationship exist between millennial teacher age and the variety of instructional technology used during PreK-5 math instruction?

Null Hypotheses

The null hypotheses for this study were

$H_0$1: There is no statistically significant correlation between millennial teachers' age and the frequency of instructional technology used during elementary math instruction as determined by the Modified USEIT Teacher Survey.

$H_0$2: There is no statistically significant correlation between millennial teachers' age and the variety of instructional technology used during elementary math instruction as determined by the Modified USEIT Teacher Survey.

Descriptive Statistics

The target population included elementary teachers in grades PreK to 5. The researcher obtained email addresses from the district, and an invitation to participate was sent out to all elementary teachers between the ages of 23 and 38, via Survey Monkey. Once collected, a screening of the data was conducted to identify possible outliers and inconsistencies between the predictor and criterion variables. A total of 184 surveys were collected. However, 27 submissions were deleted because the participants did not meet the age criteria for the study. Of the 157 remaining participant submissions, four surveys had a completion rate of 25% and were eliminated from the overall analysis. The number of usable surveys generated a sample size of 153 surveys for data analysis.

Of the 153 surveys collected for analysis, 51% (78 participants) identified as Early Millennials between the ages of 31-38. Late Millennials included 49% of the participant survey submissions (75 participants). See Table 1 for an overview.

Table 1

Frequency of Participant Age and Gender

	Frequency	Percentage
Age by group		
23-30	75	49.02%
31-38	78	50.98%
Gender		
Male	15	9.87%
Female	137[a]	90.13%

[a] One participant did not report their gender.

The millennial elementary teacher population consisted of 90% female and 10% male respondents. This statistic falls in alignment with the National Center for Education's (2016) report of elementary teacher demographics, which found 89% of all elementary teachers to be female.

In an analysis of the teachers' years of service in education, the data indicated that the greatest number, 39% (60 teachers) of participants, had taught between 3 and 5 years, followed by an average of 26% (40 teachers) who had worked 6-10 years as a teacher (Figure 1).

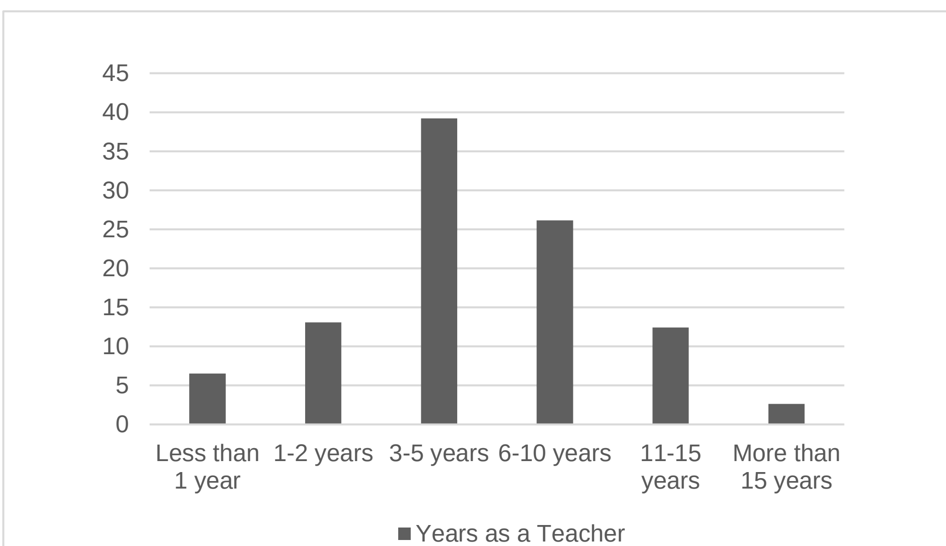

Figure 1. Teachers' years of teaching experience.

The survey responses indicated an approximate uniformed distribution of grade-level representation in grades PreK through 5, with fifth grade having the greatest percentage of participants at 25%. Of these respondents, 73% taught utilizing a self-contained all-subject model for instruction. Furthermore, 56% of the Millennial teachers had advanced education outside of the required bachelor's degree necessary to obtain the teaching position. None of the participants had earned a doctorate (Figure 2).

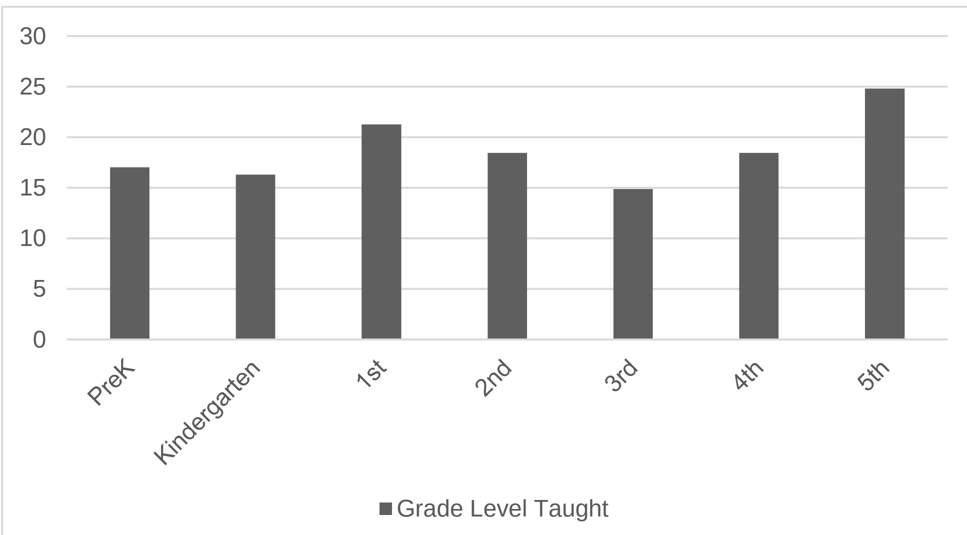

Figure 2. Millennial teachers: Grade levels taught.

Results

Assumption Testing

In association with the standard procedure for correlational analysis, the researcher conducted a data screening, and assumption tests were conducted. The IBM Statistical Package for Social Sciences (SPSS) was used to conduct the required assumption tests for the parametric Pearson Product-Moment correlation (Warner, 2013). The assumption tests analyzed each data set for bivariate normal distribution, linearity, and the presence of outliers. Scatterplots for each of the subscales were generated, and a visual inspection of the output yielded similar results of linearity (See Figure 3 and 4 for examples).

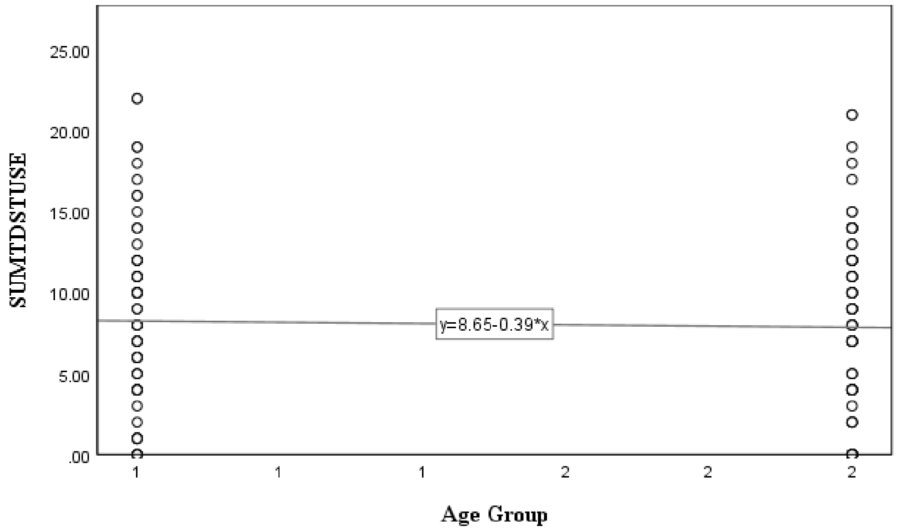

Figure 3. Scatterplot to determine the linearity of teacher-directed use of technology and Millennial age group data set.

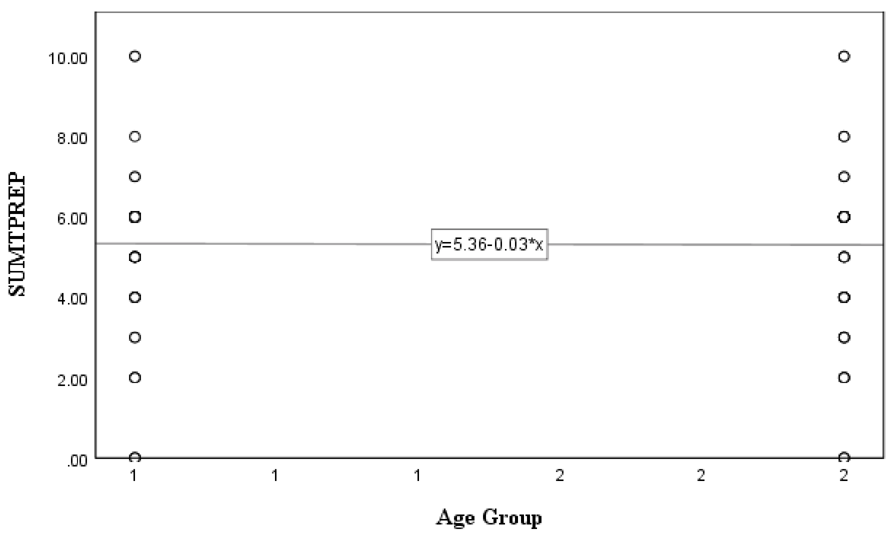

Figure 4. Scatterplot to determine the linearity of teacher use of technology for preparation and Millennial age group data set.

Additional assumption testing was conducted to identify bivariate outliers for the predictor and criterion variables and to examine normality within the data set. The null hypothesis used to test for normality was that the data would be normally distributed. To test this hypothesis, an examination of the kurtosis and skewness for each data set and age group found the data to have a non-normal distribution. Additionally, a Shapiro-Wilks test was run to determine if normality persisted. For data sets with greater than 50 samples and as large as 2000 samples, a Shapiro-Wilks test is most appropriate (Laerd Statistics, 2018). Results from the Shapiro-Wilks found all of the question sets to have a significance value greater than 0.05. This finding required the researcher to reject the null hypothesis for normality, therefore indicating a non-normal distribution of scores (See Table 2 for Shapiro-Wilks statistics).

Table 2

Assumption Test for Normality Reported by Age Group

	Shapiro-Wilks Statistics		
	statistic	*df*	sig.
Teacher-Directed Student Use			
Age Group 23-30	.961	72	.026
Age Group 31-38	.953	78	.006
Student Use of Specific Technology Applications			
Age Group 23-30	.519	72	.000
Age Group 31-38	.646	78	.000
Student Activites Without Computers			
Age Group 23-30	.960	72	.024
Age Group 31-38	.959	78	.013
Student Non-Academic Computer Use			
Age Group 23-30	.938	72	.002
Age Group 31-38	.929	78	.000
Teacher Use of Technology for Individual Student Needs			
Age Group 23-30	.934	72	.001
Age Group 31-38	.948	78	.003
Teacher Use of Technology for Preparation			
Age Group 23-30	.774	72	.000
Age Group 31-38	.796	78	.000
Teacher Use of Email to Communicate			
Age Group 23-30	.898	72	.000
Age Group 31-38	.885	78	.000
Teacher-Directed Student Use of Technology to Create Products			
Age Group 23-30	.742	72	.000
Age Group 31-38	.784	78	.000
Use of Technology to Deliver Instruction			
Age Group 23-30	.754	73	.000
Age Group 31-38	.787	80	.000
Variety of Technology Used			
Age Group 23-30	.898	72	.000
Age Group 31-38	.794	78	.000

Further assumption testing using a stem-leaf plot determined that extreme outliers existed, therefore negating the validity of a Pearson's *r* test for this study. Due to repeated violations of the required assumptions for validity for a Pearson's *r* test, and after consultation with the researcher's dissertation methodologist, the researcher concluded that the data would be better assessed utilizing a Spearman's *rho* correlational design. To conduct a nonparametric Spearman's *rho* analysis, the measured variables must be ordinal. The researcher transformed the data in SPSS to display ordinal rank prior to continuing with the analysis.

Assumption tests were then generated in SPSS for each of the variables as defined to test the validity for the use of a Spearman's *rho* test (Warner, 2013). It was determined that a Spearman's *rho* was the appropriate test because the data were ordinal, and one variable was monotonic in its relation to the other variable within each data set tested. A scatterplot matrix was used to evaluate each of the variables to confirm a monotonic relationship existed. A variable is considered monotonic when an increase in variable X is associated with a corresponding increase in variable Y (Warner, 2013). In situations in which a researcher seeks associations between a dichotomous variable, such as in the case of Early and Late Millennial age groups, and an ordinal variable such as the frequency and variety of technology use, a Spearman correlation is appropriate (Warner, 2013).

Statistical Analysis

The researcher tested the two null hypotheses for this study at an alpha level of 0.05 and a statistical power of 0.8 with a medium effect size. By maintaining an alpha level of 0.05, this prevented the likelihood of type 1 and type 2 errors (Laerd Statistics, 2018). The Modified USEiT survey focused on two teacher scales that examined teacher-directed student use of technology, as well as each teacher's use of technology during math instruction. Each of the scales was divided into subscales, which focused on specific uses of technology incorporated within the classroom.

Null Hypothesis 1

$H_0$1: There is no statistically significant correlation between millennial teachers' age and the frequency of instructional technology used during math instruction as determined by the Modified USEiT teacher scales.

A Spearman's *rho* correlational analysis was conducted using SPSS to determine if a relationship was present between the variables of age and frequency of technology used in math instruction. In a correlational analysis, it is standard practice for a *p*-value less than 0.05 to be considered significant. The scores for each item ranged from 0 to 5, with each scale examining a varying frequency of technology used by the participants.

Scale 1: Student Use of Technology as Reported by Teacher Scale. In this scale teachers were asked to approximate the frequency of student technology use based on a 5-point Likert-type scaled range of never, once or twice a year, several times a year, several times a month, and several times a week. The question sets focused on teacher-directed student use of technology during classtime as well as student use of specific technology applications during classtime scale; student activities without computers during classtime scale; and students' non-academic computer use during classtime scale. Each of the subscales had a set of questions that focused on differentiated use of the technology.

To identify possible relationships within the data, the researcher computed the sum of frequency within each question set, and a Spearman's *rho* was calculated via SPSS against the predictor variable of age. The results found teacher-directed student use of technology to have no statistically significant relationship between the variables with an $r_s = -.026$, $p = .752$.

An additional independent scale explicitly focused on teachers' use of technology for the delivery of instruction. This independent scale measured the frequency to which teachers utilized technology specifically for math instruction. No relationship was found between millennial age and the use of technology to deliver instruction during class, as computed with an $r_s = -.004$, $p = .961$. The data indicate that no significant relationship exists between the sum of frequency for the variables and age, thereby resulting in the researcher failing to reject null hypothesis 1.

Null Hypothesis 2

$H_0$2: There is no statistically significant correlation between millennial teachers' age and the variety of instructional technology used during math instruction as determined by the Modified USEiT teacher survey.

A Spearman's *rho* correlational analysis was conducted using SPSS to determine if a relationship was present between the variables of age and variety of technology used in math instruction. In education-focused correlational research, it is common practice for a *p*-value less than 0.05 to be considered significant. Within this scale, which measures for variety, teachers were asked to describe their frequency of use within a 5-point Likert-type scale with a range from 0 to 5 of never, less than once per week, once per week, three times a week, and daily. Variety was examined using the frequency of teachers' use of various instructional technology devices during their math instruction.

A bivariate correlation was run to calculate for the sum of frequency totals for the various scales against the predictor variable of age. Results found the sum of the variety scales to show no relationship with an $r_s = .032$, $p = .697$. The statistical output for the Spearman's *rho* correlational analysis concluded that no significant relationship existed between the variety of technology used and millennial teachers' age. For each of the questions within the independent subscales for variety of technology used during math instruction, the *p*-value was greater than 0.05, thereby resulting in the researcher failing to reject null hypothesis 2.

Summary

Chapter 4 provided a detailed analysis of the findings for null hypotheses 1 and 2. The predictor variable—age—and criterion variables—frequency and variety of technology used during math instruction—were measured using the Modified USEiT Teacher Survey (Russell et al., 2004). Results were reported using the sum of frequency for each scale, in addition to the individual results for variety. It was concluded that no statistically significant correlation existed between the Early and Late Millennial age groups and the frequency and variety of technology used during math instruction.

CHAPTER FIVE: CONCLUSIONS

Overview

Chapter 5 will review the research problem in conjunction with the methodology to interpret the results of the research. An extensive review of the literature was conducted to explore elementary math instruction and millennial teachers in the United States. Within this study, the predictor variable is millennial age, and the criterion variables include the frequency and variety of instructional technology used for math instruction. A review of the literature revealed a gap related to millennial teachers overall, in addition to the specific instructional technology tools used by this demographic for classroom instruction. In an effort to grasp an understanding of the relationship between millennial teachers' age and the variety and frequency of technology in the classroom, teachers were asked to report the frequency with which they required students to use technology, as well as how often they utilize technology for instructional purposes, as measured by the Modified USEiT teacher survey.

Data collected were input into the IBM Statistical Package for Social Sciences (SPSS), and a non-parametric Spearman's rank correlational analysis was run. This chapter will provide an overview of the research findings as they relate to the driving theories highlighted in chapter 2. Chapter 5 will also discuss the implications and limitations of the research, as well as offering suggestions for future studies.

Discussion

The 2017 NAEP national report card in mathematics found that there has been no significant growth among fourth-grade students in America (NAEP, 2019). Although this report indicates growth since the test's inception in 1990, the last decade has proven to have little to no growth in the area of mathematics among elementary students. The problem this study sought to address focused on the stagnant nature of math achievement in American schools, specific to elementary math education.

Millennials comprise approximately 43% of elementary teachers in the United States (NCES, 2017). This generation is often purported to possess digital literacy skills because most have been exposed to technology their entire life. The question that remains, however, is even with increased exposure to technology throughout their lifetime, does a differential exist between Early Millennials and Late Millennials as it relates to their use of technology for instructional purposes?

This quantitative, correlational study sought to determine if a relationship existed between Millennial teachers' age and the frequency and variety of instructional technology used during math instruction at public PreK-5 elementary schools in Texas.

Research Question 1

Research question 1 sought to determine if a significant relationship existed between millennial teacher age and the frequency of instructional technology used during PreK-5 math instruction as measured by the Modified USEiT Teacher Survey. A review of the literature suggested that millennials are characterized as innovators who are eager to adapt to new technologies (Lei, 2009). However, within the millennial generation, differentiated characteristics exist as a result of life experiences and the availability of technology within this demographic (Meyer, 2017). Millennials are early adapters who have grown up with technology in one form or another (DeVaney, 2016; Houck, 2011; Joiner et al., 2013; Meyer, 2016; Prensky, 2001; Zhu & Guo, 2013). With this knowledge, it was safe to assume that millennial teachers' experience with technology, despite their age group, would result in similar patterns of instructional use.

A Spearman's rank order correlation coefficient was calculated. Each of the scales used to measure the frequency of use reported a lack of significance between the criterion and predictor variables. As a result, the researcher failed to reject null hypothesis 1.

The results surprised the researcher because the literature suggests that 65% percent of Late Millennials consider themselves to be technically savvy when compared to only 40% of Early Millennials (Bridgeworks, 2017). This statistic led the researcher to posit a possible differentiation in the frequency and variety of use during math instruction. However, as the results indicate, the use of technology for math instruction among independent millennial subcohort groups does not differ substantially.

The findings from this study complement the results from Inan and Lowther's 2010 study. In their research, the authors suggested that multiple factors play into a teacher's integration of technology during instruction. Inan and Lowther found that a teacher's demographic characteristics, such as age and years of experience, positively influence the degree to which they integrate technology. However, it was concluded within their findings that it was, in fact, the years of teaching, and not age solely that determined the overall total positive impact on technology integration in the classroom (2010).

In contrast, Tondeur et al. (2017) argued that the factor that most influences a teacher's use of technology for instructional purposes stemmed not from age, but from their overall pedagogical beliefs. The study highlighted evidence to support the idea that teachers with more teacher-centered beliefs perceive the use of technology to be nonessential in the teaching and learning process and will, therefore, use it less frequently than those who prefer a more student-centered approach to instruction (Tondeur et al., 2017).

Mueller et al. (2008) laid a foundation for support of the arguments of Tondeur et al. that the pedagogical beliefs and attitudes toward technology play a significant role in the frequency of technology use despite a teacher's age. In the Mueller et al. (2008) study, the researcher deduced that a teacher's judgment toward the implementation of technology was based on their experience with technology, and it was this that would determine their overall use of technology in the classroom.

Recent research (Meyer, 2016) on the topic of technology use has sought to debunk the notion that all Millennials are technically savvy and prefer the use of technology consistently in all facets of their day-to-day interactions. Such findings complement the data for this study, which suggest that an independent variable of age alone does not significantly influence the use of technology for instructional purposes. While Meyer (2016) argued that Millennials' early experience with digital technology shaped their behavior toward technology use to some extent, the author did not find the independent factor of age as a determinant for how one would use technology in daily interactions.

Research Question 2

Research question 2 sought to determine if a relationship exists between millennial teachers' age and the variety of instructional technology used during PreK-5 math instruction. The use of instructional technology for math is supported in the literature; however, despite significant financial investments in districts across the country, there remains a discontinuity of progress. Such stagnant improvements are of great concern when the research suggests that the mathematical skills gleaned during childhood have a direct correlation with an individual's Socioeconomic Status (SES) in adulthood (Kutner, Greenberg, Jin, Boyle, Hsu, & Dunleavy, 2007; Ritchie & Bates, 2013; Watts et al., 2014). For example, in a long-range study conducted by Ritchie and Bates (2013), the mathematical level of students at the age of 7 was found to have a substantial and positive impact on the SES of those same adults at the age of 42. In response to such reports, the data from this study focus attention on a need to evaluate millennial teachers' instructional delivery using technology. Millennials are using technology. However, the method of delivery is vital for gaining a deeper understanding of its association with the continued lack of growth in elementary math. The researcher was intrigued by the Bridgeworks (2017) report, which found that the use of technology differed between Early and Late Millennials. Such findings give insight into the possible relationship between the variations of technology use among millennial teachers.

The foundation for this study is carved in the scope of constructivist ideology, wherein technology challenges educators to grow through the expansion of three frames of knowledge—content knowledge, pedagogy knowledge, and technology knowledge (Koehler et al., 2013; Paily, 2013). Instructional technology, such as interactive whiteboards, handheld tablets, laptops, software, and desktop-based devices, serve as a tool to aid students in communicating mathematically and conceptualizing mathematical reasoning (Henrie et al., 2015; National Council of Teachers of Mathematics [NCTM], 2014).

To evaluate research question 2, a Spearman's rank correlation coefficient was calculated to determine if a relationship existed between the age of millennial teachers and the variety of technology they used during their math instruction. Results of the analysis found no significant relationship between age and variety of technology use among Early and Late Millennial teachers. Therefore, the researcher failed to reject null hypothesis 2.

The results presented very little surprise for the researcher. The data suggest millennials, despite their age, are using a variety of technology in their classrooms at a consistent rate. An in-depth literature review conducted by Delgado, Wardlow, McKnight, and O'Malley (2015) reported that accessibility to instructional technology had improved significantly in the classroom. For example, by 2010, 97% of K-12 teachers had access to one or more computers in the classrooms, and the student-to-computer ratio decreased from 11 to 1 to 1.7 to 1 for daily use (Delgado, Wardlow, McKnight, & O'Malley, 2015). When compared to the current data presented in this study, the millennial teachers surveyed all had access to a variety of standard instructional technology tools that fall in line with the national average reported by Delgado et al. (2015).

Donovan et al, (2014) used their research to aid in the creation of an innovation configuration map that measured the use of 21st-century skills in the classroom. This tool, when compared to the survey utilized for this study, provided the researcher with a glimpse into how various instructional technology tools should be used in the classroom to encourage creativity, innovation, collaboration, critical thinking, and communication. The authors found that the expectation for technology used by the administration in conjunction with school-wide initiatives that promoted 21st-century skill development played a significant role in the use of various instructional technologies in the classroom (Donovan et al., 2014). The simplicity of substitution for traditional instructional tools is not a practical implementation of technology use by teachers during instruction (Christensen et al., 2011). It also proposes that teacher-directed use of technology must provide students with the opportunity for creativity with a variety of brainstorming and multimedia tools. The use of such instructional tools transforms standard learning for a practice that incites the use of critical thinking and reflection during instruction (Donovan et al., 2014).

Implications

The results from this research study have demonstrated implications for the current state of millennial teachers and the instructional technology they are using in the classroom. From the data in this study, it can be implied that early and late millennial teachers are using technology during their math instruction in similar ways. Such information is beneficial to leadership as they provide professional learning opportunities for the 43% of millennial teachers that make up the ranks of elementary education (NCES, 2017). On the surface, it appears that millennial teachers are taking a constructivist approach to teaching math, wherein technology is a consistent resource for their students. Such action supports the literature that suggests the use of technology in mathematics leads to consistent improvements overall (Aydin, 2005; Crompton, 2015; Li & Ma, 2010; Yuan-Hsuan et al., 2013). Rogers's diffusion of innovation was evident in the results of the study. Millennials are using technology during their instruction and in a consistent manner that has been communicated between members of a social system over time (Rogers, 2003). However, despite this inference, the question as to why only minimal improvements have been made to the overall national success of elementary mathematics must be explored further. Results from the 2018 NAEP test showed consistent periods of no growth among American elementary students in math. Substantial monetary investments for technology integration have been made; however, less than half of all fourth graders continue to fail to meet basic proficiency levels in mathematics (Bertram, 2014; NAEP, 2013; NCES, 2013, 2015, 2017; Organisation for Economic Co-operation and Development [OECD], 2013a).

One can infer that perhaps the concern is not the presence of technology in the classroom, but how this technology is used among millennials. Christensen (2011) argued that educators are not effectively implementing technology by using strategies that promote disruptive student-centered learning opportunities. Teachers must have an in-depth understanding of the role of technology for 21st-century learners. The researcher would argue that tools such as document cameras and projection systems are not technology tools at all. Instead, they are simply replacements for outdated practices of industrialized educational mindsets wherein the paradigmatic shift from traditional mathematical practices has not happened (Aydm, 2005). It is essential that educators recognize the importance of their role in the classroom. Instructional technology is useful, but only, however, if utilized properly. Educator roles require a shift that includes their spending class time observing, assessing, and providing feedback to their students instead of lecturing. This is relevant whether the delivery mode includes the aid of instructional technology or not (Delgado et al., 2015).

The data from this study has concluded that Late Millennials have a slight advantage over Early Millennials when it comes to using the identified tools for math instruction. Perhaps this is because Late Millennials are known for having more complex technologies available throughout their entire life, as compared to the “guinea pig” Early Millennial generation of educators. Early Millennials are flexible when it comes to the use of technology. Their adaptable nature may be the root of why their technology totals for each tested variable reported less overall use across the board.

Heid (1997) posited that the use of technology in mathematics provides opportunities for student-centered instruction wherein learners associate themselves as mathematicians who are offered opportunities for reflection and independence in their learning. In a review of the results for teacher-directed use of computers to help students solve problems and teacher-directed student use of computers for portable writing devices to record mathematical reasoning, the overall frequency totals found an increased rate of 20% for Late Millennials, when compared to Early Millennials. Additionally, Late Millennials required their students to use computers to solve problems at an increased rate of 25% over that of their Early Millennial colleagues. The current summative assessment in Texas, the STAAR test (Texas Education Agency, 2014), requires students to not only compute their findings, but also rationalize and explain their mathematical processing. These assessment items are not tested in isolation but are embedded within the assessment questions to allow students to demonstrate their mathematical understanding and critical thinking skills to communicate their ideas more authentically (Texas Education Agency, 2014). The researcher is not suggesting that the use of technology stands alone in accomplishing this goal; however, technology, when incorporated in a disruptive manner, has the potential to improve students' overall mathematical reasoning.

Limitations

Several limitations are presented in this research. The data were collected using anonymous, self-reported measures, which opened the opportunity for deflated or inflated responses to the survey questions. This survey was completely voluntary, so teachers opted to complete it at their leisure. Although the appropriate sample size was obtained, the researcher was concerned that teachers may have completed their surveys in haste, not paying close attention to the details of the questions or that each item was explicitly geared to math instruction. Although the district approved the survey, it did not assist in the distribution of the survey. For example, the original email invitations included the addresses of all the teachers in the district rather than the requested millennial elementary teachers only. When the correct distribution list was provided, and invitations were resent, teachers received a header displayed across their screen suggesting that the research correspondence might be spam. A message such as this may have impacted the overall responses received and the possible connection between the increased outliers present within the results. Additionally, participants were offered an incentive to enter their email in a drawing for a $25 Amazon gift card. The availability of a possible reward may have swayed the participants' responses, thereby skewing the data in one direction or another.

It must also be noted that this study was conducted using only one urban school district in Texas. With this limited vantage point, it is inappropriate to generalize the results beyond the population studied. Also, teachers in the study were asked to report their basic use of technology. The lack of in-depth accounts of the specifics of how the instructional tools were used on a regular basis limits the scope of interpretation for the reader. Other factors, such as years of experience, educational attainment, and hours of professional development were not factored into the analysis. Such knowledge is critical to interpreting the multifaceted connections that occur between teachers and their delivery of math instruction.

Recommendations for Future Research

By examining the subcohorts of millennial teachers, this study presents ample opportunities for future research on the continued gap in the literature on the topic. This study limited itself with the instructional tools assessed in the questionnaire. Future research calls for an examination of more complex forms of technology used by elementary millennial teachers. This can be viewed from a math perspective, or in reference to general instruction. In review of more complex forms of technology the focus simply on the frequency and variety of use, but rather an in-depth analysis of how the tools are being used during instruction. In this review of technology use, researchers should seek data centered on student-centered learning environments and higher levels of integration such as those demonstrated in the SAMR (Substitution, Augmentation, Modification, Redefinition) model. Additional correlation studies may be useful for broadening the scope of technology tools used during math instruction. The researcher would further suggest expanding the gap by conducting a qualitative or mixed-methods approach to data collection. That way, teachers can explain in more detail their approaches to mathematical instruction.

In addition, researchers could explore alternative factors that may impact millennial teachers use of technology such as teaching experience, attitude toward use, and district leadership expectations for instructional technology use.

Finally, in an effort to shed some light on the topic of millennial use of technology during math instruction, researchers could seek data related to Early and Late Millennial teachers' overall state summative data and their overall use of technology during math instruction. It would be interesting to find if Early and Late Millennials are using technology in more complex ways and whether or not its use impacts their students' overall assessment scores.

Summary

A quantitative, correlational study was used to determine if a relationship existed between millennial teachers' age and the frequency and variety of technology they use during math instructions. Data collected were found to show no significant relationship between the criterion and predictor variables. In response, the researcher failed to reject H_01 and H_02. These findings imply that millennial teachers are using technology to teach math. However, the question remains as to whether the use of technology by millennials is consistent with monolithic approaches wherein instructional tools are substituted for traditional teaching practices. There is a need for training that helps aid millennial teachers with merging their independent technology experience with their math instruction to allow for more complex use of the tools within a constructivist learning environment. School leaders can use this research as a tool for providing their millennial teachers with learning opportunities that respect their personal, technical experience and aid in using this professional knowledge to improve math instruction in the classroom.

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Appendix A

Permission for the Use of Instrument

Tate, LaDonna M

From:	Damian Bebell <bebell@bc.edu>
Sent:	Monday, February 26, 2018 10:26 PM
To:	Tate, LaDonna M
Subject:	Re: Request for Permission--USEiT Teacher Survey

Hi LaDonna,

I am happy to provide you my permission to use and modify the USEIT teacher survey as you see fit. I wish you good luck in your research on this very important topic and would kindly ask you share a copy of your results with me when you are finished!

Personally, I have been recently working more and more in early math classrooms and look forward to learning from your research!

Thanks,
Damian

On Feb 24, 2018, at 5:56 PM, Tate, LaDonna M <lmtate@liberty.edu> wrote:

Dear Dr. Bebell:

I am a doctoral candidate in the School of Education at Liberty University currently working on my dissertation titled *Relating Millennial Teachers' age to Frequency and Variety of Instructional Technology use in Elementary Math.* The purpose of this quantitative correlational study is to relate millennial teachers' age to the frequency and variety of instructional technology used during math instruction in public PreK-5 elementary schools. In my review of the literature of the USEiT study, I believe that your survey instrument encapsulates all of the requirements necessary to adequately address my research questions.

The purpose of this correspondence is to express my interest in using components of the USEiT Teacher Survey for my dissertation. My research focuses on frequency and variety of technology use in math. Therefore I will not need all of the items found on the original instrument. In a review of submitted dissertations utilizing the USEiT Teacher Survey, it notes permissions granted for researchers' to use a portion of the survey for their study (Letwinsky, 2015, Males, 2011; and Pitrelli, 2007). I humbly seek your permission to administer the USEiT Teacher Survey with the following modifications:

1. Under the demographic questioning, I will remove #6
2. Since the focus is on millennial teachers, #5 will only include the option to select 20-30 & 31-40
3. The target population comprises PreK-5 teachers, so #9 will exclude an option to choose 6-12.

4. Number 10 will now include an additional line to add "Smartboard or Promethean." VCR will change to DVD, and scanner with "Document Reader/Elmo."
5. Number 11 will now state: "During classtime, how often did students perform the following activities IN MATH?
6. Number 11 item will change its 7th item to "students use a computer or portable writing device for RECORDING MATHEMATICAL REASONING."
7. Number 11 will remove the item "students learn keyboarding skills."
8. Number 12 will now read-How often do you perform the following IN RELATION TO MATH?
9. Number 13 will now read-"How often do you ask students to produce the following using technology IN MATH?
10. Survey questions will stop at number 15 of the original instrument which will be administered online.

To aid in your decision for permissions, I have attached the proposed instrument for your review. Please note that I am still in the proposal phase and minimal unsubstantial changes to my proposed instrument may be included in the final survey under the direction of my committee. Thank you in advance for your response and consideration.

Respectfully,

LaDonna M. Tate
Doctoral Candidate
Liberty University

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Sent from Mail for Windows 10

<Instrument_Draft_Useit.docx>

Appendix B

Participant Consent

Relating Millennial Teachers' Age to the Frequency and Variety of Instructional Technology Use in Elementary Math.

You are invited to participate in a web-based online survey on the impact of Millennial teachers' use of technology during elementary math instruction. The purpose of this research is to study whether or not a correlation exists between elementary Millennial teachers' age, and the variety and frequency of technology they use during their math instruction. This research is being conducted by LaDonna Tate, a doctoral student at Liberty University in fulfillment of an Ed.D. in Educational Leadership. The online survey should take approximately 8-10 minutes to complete.

PARTICIPATION
You have been asked to participate because you are an elementary teacher in grades Pre-K through grade 5, and you have the availability of technology resources provided by your district. Your participation in this survey is completely voluntary. You may refuse to take part in the research or exit the survey at any time without penalty. You are free to decline to answer any particular question you do not wish to answer for any reason.

BENEFITS
At the end of the survey, you will be provided a link to another site that will allow you to enter your name/email to be entered into a raffle for a gift card to the local teacher supply store.

In addition to an opportunity to win a gift card, your responses may help us learn more about how Millennials utilize technology during elementary instruction, which may lead to differentiated professional learning experiences for teachers.

RISKS

There are no foreseeable risks involved in participating in this study other than those encountered in day-to-day life.

CONFIDENTIALITY

Your survey answers will be sent to a link at SurveyMonkey.com where data will be stored in a password-protected electronic format. Survey Monkey does not collect identifying information such as your name, email address, or IP address. Therefore, your responses will remain anonymous. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study.

At the end of the survey, you will be asked if you are interested in participating in a raffle for a $25 gift card to the local school supply store. If you elect to enter the raffle, you will be directed to a site where your name and email will be collected. If you choose to provide contact information such as your name and email address, your survey responses will remain anonymous to the researcher. Also, no names or identifying information would be included in any publications or presentations based on these data, and your responses to this survey will remain confidential.

CONTACT
If you have questions at any time about the study or the procedures, you may contact me at ltate@liberty.edu or the dissertation chair via email at klpaynter@liberty.edu.

If you feel you have not been treated according to the descriptions in this form, or that your rights as a participant in research have not been honored during the course of this project, or have any questions, concerns, or complaints that you wish to address to someone other than the researcher, you may contact the Liberty University Institutional Review Board at (434) 592-5530 or by email at irb@liberty.edu.

ELECTRONIC CONSENT: Please select your choice below. You may print a copy of this consent form for your records. Clicking on the "Agree" button indicates that

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

☐ Agree

☐ Disagree

<Continue to Survey>