FACTORS RELATED TO TEACHER ADOPTION RATES AND THE DIFFUSION OF A ONE TO ONE LAPTOP INITIATIVE IN ONE RURAL PUBLIC SCHOOL DISTRICT

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ABSTRACT

The purpose of this study was to better understand how a one to one (1:1) Chromebook classroom initiative diffused in a rural public school system. To investigate this process a unique three part mixed methods study was created. In phase one of the study, teachers using a 1:1 Chromebook classroom were asked to participate in an online quantitative survey. In phase two, a Delphi technique was used to create an interview questionnaire. In phase three, one-on-one interviews were administered to 17 teachers with different levels of innovativeness. Specifically, this study was designed to investigate how factors such as perceived ease of use (PEOU), perceived use (PU), teacher demographic characteristics, and time of adoption related to teacher innovativeness. The findings of the study indicated that PEOU, PU, teachers' ages, highest level of education, and time of adoption had a statistically significant relationship with teacher innovativeness. The results of this research can be used by teachers and school leaders to help understand how 1:1 technology is being adopted by school level users and determine what best practices can be utilized to help facilitate the diffusion of a 1:1 Chromebook classroom.

DEDICATION

A work of this scale requires an immense investment of time, energy, and determination. This dissertation is dedicated to those who sacrificed so much to allow me to achieve the stage in my life that I was able to spend the time and resources needed to complete this work. Specifically, I would like to thank my family, but especially Brian Solomon who taught me to always live life to its fullest. Brian, you may no longer be with us, but your spirit lives on in the memory and lives of all the people you have touched.

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LIST OF ABBREVIATIONS

1:1, One to One

AP, Advanced Placement

B, Behavior

BI, Behavioral Intention

CAI, Computer Assisted Instruction

ELA, English Language Arts

ELL, English Language Learners

GAFE, Google Apps for Education

IC, Innovation Configuration

IT, Information Technology

IRB, Internal Review Board

LoU, Level of Use

MLTI, Main Learning Technology Initiative

PEOU, Perceived Ease of Use

PIIT, Perceived Innovativeness

PU, Perceived Use

ROI, Return on Investment

SASS, School and Staffing Survey

SoC, Stages of Concern

TAM, Technology Acceptance Model

Wi-Fi, Wireless Network

LIST OF SYMBOLS

r, Correlation coefficient

$\bar{x}$, Mean

F, Outcome variable

N, Sample size

p, Significance

SD, Standard deviation

CHAPTER I

INTRODUCTION

Today, teachers, administrators, and governmental policy makers are promoting the use of technology in the K-12 classroom (Heafner, 2004; Pierce & Cleary, 2016; U.S. Department of Education, 2016b; Worley, 2011). More specifically, there has been an impetus at the federal, state, and local levels to implement one to one (1:1) classrooms across the country (Greaves, Hayes, Wilson, Gielniak, & Peterson, 2012; U.S. Department of Education, 2016b). In a 1:1 classroom, each student has access to an electronic device such as a computer or a tablet throughout the school day (Bebell & Kay, 2010). The encouragement for more technology has been promoted for an assortment of reasons, ranging from better student engagement (Harper & Milman, 2016; Pierce & Cleary, 2016), preparing students for a 21st century workforce (Pierce & Cleary, 2016; Zheng, Warschauer, Lin, & Chang, 2016), and/or helping teachers to better manage their classrooms (Cox, 2014; U.S. Department of Education, 2014, 2016b).

In an attempt to both prepare students for a 21st century workforce and enhance learning outcomes, school systems across the United States have spent vast sums of money and resources to update schools' information technology (IT) infrastructure with new computers, wireless networks (Wi-Fi), and a varied assortment of other technologies (Greaves et al., 2012; Harper & Milman, 2016; Pierce & Cleary, 2016; Worley, 2011; Zheng et al., 2016). However, while many policymakers and school leaders have embraced the growth of technology in the classroom, the results of research pertaining to classroom technology have been mixed with regard to how these

new devices affect both student learning outcomes (Harper & Milman, 2016; Inan & Lowther, 2010) and/or individual teacher's pedagogical practices (Cuban, 2009; Pérez-Sanagustín et al., 2016; Zheng et al., 2016).

In addition to not fully understanding how individual teachers will adopt these new 1:1 classrooms, it is also not fully understood how these technologies diffuse through school systems (Buabeng-Andoh, 2012; Straub, 2009). Rogers (2010) defined the diffusion process as a special form of communication where an innovation is communicated through a social system over time. Additionally, Rogers (2010) theorized that within an organization, individuals possess different stages of innovativeness or the degree to which the individual adopts a new technology earlier than other peers in their organization. Rogers (2010) classified individuals into five separate levels of innovativeness: innovators, early adopters, early majority, late majority, and laggards. Each of these innovativeness groups has differing rates of adoption or the speed at which an innovation is adopted by organizational members. Rogers (2010) S-shaped curve (see Figure 1) depicts the rate of adoption for an innovation. Typically, in the diffusion process, only a few individuals, innovators, and/or early adopters, will adopt the innovation. Soon, however, the diffusion curve begins to climb as early adopters and the early majorities begin to adopt the innovation. Over time, the trajectory of the S-shaped curve levels off as fewer individuals remain who have not yet adopted the innovation. Moreover, the rate of adoption tends to differ based on the social system in which it is being implemented. For example, schools tend to adopt innovations more slowly based on the conservative nature of the individuals in the organization (Cuban, 2009).

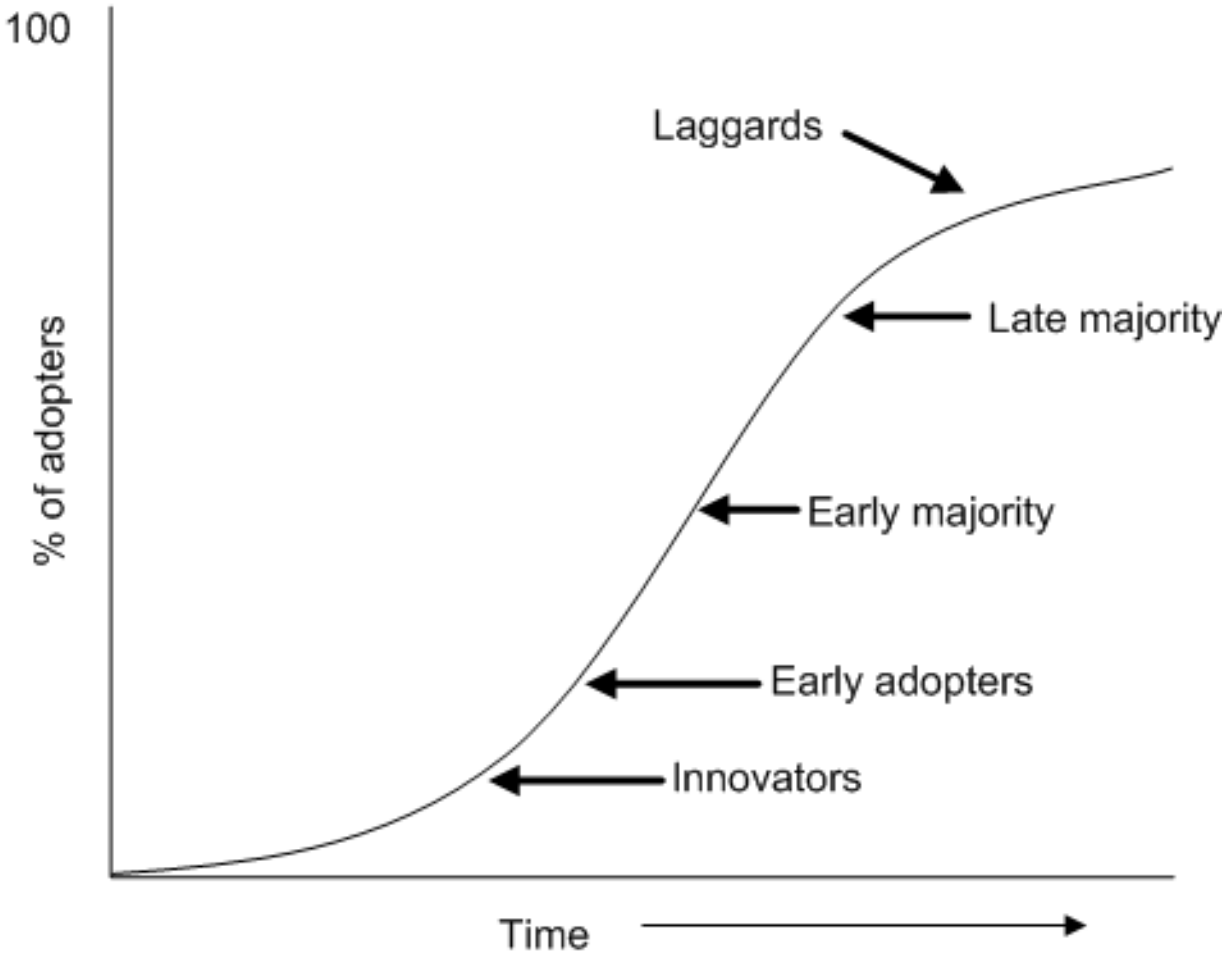

Figure 1 Rogers' Diffusion Process

While there has been a considerable amount of research conducted upon how innovations diffuse through organizations, specifically in business and in industrial fields (Arens, Worrell, & Eichhammer, 2017; Cegielski, M. Bourrie, & Hazen, 2013; Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004), there has been little research conducted as to how an innovation diffuses in an educational setting (Neyland, 2011; Pérez-Sanagustín et al., 2016). Moreover, additional research still needs to be conducted at the K-12 school level to investigate how an innovation diffuses at both the individual school and school system levels (Neyland, 2011; Pérez-Sanagustín et al., 2016). To better understand the diffusion process in a school setting, this

mixed methods study used the theory of diffusion to identify the key constructs associated with the adoption and diffusion of a 1:1 classroom (Rogers, 2010). Using these constructs, the researcher crated a three phased mixed methods study. The first quantitative phase of the study used the technology acceptance model questionnaire that is comprised of 20 Likert-style questions measuring teachers' attitudes toward the use of computers in the classroom (Davis, Bagozzi, & Warshaw, 1989). The purpose of this quantitative portion of the investigation was to establish teacher technology adoption rates of the 1:1 classroom and categorize teachers into one of the five innovativeness categories (i.e., innovators, early adopters, early majority, late majority, and laggards). In the second qualitative portion of the study, a Delphi study was conducted, in which 10 teachers were asked to collaborate and create a one-on-one interview questionnaire. Finally, in phase three of the study, the one-on-one interview questionnaire was administered to 17 teachers. All teachers participating in this study were volunteers and all of their information was kept confidential. Overall, the use of both quantitative and qualitative data allowed the researcher to better understand how the 1:1 classroom has diffused across the school district.

Background to the Problem

The educational landscape in the United States is quickly being transformed as school systems across the country begin to implement a technology rich educational framework where students learn the essential skills for success in today's information rich world (Partnership for 21st Century Learning, 2013). These learning skills include, but are not limited to, critical thinking, problem-solving, communication, and collaboration (Partnership for 21st Century Learning, 2013; Zheng et al., 2016). To integrate this framework, school leaders across the

United States have spent millions of dollars to buy new computers, update networks, and provide training to students, teachers, and administrators (U.S. Department of Education, 2016b; Zheng et al., 2016).

According to the National Center for Education Statistics, public elementary and secondary schools in the United States spent $620 billion dollars on educational technology or $12,296 per public school pupil during the 2012-2013 school year (U.S. Department of Education, 2016a). Over the coming years expenditures on technology are expected to increase further as school systems across the country move toward this technology rich framework where students have access to laptops throughout the school day, and educational content is delivered seamlessly via online learning platforms (Partnership for 21st Century Learning, 2013; U.S. Department of Education, 2016b). However, for this technology to fully benefit student learning, research has suggested that these technologies should be used as a regular part of classroom instruction (Pérez-Sanagustín et al., 2016). For example, a number of studies (Almekhlafi & Almeqdadi, 2010; Cuban, 2009; Pérez-Sanagustín et al., 2016) have indicated that one of the key factors that contribute to the implementation of technology in the classroom is how these tools are being used by teachers. To accomplish this goal of providing students with a technology rich learning environment, educational leaders have suggested implementing a transformational change in American's national educational system (Partnership for 21st Century Learning, 2013; U.S. Department of Education, 2016b).

In order to transition to a more technology literate society, the U.S. Department of Education (2016b) has suggested that K-12 schools focus on transformational educational change. According to Avolio, Waldman, and Yammarino (1991) and Warrick (2011), transformational leaders are individuals who produce positive changes in individuals by

motivating followers to transcend their self interests in the persuit of a collective purpose. As schools transition toward a technology rich framework, school administrators will need to train and support transformational educational leaders who are proficient in the use of technology to help set a vision for technology in learning (U.S. Department of Education, 2016b). To accomplish this objective, educational leaders will need to be well versed in the different learning, leadership, technology, and organizational communication theories to foster a transformative technological change in education (Harper & Milman, 2016; Zheng et al., 2016).

For educational leaders, the use of technology is one way to transform both pedagogy and how students learn. These educational entrepreneurs want students to have the critical thinking skills they will need to be competitive in today's global job market (American Academy of Arts & Sciences, 2013; Phiri, Meinel, & Suleman, 2016). One way this focus on skill acquisition rather than traditional rote memorization can be accomplished in the classroom is to use these new technologies, such as a 1:1 classroom (U.S. Department of Education, 2016b). In a 1:1 classroom, each student has access to an electronic device such as a computer or a tablet (Bebell & Kay, 2010). Using these devices, students have access to not just the facts they are studying but are also taught critical thinking skills and how to navigate the myriad of information that is available in the digital information age (U.S. Department of Education, 2016b; Zheng et al., 2016).

In addition to providing students with 1:1 devices, technology companies like Google, Apple, and Microsoft have begun to develop online educational platforms to help teachers administer classroom content via a seamless interface (Zheng et al., 2016). One example of the foray of these technology companies into online learning is the Google Apps for Education (GAFE) platform. The GAFE platform was first developed by Google in 2006 (Google, 2016).

Currently, there are over 50 million students, teachers, and administrators using GAFE worldwide (Google, 2016). The core services provided by GAFE include Gmail, Google Calendar, Google Docs, Google Slides, Google Sheets, and Google Forms. In the classroom, teachers can use the GAFE platform in conjunction with 1:1 student computers to organize class content, create assignments, and assess student work. Furthermore, because all of the classroom assignments are saved digitally online, students and teachers can work collaboratively, both synchronously and asynchronously, from any computer or device that has Internet access. Additionally, when teachers assign work to students using the GAFE platform students can access their work whether they are online or offline, as the Chromebooks will save student work digitally on their devices until the work can be permanently saved on their Google Drive. This feature allows students with limited Internet access to work on their classwork both at home and at school regardless of their ability to access the Internet.

While both public policy makers and technology companies like Google have advocated for school districts to adopt 1:1 computers, there has been little research conducted to assess both how teachers are adopting new technologies and how these technologies have diffused within school systems (Neyland, 2011; Pérez-Sanagustín et al., 2016). As such, one of the purposes of this study was to add to the overall body of knowledge regarding educational technology by examining the factors affecting teacher technology adoption rates and diffusion of a 1:1 Chromebook classroom.

Statement of the Problem

Recent reports from both private and governmental agencies have advocated for the use of more technology in the classroom (Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014;

Johnson, 2015; Partnership for 21st Century Learning, 2013; U.S. Department of Education, 2014, 2016b). These reports suggest that the use of this new technology can be used as a way to teach students 21st century learning skills (Bernard et al., 2014; Johnson, 2015; Partnership for 21st Century Learning, 2013; U.S. Department of Education, 2014, 2016b). However, while these reports have praised the use of technology in the classroom, there has been little research conducted that specifically assesses how teachers are integrating this technology into their classrooms (Neyland, 2011; Pérez-Sanagustín et al., 2016). Similarly, more research needs to be conducted into which pedagogical practices teachers should use to ensure that these technologies are fully promoting student learning and engagement (Mumtaz, 2000; Orrill, Hannafin, & Glazer, 2004). Additionally, little research has been conducted on how an innovation, like a 1:1 classroom, diffuses in a large school system (Cuban, 2009). This study was designed to examine some of these gaps in the research regarding both how teachers adopt these new 1:1 devices and how these technologies are diffusing throughout a school system. The results of this study can help both school administrators and teachers to determine the best pedagogical practices to promote both teacher and student engagement.

At the start of the 2016-2017 school year, school leaders in a rural school district in east Tennessee decided to implement a 1:1 classroom initiative throughout the school system. A plan was created to distribute Google Chromebooks over a three-year period to all students in the district. Beginning in the 2016-2017 year, teachers in the fourth, seventh, and 10 grades received Chromebooks for students to use in their classrooms. Then, over the next two school years, teachers in the fifth, sixth, eighth, ninth, 11, and 12 grades were scheduled to receive Chromebook as well, so that by the end of the 2018-2019 school year all students in the system, grades fourth through twelfth, would have access to a personal Chromebook. Before each school

year, teachers completed training classes at the central office on how to incorporate these new Chromebooks into their classrooms. To better understand the diffusion process in a rural school system, the researcher in this study investigated how the 1:1 Chromebook initiative diffused across the county by assessing how teachers in the district adopted this new technology into their classrooms.

Purpose of the Study

According to Rogers (2010), the diffusion of an innovation within an organization is a complex communicative process in which multiple factors can affect how a technology is adopted by organizational members (Buabeng-Andoh, 2012). To better understand this complex communicative process, this study used the theory of diffusion to identify the key constructs that influence the adoption and diffusion of a 1:1 classroom across a rural public school system.

Rogers (2010) outlined four main constructs that affect the overall diffusion process. These constructs include the characteristics of the innovation (i.e., relative advantage, compatibility, trialability, observability, and technological complexity), the social system in which the innovation is being introduced, the communication channels used to disseminate information about the innovation, and the time it takes for the innovation to be adopted by organizational members.

Research Questions

Using Rogers' (2010) four constructs relating to the diffusion process and a preliminary review of the literature, the researcher created the following research questions.

RQ1 Is there a relationship between the perceived ease of use (PEOU) of the 1:1 Chromebook classroom and teachers' innovativeness?

RQ2 Is there a relationship between the perceived use (PU) of the 1:1 Chromebook classroom and teachers' innovativeness?

RQ3 Do demographic characteristics of teachers (i.e., age, years of teaching experience, gender, highest level of education, grade level taught, and subject taught) using a 1:1 Chromebook classroom result in differences among teachers' innovativeness?

RQ4 Does the time required for teachers to adopt a 1:1 Chromebook classroom differ among teachers' innovativeness?

RQ5 Does the time required for teachers to adopt a 1:1 Chromebook classroom differ when controlling for teachers' time since initial training?

RQ6 How do teachers with different levels of innovativeness (i.e., innovator, early adopters, early majority, late majority, and laggards) describe the diffusion of a 1:1 Chromebook classroom?

Rationale for the Study

According to recent research, there has been an impetus at all educational levels to increase student access to technology (Bebell & Kay, 2010; Bernard et al., 2014; U.S. Department of Education, 2016b). According to a recent report (Singer, 2017), half of all elementary and secondary students in the United States, a total of 30 million students, used Google education apps like Gmail and Docs in the classroom. The initiative to provide every student in America a personal computer began in the 1990s, when educational leaders first made multibillion dollar investments in educational technologies (Cuban, 2009). Since that time, the

student to computer ratio has dropped from 125:1 in 1983 to 3:1 by 2014 (Zheng et al., 2016). As access to personal computers increased, educational researchers began to study the connection between these new technologies and student learning (Cuban, 1986, 2009). For example, recent studies have shown that technology has the ability to increase students' engagement, decrease discipline problems, engage students in complex cognitive tasks like analyzing complicated texts, and make classrooms more student-centered (Bebell & Kay, 2010; U.S. Department of Education, 2016b; Zheng et al., 2016). However, even with these investments in 1:1 computing and studies linking technology use to higher student learning outcomes, there have been relatively few studies examining how these technologies are being utilized by teachers (Buabeng-Andoh, 2012; Sandholtz & Reilly, 2004). As such, one of the purposes of this study was to add to the literature regarding the diffusion of a 1:1 classroom in a rural school district setting.

Conceptual Framework

Philosophically, the study was based on the diffusion of innovation theory first postulated by Professor Everett Rogers (2010) from the University of New Mexico. Rogers (2010) theorized that innovations are adopted and/or rejected by organizational members through a complex social mechanism that he called the diffusion process. In the diffusion process, "an innovation is communicated through certain channels over time" (Rogers, 2010, p. 5) through the structure of an organization. Rogers (2010) concluded that this process is a special type of communication in which the messages pertain to the adoption or rejection of a new idea. Moreover, the diffusion process can be slow, but Rogers (2010) suggested that by understanding

the key elements of the diffusion process, organizational leaders can help ensure the successful adoption of an innovation by organizational members.

Rogers (2010) asserted that there are four central elements involved in the diffusion process. First, the innovation, defined as a practice or object, is perceived as new by an individual. Second, the innovation is communicated to organizational members who create and share information with one another to reach a mutual understanding about the innovation. Third, the innovation diffuses through an organization over time. Finally, the innovation is communicated through a social system. Each of these four elements is essential to the diffusion process and must be fully articulated for the innovation to properly diffuse. Through his research, Rogers (2010) also discovered that the diffusion process follows an S-shaped curve, where the innovation is initially adopted by a few innovators, or early adopters. Over time, the innovation will diffuse through the rest of the organization as more individuals adopt the new technology. To better understand how the diffusion process works and why individuals adopt new technologies, each of the four elements will be discussed in some detail.

The first element of the diffusion process is the innovation. The innovation is defined as "an idea, practice or object that is perceived as new by an individual" (Rogers, 2010, p. 12). Most diffusion research focuses on how a new technology is adopted by group members (Rogers, 2010). In this study, technology is defined as a "design for instrumental action that reduces the uncertainty in the cause and effect relationships involved in achieving a desired outcome" (Rogers, 2010, p. 13). Typically, the technology is comprised of a hardware component and a software component (Rogers, 2010). For example, in this study, the hardware component was the Chromebook laptops students use in class, and the software component was the GAFE platform teachers use to organize classwork online. Additionally, Rogers (2010)

suggested that innovations that have a greater relative advantage, compatibility, trialability, observability, and less technological complexity will be more rapidly adopted by organizational members. Essentially, Rogers (2010) theorized that those innovations that have higher rates of adoption successfully diffuse because organizational members communicate these positive attributes to one another. Conversely, if enough organizational members perceive the innovation in a negative manner, the diffusion process may slow or even stop (Rogers, 2010). Thus, the perceived relative advantage, compatibility, trialability, observability, and technological complexity can have a profound impact on the successful diffusion of an innovation.

Communication is the second element of the diffusion process. According to Rogers (2010), diffusion is a unique type of communication process in which the message concerns a new idea. In this communicative process, individuals rely on a subjective evaluation of an innovation that is conveyed to them via interpersonal relationships. Rogers (2010) theorized that the diffusion process works best when an organization is comprised of homophilious individuals. "Homophily is the degree to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status, and the like" (Rogers, 2010, p. 19). Heterophily is the opposite of homophily and is defined as the degree to which two or more individuals who interact differ in certain attributes (Rogers, 2010). Most organizations tend to be more heterophilious, with organizational members having different backgrounds and differing attributes. The heterophilious nature of most organizations tends to slow the diffusion process because these heterophilious organizational members do not always communicate ideas efficiently. For example, in a perfect diffusion scenario, all individuals in an organization would have similar attributes such as a higher level of technological competency. In this scenario, the innovation would diffuse quickly as the homophilious participants shared this common attribute

and thus communicate in a more efficient manner. This scenario, however, is not typical as most organizations are comprised of heterophilous individuals with different attributes and differing skill levels (Rogers, 2010).

Additionally, the manner in which an innovation is implemented and ultimately communicated can also affect the diffusion process. Typically, in large bureaucratic organizations, the decision to adopt an innovation takes place in a top down process where a leader or change agent, who may be more technically competent, communicates with stakeholders who do not share the same level of expertise (Cuban, 2009; Rogers, 2010). This differentiation of skill and attribute levels can lead to ineffective communication causing the diffusion process to slow. To overcome these differences in technical attributes and skill levels, Rogers (2010) suggests that organizational leaders should implement an organizational structure where change becomes a natural part of the organization's culture, or what researchers call an architecture of innovation (Miller, 2013; Morris, 2011). Additionally, this focus on change through the architecture of innovation can help lessen the time that it takes for an innovation to successfully diffuse.

Time is the third element of the diffusion process. Rogers (2010) theorized that individuals pass through a decision stage from first knowledge of an innovation to formulating an attitude regarding whether or not they will adopt or reject a new idea. Innovativeness is the degree to which the individual adopts a new technology earlier than other peers in their organization. Rogers (2010) classified individuals into five separate levels of innovativeness: innovators, early adopters, early majority, late majority, and laggards. Each of these groups of adopters will have differing rates of adoption as individuals implement the innovation into their routines. The rate of adoption is the speed at which an innovation is adopted by members of an

organization. Rogers' (2010) S-shaped curve (see Figure 1) depicts the rate of adoption for an innovation. Typically, in the diffusion process, only a few individuals, innovators and/or early adopters, will adopt the innovation. Soon, however, the diffusion curve begins to climb as early adopters and the early majorities begin to adopt the innovation. Overtime, as fewer individuals remain who have not yet adopted the innovation, the trajectory of the S-shaped curve levels off.

To further clarify the time element of the diffusion process, Rogers (2010) partitioned the innovativeness dimension into the five adopter categories by calculating each innovativeness categories' standard deviations (SD) from the mean ($\bar{X}$) (see Figure 2). For example, the innovator's category comprises 2.14% of the individuals in a system to adopt an innovation or in the area below - 1SD on a curve of normality. The early adopters category comprises 13.5% of individuals to adopt a new innovation. Individuals in the early adopters category encompass an area between -2SD and -1SD. The early majority innovativeness category is the area between the average adoption rate for individuals adopting a new innovation and -1SD or 34% of the population. The late majority category of innovativeness incorporates the area between the average adoption rate for an individual and +1SD or 34% of the population. Finally, the laggard category of innovativeness comprises 16% of the total population or anyone above +1SD.

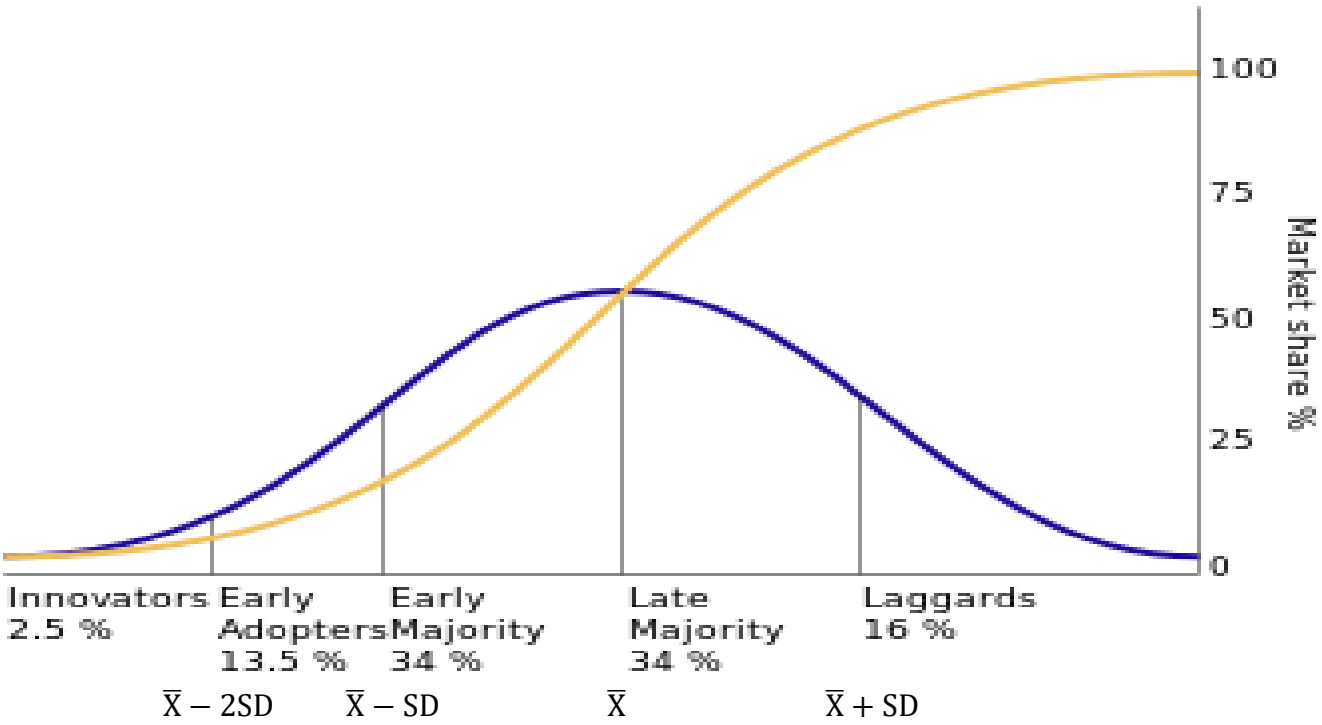

Figure 2 Bell Shaped Curve Showing Categories of Innovativeness and Adoption Rates

The fourth element of the diffusion process is the social system in which the innovate on is being adopted. The social system represents a boundary in which the innovation diffuses, and is defined as "the set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (Rogers, 2010, p. 23). Both formal and informal communication networks exist within these organizational social systems (Mumby, 2013; Rogers, 2010). According to Rogers (2010), these formal and/or informal social structures can either advance the adoption of the innovation or impede its diffusion. For example, in a bureaucratic organization, like a public school system, the formal structures tend to be hierarchical; information is typically disseminated in a top down arrangement (Cuban, 1986, 2009). In comparison, an informal communication channel might be a group of teachers who meet regularly to have lunch or coffee. Essentially, it is through these formal and informal channels of

communication that individuals decide whether or not they will adopt an innovation (Cuban, 2009).

Using these formal and informal social systems, organizational members can make one of three innovation decisions when deciding whether or not they will adopt an innovation (Rogers, 2010). The first type of decision is the optimal innovation-decision, whereby the choice to adopt or reject an innovation is made by individual members of the organization independent of other group members. The second type of decision is called the collective innovation-decision; here choices to adopt or reject an innovation are made by a consensus of the group's members. The third type of decision is the authoritarian innovation-decision. In this third innovation-decision, the choice to adopt or reject the decision is made by a few individuals who possess the power or technical expertise. In the current study, the decision to adopt the 1:1 GAFE classroom most thoroughly replicates the authority innovation-decision approach. School leaders from the school system central office first decided to rollout the 1:1 Chromebook classroom over a three-year period. This decision was made with minimal teacher or student input. After the decision was made to implement a 1:1 Chromebook classroom, teachers learned how to use these devices through a mixture of formal and informal communication networks.

Overall, the diffusion process is complex, but by learning how innovations diffuse and how these changes are adopted by group members, organizational leaders can better ensure that innovations are successfully implemented in their respective organizations. One way to help facilitate effective implementation is to create a structure of permanent innovation where each organizational member understands the role they can play in the creative process. Morris (2011) developed the term permanent innovation, which he defined as a “process of innovating regularly, constantly, and continuously, by developing an organizational culture that embraces

innovation as a core value, practices innovation as a core methodology, and produces innovations as a consistent output" (p. 20). By creating an architecture of permanent innovation, leaders push their followers beyond their predetermined capacities to expand their creativity and thus broaden the creativity of their organization (Miller, 2013; Morris, 2011). By engaging in this behavior, leaders can ensure that their organization remains competitive and that the diffusion process is effectively implemented.

Significance/Importance of the Study

For many years there has been an impetus at the federal, state, and local levels to integrate more technology into classrooms across the United States (U.S.). For example, in the 2013-2014 school year, U.S. schools purchased over 23 million laptops, tablets, and Chromebooks for classroom use (Zheng et al., 2016). As such, a more thorough understanding of how students and teachers interact with these devices is necessary as more school districts move toward a 1:1 platform where every student has access to an electronic device throughout the school day. Moreover, the decision to adopt an innovation can be complex. However, by analyzing the characteristics associated with the diffusion process, school leaders can choose the best practices that will help ensure the successful implementation of these devices.

Based on these investments in classroom technology, one might assume that most teachers in the United States not only have access to these new technologies but also use these devices as a regular part of classroom instruction. However, there has been little research conducted assessing both how teachers are adopting these new technologies and how these new devices are diffusing through a school system (Neyland, 2011; Pérez-Sanagustín et al., 2016). Therefore, as more school districts move toward a 1:1 classroom, it is important for all

stakeholders to understand how this technology can be best utilized in the classroom. One of the purposes of this study was to add to the overall body of knowledge regarding the diffusion by studying how teachers adopt new technologies and how that technology diffuses in a rural school setting.

Definition of Terms

Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters (Rogers, 2010).

Complexity is the degree to which an innovation is perceived as difficult to understand and use (Rogers, 2010).

Computer assisted instruction (CAI) is a pedagogical technique whereby a computer is used to deliver classroom instruction (Tatnall & Davey, 2014).

Diffusion is a process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2010).

Google Apps For Education (GAFE) are a suite of applications, including Google Docs, Slides, Sheets, Forms, and Gmail, created by Google that are used by schools for cloud computing (Nevin, 2009).

Heterophily is the degree to which two or more individuals who interact differ in certain attributes such as beliefs, education, and socioeconomic status (Rogers, 2010).

Homophily is the degree to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, and socioeconomic status (Rogers, 2010).

Innovation is an idea, practice, or object that is perceived as new by an individual (Rogers, 2010).

Observability is the degree to which the results of an innovation are visible to others (Rogers, 2010).

One-to-one (1:1) is a program where teachers use handheld devices or laptops that are connected to the Internet and support various pedagogical activities. In a 1:1 classroom each student has access to the devices either during the class period or all day, depending on school district protocol (C. Liu & Milrad, 2010).

Permanent innovation is a process of innovating regularly, constantly, and continuously, by developing an organizational culture that embraces innovation as a core value, practices innovation as a core methodology, and produces innovations as a consistent output (Morris, 2011).

Relative advantage is the degree to which an innovation is viewed as more advantageous than the idea it supersedes (Rogers, 2010).

Technology is a design for instrumental action that reduces the uncertainty in the cause and effect relationships involved in achieving the desired outcome (Rogers, 2010).

Trialability is the degree to which an innovation may be experimented with on a limited basis (Rogers, 2010).

Limitations of the Study

The limitations of a study are the shortcomings, conditions, or influences that cannot be controlled by the researcher, which place restrictions on the methodology (Joyner, Rouse, & Glatthorn, 2012). One limitation of this study was the sample being used. Only teachers in the fourth through twelfth grades who used the 1:1 classroom were surveyed. A larger survey, which

sampled more teachers, would add more validity to the research and make the findings more generalizable.

A second limitation of this study is how the survey instrument was delivered. Teachers were asked to voluntarily answer questions via an online survey and to voluntarily participate in a follow up interview and Delphi study. The voluntary nature of the study may have limited the number of responses received making the study less generalizable.

A third limitation of this study was the length of time that the research was conducted. Based on the approval of the Internal Review Board (IRB), data were collected during the 2018-2019 school year from the current fourth through twelfth grade teachers who were using Chromebooks in their classrooms. As such, the study was only generalizable to teachers in the district and in districts with similar demographic and instructional profiles who are trained and are using the 1:1 GAFE classroom.

A fourth potential limitation was teacher familiarity with Google applications, Google classrooms, and/or Chromebooks. Some teachers may have had access to these technologies before the study was conducted. Prior access to these technologies could create an inequitable situation for some teachers in the study who did not have the same level of access. Additionally, teacher biases regarding technology, either positive or negative, could have affected whether a teacher decided to adopt the 1:1 classroom.

A fifth limitation was the timeframe when teachers were first trained to use the 1:1 classroom. School administrators decided to implement the 1:1 classroom over a three-year period. Beginning in the 2015-2016 school year, students and teachers in the fourth, seventh, and tenth grades were given Chromebooks. Next, in the 2016-2017 school year students and teachers in the fifth, eighth, and eleventh grades were given Chromebooks. Finally, in the 2017-2018

students and teachers in the sixth, ninth, and twelfth grades were given Chromebooks. Subsequently, at the beginning of each school year teachers in the corresponding grade bands were trained at the county central office to use the Chromebooks in their classroom. As such this staggered rate of training may have affected the overall teacher adoption rate and thus limited the scope of the study. To control for this training timeframe limitation the researcher used both an analysis of variance (ANOVA) and an analysis of covariance (ANCOVA) to determine if the time of training affected teacher technology adoption rates.

Delimitations of the Study

Delimitations are the "boundaries of the study and ways in which the findings may lack generalizability" (Joyner et al., 2012, p. 209). The delimitations in this study are as follows. First, this study was delimited by the use of an availability sample of teachers. The researcher decided to study teacher adoption rates of a 1:1 classroom instead of the adoption rates of students, administrators, substitute teachers, or paraprofessionals. To accurately understand the diffusion of a 1:1 GAFE classroom, it would be better if the study contained participants from a larger population with a varied assortment of school leadership positions.

The second delimitation in this study is the type of technology the researcher chose to investigate. By focusing on a school system that is using only Chromebooks, this study may have less transferability to other schools using different devices such as tablets. A third delimitation was the time frame in which the study was conducted. The online survey and the one-on-one teacher interviews were administered during one school semester. Future longitudinal studies may provide a more in depth understanding of the overall diffusion process. A fourth delimitation was the voluntary nature of the participants. For example, teachers' answers to the

survey and participation in both the Delphi study and follow-up interviews were voluntary. Thus, the study was limited to those teachers and administrators who agreed to participate. The final delimitations were the types of data collection methods used in the study. Data collection methods in this study were in part chosen due to the time constraints and the resources available to the researcher. Additional research may need to be conducted in the future to further investigate these delimitations.

CHAPTER II

LITERATURE REVIEW

Introduction

The purpose of this study was to better understand the diffusion process of a 1:1 GAFE classroom in a K-12 setting. To better understand this potential relationship, a thorough literature review was conducted. Through this review, a number of different theories and topics were analyzed to investigate how different variables have affected both teacher adoption rates and the diffusion process.

The literature review begins with a brief overview of the use of technology in the classroom. Next, the review analyzed the history of diffusion research. The review concluded with an analysis of the factors affecting teacher technology adoption rates. During the research process, the following databases were used for this literature review: Education Resource Information Center (ERIC), ProQuest, the Tennessee Electronic Library (TEL), Academic OneFile, Journal Storage (JSTOR), Elton B. Stephens Company (EBSCO), and Gale. A majority of these databases were accessed using the University of Tennessee at Chattanooga's online library. These resources included peer-reviewed articles, books, dissertations, and government reports.

The History of Technology Use in the Classroom

Historically, American classrooms have used a variety of technological devices to aid teachers with instruction including textbooks, chalkboards, and projectors. Cuban (2009) documented the use of technology in the classroom from the 1920s to the present. Cuban's (2009) research analyzed the use of film and radio in the 1920s, television in the 1950s through the 1980s, and the advent of computer assisted instruction (CAI) in the 1990s to the present. Each successive technological adoption tended to follow a familiar trend line, similar to Rogers' (2010) S-shaped curve depicting the process of diffusion (see Figure 1). Cuban (2009), utilizing Rogers' (2010) diffusion theory, asserted that early innovators and/or early adopters introduced, used, and advocated for wider acceptance of a classroom technology. However, over time many of these classroom innovations failed to reach widespread diffusion across American school systems (Cuban, 2009). With each successive technological adoption, researchers found that many of the reformers and policy makers who were suggesting these changes did not fully understand the conservative organizational culture of schools (Cuban, 2009; Tatnall & Davey, 2014). As such, many of these technological advances went unused in the classroom. Teachers used these devices only occasionally and instead tended to rely on more direct methods of instruction (Cuban, 2009; Tatnall & Davey, 2014).

Researchers found that a number of individual level and system level factors accounted for the failure of teachers to adopt these new technologies (Cuban, 2009; Tatnall & Davey, 2014). For example, individual level factors such as teacher attitudes toward technology adoption, the complexity of the technology, and teacher workload had a negative effect on technology implementation (Cuban, 2009). In the 1980s desktop computers began to appear in schools across the country. As with previous technological adoptions, innovators and early

adopters pushed for and utilized these new computers in their classrooms. However, because of teacher attitudes and the technological complexity of these early computers, the innovation failed to reach extensive acceptance by all teachers (Cuban, 2009). In addition to the individual level factors, system level factors like a complex organizational structure and a lack of teacher training also hindered the diffusion process (Cuban, 2009; Neyland, 2011). To overcome these obstacles researchers suggested that organizational leaders should understand both the history of technology adoption and the theoretical mechanisms of the diffusion process (Berkun, 2010).

History of Computer-Assisted Instruction (CAI)

The use of computer-assisted instruction (CAI) at the K-12 level has grown rapidly in the past 20 years (Tatnall & Davey, 2014). CAI is defined as a pedagogical technique whereby a computer is used to deliver classroom instruction (Tatnall & Davey, 2014). The history of CAI has its roots in distance learning, where in the past, students would take correspondence classes through the mail to attain degrees or certificates without attending a traditional school campus (Tatnall & Davey, 2014). However, since the advent of the Internet, the use of distance learning has grown in conjunction with the growth of technology. This growth in online education has allowed individuals to work on their educational goals at their convenience from the comfort of their home (Bartley & Golek, 2004; Tatnall & Davey, 2014).

Initially, online education was limited to a small number of homebound students; however, by the early 1990s, CAI began to grow beyond this isolated group. Here again, the growth of online learning was initially focused at the secondary and postsecondary levels and use slowly matriculated to the K-12 level. Originally, this early form of online learning focused on trying to transcribe a traditional classroom experience into distance education. Furthermore, this

early form of online learning was usually centered in rural states like Alaska, North Dakota, and Nebraska (Evergreen Education Group, 2015). Over the course of the late 20th and early 21st centuries, as more Americans gained access to the Internet, online education grew as well.

According to educational researchers (Evergreen Education Group, 2015), over the past few years, CAI has grown substantially. Unlike the early inception of CAI, which focused on distance learning platforms, today, millions of American students use computers, tablets, and smartphones to access class material (Evergreen Education Group, 2015; Zheng et al., 2016). Students use these devices for a myriad of reasons, including to turn in assessments and interact with both teachers and class peers via a seamless online interface (Zheng et al., 2016). Currently, at the K-12 level most students have utilized a hybrid/blended-learning environment through which they interact with a traditional classroom teacher during the day, but may also access instructional material at home or during their free time (Evergreen Education Group, 2015).

In K-12 classrooms, students have also used a blended-learning environment for reasons ranging from recovering missing class credits or to take advanced placement (AP), honors, or dual enrollment courses that are not available in their traditional schools. Additionally, as of 2015, an estimated 1.8 million homeschool children in the United States (U.S.) have taken online courses every year where they receive the same credit as their peers from a traditional public or private institution (Evergreen Education Group, 2015). In 2015, of the 55 million K-12 students in the U.S., 47 million (85%) attended noncharter public schools (Evergreen Education Group, 2015). Most of these same public schools are believed to be using some form of digital learning. This use may range from complete online courses, where students are receiving credit as they would in at a brick and mortar school, or students may be accessing the Internet as a digital enhancement to instruction in their classes. Furthermore, it is estimated that the use of online and

blended instruction will only increase in the coming years as access to new technology and the Internet increases (Zheng et al., 2016). Additionally, while more students are using CAI in some form in their classes, there are currently few online learning models, demonstrating how educators can optimize online instruction in their classrooms (Johnson, 2015).

One-to-One Laptop Programs

In the United States, CAI has seen rapid growth in recent years as school districts across the country adopted one-to-one laptop programs (Harper & Milman, 2016; Zheng et al., 2016). One-to-one is defined as an orchestration program where teachers use handheld devices or laptops that are connected to the Internet to support various pedagogical activities. Depending of the school district protocol, students in a 1:1 classroom have access to a device either partially, during a class period, or all day (C. Liu & Milrad, 2010). For example, some districts have opted to allow students to take their technology home with them at the end of the school day (C. Liu & Milrad, 2010), while other districts have decided to only allow students to use their devices at school (C. Liu & Milrad, 2010). Regardless of the school district protocol, this growth in the use of educational technology has been in part fueled by the low cost of these new laptops and by an impetus at the local, state, and federal levels to increase CAI use in the classroom.

The first one-to-one laptop programs were introduced in the United States in the 1990s (Zheng et al., 2016). However, these early programs were implemented sporadically in different school districts across the United States. The first statewide 1:1 program was started in 2002 when the Maine Learning Technology Initiative (MLTI) was developed to provide a laptop to all seventh through twelfth grade teachers and students. Over the years, as the prices of laptops have fallen, more school systems across the county have implemented their own one-to-one classroom

initiatives similar to the MLTI (Cuban, 2009; Zheng et al., 2016). Singer (2017), estimated that half of all students in the United States have access to a laptop during the school day. These one-to-one programs have been funded by a variety of state, federal, and private grants. For example, in 2016 the Tennessee State Legislature provided an additional $200 million in educational funding for local school districts to purchase student and teacher laptops (Roscorla, 2016).

Literature regarding the use of these one-to-one devices has been varied. For example, Cuban (2009), who has studied the history of educational technology in the United States, argued that laptops, like other educational technologies, will become relics of the past. However, other researchers, such as Zheng et al. (2016) and Harper and Milman (2016), have argued that the use of laptops in the classroom are different from previous attempts to revolutionize education through the use of technology. Specifically, these researchers asserted that laptops have the ability to improve educational outcomes, transform pedagogical practices, and develop 21st century learning skills. For example, researchers have shown that 1:1 programs improved students' English language arts (ELA) skills (Bebell & Kay, 2010; Grimes & Warschauer, 2008), and improved students' writing (Lowther, Inan, Strahl, & Ross, 2012). However, other studies showed that there was no statistical change in students' math (Carr, 2012) and science (T. Liu, Lin, Tsai, & Paas, 2012) learning outcomes when students used a 1:1 classroom.

Pedagogically, 1:1 programs were shown to increase student individualized learning (Annable, 2013; Zheng et al., 2016), help facilitate the student-teacher connection both at school (Lei & Zhao, 2008) and at home (Corn, Tagsold, & Argueta, 2012; Lei & Zhao, 2008), and help teachers facilitate differentiated instruction (Hutchison, Beschorner, & Schmidt-Crawford, 2012; Rosen & Beck-Hill, 2012). Additionally, 1:1 programs also have the ability to develop 21st century learning skills. Grimes and Warschauer (2008) and Mo et al. (2013) demonstrated that

1:1 programs have increased students' technological proficiency, promoted students' learning autonomy (Grimes & Warschauer, 2008; Lei & Zhao, 2008), and helped improve students' problem-solving skills (Maninger & Holden, 2009).

Overall, the research investigating 1:1 programs demonstrated mixed results with regard to student learning outcomes with students exhibiting improved English language arts (ELA), writing and reading comprehension (Bebell & Kay, 2010; Grimes & Warschauer, 2008). However, students showed no statistical change in math or science reasoning (Carr, 2012; Harper & Milman, 2016; T. Liu et al., 2012; Zheng et al., 2016). The research generally indicated that 1:1 programs had the largest impact on teacher pedagogical practices (Harper & Milman, 2016; Zheng et al., 2016). For example, teachers used new educational technology to increase student individualized learning, improve the student-teacher connection, and 1:1 programs helped teachers to facilitate differentiated instruction (Annable, 2013; Corn et al., 2012; Harper & Milman, 2016; Lei & Zhao, 2008; Zheng et al., 2016). Finally, 1:1 programs promoted 21st century learning skills by improving students' technological proficiency, promoting learning autonomy, and improving students' problem solving skills (Grimes & Warschauer, 2008; Harper & Milman, 2016; Maninger & Holden, 2009; Mo et al., 2013; Zheng et al., 2016).

In general, research indicates that use of educational technology is expected to increase over the next few years as more school systems across the country adopt 1:1 classrooms (Harper & Milman, 2016; U.S. Department of Education, 2016b; Zheng et al., 2016). As these schools adopt this new technology, educational researchers will need to keep pace with these changes by further evaluating how these devices affect student learning outcomes, teacher pedagogical practices, and the diffusion of these devices across school systems. Specifically, additional research needs to be conducted, which focuses on certain technology applications, such as the

use of Chromebooks vs. tablets (Harper & Milman, 2016; Zheng et al., 2016). Methodologically, most of the current 1:1 research has been conducted using the case study method. Therefore, it is recommended that future longitudinal studies be conducted using experimental or quasi-experimental methods to investigate the effect of these 1:1 programs over several years and in different educational settings throughout the K-12 framework (Harper & Milman, 2016; Zheng et al., 2016). Finally, it is also recommended that researchers move away from the impact(s) of 1:1 programs and instead focus on contextual factors associated with the adoption of these programs. It is suggested that any new research focus on factors such as planning, design, development, and implementation of 1:1 programs by focusing on ways teachers and students have adopted these devices (Harper & Milman, 2016; Zheng et al., 2016).

Technology Adoption and Diffusion Theories

The decision to adopt or reject an innovation has long been a source of scientific inquiry, which has been researched throughout multiple disciplines including business, industry, and education (Straub, 2009). Based on this body of research several models have been created to describe how and why individuals and organizations adopt new technologies. These models include the technology acceptance model (Davis et al., 1989), the concerns-based adoption model (CBAM) (Hall, 1973), and the model described by Rogers (2010) termed the diffusion of innovation. Both the TAM and CBAM models were developed to research the adoption of technology in an educational setting, while Roger's (2010) diffusion of innovation theory was developed to understand how individuals within an organizational setting adopt innovations, and how those innovations diffuse throughout an organization. As such, each of these theoretical

frameworks describes the adoption/diffusion process from different organizational perspectives. To better understand these models each will be described in some detail.

Technology Acceptance Model

The TAM was originally developed by Davis et al. (1989) to describe how teachers adopted email. Today the TAM is "considered the most influential and commonly employed theory for describing an individual's acceptance of information systems" (Lee, Kozar, & Larsen, 2003, p. 752). According to Lee et al. (2003),

> the TAM has been applied to different technologies (e.g. word processors, e-mail, WWW, GSS, Hospital Information Systems) under different situations (e.g., time and culture) with different control factors (e.g., gender, organizational type and size) and different subjects (e.g. undergraduate students, MBAs, and knowledge workers), leading its proponents to believe in its robustness. (p. 753)

The TAM is designed to measure two variables, perceived ease of use (PEOU) defined "as the degree to which a person believes that using a particular system would be free of effort," (Davis et al., 1989, p. 320) and perceived usefulness (PU) defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis et al., 1989, p. 320). PU can be used as both a dependent and independent variable since it is used to predict PEOU. In most TAM studies PU and PEOU are used to predict Behavioral Intention (BI) and Behavior (B). Typically, B and BI are measured using the frequency of use of a particular technology (Lee et al., 2003).

The history of TAM begins in the 1980s as organizational leaders began to introduce new information systems into their respective organizations (Lee et al., 2003). With the introduction of these new systems organizational leaders wanted to understand how these new technologies were being adopted or rejected by group members (Cuban, 1986, 2009; Davis et al., 1989; Lee et

al., 2003; Rogers, 2010). Over the past 29 years the TAM has grown in popularity with researchers using the model to understand how and why individuals adopt new technologies (Lee et al., 2003). Lee et al. (2003), who conducted a meta-analysis on TAM research, attributed TAM's popularity with its ease of use and the fact that it can be applied to assess the usefulness of different technologies in a multitude of settings. However, some have cautioned that these same attributes could also be viewed as flaws within the TAM.

Critiques of TAM Research

While the TAM has become one of the most popular theories used by information systems researchers, the model is not without its detractors. For example, some argued that TAM's simplicity and ease of use has attracted too many researchers into the field who wish to conduct quick and easy studies (Barki & Hartwick, 1994; Lee et al., 2003). Due to the nature of these studies and their proliferation, other researchers asserted that these studies added little to the overall body of knowledge regarding technology adoption (Barki & Hartwick, 1994). Additionally, TAM research in the past has neglected to examine the different environments in which these new technologies are being adopted (Venkatesh & Bala, 2008; Venkatesh, Speier, & Morris, 2002). As such, more research needs to be conducted regarding the link between user acceptance and environmental factors.

Another critique of TAM research is the fact that many times these studies rely on self-reporting of technology usage (Lee et al., 2003). For example, Straub (2009) found that research based on self-reporting demonstrated distinctly different results than research based on actual usage. Due to this self-reporting bias TAM researchers should instead rely on actual usage data gathered using objective research methodologies. Finally, some researchers have argued that the

TAM is too narrow in scope, and that it failed to fully assess user adoption of IT. Therefore, Venkatesh and Bala (2008) and Lee et al. (2003) suggest integrating additional theories such as the diffusion of innovation, social cognitive theory, and the social network theory with TAM to generate a richer understanding of how IT systems are adopted or rejected by users.

Concerns-Based Adoption Model (CBAM)

The concerns-based adoption model (CBAM) was first developed by Hall (1973) to study the cognitive concerns and motivations of teachers who adopt new technologies or innovations in the classroom (Gundy & Berger, 2016). Specifically, the CBAM assesses the adoption process from a developmental perspective, focusing on how individual's concerns can influence the adoption of an innovation (Straub, 2009). The CBAM was developed based on six underlying assumptions. First, change is a process, not an event. Second, change is accomplished by individuals. Third, change is a highly personal experience. Fourth, change involves developmental growth. Fifth, change is best understood in operational terms. Sixth, the focus of facilitation should be on individuals, innovations, and context (Hall, 1973; Straub, 2009). These underlying assumptions form the basis of the three components measured by the CBAM, the stages of concern (SoC), the level of use (LoU), and the innovation configuration (IC) (Gundy & Berger, 2016; Hall, 1973; Straub, 2009). Using the CBAM, researchers can gain a better understanding of both the concerns of a population as an innovation is adopted, and assess how organizational leaders can help facilitate technology adoption.

The strengths of the CBAM are in its application of cognitive concerns through the context of an educational setting (Straub, 2009). "By addressing the concerns of teachers from a developmental perspective, the CBAM can provide administrators with an idea of how teachers

will adapt to change and provide a framework to anticipate future needs" (Straub, 2009, p. 632). In practice the CBAM is most frequently used to describe teacher change (Gundy & Berger, 2016; Straub, 2009). Methodologically, researchers use quantitative measures, such as survey, and/or qualitative measures, such as interviews, to assess the SoC, LoU, and IC. For example, in a study by Christou, Eliophotou-Menon, and Philippou (2004) the CBAM was administered to 655 teachers in Cyprus to determine how teachers reacted to the implementation of a new mathematics curriculum.

Critiques of the CBAM

While the CBAM has been used in numerous studies (Christou et al., 2004; Gundy & Berger, 2016; Straub, 2009), criticisms of the model have emerged. One major critique of the CBAM is that it focuses solely on teachers as the end users of an innovation. While it is important to understand how and why teachers use a new technology, it is also important from an educational perspective to understand how students in the classroom are using the same technology (Straub, 2009). As student centered pedagogy becomes more prominent it may be necessary to refine the CBAM to assess student adaptation to new technologies.

Another critique of the CBAM is how change is viewed within the model from a top-down approach. Adaptation of new technologies is both a top-down and bottom-up process (Rogers, 2010). As such, more research needs to be conducted to explore how the CBAM could be used to assess informal levels of adaptation (Straub, 2009). However, by far the central critique of the CBAM is the fact that it is only applicable in an educational setting. Other models of adaptation and diffusion, like Roger's theory of diffusion and the TAM, are more adaptable,

because they can be used in a multitude of settings outside the field of education. As such, more research needs to be conducted on how the CBAM could be used outside the field of education.

Innovation Adoption and Diffusion Theories

The history of innovation and diffusion research began as a "series of independent intellectual enclaves" (Rogers, 2010, p. 39) in the 1940s and 1950s. Initially, the study of innovation-adoption focused on the adoption of specific innovations within individual academic disciplines. For example, in the social sciences individual innovations where analyzed within specific academic fields such as education, business, and psychology (Rogers, 2010; Straub, 2009). Additionally, the adoption and diffusion processes were studied as independent entities from one another (Straub, 2009). However, in 1962 Everett Rogers wrote the first edition of his seminal work, *The Diffusion of Innovations,* in which he described the individual adoption process as part of a larger diffusion model (Rogers, 2010; Straub, 2009).

The strength of Rogers' theory is the broad foundation it provides for understanding the factors which influence the choices an individual makes about an innovation (Straub, 2009). According to Rogers (2010) and Straub (2009), the adoption process is inseparable from the diffusion process. Adoption theory is a micro perspective that focuses the individual and the choices made to either accept or reject a particular innovation (Straub, 2009). Rogers (2010), defined the diffusion process as a special form of communication where an innovation is communicated through a social system over time. Organizational members choose whether or not to adopt an innovation through a social cognitive decision-making process whereby they interact with others in their organization. Working with peers in their respective organizations, individuals decide whether or not they will adopt a new innovation based on information they

receive from peers who have had a prior interaction with the new technology (Rogers, 2010). Over time, as more organizational members interact with the new technology and communicate with each other about the benefit or detriments of an innovation the idea will diffuse through the organization. When implementing a new technology, it is important for leaders to understand how this communicative process operates so they can ensure that the innovation successfully diffuses (Rogers, 2010).

Critiques of Diffusion Research

As with other scientific paradigms, Rogers' (2010) diffusion of innovation theory makes simplifying assumptions about the world. In the fifth edition of Rogers' (2010) *Diffusion of Innovation*, he explains four of these inherent assumptions applicable to diffusion research. The first of these assumptions is what Rogers (2010) called the proinnovation bias, or the implication in diffusion research that an innovation should be adopted by all members of an organization because of the innovation's inherent newness. Rogers (2010), warned that the proinnovation bias could lead diffusion researchers to ignore the rejection of innovation or fail to study anti diffusion programs designed to prevent the spread of bad innovations, like crack cocaine or cigarettes. To overcome this proinnovation bias Rogers (2010) suggested that diffusion researchers should look at alternative research approaches other than post hoc data gathering. Additionally, Rogers (2010), suggested that diffusion researchers could also be more questioning of the innovation they choose to study and acknowledge, when appropriate, rejection, discontinuance, and reinvention decisions that frequently occur during the diffusion process. Finally, Rogers (2010), recommended that diffusion researchers should focus on the why aspect of their research instead of just the how when investigating the diffusion of a new innovation.

The second supposition that Rogers (2010) detailed is the individual-blame or source bias assumption. Many times, in diffusion research the researcher tended to side with the change agency that promotes a new innovation. This bias can lead to a tendency to hold individuals within organizations responsible for failing to innovate rather than also acknowledging system-blame when innovations fail to diffuse. To overcome this bias Rogers (2010) recommended that diffusion researchers should look for other sources of data rather than relying solely on individuals' recall as the unit of analysis. Rogers (2010), also warned that researchers should keep an open mind about the causes of social problems within an organization that could be hindering the diffusion process. Finally, Rogers (2010), suggested that researchers should incorporate both communication structural variables as well as intra-individual variables into diffusion research to overcome the individual-blame source bias.

The third assumption articulated by Rogers (2010), is the recall problem inherent in much of the diffusion research. In most diffusion research respondents are asked to recall when they adopted a new innovation. However, an individual's memory is not always accurate (Kahneman, 2013; Newman & Lindsay, 2009; Rogers, 2010; Schacter, Guerin, & Jacques, 2011). According to Bernstein and Loftus (2009),

> In essence, all memory is false to some degree. Memory is inherently a reconstructive process. Whereby we piece together the past to form a coherent narrative that becomes our autobiography. In the process of reconstructing the past, we color and shape our life's experiences based on what we know about the world. (p. 343)

Therefore, researchers need to understand that data based solely on human recall could be incorrect because of the inaccurate nature of human memory. To overcome this recall bias, Rogers (2010), suggested that diffusion researchers should look to alternative research designs to gather different datasets. By using multiple datasets and not relying solely on an individual's

memory, the dataset's congruence can be confirmed through cross referencing to justify when an innovation has been adopted.

The final assumption inherent in diffusion research is what Rogers (2010) called the issue of equality in the diffusion of innovations. According to Rogers (2010), in the past diffusion researchers have not paid much attention to the socio-economic benefits of innovations that are distributed among individuals in a social system. As such, future research should, according to Rogers (2010), address the socioeconomic gap among members of a social system and investigate how this variable affects the diffusion of new innovations.

Overall these four underlying assumptions inherent in the diffusion process should be addressed in all diffusion research. To overcome these four inherent assumptions Rogers (2010) recommended using alternate methods of research. For example, rather than relying solely on survey data, researchers could look for alternative datasets and/or use alternative research designs like field studies. By addressing these assumptions and using alternative research methods, diffusion researchers will be able to add further to the body of knowledge regarding the diffusion process.

Teacher Technology Adoption Factors

The decision of individuals to adopt or reject an innovation is a key aspect of the diffusion process (Rogers, 2010). Within the context of the classroom, teachers ultimately decide if a new technology will be adopted (Cuban, 2009; Neyland, 2011; Rogers, 2010). Thus, understanding the factors associated with teacher adoption rates is key to understanding how new classroom technologies diffuse in a school setting. A review of the literature indicated that both individual and system level factors can affect teachers' decisions to adopt or reject a new

classroom technology (Buabeng-Andoh, 2012; Cuban, 2009; Neyland, 2011; Rogers, 2010). The following review of the literature provided insight into these factors as they relate to teacher adoption rates and the overall diffusion process.

Individual Level Factors

Individual level factors influencing teacher technology adoption rates include teacher attitudes, computer competence, self-efficacy, gender, teacher experience, and teacher workload (Buabeng-Andoh, 2012; Neyland, 2011). For example, positive teacher attitudes toward technology have been shown to be correlated with higher rates of technology adoption (Demirci, 2009). Additionally, Teo (2008), in study of preservice teachers using new technology, demonstrated that if teachers believed new technology would aid them in the classroom, they were more likely to incorporate the technology into their pedagogical practices. Moreover, Peralta and Costata (2007), in a study of teachers from five European countries found that teachers' computer competence positively correlated to technology adoption rates. For example, if teachers routinely used computers both at work and at home, they were more likely to adopt that technology in the classroom, and were more willing to try using new technologies in their classes (Baturay, Gökçearslan, & Ke, 2017; Buabeng-Andoh, 2012; Peralta & Costata, 2007). Conversely, if teachers had prior negative experiences using technology, they were less likely to use and experiment with new technology in their classes (Buabeng-Andoh, 2012). Moreover, a study of 476 preservice teachers in Turkey found that teachers who use technology on a daily basis outside of the classroom were more likely to adopt educational technology in the classroom (Baturay et al., 2017). Thus, to increase teacher technology adoption rates teachers should be

given more training time to use educational technology both inside and outside of the classroom (Baturay et al., 2017).

Overall, the research regarding teacher technology adoption rates and gender was mixed. Some studies suggested that more male teachers use technology in the classroom as compared to their female colleagues (Baturay et al., 2017; Buabeng-Andoh, 2012; Neyland, 2011). However, other researchers suggested that gender had little or no correlation with technology adoption rates among teachers (Neyland, 2011). Neyland (2011), asserted that if a gender gap still exists with regard to using technology as a pedagogical tool the gap has diminished as more teachers overall have access to computers both inside and outside of the classroom.

Neyland (2011), suggested that the next individual level factor, years of teaching experience, tended to be negatively correlated with technology adoption. According to the U.S. Department of Education (2000) teachers with less teaching experience were found to be more likely to use technology in their classrooms when compared to their more experienced colleagues. For example, teachers with up to three years of experience reported spending 48% of their time using a computer, teachers with four to nine years of experience spent 45% of their time using a computer, teachers with 10 to 19 years of experience spent 47% of their time using a computer, and teachers with twenty or more years of experience spent 33% of their time using a computer in the classroom (U.S. Department of Education, 2000). The reason for this disparity may be that younger teachers have more experience using technology both at home and at work when compared to their older colleagues (Buabeng-Andoh, 2012; Neyland, 2011).

The final individual level factor thought to affect teachers' use of technology is teacher workload. Researchers indicated that teacher workload is negatively correlated with teacher technology adoption rates (Abuhmaid, 2011; Buabeng-Andoh, 2012; Neyland, 2011). Teachers

who are already overburdened with covering class content, student behavior issues, and administrative tasks found it difficult to find the time to learn new computer systems (Abuhmaid, 2011; Buabeng-Andoh, 2012). For teachers to fully realize the aims of instituting a new innovation, it will be necessary to reduce their workload. To reduce teacher workload while implementing new technology, school systems will need to assist teachers by putting in place additional resources to help teachers adjust as they learn how to utilize the new technology.

To assist the diffusion process school leaders need to understand how these individual level factors affect teacher technology adoption rates. Overall, positive teacher attitudes, enhanced computer competence, and enhanced teacher self-efficacy positively affected teacher technology adoption rates (Buabeng-Andoh, 2012; Neyland, 2011). However, years of teacher experience, and teacher workload negatively affects teacher technology adoption rates, and the gender gap, if it exists, is having less of an effect upon teacher technology adoption rates as more teachers have access to new devices (Buabeng-Andoh, 2012; Neyland, 2011). In addition to understanding how these individual level factors affect the diffusion process, it is also important for school leaders to understand how system level factors can affect teacher technology adoption rates.

System Level Factors

System level factors include, but are not limited to, teacher professional development, IT support, leadership support, and technological complexity (Buabeng-Andoh, 2012). These system level factors can help or hinder teachers as they try to adopt new technologies in their classes. Researchers have concluded that to successfully implement new technologies in schools, administrators need to provide staff with extensive training and, at the same time facilitate

communication networks that contribute to teachers' pedagogical improvement (Buabeng-Andoh, 2012).

Teacher professional development is a key factor to the successful integration of CAI into the classroom (Buabeng-Andoh, 2012). For example, in a study of 400 preservice teachers, researchers found that professional development and continuing administrative support were among the greatest determinants of successful IT integration (Mueller, Wood, Willoughby, Ross, & Specht, 2008). To maximize computer usage in the classroom researchers indicated that administrators should focus attention on training sessions that emphasize pedagogical techniques over technical issues (Sandholtz & Reilly, 2004). Moreover, these training courses should address teachers' beliefs about successful CAI integration, and policies for enhancing teaching and learning (Chen, 2008). Given time to practice during IT training sessions, teachers learned to share and collaborate with one another to develop best practices they can utilize in their classrooms (Buabeng-Andoh, 2012).

In addition to providing teachers with peer to peer IT and training sessions administrators also need to develop IT support structures to aid teachers with technology issues. If computer systems are not cared for or if technical issues are neglected, teachers will become frustrated, teacher adoption rates will slow, and the diffusion process will dwindle. For example, the ICT Strategy Group Report (2013) found that 85.3% of schools surveyed indicated that IT support and maintenance to be a high or very high priority, and that IT support was an important element to maintain hardware and IT infrastructure (Buabeng-Andoh, 2012). Therefore, if there is limited technical support, teachers will become frustrated, and they will fail to implement the innovation.

In addition to IT support, teachers need supportive leaders to help them implement new technology. To help foster the transition into a more technologically advanced classroom,

teachers need strong leaders who understand the set of complex tasks that students in the 21st century will be asked to accomplish (U.S. Department of Education, 2016b). School administrators need to have the vision and determination to implement the changes necessary to make sure students are successful. At the same time, leaders must be able to collaborate with their colleagues to make sure they espouse a shared vision that teachers perceive as beneficial to themselves and their students. Overall, the transformational leadership model can be a beneficial for helping teachers and administrators to achieve the goals that they need to foster innovation and change in today's society (Buabeng-Andoh, 2012; Miller, 2013; Morris, 2011).

The final system level factor that may affect teacher technology adoption rates is the complexity of the technology. Rogers (2010), outlined five technology characteristics, relative advantage, compatibility, complexity, trialability, and observability, that affected teacher adoption rates. Additionally, Rogers (2010), stressed that school leaders need to understand teachers' perceptions of an innovation, as these perceptions can help to predict whether or not teachers will adopt an innovation (Buabeng-Andoh, 2012). Overall, researchers indicated that when school leaders want to implement an innovation into their schools, they need to examine all five of Rogers' technology characteristics to ensure a the technology successful diffuses (Buabeng-Andoh, 2012).

When implementing a new CAI technology into the classroom, school administrators need to understand how these individual and system level factors affect teacher technology adoption rates. As stated previously, at the individual level researchers indicated that teacher attitudes, teacher computer competence, teacher self-efficacy, gender, years of teaching experience, and teacher workload can have either a positive or negative effect on technology adoption rates (Buabeng-Andoh, 2012; Neyland, 2011). At the system level teacher professional

development, IT support, leadership support, and technological complexity had a meaningful effect on teacher adoption rates and the overall diffusion process. Overall, understanding these individual and system level factors can aid school leaders in creating an innovative structure that aids diffusion (Buabeng-Andoh, 2012; Miller, 2013).

Chapter II Summary

The literature provides an important theoretical foundation for this study. The review began with a brief history of the use of technology in the classroom, followed by a description of the history of diffusion research, and concluded with a review of the factors affecting teacher technology adoption rates and the diffusion of technology in an educational setting. Overall, the review indicated that understanding how and why teachers adopt technology is an important step toward understanding how new technologies diffuse in a school setting (Buabeng-Andoh, 2012; Cuban, 2009; Neyland, 2011; Sandholtz & Reilly, 2004). However, findings from the review also indicated that more research should be conducted at the school system level to better understand how ideas are communicated between groups of individuals and, more specifically, how a 1:1 classroom diffuses in a rural school setting. As such, one of the purposes of this study was to fill in some of the gaps in the literature a by analyzing how the 1:1 classroom model has diffused in a rural school setting.

CHAPTER III

METHODOLOGY

Research Methods

The purpose of this study was to better understand the relationship between the different factors that influence the diffusion of a 1:1 GAFE classroom in one rural east Tennessee school system. To investigate this phenomenon, a mixed methods research design was created to examine the research questions. The mixed methods design allowed the researcher to collect both quantitative and qualitative data to help determine what relationship, if any, exists between different variables as they relate to the diffusion process. The study was conducted in three phases with the quantitative data being gathered in phase one and the qualitative data being gathered in phases two and three. In phase one, teacher's innovativeness was determined by administering the using the TAM survey (see Appendix G for an example of the survey). The TAM was created by Davis et al. (1989) to assess the relationship between a new technology and users' perceived ease of use (PEOU) and the users' perceived use (PU). In this study the TAM was used to assess the PEOU and PU of a 1:1 classroom. The survey is based on a seven-point Likert scale comprised of twenty questions. Additionally, eight demographic questions and four open-ended questions were added to the survey. The TAM survey data and the demographic questions were used to answer research questions one through five, while the four open-ended questions were used in the Delphi study.

In the phase two a Delphi study (Hsu & Sandford, 2007) was conducted in which ten teachers were asked to collaborate to create a one-on-one interview questionnaire. Data from four open-ended survey questions were used to assist the Delphi participants. Finally, in phase three of the study the one-on-one interview questionnaire was administered to fifteen teachers via one-on-one video conferences using Google Hangout. All teachers participating in the Delphi study and one-on-one interviews were volunteers, and all of their information was kept confidential. Additionally, all participants in phases two and three were asked to sign an informed consent agreement before they could participate. Overall, the data collected from these interviews were used to answers research question six. Moreover, these qualitative interviews combined with the quantitative survey data provided a more in-depth analysis of the diffusion process.

The study's design is mixed methods because it combined both quantitative and qualitative data collection techniques. According to Patton (2015),

> the core meaning of a mixed methods social inquiry is to invite multiple mental models into the same inquiry space for the purposes of respectful conversation, dialogue, and learning one from the other, toward a collective generating of better understanding of the phenomena being studied. (p. 317)

Utilizing both quantitative and qualitative data techniques, the researcher used data triangulation to help determine how or what relationship existed between the dependent and independent variables as they relate to the diffusion process (Patton, 2015). Additionally, by combining these designs the researcher gathered data, which allowed for a more in-depth assessment of the complex diffusion process. A prototypical version of the triangulation design is presented in Figure 3.

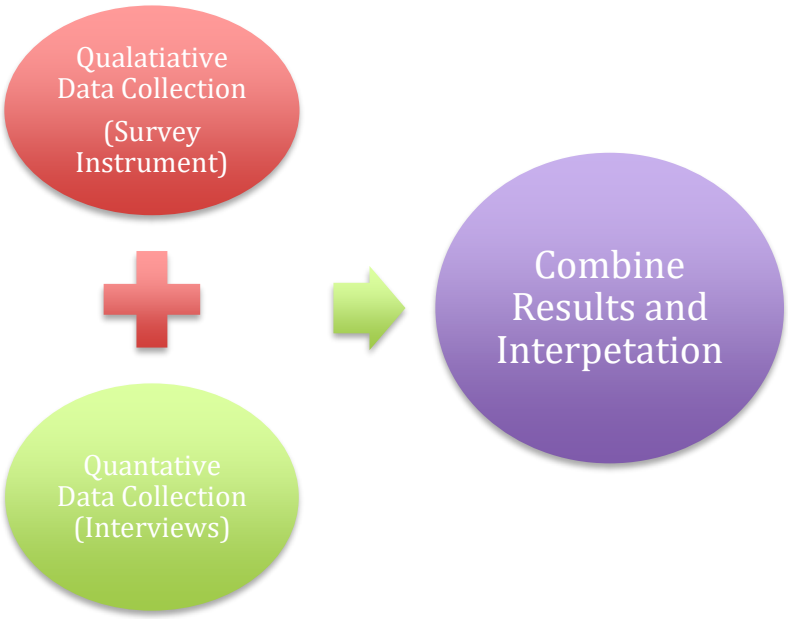

Figure 3 Triangulation design

In addition to allowing for data triangulation, a second rationale supporting a mixed methods design was because data were collected in the field. Typically, researchers prefer to use a true randomized experimental study, as there is more control over how the independent variable affects the dependent variable (Field, 2013; Fraenkel, Wallen, & Hyun, 2015; Gliner, Morgan, & Leech, 2009; Patten, 2012). However, because data were collected in the field, teachers could not randomly assign participants to control or experimental groups. As such, a mixed methods design was chosen because it allows for an in-depth study of the phenomena without creating a controlled experiment (Fraenkel et al., 2015).

The final reason why a mixed methods design was chosen for this study had to do with the nature of the study and the research questions being assessed. According to Fraenkel et al. (2015) "the nature of the research question or questions will determine the type of design to be used" (p. 561). In this study research questions one through five were assessed through a quantitative analysis, however research question six, which is designed to evaluate how

individual teachers are interpreting the diffusion process, was more easily assessed through a qualitative analysis.

Overall, the use of a mixed methods approach in this study was chosen because a true experimental study could not be undertaken, the mixed methods design allowed for a more in-depth analysis of the data than had been previously conducted, and because of the nature of the research questions. Thus, the use of a mixed methods approach in this study allowed the researcher to combine both quantitative and qualitative data to generate a better overall understanding of the diffusion process as it relates to the adoption of a 1:1 classroom.

Population

This study took place at a rural public school system in rural east Tennessee. The county school system has a total of 27 schools (Tennessee Department of Education, 2012). The system has a total student body of 14,021 (Tennessee Department of Education, 2012). Demographically the system is 90.6% White (13,077), 1.4% African American (195), 1.3% Asian (190), 6.4% Hispanic (923), and 0.3% Native American (42) (Tennessee Department of Education, 2012). The system employs approximately 1,100 teachers and 60 school administrators (Tennessee Department of Education, 2012). Additionally, 62% of the student population is considered economically disadvantaged (Tennessee Department of Education, 2012). The school system is located in a county with a total population of 95,946, of which 95.8% is White (U.S. Census Bureau, 2016). In the 25 and over age group, 81.8% of the population are high school graduates, and 15.4% have a bachelor's degree or higher (U.S. Census Bureau, 2016).

Sample

The sample for this study was drawn from a population of certified teachers in the school system in grades 4-12 (N = 1,068). All teachers in the county in grades 4-12 were required to attend a one-day training session at the school system central office. The participants in this study were expected to be a valid representation of the population in terms of gender, age, and teaching experience. All participants in the study were volunteers. For part one of the study, the online survey was emailed to all certified teachers in the school system. A number of steps were taken to maximize the response rate to the online survey. First, the researcher asked the Assistant Superintendent of Schools to forward a statement supporting the research project to all teachers in the school system (see Appendix E for an example of the letter of support). This statement was also attached to the email containing the survey link and emailed to all teachers in the county. Additionally, two reminder emails were sent to teachers one and two weeks after the original email. In all, after three weeks, the final sample size of teachers who completed the online survey was N = 264. Ten teachers participated in phase two of the study (the Delphi study) and 17 teachers participated in the phase three (the follow-up interviews).

Before the study commenced, the researcher received permission from school administrators, i.e., the assistant superintendent of the school system to conduct the study (see Appendix D for an example of the approval letter). Next, the researcher requested permission to conduct the study from the UTC IRB committee (see Appendix A for an example of the IRB approval letter). At each stage of the study the researcher collected informed consent agreements from individuals who participated in the study (see Appendix F, Appendix G, and Appendix H for an example of these informed consent agreements). Additionally, to incentivize participation in the study all individuals who participated in either the Delphi study or the one-on-one

interviews had a chance to win one of three $50.00 American Express gift cards. At the conclusion of the study, participants' names were placed into an online random name picker (Hedges, 2008) and three participants were randomly chosen to receive a gift card.

Instrumentation

Survey Instrument

In phase one of the study, the researcher used the TAM survey to answer research questions one and two (see Appendix I for an example of the online survey). The TAM survey was originally created in 1989 to measure individuals' attitudes towards the use of email, however today the TAM has become the preferred instrument to measure user attitudes regarding the use of various innovations (Lee et al., 2003). According to Lee et al. (2003), the TAM "is considered to be the most influential and commonly employed theory for describing and individual's acceptance of information systems" (p. 752). The TAM is comprised of 20 questions and is divided into two sections. Each section is comprised of ten questions that are designed to measure two variables, PEOU and PU. For the purposes of this study, TAM survey questions were edited to measure the PEOU and PU of the 1:1 Chromebook classroom.

In addition to the assessing the PEOU and PU of teachers using the 1:1 classroom the survey also contained eight demographic questions and four open-ended questions. The eight demographic questions were used to answer research questions three, four, and five, while the four demographic questions were used to guide the Delphi study (see questions #30-38). Participants were asked to respond to the following four open-ended questions (survey questions #36-39):

- What characteristics of educational innovations relate to their successful adoption?
- What characteristics of faculty members relate to the successful adoption of one-to-one Chromebook classrooms?
- What school level characteristics contribute to the successful adoption of a one-to-one Chromebook classroom?
- What school system level characteristics contribute to the successful adoption of a on-to-one Chromebook classroom?

The survey instrument was administered online using the Qualtrics platform provided by the University of Tennessee at Chattanooga, and participants were given three weeks in which to respond. To increase the response rate an introductory statement from the Assistant Superintendent of Schools was added to the email containing the survey. Additionally, two reminder emails were sent to teachers one and two weeks after the original email was sent. Moreover, these responses were analyzed to determine if there was a statistically significant variance between those teachers who answered the original email and those that answered the reminder emails. To conduct this analysis responses to the original email were coded as a 1 and responses to the second and third emails were coded as 2 and 3. Next, an ANOVA was used to determine if there was a statistically significant relationship between these groups and teacher innovativeness. In all, this analysis helped the researcher to better understand the overall response rate and potential nonrespondents.

According to Gliner et al. (2009), online surveys are a preferred methodological instrument, because participants can complete the survey at their leisure from their home or work computer. Online surveys are more cost effective than sending questioners through the mail, and online

surveys allow researchers the ability to export the data to an online statistical analysis software, like SPSS, so that the data can be quickly analyzed (Gliner et al., 2009). While there are many advantages to online surveys a lack of environmental controls could lead to a decrease in data quality (Meade & Craig, 2012). For example, careless and/or inattentive responses to online surveys could lead to "spurious within-group variability and lower reliability, which, in turn, will attenuate correlations and potentially create Type II errors in hypothesis testing" (Meade & Craig, 2012, p. 1). One method researchers can use to ensure the reliability of datasets generated from online surveys is to use an instructed response/attention check question (Meade & Craig, 2012). Instructed response/attention check questions help the researcher to screen datasets for inattentive responses, thus providing a reliability check for researchers using online surveys (Meade & Craig, 2012). Using a post-hoc analysis researchers can remove respondents' data if these questions are answered incorrectly. To increase the reliability of the dataset in this study the researcher added an instructed response question to the online survey (see survey question #15). Accordingly, datasets were discarded for any respondent who answered survey question #15 incorrectly.

Delphi Study

In phase two of the study a Delphi technique was used to create a one-on-one questionnaire. Ten teachers were asked to participate in the Delphi study. Participation in the Delphi study was voluntary, and all volunteers were asked to sign an informed consent agreement before they participated in the study. These ten teachers collaborated to create an interview questionnaire that was administered to interviewees in phase three of the study.

The Delphi technique was first developed by the Rand Corporation in the early 1950s (Hsu & Sandford, 2007). The technique is a widely used and accepted method for gathering data from respondents within their domain of expertise (Hsu & Sandford, 2007). "The technique is designed as a group communication process which aims to achieve a convergence of opinion on a specific real world issue" (Hsu & Sandford, 2007, p. 1). The researcher in this study chose to use the Delphi method because of the multidimensional nature of the research questions, which deal with uncertainty in a domain of imperfect knowledge. The objective of this technique is to achieve consensus among a panel of teachers who have experience using the 1:1 classroom. Additionally, the researcher chose this technique after a review of the literature, which showed that the Delphi technique had a greater level of accuracy than other group consensus techniques (Hsu & Sandford, 2007; Linstone & Turoff, 2011).

Methodologically, the Delphi technique involves three phases: the selection of expert panelists, the collection of relevant topics and issues, and the ranking of reported issues (Bourrie, 2014). The term expert is subjective and requires the researcher to operationally define what constitutes an expert for the purposes of their study (Bourrie, 2014). In this study the expert panel was comprised of those teachers who have been trained to use the 1:1 classroom in the school system. The four open-ended questions from the survey instrument in phase one of the study were used to select relevant topics. Before the expert panel was formed the researcher reviewed and synthesized teacher comments from the four open-ended questions. These comments were assessed by the researcher and used to create a list of potential interview questions.

Typically, a Delphi study consists of multiple rounds where expert panelists are asked to analyze questions and rank their responses. These rounds continue until the group reaches a

consensus. In this study the researcher employed a two-round Delphi technique. In phase one, each expert panelist received an initial questionnaire via Google Forms where they were asked to assess the topics and rank potential interview questions (see Appendix J for an example of the round one Delphi Study Google Form). This form contained five potential interview questions and an analysis of the data of the four open-ended questions from the online survey.

1. Topic 1: What characteristics of educational innovations relate to their successful adoption? Example Question: In your opinion as an educator are Chromebooks easy to use, why or why not?
    a. Use the example question: In your opinion as an educator are Chromebooks easy to use, why or why not?
    b. Use the example question and additional question(s) (choose other and type the question).
    c. Do not use the example question (please choose other and provide additional feedback).
    d. Other:
2. Topic 2: What characteristics of faculty members relate to the successful adoption of one-to-one Chromebook classrooms? Example: How does a teacher's willingness to try new technology relate to the adoption of the one-to-one Chromebook classroom?
    a. Use the example question: How does a teacher's willingness to try new technology affect the adoption of one-to-one Chromebook classroom?
    b. Use the example question and additional question(s) (choose other and type the question).

c. Do not use the example question (please choose other and provide additional feedback).

d. Other:

3. Topic 3: What school level characteristics contribute to the successful adoption of a one-to-one Chromebook classroom? Example: What type of administrative support contributes to the successful adoption of a one-to-one Chromebook classroom?

    a. Use the example question: What type of administrative support contributes to the successful adoption of a one-to-one Chromebook classroom?

    b. Use the example question and additional question(s) (choose other and type the question).

    c. Do not use the example question (please choose other and provide additional feedback).

    d. Other:

4. Topic 4: What school system level characteristics contribute to the successful adoption of an on-to-one Chromebook classroom? Example: What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?

    a. Use the example question: What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?

    b. Use the example question and an additional question(s) (choose other and type the question).

    c. Do not use the example question (please choose other and provide additional feedback).

    d. Other:

5. This question seeks to explore how individual teachers have experienced the adoption and diffusion of the one-to-one classroom. Example question: As an educator, overall, how would you describe the diffusion of the one-to-one Chromebook classroom in the school system?
    a. Use the example question: As an educator, overall, how would you describe the diffusion of the one-to-one Chromebook classroom in the school system?
    b. Use the example question and an additional question(s) (choose other and type the question).
    c. Do not use the example question (please choose other and provide additional feedback).
    d. Other:

Each Delphi participant was given two weeks to complete the survey and evaluate the questions related to the successful diffusion of a 1:1 Chromebook classroom. After round one the group had reached a consensus on questions one, two, three, and five. Next, in round two of the Delphi study participants were given another Google Form containing two additional interview questions and group averages from round one (see Appendix K for an example of the round two Delphi Study Google Form). After this round, the group decided to break question four into two separate questions.

- What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?
- What type of support could the school system offer to aid in the successful diffusion of the one-to-one Chromebook classroom?

Thus, after two rounds, a total of six questions were created for the interview questionnaire.

One-On-One Interview Instrument

Initially the researcher had planned to interview 25 teachers for follow-up interviews. However, only 17 teachers agreed to participate in the interviews. All 17 interviewees were volunteers and signed an informed consent agreement before they participated. Also, before the interviews were conducted the researcher submitted a Form B, application for research changes, to the UTC IRB (see Appendix B for an example of the form). This application described the six interview questions that were created through the Delphi study. After one week the UTC IRB approved these changes (see Appendix C for the IRB approval of changes letter) and the researcher commenced with the one-on-one interviews using the interview questionnaire. The guide was designed to elicit information regarding the types of social systems used in the diffusion process (Patton, 2015). Before each interview started the researcher read the same introductory statement to each interviewee (see Appendix L for an example of the interview questionnaire).

The interview guide format was chosen because it helped to ensure that the same basic questions are asked with each interviewee (Patton, 2015). These interviews were also used to assess the overall diffusion process from each respondent's perspective. The purpose of this interview process was to both answer research question six and provide a more in-depth assessment of the overall diffusion process from individual teacher perspectives.

Interviews were chosen as the desired medium to collect this qualitative data after a preliminary review of the research regarding the diffusion process. For example, according to both Patton (2015) and Creswell (2013) within the field of qualitative inquiry, interviews allow the researcher to investigate more in-depth phenomena that may be more difficult to study from a purely quantitative perspective. In this study the interview questions are designed to allow for

interview guided design. According to Patton (2015) a guided interview allows the researcher to focus on a particular issue, and at the same time explore topics that are important to the interviewee.

The interviews in this study were conducted using a phenomenological framework. Phenomenologists seek to describe a common meaning for a group of individuals by analyzing the lived experiences of a concept or phenomena. “The basic purpose of phenomenology is to reduce individual experiences with a phenomenon to a description of the universal essence” (Creswell, 2013, p. 76). In a phenomenological study the essence refers to what and how individuals experience the phenomena being studied (Creswell, 2013). For example, the phenomenological approach used in this study allowed the researcher to create a more in-depth picture of teachers’ experiences when they interacted with the 1:1 classroom.

Research Design

This pragmatic, explanatory, mixed methods study was administered in three phases. In phase one, teachers completed the TAM survey developed by Davis et al. (1989). This survey allowed the researcher to assess each teacher’s level of innovativeness and determine the PEOU and PU of teachers using the 1:1 classroom. The TAM was administered online and distributed to teachers through their school emails using the Qualtrics instrument provided by UTC. Eight demographic questions were added to the TAM survey to assist in answering research questions three, four, and five. In phase two of the study a Delphi technique was used to create an interview questionnaire that was administered in phase three of the study. In phase three, 17 teachers were asked to participate in follow-up interviews. The purpose of these interviews was to gather further qualitative data regarding the diffusion process and answer RQ6.

Researchers have long been engaged in a paradigm war debating the superiority of quantitative versus qualitative research methodologies (Creswell, 2013). Quantitative researchers argued that research had to be objective to allow for bias free generalizations. Alternatively, qualitative researchers argued that research is inherently value bound, and thus objectivity could never truly be understood (Creswell, 2013; Patton, 2015). Over time, a new mixed methods approach emerged, which combined the strengths of both quantitative and qualitative research designs (Patton, 2015).

Again, the overall design of this study was a pragmatic, explanatory, mixed methodology, which was administered in three phases. Overall, researchers who utilize a mixed methods approach adhere to a pragmatic philosophy. The pragmatic philosophy allowed the researcher to use the most appropriate methodology to answer the research questions (Patton, 2015). While the explanatory design of this study allowed the researcher to use the quantitative data from the survey and refine the information through one-on-one interviews to create a more in-depth analysis of the complex diffusion process.

In this study, the dependent variable was teachers' innovativeness. Teachers' innovativeness was determined by assessing each teacher's Perceived Level of Innovativeness (PIIT). PIIT is a self-reported metric generated from survey questions #24-27. These four questions were developed by Agarwal and Karahanna (2000) to determine an individual's willingness to try new technologies. Used in conjunction with the TAM, the PIIT metric allows a researcher to measure innovativeness as it relates to PU and PEOU. To determine each teacher's PIIT score an average score will be generated by adding the four PIIT questions. These averages were transformed into a z-score to determine each level of innovativeness (Fraenkel et al., 2015).

Once teachers' PIIT scores were converted into z-scores, they were categorized into one of the five innovativeness categories by determining how they fall under a curve of normality (see figure 4). For example, the innovator's category comprises 2.14% of the individuals in a system to adopt an innovation or the area below -2sd on a curve of normality. The early adopters category comprises 13.5% of individuals to adopt a new innovation. Individuals in the early adopters category encompass an area between -2sd and -1sd. The early majority innovativeness category is the area between the average adoption rate for individuals adopting a new innovation and -1sd or 34% of the population. The late majority category of innovativeness incorporates the area between the average adoption rate for an individual and +1sd or 34% of the population. Finally, the laggard category of innovativeness comprises 16% of the total population or anyone above +1sd. Once each teacher's rate of adoption was determined they were coded as follows: 1= innovators, 2=early adopters, 3=early majority, 4=late majority, and 5= laggards.

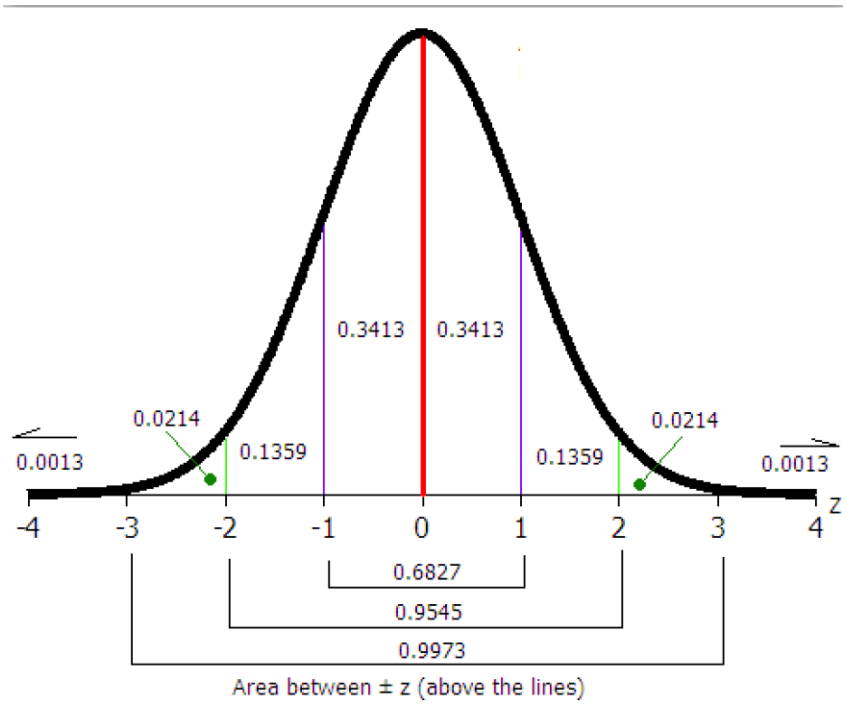

Figure 4 Curve of normality

Data Analysis Techniques

The purpose of the analysis in this mixed methods study was to analyze both the quantitative and qualitative data collected through the various research methods. As such, different data analysis techniques were used for the separate quantitative and qualitative phases of the research. Results from the quantitative portion of the study were assessed using the SPSS software provided by UTC. Results from the qualitative portion of the study were analyzed using the QDA Data Miner that was also provided by UTC. The following data analysis techniques were employed to describe the data and answer each research question (see Appendix M for an example of the variables that were analyzed in each research question).

Quantitative Data Analysis

For the quantitative data analysis, individual teacher scores were coded and evaluated using the SPSS software. For all five of the quantitative research questions, an exploratory data analysis was conducted to test for normality, and kurtosis and skewness statistics were examined to ensure the data were normally distributed (Field, 2013). Additionally, charts and graphs were used as necessary to describe the results for each of the research questions. The following quantitative data analysis techniques were used to assess research questions one through five.

Research Question One

Research question one: Is there a relationship between the PEOU of the 1:1 Chromebook classroom and teachers' innovativeness? The purpose of RQ1 was to assess the first element of the diffusion process, the innovation, by measuring the PEOU of a 1:1 Chromebook classroom, and determine if there is a correlation between the independent and dependent variables. The teacher's PEOU scores, the independent variable, were calculated by averaging an overall mean score for question #3-12. The dependent variable RQ1 is teacher innovativeness, which was determined by calculating each teacher's PIIT score. Teachers' PIIT scores were a self-reported metric generated from survey questions #24-27. To determine each teacher's PIIT score, a mean score was generated by adding together the four PIIT questions. Next, these mean PIIT scores were transformed into a z-score. Finally, a Pearson's *r* correlation coefficient was used to determine if there is a positive or negative relationship between teachers' PEOU scores and teacher innovativeness (PIIT scores).

Research Question Two

Research question two: Is there a relationship between the perceived use (PU) of the 1:1 Chromebook classroom and teachers' innovativeness? The purpose of RQ2 was to assess the first element of the diffusion process, the innovation, by assessing the PU of a 1:1 classroom. The PU, the independent variable, was determined through teachers' answers to survey questions #13-23 by generating an average mean score for all 10 questions. The dependent variable for RQ2 was teacher innovativeness. Teacher innovativeness was determined in the same manner as RQ1 by determining teachers' PIIT scores. A Pearson's *r* correlation coefficient was used to determine if there was a positive or negative relationship between teachers' PU scores and their innovativeness scores.

Research Question Three

Research question three: Do demographic characteristics of teachers (i.e., age, years of teaching experience, gender, subject taught, grade taught, and highest level of education) using a 1:1 Chromebook classroom result in differences among teachers' innovativeness? The purpose of RQ3 was to assess the heterophilious/homophilious characteristics of teachers adopting the 1:1 classroom. The independent homophilious variables were determined by gathering basic demographic information about teachers such as age, years of teaching experience, gender, subject taught, and level of education (survey questions #30-35). The dependent variable for research question three was teacher innovativeness. Teacher innovativeness was determined in the same manner as RQ1 and RQ2. A multivariate linear regression was used to compare each homophilious characteristics to teacher's innovativeness scores to determine if there was a statistically significant relationship between these variables. For example, teacher's ages (the

independent variable) were compared to each teacher's innovativeness score to determine if a statistical relationship exists. Next teachers' years of teaching experience were compared to teachers' innovativeness scores. Finally, gender, highest level of education, subject taught, and grade level taught were compared in the same manner.

Research Question Four

Research question four: Does the time required for teachers to adopt a 1:1 Chromebook classroom differ among teachers' innovativeness? The independent variable for RQ4 was time. According to Rogers (2010), the diffusion process occurs in stages, with some individuals choosing to adopt an innovation earlier than others. As such, the time variable was assessed by determine the rate of adoption. Teachers' rates of adoption were determined by asking teachers how many times they used the 1:1 classroom per week (survey question #28). Using this data, each teacher was grouped based on how many days per week they used the 1:1 classroom. For example, teachers who used the Chromebook classroom once per week were placed in group one, teachers who used the classroom two days a week were placed in group two, teachers who used the Chromebook classroom three days a week were placed in group three, teachers who used the classroom four days a week were place in group four, and teachers who used the Chromebook classroom five days a week were placed in group five. The dependent variable for RQ4 was teacher innovativeness. Teacher innovativeness was determined in the same manner as RQs one through three. Finally, an ANOVA was used to compare the groups and determine if there was a statistically significant difference between each teacher's adoption rate (time) and teacher's innovativeness.

Research Question Five

Research question five: Does the time required for teachers to adopt a 1:1 Chromebook classroom differ when controlling for teachers' time since initial training? The purpose of RQ5 was to assess how the time variable relates to teacher innovativeness, when controlling for teachers' time since initial training. The independent variable for RQ5, time, was calculated using the same methodology as RQ4, by calculating each teacher's adoption rate. The dependent variable for RQ5 was teacher innovativeness. Teacher innovativeness was determined in the same manner as research questions one through four. However, because teachers were trained at different times an ANCOVA was used to hold the teacher training timeframe variable constant. Survey question #29 asks when teachers were first trained to use the 1:1 classroom. Teacher's answers from survey question #29 will be used as a covariate. As such, the ANCOVA tested for the difference between groups of innovators adjusted for the time since training covariate.

Qualitative Data Analysis

To assess the qualitative data generated in this study, the researcher used the QDA Data Miner provided by UTC. The QDA Miner is a software tool used by researchers to analyze interviews and other qualitative texts (Patton, 2015). The QDA allowed the researcher the flexibility to code qualitative data and analyze the data using different statistical analyses. The following data analysis techniques were used to assess RQ6.

Research Question Six

Research question six: How do teachers with different levels of innovativeness (i.e., innovator, early adopters, early majority, late majority, and laggards) describe the diffusion of a

1:1 Chromebook classroom? Research question six was designed as a qualitative research question. According to Patton (2015), in qualitative research the intent is to explore a set of factors that surround a central phenomenon and present the varied perspectives and meanings that participants hold. In this study research question six was created to understand how teachers with different levels of innovativeness perceived the complex diffusion process. Research question six used a mix of quantitative and qualitative data to reach a more in-depth understanding of the diffusion process. Quantitative survey data were used to categorize teachers into one of the five innovativeness categories, and the qualitative data from the one-on-one interviews were used to explain the mechanisms involved in the diffusion process from an individual teacher perspective (Creswell, 2013).

Using the data from the quantitative portion of the study teachers were categorized into one of the five innovativeness categories (i.e., innovator, early adopters, early majority, late majority, and laggards). All interviewees were volunteers and signed an informed consent agreement before they participated in the study. In all, 17 teachers agreed to participate in the follow-up interviews. The researcher used the interview questionnaire developed in the Delphi study to assess the diffusion process from the individual teacher perspective. To determine who would participate in these interviews, respondents were asked if they were willing to be contacted for follow-up interviews (see survey question #40). If teachers were willing to conduct a voluntary interview their contact information was collected (see survey questions #43-46).

After the Delphi study was completed the researcher contacted all of the teachers who agreed to participate to set up a time to conduct the interview. In all, 17 teachers agreed to participate in an interview. All interviews were conducted using Google Hangouts or Apple Facetime, and with the interviewee's permission, the interviews were recorded. After the

interviews were completed, the researcher analyzed the data, looking for common topics or themes. Once these topics were identified the data were input into the QDA Data Miner.

The researcher used the following techniques outlined by Creswell (2013) for conducting a phenomenological data analysis. After interview data were entered into the QDA Data Miner, the researcher thoroughly analyzed the data looking for significant statements, sentences, or quotes that provide an understanding of how teachers experienced the 1:1 classroom. Once these statements were identified, the research developed clusters of meaning or themes. These themes were used to write a textual description of the 1:1 phenomena. Finally, from this textual description, the researcher developed a composite description, called the essential, invariant structure or essence. The essential, invariant structure is a passage focusing on the common experiences of the participants (Creswell, 2013). For example, in this study, the invariant structure passage focused on what and how teachers from each of the five innovativeness categories experienced the 1:1 classroom. Overall, the purpose of the phenomenological data analysis used in this study was to generate a more in-depth understanding of the diffusion phenomena as it relates to the adoption of a 1:1 Chromebook classroom.

Chapter III Summary

The purpose of this study was to better understand the relationship between the different factors that influence the diffusion of a 1:1 GAFE classroom in one rural east Tennessee school system. To investigate this phenomenon a mixed methods research design was utilized to examine the research questions. To garner a more in-depth understanding of the diffusion process, as it pertains to the adoption of a 1:1 classroom, the researcher designed a unique three-part mixed methods study.

In phase one, the quantitative phase of the study, teachers were asked to answer an online survey. The purpose of this online survey was to assess teacher adoption rates and categorize teachers into one of the five innovativeness categories. In phase two of the study, a Delphi technique was used to create an interview questionnaire. Finally, in phase three of the study, the interview questionnaire was used to conduct one-on-one interviews with 17 teachers. The purpose of these one-on-one interviews was to reach a more in-depth understanding of the diffusion process as it pertains to teachers' experiences as they adopted the 1:1 classroom. Overall, this unique three phase mixed methods study added to the body of knowledge regarding the diffusion of new technologies by investigating the 1:1 classroom model through an analysis of the shared experiences of teachers adopting the Chromebook classroom.

CHAPTER IV

RESULTS

The purpose of this study was to examine the factors related to teacher adoption rates and the diffusion of a 1:1 Chromebook classroom. To address the complex diffusion process, a three phase mixed methods study was created. In phase one, the quantitative phase of the study, teachers were asked to complete an online survey. The results of phase one were used to answer RQs one through five. In phase two, ten teachers participated in a Delphi study, the purpose of which was to create an interview questionnaire. Finally, in phase three of the study, 17 teachers were interviewed. The purpose of these interviews was to garner a more in-depth understanding of the diffusion process and answer RQ6. This chapter begins with an analysis of the descriptive statistics, followed by an analysis of RQs one through five, a presentation of the Delphi study findings, and finally an analysis of the interview data.

Quantitative Data Results

For the quantitative data analysis, individual teacher scores were coded and evaluated using the SPSS software. For all five of the quantitative research questions, an exploratory data analysis was conducted to test the requisite assumptions for each statistical test. Additionally, tables and graphs were used as necessary to describe the results for each research question. The following quantitative data analysis techniques were used to assess RQs one through five.

Data Screening

In this study, data were collected from one rural public school system in east Tennessee. Originally, the researcher distributed a list with 1,145 emails. After one week, 198 teachers had completed the online survey, after the second week, 44 additional participants had responded, and after week three 25 more teachers completed the assessment (see Table 1 for a description of survey completion times). After the surveys were completed, the researcher removed any incomplete responses. Of the original 1,145 email addresses, 77 were returned with an incorrect email addresses or respondents indicated that they were not teachers (i.e., administrators or school counselors) and these data were removed. This process lowered total teacher email count to 1,068. In all, after three weeks, 283 teachers had completed the survey. However, 19 respondents answered the attention check question incorrectly (see survey question #15), and their information was also removed from the data. Thus, a total of N=264 teachers completed the online survey for a response rate of 24.7%.

Table 1 Online Survey Completion Date Groups

Completion Date	Frequency	Percent
Week One	198	75.0
Week Two	44	16.7
Week Three	22	8.3
Total	264	100.0

Response Rate Analysis

Online survey response rates were analyzed using an ANOVA to determine if there was a statistically significant variance between teachers who answered the original email and teachers

who answered the two reminder emails. The purpose of this analysis was to better understand the overall response rate and potential nonrespondents. Prior to conducting the ANOVA, the assumption for normality was evaluated and determined to be satisfied as the dependent variable (PIIT) was normally distributed and the three groups' distributions were associated with a skew and kurtosis less 1.96 for a $p < .05$ (Field, 2013) (see Table 2 for an example of the descriptive statistics). Additionally, the assumption of homogeneity of variances was tested and satisfied based on a Levene's F test, $F(2,261) = 2.752$, $p = .065$ (see Table 3 for an example of the Levene's test results).The results of the one-way ANOVA determined that there was no statistically significant difference between groups of teachers $F(2,261) = 1.234$, $p = 0.293$ (see Table 4 for an example of the ANOVA results).

Table 2 Online Survey Completion Date Groups Descriptive Statistics

	N	*M*	*SD*	Skew	Std. Error Skew	Kurtosis	Std. Error Kurtosis
Week One	198	-0.432	1.039	-0.238	0.173	-0.438	0.344
Week Two	44	0.222	0.800	-0.524	0.357	-0.213	0.702
Week Three	22	-0.039	1.215	-0.504	0.491	-0.850	0.953

Table 3 Levene's Statistic for Survey Completion Date Groups

	Levene Statistic	df1	df2	Sig.
Based on Median	2.762	2	261	.065

Table 4 ANOVA Test Results Comparing Survey Completion Groups and Teacher Innovativeness

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.454	2	.727	1.234	.293
Within Groups	153.759	261	.589		
Total	155.213	263			

Descriptive Statistics

The dependent variable for RQs one through five was teacher innovativeness. Teacher innovativeness was determined by calculating each teacher's PIIT score, which is the mean score from survey questions #24-27. These PIIT scores were then converted to z-scores and teachers were categorized into one of the five innovativeness categories. Innovators were those teachers with a z-score that is less than or equal to $1.843 \leq 3.463$. Early adopters were those teachers with scores between $0.763 \leq 1.842$. Early majority teachers scored between $0.762 \leq -0.316$. Late majority teachers scored between $-0.315 \leq -1.396$, and laggards scored between $-1.395 \leq -2.476$ (see Figure 5). In all, the sample was comprised of one innovator (0.4%), 84 early adopters (31.8%), 97 early majority (36.7%), 34 late majority (12.9%), and 48 laggards (18.2%). The teacher innovativeness z-score mean was 0.00134, the median was 0.179, and the mode was 0.179 (See Table 5 for a description of teacher adopter categories).

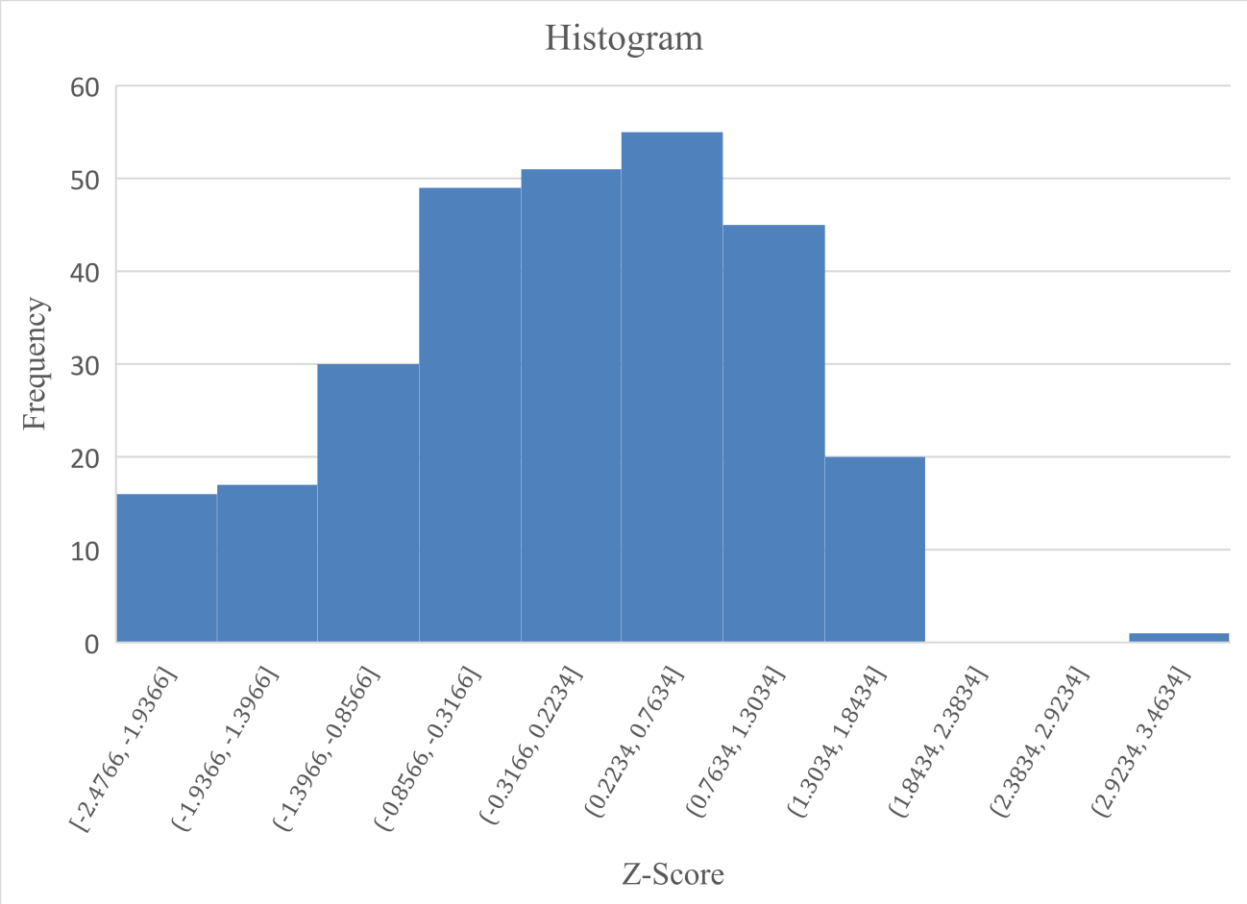

Figure 5 Teacher PIIT Scores Histogram

Table 5 Adopter Categories

	Frequency	Percent
Laggard	48	18.2
Late Majority	34	12.9
Early Majority	97	36.7
Early Adopters	84	31.8
Innovator	1	.4
Total	264	100.0

Table 6 and Figure 6 indicated that a majority of participants 33.3% were between 40-49 years old. There were 33 teachers in the 20-29 years old (12.5%), 68 teachers were 30-39 years old (25.8%), 57 teachers were 50-59 years old (21.6%), 14 teachers were 60-69 years old (5.3%), and 4 teachers were 70-79 years old (1.4%). Overall, the study sample paralleled the Tennessee teacher demographic analysis in the School and Staffing Survey (SASS) by the National Center for Education Statistics (2012). Data from the SASS represents the entire teacher population in Tennessee in grades K-12 (Hope Street Group, 2016; National Center for Education Statistics, 2012). The SASS categorized the average teacher age in Tennessee as less than 30 years (17.7%), 30-49 years (49.1%), 50-54 years (15.0%), and 55 or more years (18.3%) (National Center for Education Statistics, 2012).

Table 6 Participants' Age

Study Sample			SASS	
Age Range	Frequency	Percent	Age Range	Percent
20-29	33	12.5	Less than 30	17.7
30-39	68	25.8	30-49	49.0
40-49	88	33.3		
50-59	57	21.6	50-54	15.0
60-69	14	5.3	55 or more	18.3
70-79	4	1.5		
Total	264	100.0	Total	100.0

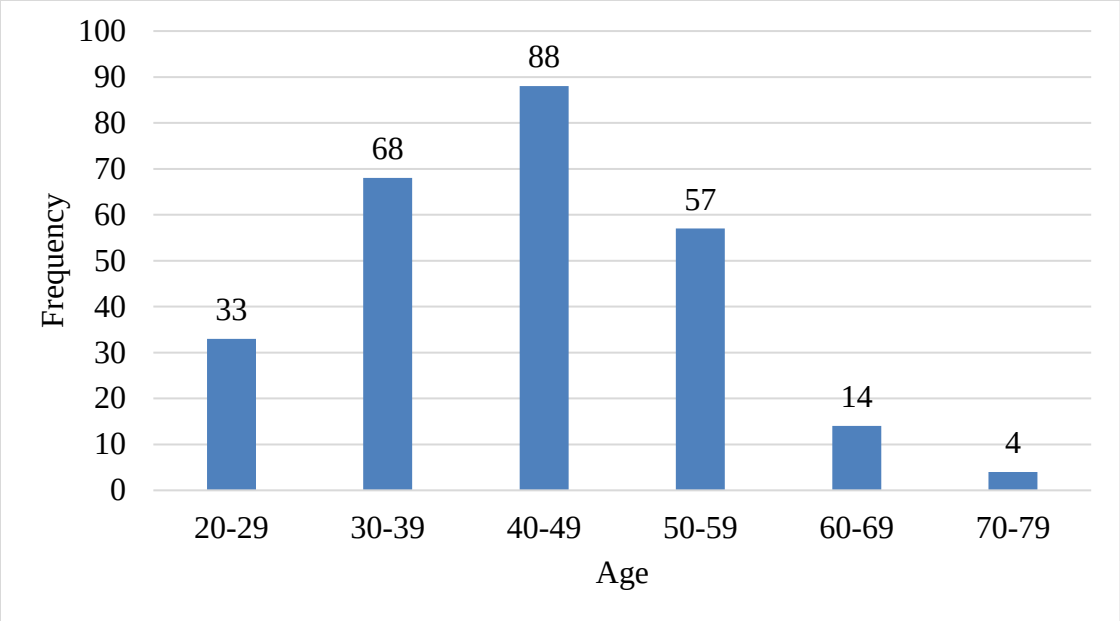

Figure 6 Participants' Age Bar Graph

Table 7 and Figure 7 documented that a majority of participants in the sample (n = 195) were female (73.9%), while 68 teachers were male (25.8%), and one participant choose other/not applicable (0.4%). With regard to gender the sample population closely matched the data in the SASS (National Center for Education Statistics, 2012). The SASS reported a male teacher population of 20.6% and a female population of 79.4%.

Table 7 Participants' Gender

Study Sample			SASS	
Gender	Frequency	Percent	Gender	Percent
Male	68	25.8	Male	20.6
Female	195	73.9	Female	79.4
Other/Not Applicable	1	0.4		
Total	264	100.0	Total	100.0

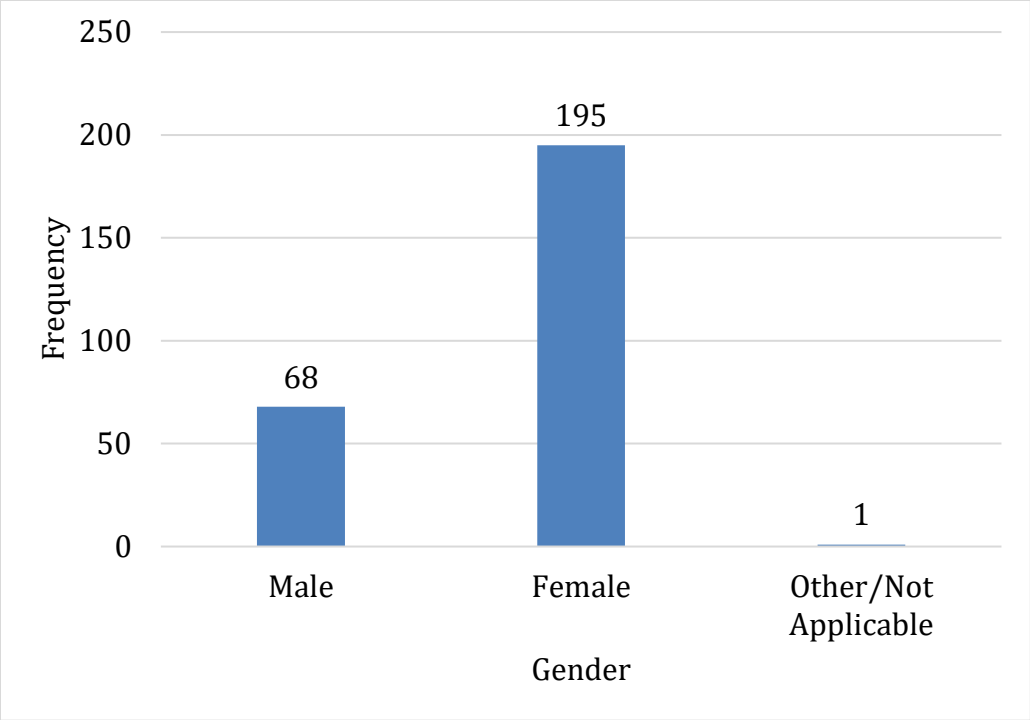

Figure 7 Participants' Gender Bar Graph

Table 8 and Figure 8 demonstrated that a majority of teachers who participated in the survey (30.2%) had 10 or less years of teaching experience. There were 84 teachers who had 11-20 years of teaching experience (31.8%), 58 teachers had 21-30 years of teaching experience (22.0%), and 16 teachers had 31 or more years of experience (6.1%). The study sample contained a slightly lower percentage of teachers with 0-10 years of teaching experience (40.2%) when compared to the teachers with 0-9 years of experience (43.8%) reported in the SASS (National Center for Education Statistics, 2012).

Table 8 Years of Teaching Experience

Study Sample			SASS	
Years of Teaching Experience	Frequency	Percent	Years of Teaching Experience	Percent
0-10	106	40.2	0-9	43.8
11-20	84	31.8	10-14	16.7
21-30	58	22.0	15 or more	39.5
31+	16	6.1		
Total	264	100.0	Total	100.0

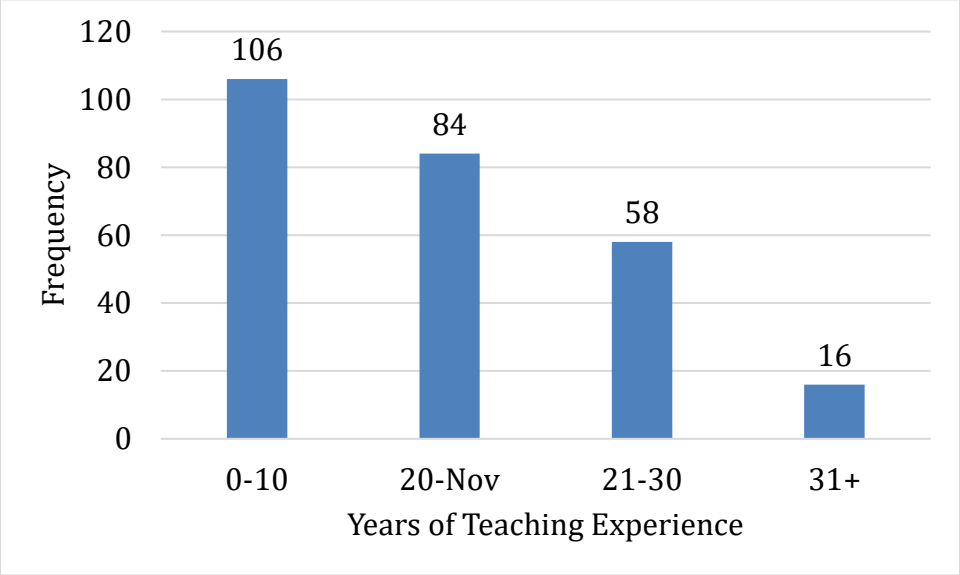

Figure 8 Years of Teaching Experience Bar Graph

Table 9 and Figure 9 indicated that a majority of teachers participating in the study held an educational specialist degree (42.8%). One teacher had an associates degree (0.4%), 50 teachers had bachelors degrees (18.9%), 83 teachers had masters degrees (31.4%), 16 teachers had doctorates (6.1%), and one teacher chose other degree (0.4%). Compared to the population reported in the SASS (National Center for Education Statistics, 2012) the sample had a larger

percentage of teachers who held a degree higher than a masters. In the sample 48.9% of the respondents reported having a degree higher than a masters while the SASS reported that 14.4% of teachers in Tennessee held a degree higher than a masters.

Table 9 Highest Level of Education

Study Sample			SASS	
Highest Level of Education	Frequency	Percent	Highest Level of Education	Percent
Associates	1	.4		
Bachelors	50	18.9	Bachelors	35.1
Masters	83	31.4	Masters	46.3
Specialist	113	42.8	Higher than a Masters	14.4
Doctorate	16	6.1		
Other	1	.4		
Total	264	100.0	Total	95.8

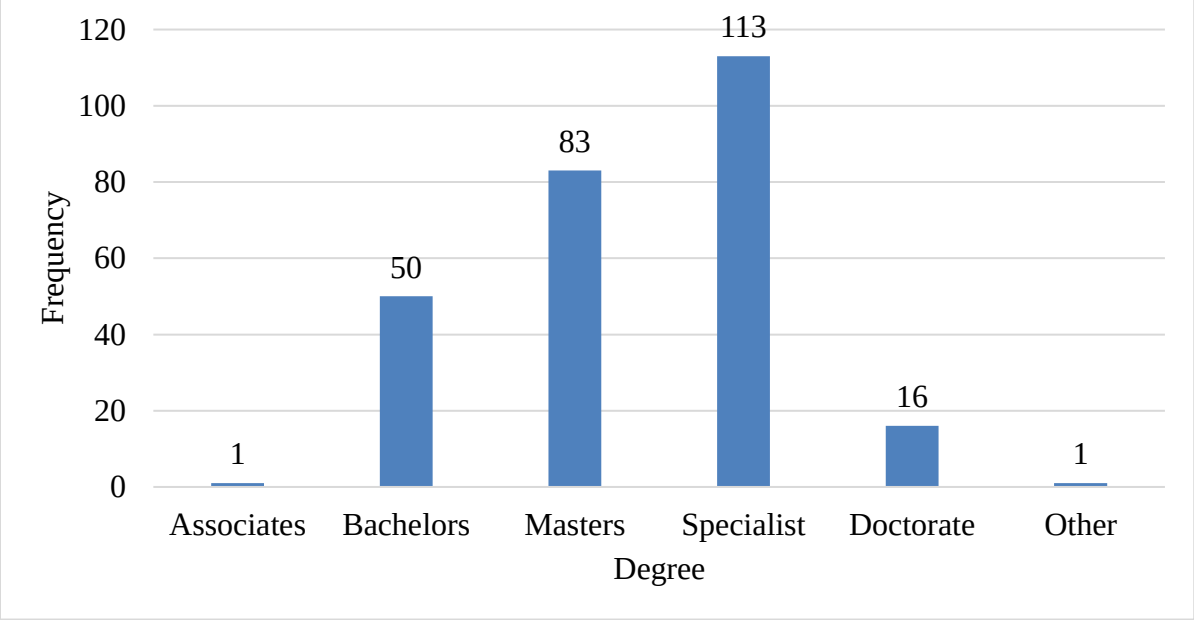

Figure 9 Highest Level of Education Bar Graph

Table 10 and Figure 10 demonstrated that a majority of participants (45.5%) taught high school grades 9-12. There were 82 teachers who taught in an elementary school, grades k-5 (31.1%), and 62 teachers taught middle school, grades 6-8 (23.5%). The larger number of high school teachers in the sample may reflect the fact that four grades represented at the high school level (9-12), while there are only three grades at the middle school level (6-8), and only two grades at the elementary level (4-5).

Table 10 Grade Level Taught

	Frequency	Percent
Elementary (k-5)	82	31.1
Middle (6-8)	62	23.5
High (9-12)	120	45.5
Total	264	100.0

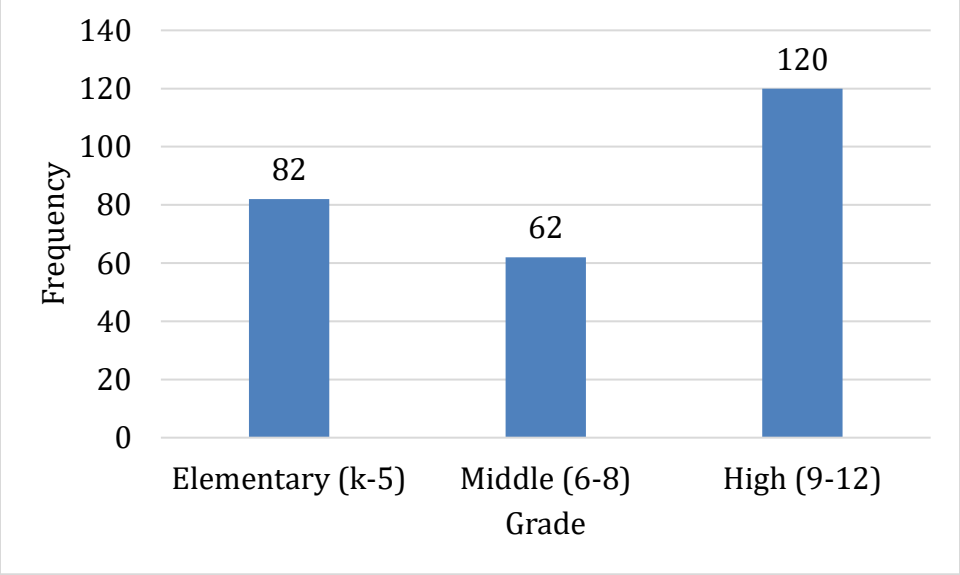

Figure 10 Grade Level Taught Bar Graph

Overall, the majority of teachers participating in the study were in the category of 40-49 years old and female. The majority had been teaching between 1-10 years, held a specialist degree, and taught high school. The study sample paralleled the Tennessee teacher population in the SASS report (National Center for Education Statistics, 2012) with regard to factors such as teachers' ages and gender. However, the sample differed from the population in the SASS (National Center for Education Statistics, 2012) with regard to years of teaching experience and highest level of education.

Results for Research Question One

Research question one: Is there a relationship between the PEOU of the 1:1 Chromebook classroom and teachers' innovativeness? The purpose of research question one was to assess the first element of the diffusion process, the innovation, by measuring the PEOU of a 1:1 Chromebook classroom. Teachers' PEOU scores, the independent variable, were calculated by averaging an overall mean score for question #3-12. The dependent variable in research question one was teacher innovativeness, which was determined by calculating each teacher's PIIT score. Teachers' PIIT scores were a self-reported metric generated from survey questions #24-27. To determine each teacher's PIIT score, a mean score was generated by adding together the four PIIT questions. Next, these mean PIIT scores were transformed into a z-score. Finally, a Pearson's *r* correlation coefficient was used to determine if there was a relationship between teachers' PEOU scores and teacher innovativeness (PIIT scores). The results of the Pearson correlation demonstrated that there was not a correlation between PEOU and teacher innovativeness, $r = 0.073$, n = 264, $p = 0.236$ (see Table 11 for an example of the Pearson's

results for RQ1). Additionally, Figure 11 demonstrated the lack of a positive or negative linear relationship between the two variables.

Table 11 Pearson's *r* Correlation Results for RQ1

		PEOU Mean	Z-score (PI Mean)
Pearson Correlation	PEOU Mean	1	.073
Sig. (2-tailed)			.236
N		264	264

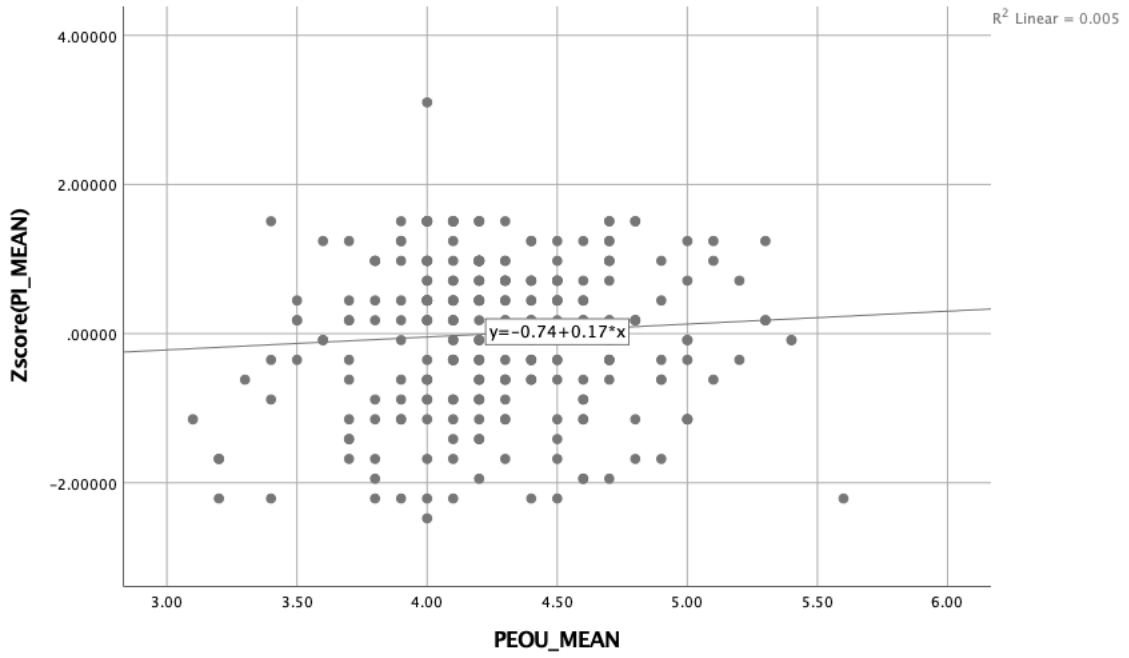

Figure 11 Pearson's *r* Correlation Scatterplot for RQ1

Results for Research Question Two

Research question two: Is there a relationship between the PU of the 1:1 Chromebook classroom and teachers' innovativeness? The purpose of research question two was to assess the

first element of the diffusion process, the innovation, by assessing the PU of a 1:1 classroom. The PU, the independent variable, was determined through teachers' answers to survey questions #13-23. These questions were averaged into a mean PU score for each teacher. The dependent variable for research question two was teacher innovativeness. Teacher innovativeness was determined in the same manner as RQ1 by determining teachers' PIIT scores. A Pearson's *r* correlation coefficient was used to determine if there was a positive or negative relationship between teachers' PU scores and their innovativeness scores. The results of the Pearson correlation demonstrated that there was a positive correlation between PU and teacher innovativeness, $r = 0.546$, n = 284, $p < 0.001$ (see Table 12 for an example of the Pearson's results for RQ2). Additionally, Figure 12 demonstrated the positive relationship between the two variables.

Table 12 Pearson's *r* Correlation Results for RQ2

		PU Mean	Z-score (PI Mean)
Pearson Correlation	PU Mean	1	.564**
Sig. (2-tailed)			.000
N		264	264
**. Correlation is significant at the 0.01 level (2-tailed).			

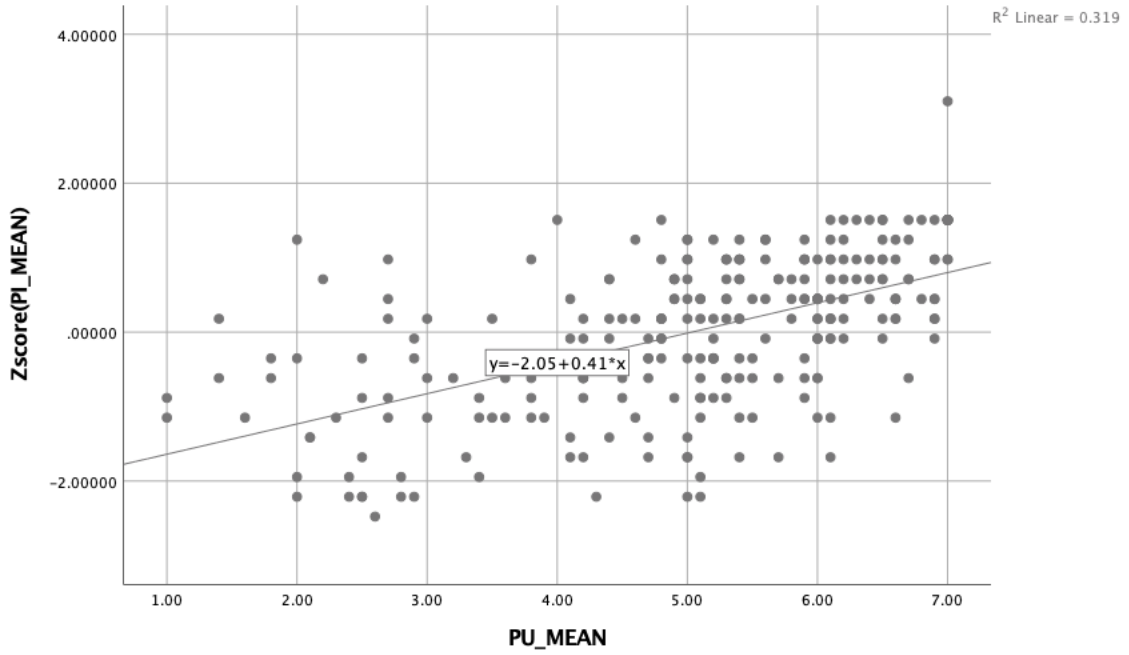

Figure 12 Pearson's *r* Correlation Scatterplot for RQ2

Results for Research Question Three

Research question three: Do demographic characteristics of teachers (i.e., age, years of teaching experience, gender, subject taught, grade taught, and highest level of education) using a 1:1 Chromebook classroom result in differences among teachers' innovativeness? The purpose of research question three was to assess the heterophilious/homophilious characteristics of teachers adopting the 1:1 classroom. The independent homophilious variables were determined by gathering basic demographic information about teachers such as age, years of teaching experience, gender, subject taught, grade taught, and level of education (survey questions #30-35). The dependent variable for research question three was teacher innovativeness. Teacher innovativeness was determined in the same manner as RQ1 and RQ2. A multivariate linear regression was used to compare each homophilious characteristics to teachers' innovativeness scores to determine if there was a statistically significant relationship between these variables.

For example, teachers' ages (the independent variable) were compared to each teachers' innovativeness score to determine if a statistical relationship existed. Next teachers' years of teaching experience were compared to teachers' innovativeness scores. Finally, gender, highest level of education, subject taught, and grade level taught were compared in the same manner.

Prior to conducting the multivariate regression, assumptions were tested to ensure the model was accurate. First, the assumptions of linearity and homoscedasticity were tested by analyzing a scatterplot comparing the independent and dependent variables. Figure 13 demonstrates that the model meets the assumptions for both homoscedasticity and linearity. Furthermore, Table 13 demonstrated that the model met the assumption of multicollinearity where the VIF is below 10 and the tolerance scores are above 0.2 (Field, 2013). The Durbin-Watson statistic showed that the assumption of independence had been met, as the obtained value was close to two (Durbin-Watson = 1.77). Finally, Cooke's Distance values were all under one, suggesting that individual cases were not unduly influencing the model (Field, 2013).

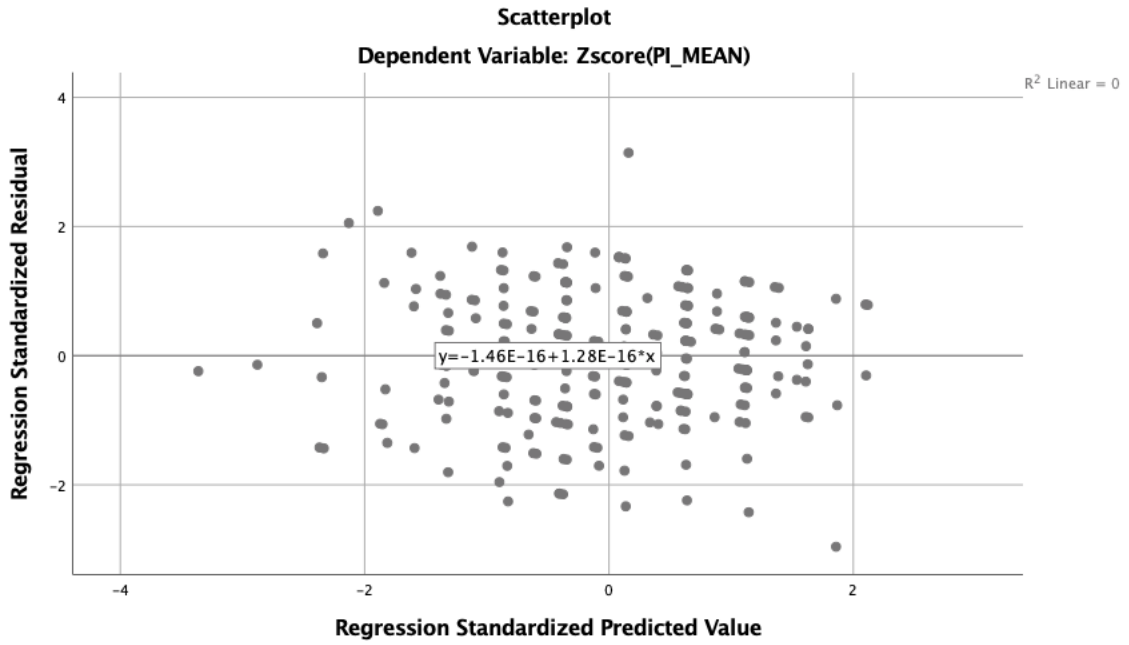

Figure 13 Multiple Regression Scatterplot for RQ3

Table 13 Multicollinearity Statistics for RQ3

	Collinearity Statistics	
	Tolerance	VIF
(Constant)		
Years of Teaching Experience	.499	2.003
Highest Level of Education	.807	1.239
Gender	.926	1.080
Age	.556	1.798
Grade	.872	1.147
Subject	.889	1.125

The findings from the multivariate regression analysis revealed that the model explained 11.9% of the variance and that the model was a significant predictor of teacher innovativeness, $F(6,257) = 5.783$, $p = 0.001$ (see Table 14 for an example of the regression analysis results). Both

teacher's age (B = -0.170, $p < 0.05$) and level of education (B = 0.176, $p < 0.05$) contributed significantly to the model. However, years of teaching experience (B = -0.178, p = 0.052), gender (B = 0.176, p = 0.210), grade taught (B = -0.085, p = 0.252), and subject taught (B = -0.002, p = 0.907) did not significantly contribute to the model, PIIT Score = -0.53 + (-0.170*Age) + (0.176*Level of Education) (see Table 15 for an example of the regression analysis results by teacher characteristic).

Table 14 Multiple Regression Results for RQ3

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.345[a]	.119	.098	.96871647	.119	5.783	6	257	.000

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	32.563	6	5.427	5.783	.000[b]
	Residual	241.172	257	.938		
	Total	273.735	263			

Table 15 Regression Analysis for RQ3

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	-.053	.489		-.109	.913
Years of Teaching Experience	-.178	.091	-.162	-1.955	.052
Highest Level of Education	.176	.075	.153	2.343	.020
Gender	.176	.140	.077	1.258	.210
Age	-.170	.070	-.190	-2.425	.016
Grade	-.085	.074	-.072	-1.147	.252
Subject	-.002	.014	-.007	-.117	.907

Results for Research Question Four

Research question four: Does the time required for teachers to adopt a 1:1 Chromebook classroom differ among teachers' innovativeness? The independent variable for RQ4 was time. According to Rogers (2010), the diffusion process occurs in stages, with some individuals choosing to adopt an innovation earlier than others. As such, the time variable was assessed by determining the rate of adoption. Teachers' rates of adoption were determined by asking teachers how many times they used the 1:1 classroom per week (survey question #28). Teachers were then placed into one of five groups based on their answer to survey question #28. The dependent variable for RQ4 was teacher innovativeness. Teacher innovativeness was determined in the same manner as RQs one through three. An ANOVA was used to compare the variables and determine if there was a statistically significant difference between each group and teachers' innovativeness.

Prior to conducting the ANOVA, the assumption for normality was evaluated and determined to be satisfied as the dependent variable (PIIT) was normally distributed and the five groups' distributions were associated with a skew and kurtosis less than 1.96 for a $p < .05$ (Field, 2013) (see Table 16 for an example of the descriptive statistics for RQ4). Additionally, the assumption of homogeneity of variances was tested and satisfied based on a Levene's F test, $F(4,259) = 1.273$, $p = 0.281$ (see Table 17 for an example of the Levene' test results for RQ4).

Table 16 Time Chromebooks Used by Teachers Descriptive Statistics for RQ4

	N	*M*	*SD*	Skew	Std. Error Skew	Kurtosis	Std. Error Kurtosis
One Day a Week	37	-1.155	0.757	0.052	0.388	-0.855	0.759
Two Days a Week	22	-0.919	0.702	0.043	0.491	0.275	0.953
Three Days a Week	47	-0.283	0.717	-0.665	0.347	0.949	0.681
Four Days a Week	25	-0.128	0.984	-0.392	0.464	-0.963	0.902
Five Days a Week	133	0.600	0.757	-0.624	0.210	1.321	0.417

Table 17 Levene's Statistic for RQ4

	Levene Statistic	df1	df2	Sig.
Based on Median	1.273	4	259	.281

Overall, there was a statistically significant difference between groups of teachers as determined by the one-way ANOVA, $F(4,259) = 50.709$, $p = 0.001$ (see Table 18 for an example of the ANOVA results for RQ4). A Tukey post hoc test revealed that there was a statistically significant difference between teachers' PIIT scores who used the Chromebook classroom when grouped by days used per week. Specifically, there was a statistically significant relationship between teachers who used the Chromebook classroom one day a week and three days a week (*p*

= 0.001), one day a week and four days a week (p = 0.001), and one day a week and five days a week (p = 0.001). There was a statistically significant relationship between those teachers who used the Chromebook classroom two days a week and three days a week (p = 0.014), two days a week and four days a week (p = 0.005), and teachers who used Chromebooks two days a week and five days a week (p = 0.001). Finally, there was a statistically significant relationship between teachers who used the Chromebook classroom four days a week and five days a week (p = 0.001). There was no statistically significant difference between teachers who used Chromebooks one day a week and two days a week (p = 0.784), and no statistically significant difference between teachers who used Chromebooks three and four days a week (p = 0.926) (see Table 19 and Figure 14 for an example of the Turkey's test results).

Table 18 ANOVA Tests Results for RQ4

ANOVA					
Z-score (PI Mean)					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	120.223	4	30.056	50.709	.000
Within Groups	153.513	259	.593		
Total	273.735	263			

Table 19 Tukey Post Hoc Test Results for RQ4

Multiple Comparisons						
Dependent Variable: Z-score (PI Mean)						
Tukey HSD						
(I) Days Used Per Week	(J) Days Used Per Week	Mean Difference (Liou & Kuo)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
One Day	Two	-.23656178	.20726973	.784	-.8059508	.3328272
	Three	-.87179696*	.16920451	.000	-1.3366173	-.4069766
	Four	-1.02708923*	.19931825	.000	-1.5746348	-.4795437
	Five	-1.75655551*	.14309348	.000	-2.1496465	-1.3634645
Two Days	Three	-.63523519*	.19887782	.014	-1.1815709	-.0888995
	Four	-.79052746*	.22505552	.005	-1.4087757	-.1722792
	Five	-1.51999374*	.17719472	.000	-2.0067639	-1.0332236
Three Days	Four	-.15529227	.19057652	.926	-.6788235	.3682390
	Five	-.88475855*	.13064223	.000	-1.2436448	-.5258723
Four Days	Five	-.72946628*	.16782428	.000	-1.1904950	-.2684375

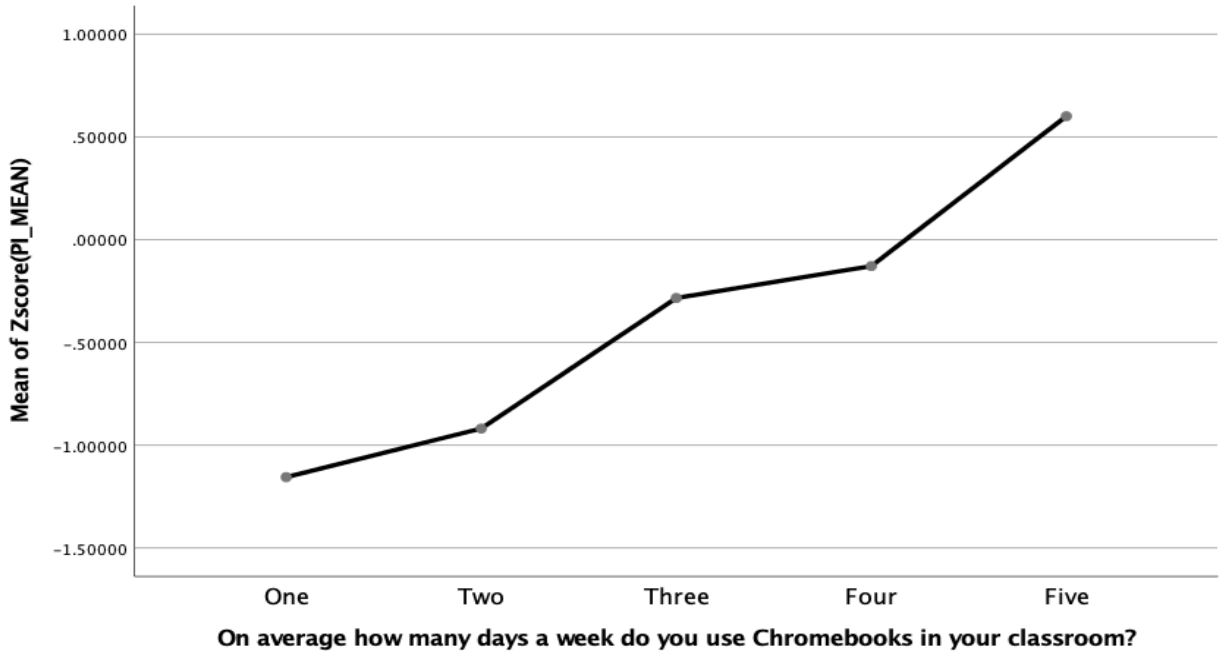

Figure 14 ANOVA Results Line Graph for RQ4

Results for Research Question Five

Research question five: Does the time required for teachers to adopt a 1:1 Chromebook classroom differ when controlling for teachers' time since initial training? The purpose of RQ5 was to assess how the time variable relates to teacher innovativeness, when controlling for teachers' time since initial training. The independent variable for RQ5, time, was calculated using the same methodology as RQ4, by calculating days used per week. The dependent variable for RQ5 was teacher innovativeness. Teacher innovativeness was determined in the same manner as RQs one through four. However, because teachers were trained at different times an ANCOVA was used to hold the teacher training timeframe variable constant. Survey question #29 asks when teachers were first trained to use the 1:1 classroom. Teachers' answers from survey question #29 were used as a covariate. As such, the ANCOVA tested for the difference between groups of innovators adjusted for the time since training covariate.

Prior to conducting the ANCOVA, a Levene's test for homogeneity and normality check were carried out. Both assumptions for homogeneity and normality were met with a Levene's F test result of $F(4,259) = 1.584$, $p = 0.179$ (see Table 20 for an example of the Leven's test results for RQ5). The ANCOVA determined that the covariate, time since initial training, was not significantly related to teacher's perceived innovativeness, $F(1,258) = 1.760$, $p = 0.186$, $r = 0.082$ (see Table 21 for an example of the ANCOVA results for RQ5). However, there was still a significant relationship between time of adoption and teacher innovativeness after controlling for the effect of teacher's time since initial training, $F(4,258) = 46.794$, $p = 0.001$, $\eta^2 = 0.42$ (see Table 22 for an example of the ANCOVA parameter estimates for RQ5).

Table 20 Levene's Statistic for RQ5

F	df1	df2	Sig.
1.584	4	259	.179

Table 21 ANCOVA Results for RQ5

Tests of Between-Subjects Effects						
Dependent Variable: Z-score (PI Mean)						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	121.263[a]	5	24.253	41.038	.000	.443
Intercept	5.055	1	5.055	8.554	.004	.032
Time First Trained	1.040	1	1.040	1.760	.186	.007
Time	110.617	4	27.654	46.794	.000	.420
Error	152.472	258	.591			
Total	273.736	264				
Corrected Total	273.735	263				

Table 22 ANCOVA Parameter Estimates for RQ5

Parameter Estimates							
Dependent Variable: Z-score (PI Mean							
					95% Confidence Interval		
Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound	Partial Eta Squared
Intercept	.680	.089	7.614	.000	.504	.855	.183
Time First Trained	-.027	.020	-1.327	.186	-.066	.013	.007
1 Day a Week	-1.729	.144	-11.977	.000	-2.013	-1.445	.357
2 Days a Week	-1.479	.180	-8.229	.000	-1.832	-1.125	.208
3 Days a Week	-.861	.132	-6.541	.000	-1.120	-.602	.142
4 Days a Week	-.716	.168	-4.267	.000	-1.047	-.386	.066
5 Days a Week	0[a]	.	.	.	.	.	.

Quantitative Data Summary

A Pearson's *r* correlation coefficient was used to answer RQ1 and RQ2. The results of these correlations demonstrated that, for RQ1, there was not a correlation between PEOU and teacher innovativeness. The results for RQ2 indicated that there was also a positive correlation between PU and teacher innovativeness. A multivariate analysis of regression was used to answer RQ3. The results of the regression analysis demonstrated that there was a statistically significant relationship between some teacher characteristics (i.e., age, years of teaching experience, gender, subject taught, and highest level of education) and teacher innovativeness. Specifically, of the six variables tested, teachers' age and highest level of education had a statistically significant relationship with the dependent variable, teacher innovativeness. To answer RQ4, an ANOVA was conducted. The results of the ANOVA demonstrated that there was a statistically significant relationship between the time of adoption and teacher innovativeness. Finally, to answer RQ5, an ANCOVA was conducted. The results of the ANCOVA indicated that there was not a statistically significant relationship between teachers' initial time of training and teacher innovativeness. However, when controlling for the effect of teacher time since initial training there was a statistically significant relationship between time of adoption and teacher innovativeness.

Qualitative Data Results

In this study the researcher analyzed three sources of qualitative data: the four open-ended survey questions, the Delphi study results, and the results from the one-on-one teacher interviews. The purpose of gathering qualitative data was to analyze the factors associated with

teacher adoption and to answer RQ6. The following data analysis techniques were used to analyze the qualitative data results.

Open-Ended Question Results

Prior to conducting the Delphi study, the researcher analyzed the four open-ended questions from the online survey (questions #36-39). Each of these questions assessed a different factor related to teacher technology adoption. A total of N=264 teachers responded to these four open-ended questions. Data from these four questions was formatted and input into the QDA Data Miner. The following results were then presented to the ten Delphi participants in phase two of the study.

Open-ended survey question one asked, what characteristics of educational innovations relate to their successful adoption? The purpose of this question was to assess the factors related to the innovation (i.e., Chromebooks). A majority of respondents, 57%, indicated that ease of use was an important characteristic of adoption (see Table 23 for an example of the responses to open-ended question one). As such, the following potential interview question was developed from the data: In your opinion as an educator, are Chromebooks easy to use, why or why not?

Table 23 Responses to Open-Ended Question One

Category	Code	Count	% Codes
Innovation Characteristics	Ease of Use	97	57.10%
Innovation Characteristics	Blended Learning	1	0.60%
Innovation Characteristics	Training	14	8.20%
Innovation Characteristics	Flexibility	6	3.50%
Innovation Characteristics	Other	26	15.30%
Innovation Characteristics	Money	7	4.10%
Innovation Characteristics	Differentiated learning	4	2.40%
Innovation Characteristics	Curriculum	5	2.90%
Innovation Characteristics	Student Engagement	10	5.90%

Open-ended question two asked, what characteristics of faculty members relate to the successful adoption of one-to-one Chromebook classrooms? The purpose of this question was to assess teacher level characteristics that effect technology adoption. A majority of respondents, 49.2%, indicated that a teacher's willingness or desire to learn was an important characteristic of technology adoption (see Table 24 for an example of the responses to open-ended question two). As such, the following potential interview question was created from the data: How does a teacher's willingness to try new technology relate to the adoption of the one-to-one Chromebook classroom?

Table 24 Responses to Open-Ended Question Two

Category	Code	Count	% Codes
Teacher Characteristics	Willingness/Desire to Learn	93	49.20%
Teacher Characteristics	Flexibility	19	10.10%
Teacher Characteristics	Other	17	9.00%
Teacher Characteristics	Tech Savvy	13	6.90%
Teacher Characteristics	Ease of Use	11	5.80%
Teacher Characteristics	Youth/Age	9	4.80%
Teacher Characteristics	Innovative	8	4.20%
Teacher Characteristics	Faculty Collaboration/Support	7	3.70%
Teacher Characteristics	Open-Minded/Curious	6	3.20%
Teacher Characteristics	Tech Support	2	1.10%
Teacher Characteristics	Student Needs with Regard to Technology	2	1.10%
Teacher Characteristics	Patience	2	1.10%

Open-ended question three asked, what school level characteristics contribute to the successful adoption of a one-to-one Chromebook classroom? The purpose of this question was to assess school level characteristics that effect technology adoption. A majority of respondents, 22.0%, indicated that administrative support was an important characteristic of technology adoption at the school level (see Table 25 for an example of the responses to open-ended question three). As such, the following potential interview question was created from the data: What type of administrative support contributes to the successful adoption of a one-to-one Chromebook classroom?

Table 25 Responses to Open-Ended Question Three

Category	Code	Count	% Codes
School Characteristics	Admin. Support	45	22.00%
School Characteristics	Faculty/Culture that is Willing to Learn	32	15.60%
School Characteristics	Training	24	11.70%
School Characteristics	Technology Support	22	10.70%
School Characteristics	Other	20	9.80%
School Characteristics	Clear Expectations	14	6.80%
School Characteristics	Collaboration with Peers	11	5.40%
School Characteristics	Technology Infrastructure	9	4.40%
School Characteristics	Student Internet Usage Policy/Online Discipline	9	4.40%
School Characteristics	Monetary Support	6	2.90%
School Characteristics	Time	5	2.40%
School Characteristics	Organization	4	2.00%
School Characteristics	Student Engagement	4	2.00%

Open-ended question four asked, what school system level characteristics contribute to the successful adoption of a one-to-one Chromebook classroom? The purpose of this question was to assess school system level characteristics that effect technology adoption. A majority of respondents, 32.9%, indicated that teacher training was an important school system level characteristic associated with the adoption of the Chromebook classroom (see Table 26 for an example of the responses to open-ended question four). As such, the following potential interview question was created from the data: What type of school system level characteristics contribute to the successful adoption of a one-to-one Chromebook classroom?

Table 26 Responses to Open-Ended Question Four

Category	Code	Count	% Codes
School System Characteristics	Training	73	32.90%
School System Characteristics	Monetary Support	40	18.00%
School System Characteristics	Tech Support	30	13.50%
School System Characteristics	Culture of Support	20	9.00%
School System Characteristics	Other	18	8.10%
School System Characteristics	Technology Infrastructure	8	3.60%
School System Characteristics	Admin. Support	7	3.20%
School System Characteristics	Innovative	7	3.20%
School System Characteristics	Planning	6	2.70%
School System Characteristics	Willingness to Try New Tech./Learn	5	2.30%
School System Characteristics	Consistency	4	1.80%
School System Characteristics	Disciplinary Policies	2	0.90%
School System Characteristics	Flexibility	2	0.90%

In all, the results from the four open-ended questions were used to create four new interview questions. These four questions plus one more question assessing RQ6 were presented to the ten Delphi participants using a Google Form. The Delphi study was conducted over two rounds where participants were able to both comment and rank potential interview questions.

Delphi Study Results

In phase two of the study, a Delphi technique was used to create an interview questionnaire. This questionnaire was to be used in phase three of the study, one-on-one follow-up interviews. All participants in the Delphi study were volunteers. Delphi participants were chosen based on their answer to question #40 of the online survey. Specifically, question #40 asked participants if they would be willing to participate in either the Delphi study or a follow-up interview. In all, 19 teachers agreed to participate in the Delphi study. Of these 19 teachers, 10 were chosen at random to participate in the Delphi study. After the 10 participants were chosen,

they were contacted via email with a link to a Google Form. This form contained five potential interview questions and the data from the four open-ended survey questions. In round one, participants were given one week to answer the form, and reach a group consensus. Group consensus was defined as being ≤ 75% agreement per question (Heiko, 2012). After round one, the group had reached a consensus on four of the five interview questions (see Table 27 for an example of the round one Delphi study results).

Table 27 Results from Round One of the Delphi Study

Question	Frequency	Percent
1. In your opinion as an educator are Chromebooks easy to use, why or why not?	9	90%
2. How does a teacher's willingness to try new technology relate to the adoption of the one-to-one Chromebook classroom?	9	90%
3. What type of administrative support contributes to the successful adoption of a one-to-one Chromebook classroom?	11	100%
4. What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?	7	70%
5. As an educator, overall, how would you describe the diffusion of the one-to-one Chromebook classroom in the school system?	9	90%

In round two of the Delphi study a new Google Form was created to reach a group consensus on interview question four. The same ten participants were given one week to answer a second Google Form. Specifically, participants were asked if the researcher should split question four into two questions.

- What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?

- What type of support could the school system offer to aid in the successful diffusion of the one-to-one Chromebook classroom?

Participants agreed that interview question four should be split into two questions with a group consensus of 80%. Using the combined data form round one and two of the Delphi study the researcher created an interview questionnaire with six interview questions.

Interview Results

In phase three of the study, one-on-one interviews were conducted with 17 teachers. The purpose of these individual interviews was to reach a more in-depth understanding of the diffusion process as it pertains to teachers' experiences as they adopted the 1:1 classroom. All of the interviews were video recorded using either Google Hangouts or Apple Facetime. After the interviews were conducted, data was input into the QDA Data Miner to assess teacher responses and identify key themes related to the adoption of the one-to-one Chromebook classroom. The 17 interviewees were given pseudonyms. To help guide the interviews, the interviewer used the interview questionnaire created in phase two of the study. Responses to the interview questionnaire are described in greater detail below.

Interviewee Demographics

A majority of the interviewees were early adopters, 12 out of 17 (see Table 28 for an example of the interviewee demographics). Most of the participants interviewed were female (12 out of 17), high school teachers (13 out of 17). Five teachers taught science, four taught English language arts, three teachers taught math, two teachers taught social studies, and one teacher

each taught agricultural studies, business, and special education. The mean years of teaching experience was *M* = 13.6, and the median years of teaching experience was 13 years.

Table 28 Interviewee Demographics

Demographic Characteristic	Category	Frequency	Percent
Adopter Category	Early Adopter	12	70.6
	Early Majority	5	29.4
Gender	Male	5	29.4
	Female	12	70.6
Grade	Middle School	4	23.5
	High School	13	76.5
Subject	Science	5	29.4
	English Language Arts	4	23.5
	Math	3	17.6
	Social Studies	2	11.8
	Other	3	17.6

Interview Data Analysis

After the interviews were conducted interviewees were numbered and given a pseudonym based on a letter in the Greek alphabet. All of the interviews were transcribed and the transcripts were input into the QDA Data Miner (see Appendix N for an example of the interview transcripts). The QDA Data Miner was used to analyze the transcripts for specific factors or themes related to the diffusion of the one-to-one classroom (i.e., the innovation, teacher willingness to try technology, administrative support, teacher training, and school system support). Additionally, the researcher used the data from the interviews to answer RQ6. A detailed analysis of the interview data is reported below.

The Innovation

Interview question one asked, in your opinion as an educator are Chromebooks easy to use, why or why not? All seventeen of the teachers interviewed described the Chromebooks as easy to use (see Table 29 for an example of the interview data results). For example, Eta (personal communication, April 17, 2019) stated, "I first taught in a school where they had one-to-one MacBooks and in my opinion the Chromebooks are easier to use." Mu was another teacher who thought the Chromebooks were easy to use. Mu (personal communication, April 30, 2019) stated that the Chromebooks were "extremely easy to use, because she had grown up with the technology." Overall, the comments from both Eta and Mu were similar to the other fifteen respondents, all of whom made statements indicating that the Chromebooks were easy to use.

Table 29 Interview Data Analysis

Factor	Code	Count	Percentage
Innovation	Ease of Use (Positive)	17	100%
Teacher Willingness	Willingness (Positive)	16	94.12%
Teacher Willingness	Fear of Technology	5	29.41%
Teacher Willingness	Teachers Age	4	23.53%
Admin Support	Admin. Support (Positive)	12	70.59%
Admin Support	Individual Teachers Decision	4	23.53%
Admin Support	Admin Support Not Necessary	3	17.65%
Training	Initial Training (Positive)	9	53.04%
Training	Need Additional Training	8	47.06%
Training	Teachers Training Teachers	5	29.41%
Training	Departmental/Subject Specific Training	7	41.18%
School System Support	Additional IT Support	6	35.29%
School System Support	Student Broadband at Home	3	17.65%
School System Support	Lead Technology Teacher	10	58.82%
School System Support	Blended Learning Cohort	3	17.65%
School System Support	Monetary Support	3	17.65%
RQ6 Diffusion	Diffusion (Positive)	15	88.2%
RQ6 Diffusion	Diffusion (Negative)	2	11.76%

Teacher Willingness

Interview question two asked, how does a teacher's willingness to try new technology relate to the adoption of the one-to-one Chromebook classroom? A majority of the teachers interviewed (16 out of 17) stated that teachers' willingness to use technology was related to adoption. For example, Pi (personal communication, April 24, 2019) said, "I think a teacher's receptiveness to using the Chromebooks is closely tied to their embracing of technology." Five of the teachers interviewed discussed how fear of technology or fear of change had a negative impact on technology adoption. Mu (personal communication, April 30, 2019) said, "there is a

fear factor for some teachers which keeps them from adopting the Chromebooks." Age was another factor that some interviewees associated with a reluctance to adopt the Chromebooks. Mu (personal communication, April 30, 2019) again stated, "I have had conversations with teachers approaching retirement who have told me that they do not want to put the work in on learning a new technology." As such, the teachers interviewed indicated that a teacher's willingness to use technology was related to adoption rates, however factors like fear of technology and teachers' age may negatively impact adoption.

Administrative Support of Technology

Interview question three asked, what type of administrative support contributes to the successful adoption of a one-to-one Chromebook classroom? A majority of the interviewees (12 out of 17) indicated that school administrative support was an important aspect of technology adoption. For example, Pi (personal communication, April 24, 2019) said, "an administrator's attitude toward using the Chromebooks is going to trickle down to the teachers." However, four interviewees stated that the decision to adopt new technology was an individual teacher decision regardless of administrative support. For example, Beta (personal communication, April 23, 2019) said, "I think that on the administrative side it is important to support a teacher who is struggling using technology, but I don't think it's the principal's duty to convince them [teachers] to try new things."

Teacher Technology Training

Interview question four asked, what type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom? Over half of the teachers

interviewed (9 out of 17) liked the initial Chromebook training provided by the school system. However, eight interviewees believed that the school system needed to offer additional training. Seven of the teachers interviewed wanted the additional trainings to be departmental or subject specific. Moreover, five of the interviewees wanted these additional trainings to be led by other teachers. For example, Lambda (personal communication, April 24, 2019) said, "teachers have already used the technology in the class. In these trainings they show us how to use it, and make us use it during the training." As such, teachers indicated that they liked the initial Chromebook training provided by the school system, however, interviewees also wanted additional subject specific trainings taught by classroom teachers.

Additional School System Support

Interview question five asked, what type of support could the school system offer to aid in the successful diffusion of the one-to-one Chromebook classroom? Interviewees held a number of different views about additional technology support the school system could provide. Six of the teachers interviewed wanted additional IT support at their school. While three teachers each mentioned the need for student access to broadband at home, aid from the blended learning cohort, and the need for additional monetary support. Ten teachers discussed the lead technology teacher who visits each school once a week. For example, Epsilon (personal communication, April 24, 2019) said, "we have a support person from central office who is here one day a week. I save my questions and ask her when she is here or I send her an email."

Research Question Six Results

Interview question six was designed to assess RQ6. Interview question six asked, as an educator, overall, how would you describe the diffusion of the one-to-one Chromebook classroom in the school system? A majority of the teachers interviewed (15 out of 17) provided a positive description of the diffusion process in the school system. For example, Epsilon (personal communication, April 24, 2019) said,

> I think it [the diffusion of the one-to-one Chromebook classroom] went very well. I got my Chromebooks in a timely fashion. I got training on the Chromebooks in a timely fashion, and I don't have any real complaints about the adoption of the Chromebooks.

Pi was another teacher who described the diffusion of the Chromebooks in a positive manner. Pi (personal communication, April 24, 2019) said, "For me, it [the diffusion of the one-to-one Chromebook classroom] has gone well. Initially there were some issues with connectivity in the classroom, but that has been ultimately resolved." Pi (personal communication, April 24, 2019) went on to say, "I love the idea of the kids creating their own learning experiences, like creating presentations using the Chromebooks. I just feel like that is really invaluable, and then I learn from them too."

Two teachers interviewed, Lambda and Mu, were more critical of the diffusion of the one-to-one Chromebook classroom. Specifically, they disapproved of how the school system had initially trained teachers and how school system leaders lacked a clear vision for teacher and student technology usage. Lambda (personal communication, April 24, 2019) stated, that in some ways the school system was playing catch-up regarding the online classroom. For example, Lambda (personal communication, April 24, 2019) stated that the school system had recently purchased a new application called Go Guardian, which allowed teachers to actively monitor students' online progress during class sessions. In Lambda's opinion, this technology should

have been adopted before the Chromebooks were distributed to teachers and students. Speaking to the lack of a clear vision Mu (personal communication, April 30, 2019) said, “what I have seen is that not even all of the students have bought into this Chromebook thing. I think it all comes back to, what’s the vision and what’s the goal?” However, while both Lambda and Mu were critical of different aspects of the diffusion process, they both stated that the Chromebooks were an important tool, which both teachers used on a regular bases in their classrooms. Moreover, Lambda (personal communication, April 24, 2019) stated that hindsight is also part of the standard adoption process, whereby users look for better ways to use new technologies that have been recently introduced.

Chapter IV Summary

Chapter IV provided a description of the analysis and the results related to this study and the research questions herein. The quantitative and qualitative results supported the following research conclusions. For RQ1, a Pearson’s *r* correlation coefficient demonstrated there was a positive correlation between PEOU and teacher innovativeness. For RQ2, a Pearson’s *r* correlation coefficient demonstrated there was a positive correlation between PU and teacher innovativeness. For RQ3, the findings from the multivariate regression analysis revealed that the model was a significant predictor of teacher innovativeness. Specifically, both of the demographic characteristic teacher’s age and level of education contributed significantly to the model. For RQ4, an ANOVA determined there was a statistically significant relationship between how many days per week teachers used their Chromebooks and teacher innovativeness. For RQ5, an ANCOVA demonstrated that there was not a statistically significant relationship between the covariate, teacher’s initial time of training and teacher innovativeness. Finally,

follow-up interviews were conducted to answer RQ6. Data from these interviews indicated that a majority of teachers interviewed provided a positive description of the diffusion process. A discussion of the findings with recommendations for future research will be offered in Chapter V.

CHAPTER V

SUMMARY AND DISCUSSION

As previously stated, this dissertation was designed to study factors related to teacher adoption rates and the diffusion of a 1:1 Chromebook classroom in one rural public school system. Chapter V includes a restatement of the problem, a review of the methodology, and a summary and discussion of the results. After the discussion of the results there is an interpretation of the findings as they relate to the previous research, and suggestions for future research. Chapter V concludes with a summary of the study.

Restatement of the Problem

Recent reports from both private and governmental agencies have advocated the use of more technology in the classroom (Bernard et al., 2014; Johnson, 2015; Partnership for 21st Century Learning, 2013; U.S. Department of Education, 2014, 2016b). These reports suggest that the use of this new technology can be used as a way to teach students 21st century learning skills (Bernard et al., 2014; Johnson, 2015; Partnership for 21st Century Learning, 2013; U.S. Department of Education, 2014, 2016b). However, while these reports have praised the use of technology in the classroom, there has been little research conducted that specifically assesses how teachers are integrating this technology into their classrooms (Neyland, 2011; Pérez-Sanagustín et al., 2016). Similarly, more research needs to be conducted into pedagogical practices teachers should use to ensure that these technologies are fully promoting student

learning and engagement (Mumtaz, 2000; Orrill et al., 2004). For example, according to Mumtaz (2000), more research needs to be conducted regarding both the factors that discourage teachers from using technology and the factors that encourage teachers to use technology. Additionally, little research has been conducted on how an innovation, like a 1:1 classroom, diffuses in a large school system (Cuban, 2009). This study was designed to investigate some of these gaps in the research regarding both how teachers adopt these new 1:1 devices and how these technologies are diffusing throughout a school system. The results of this study can help both school administrators and teachers to determine the best pedagogical practices to promote both teacher and student engagement.

At the start of the 2016-2017 school year, school leaders in a rural school district in east Tennessee decided to implement a 1:1 classroom initiative throughout the school system. A plan was created to distribute Google Chromebooks over a three-year period to all students in the district. Beginning in the 2016-2017 year, teachers in the fourth, seventh, and tenth grades received Chromebooks for students to use in their classrooms. Over the next two school years, teachers in the fifth, sixth, eighth, ninth, eleventh, and twelfth grades were scheduled to receive Chromebooks as well, so that by the end of the 2018-2019 school year all students in the system, grades four through twelve, would have access to a personal Chromebook. Before each school year, teachers completed training classes at the central office on how to incorporate these new Chromebooks into their classrooms. To better understand the diffusion process in a rural school system, the researcher in this study investigated how the 1:1 Chromebook initiative diffused across the county. This investigation was accomplished by assessing how teachers in the district adopted this new technology into their classrooms.

Review of the Methodology

To investigate the diffusion process, a mixed methods research design was created to examine the research questions. The mixed methods design allowed the researcher to collect both quantitative and qualitative data to help determine what relationship, if any, existed between different variables as these relate to the diffusion process. The study was conducted in three phases with the quantitative data being gathered in phase one and the qualitative data being gathered in phases two and three. In phase one, teachers' perceived innovativeness was determined by administering the TAM survey. A total of 264 teachers completed the online survey, and survey data from phase one was used to answer RQs one through five.

RQ1 Is there a relationship between the PEOU of the 1:1 Chromebook classroom and teachers' innovativeness?

RQ2 Is there a relationship between the PU of the 1:1 Chromebook classroom and teachers' innovativeness?

RQ3 Do demographic characteristics of teachers (i.e., age, years of teaching experience, gender, subject taught, grade level taught, and highest level of education) using a 1:1 Chromebook classroom result in differences among teachers' innovativeness?

RQ4 Does the time required for teachers to adopt a 1:1 Chromebook classroom differ among teachers' innovativeness?

RQ5 Does the time required for teachers to adopt a 1:1 Chromebook classroom differ when controlling for teachers' time since initial training?

In this study, there was one dependent variable, four independent variables, and one covariant. The dependent variable for all five quantitative research questions was teacher innovativeness. The four independent variables were PEOU, PU, teacher demographic

characteristics (i.e., age, years of teaching experience, gender, highest level of education, grade level taught, and subject taught), and the time required to adopt. The covariant controlled for in RQ5 was teachers' time since initial training.

In phase two of the study a Delphi technique (Hsu & Sandford, 2007) was used to create an one-on-one interview questionnaire. Data from four open-ended survey questions were used to assist ten Delphi participants in creating the questionnaire. Finally, in phase three of the study the one-on-one interview questionnaire was administered to 17 teachers via one-on-one video conferences. Data from these qualitative interviews were used to provide a more in-depth analysis of the diffusion process. Additionally, the data from these interviews were used to answer RQ6: How do teachers with different levels of innovativeness (i.e., innovator, early adopters, early majority, late majority, and laggards) describe the diffusion of a 1:1 Chromebook classroom?

Summary of the Findings

This section focuses on the results from Chapter IV. Information included details how data were analyzed to answer the six research questions. The summary is divided into an analysis of the quantitative and qualitative findings, followed by a discussion of the findings, the relationship of the findings to previous research, and suggestions for additional research.

Summary of the Quantitative Findings

The analysis of RQ1 focused on determining if there was a correlation between teacher innovativeness and PEOU. The results of a Pearson correlation coefficient demonstrated that there was not a correlation between PEOU and teacher innovativeness. The analysis for RQ2

focused on determining if there was a correlation between teacher innovativeness and PU. The results of a Pearson correlation coefficient demonstrated that there was a positive correlation between PU and teacher innovativeness. PU was defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis et al., 1989, p. 320). This result indicates that teachers who believed the Chromebooks could enhance their job performance also had higher innovativeness scores.

The analysis for RQ3 focused on determining if there was a relationship between teacher demographic characteristics and teacher innovativeness. The purpose of RQ3 was to assess the heterophilious/homophilious characteristics of teachers adopting the 1:1 classroom. The independent homophilious variables were determined by gathering basic demographic information about teachers such as age, years of teaching experience, gender, subject taught, grade level taught, and level of education. The findings from the multivariate regression analysis revealed that the model explained 11.9% of the variance and that the model was a significant predictor of teacher innovativeness. Specifically, both teacher's age and highest level of education significantly contributed to the model.

The analysis for RQ4 focused on determining if there was a relationship between time of adoption and teacher innovativeness. The results of a one way ANOVA determined that there was a statistically significant difference between the time teachers used the Chromebooks each week and teacher innovativeness. Specifically, the findings indicate that there was a difference between the number of times teachers used the Chromebooks each week and teacher innovativeness. For example, teachers who used the Chromebooks two days a week had higher innovativeness scores than teachers who used the Chromebooks one day a week. Teachers who used the Chromebooks three days a week, on average, had a higher innovativeness score than

teachers who used the Chromebooks one or two days a week. Teachers who used the Chromebooks four days a week had a higher innovativeness score than teachers who used the Chromebooks one, two, or three days a week. Finally, teachers who use the Chromebooks five days a week had a higher innovativeness score than teachers who used the 1:1 classroom less than five days a week.

The analysis for RQ5 focused on determining if there was a relationship between time of adoption and teacher innovativeness while controlling for the covariant, time of initial training. The results of an ANCOVA determined that the covariate, time since initial training, was not significantly related to teachers' perceived innovativeness. However, there was still a significant relationship between time of adoption and teacher innovativeness after controlling for the effect of teachers' time since initial training.

Summary of the Qualitative Findings

The purpose of the qualitative interviews was to analyze specific factors related to the diffusion process. These factors included the innovation, teacher level factors, school level factors, and school system level factors. With regard to the innovation, all of the teachers interviewed indicated that the Chromebooks were easy to use. All of the interviewees also stated that a teacher's willingness to use new technology was related to adoption of the technology. At the school level, teachers stated that administrative support was an important aspect of the technology adoption process. However, several interviewees also stated that ultimately technology adoption is an individual teacher's decision, regardless of administrative support.

At the school system level two factors were assessed: teacher technology training and school system support. Again, a majority of the interviewees stated that the initial Chromebook

training provided by the school system was adequate with regard to technology adoption. However, when interviewed, several teachers suggested a need for additional technology training in the school system. Specifically, teachers wanted these training sessions to be led by other teachers who had experience using the technology. Teachers also suggested that these training sessions be subject and grade specific. When asked about additional school system support interviewees' answers were varied. For example, six of the teachers interviewed wanted additional IT support at their school. While three teachers each mentioned the need for student access to broadband at home, aid from the blended learning cohort, and the need for additional monetary support.

Qualitative interviews were also used to answer RQ6. The purpose of RQ6 was to reach a more in-depth understanding of the diffusion phenomena by assessing how teachers with different levels of innovativeness experienced the Chromebook adoption process. Overall, a majority of the interviewees (15 out of 17) provided a positive description of the diffusion process in the school system. For example, Pi (personal communication, April 24, 2019) said, "For me, the diffusion of the one-to-one Chromebook classroom has gone well. Initially there were some issues with connectivity in the classroom, but that has been ultimately resolved." Pi (personal communication, April 24, 2019) went on to say, "I love the idea of the kids creating their own learning experiences, like creating presentations using the Chromebooks. I just feel like that is really invaluable, and then I learn from them too." However, two of the teachers interviewed were more critical of the diffusion process. Specifically, they disapproved of how the school system had initially trained teachers. Moreover, these teachers asserted that school system leaders lacked a clear vision for teacher and student technology usage.

Discussion of the Findings

An analysis of the data led to the following findings. First, the PEOU of the Chromebooks was not correlated to teacher innovativeness. Although there was a slight positive correlation between PEOU and teachers' innovativeness ($p = 0.236$) the finding was not statistically significant. The second finding was that the PU of the Chromebooks was positively correlated to teacher innovativeness. This result implies that teachers with higher innovativeness scores also believed the Chromebooks enhanced their job performance. This finding also aligns with Rogers (2010) theory of diffusion. Rogers (2010) theorized that those innovations that have higher rates of adoption successfully diffuse because organizational members communicate these positive attributes to one another. Thus, the perceived relative advantage of the Chromebooks was communicated by teachers to one another and through this activity increased the rate of adoption.

The third finding was that both teachers' ages and highest level of education had a statistically significant relationship with teacher innovativeness. This result implies that younger teachers had adopted the 1:1 classroom at a higher rate than older teachers. Additionally, teachers with higher levels of education had adopted the 1:1 classroom at a higher rate than teachers with less education. These findings align with the literature pertaining to teacher level factors associated with technology adoption. For example, both Buabeng-Andoh (2012) and Neyland (2011) found that younger teachers were more likely to use technology when compared to their older colleagues.

The fourth finding was that there was a statistically significant difference between the time teachers used the Chromebooks each week and teacher innovativeness. This result implies that teachers who use the 1:1 Chromebooks were more innovative than teachers who used the 1:1

classroom fewer days per week. Also, these findings aligned with Rogers' (2010) theory on time, the third element of the diffusion process. Rogers (2010) theorized that over time individuals pass through a decision stage from first knowledge of an innovation to formulating an attitude regarding whether or not they will adopt or reject a new idea. Innovativeness is the degree to which the individual adopts a new technology earlier than other peers in their organization. Rogers (2010) classified individuals into five separate levels of innovativeness: innovators, early adopters, early majority, late majority, and laggards. Each of these groups of adopters will have differing rates of adoption as individuals implement the innovation into their routines. The results of this study indicated that innovators and early adopters used the 1:1 classroom four to five days a week, while the late majority a laggards used the 1:1 classroom one to two days a week.

The fifth finding was that there was not a statistically significant relationship between the covariant, time since initial training, and teacher innovativeness. This finding implies that even though teachers were trained at different times over a three year span, the training times did not affect innovativeness. For example, teachers who were trained in 2016 were not more or less innovative than teachers who were trained in 2018.

The sixth finding was that teacher interviews indicted a majority of teachers, regardless of their level of innovativeness, had a positive experience using the 1:1 classroom. The findings of these interviews indicated that teachers in the school system found the Chromebooks aided their pedagogical practices. Specifically, the interview outcomes suggested that the Chromebooks were easy to use. Moreover, interviewees felt that their schools' administration was supportive of the 1:1 classroom, and that they had been properly trained to use the Chromebooks.

Overall, these findings indicate that the adoption of the 1:1 classroom in this school system has aligned with Rogers' (2010) theory of diffusion. Rogers (2010) defined the diffusion process as a special form of communication where an innovation is communicated through a social system over time. In this study, the 1:1 Chromebook classroom was communicated and adopted by teachers over a three year period within the school system.

Relationship of the Study to Prior Research

One of the purposes of this study was to add to the overall body of knowledge regarding educational technology by examining the factors affecting teacher technology adoption rates and the diffusion of a 1:1 Chromebook classroom. To better understand this potential relationship, a thorough literature review was conducted. The review began with a brief history of the use of technology in the classroom, followed by a description of the history of diffusion research, and concluded with a review of the factors affecting teacher technology adoption rates and the diffusion of technology in an educational setting. Below, is an analysis of the results of this study as these relate to the topics discussed in the literature review.

The History of Technology Use in the Classroom

The literature review began with a summary of the history of technology use in the classroom. Historically, American classrooms have used a variety of technological devices to aid teachers with instruction including textbooks, chalkboards, and projectors (Cuban, 1986, 2009). Cuban's (2009) research analyzed the use of film and radio in the 1920s, television in the 1950s through the 1980s, and the advent of CAI in the 1990s to the present. With each successive technological adoption, researchers found that many of the reformers and policy makers who

were suggesting these changes did not fully understand the conservative organizational culture of schools (Cuban, 2009; Tatnall & Davey, 2014). As such, many of these technological advances went unused in the classroom. Teachers used these devices only occasionally and instead tended to rely on more direct methods of instruction (Cuban, 2009; Tatnall & Davey, 2014).

The results of this study tend to refute the claims made by Cuban (2009) that school laptop initiatives, like other educational technology programs, would fail to be adopted by teachers. Both the quantitative and qualitative data gathered in this study indicate that over the past three years the 1:1 program has been adopted by teachers in the school system. For example, quantitative data demonstrated that a majority of teachers (77.7%) were using the Chromebooks in their classroom three to five days a week. Moreover, qualitative data from the one-on-one interviews showed that the Chromebooks were both easy to use and that teachers were using the devices as a regular part of classroom instruction.

Technology Adoption and Diffusion Theories

The next major topic discussed in the literature review was a description of the history of diffusion and technology adoption research. Several diffusion and adoption models were discussed in the literature review including the TAM (Davis et al., 1989), the CBAM (Hall, 1973), and Rogers' (2010) theory of diffusion. The TAM was originally developed by Davis et al. (1989) to describe how teachers adopted email. Today the TAM is "considered the most influential and commonly employed theory for describing an individual's acceptance of information systems" (Lee et al., 2003, p. 752). The TAM was designed to measure two variables, PEOU defined "as the degree to which a person believes that using a particular system would be free of effort," (Davis et al., 1989, p. 320) and PU defined as "the degree to which a

person believes that using a particular system would enhance his or her job performance" (Davis et al., 1989, p. 320).

In this study the TAM was used to measure the PEOU and PU of the 1:1 Chromebook classroom. The results indicated that both PEOU and PU were positively correlated to teacher innovativeness. Thus, the findings of this study align with the literature regarding the positive relationship between PEOU, PU, and how these variables influence technology adoption (Davis et al., 1989; Marangunić & Granić, 2015).

Rogers' (2010) theory of diffusion was the final adoption theory discussed in the literature review. Rogers (2010) asserted that there were four central elements involved in the diffusion process. First, the innovation, defined as a practice or object, is perceived as new by an individual (Rogers, 2010). In this study, the innovation was the 1:1 Chromebook classroom. Second, the innovation is communicated to organizational members who create and share information with one another to reach a mutual understanding about the innovation (Rogers, 2010). In this study, teachers used both formal and informal communication networks to share information about the 1:1 classroom. Third, the innovation diffuses through an organization over time (Rogers, 2010). In this study, over the past three school years, teachers in the school system have adopted the 1:1 classroom. Finally, the innovation is communicated through a social system (Rogers, 2010). In this study, the 1:1 Chromebook classroom was communicated and diffused through the school system.

Teacher Technology Adoption Factors

After analyzing the different adoption and diffusion theories, the literature review concluded with an examination of the factors affecting teacher technology adoption. These

factors were divided into individual level factors and system level factors. Individual level factors influencing teacher technology adoption rates included teacher attitudes, computer competence, self-efficacy, gender, teacher experience, and teacher workload (Buabeng-Andoh, 2012; Neyland, 2011). The results of this study were comparable to the literature on individual level factors in the following ways. First, with regard to teacher attitudes toward technology, the results of the study aligned with the literature review. According Demirci (2009), Teo (2008), and Pérez-Sanagustín et al. (2016), positive teacher attitudes toward technology have been shown to be correlated with higher rates of technology adoption. A majority of the teachers interviewed in this study (16 out of 17) stated that teachers' willingness to use technology was related to adoption. For example, Pi (personal communication, April 24, 2019) said, "I think a teacher's receptiveness to using the Chromebooks is closely tied to their embracing of technology."

Overall, the research regarding teacher technology adoption rates and gender was mixed. Some studies suggested that more male teachers use technology in the classroom when compared to their female colleagues (Baturay et al., 2017; Buabeng-Andoh, 2012; Neyland, 2011). However, other researchers suggested that gender had little or no correlation with technology adoption rates among teachers (Neyland, 2011). Neyland (2011) asserted that the gender gap with regard to pedagogical technology use has diminished, because today individuals have greater access to computers in their daily lives. The researcher in this study also analyzed gender as it relates to teacher innovativeness. The findings from a multivariate regression found that there was not a statistically significant relationship between gender and teacher innovativeness. Thus, the results align with Neyland's (2011) assertion that if a gender gap exists the gap has

diminished as more teachers, regardless of gender, have access to computers both inside and outside the classroom.

Neyland (2011), suggested that the next individual level factor, years of teaching experience, tended to be negatively correlated with technology adoption. Moreover, according to the U.S. Department of Education (2000), teachers with less teaching experience were found to be more likely to use technology in their classrooms when compared to their more experienced colleagues. In this study the researcher also investigated if years of teaching experience were related to teacher innovativeness. However, the findings from a multivariate regression found that there was not a statistically significant relationship between years of teaching experience and teacher innovativeness.

In addition to assessing individual level factors that relate to technology adoption the researcher in this study also investigated several system level factors. System level factors assessed included teacher professional development, leadership support, and technological complexity (Buabeng-Andoh, 2012). The first system level factor assessed in this study was teacher technology training. For example, over half of the teachers interviewed (9 out of 17) provided a positive description of the initial Chromebook training offered by the school system. Moreover, to maximize computer usage in the classroom researchers indicated that administrators should focus attention on training sessions that emphasize pedagogical techniques over technical issues (Sandholtz & Reilly, 2004). Here again the results of the study aligned with the literature review. Seven of the teachers interviewed wanted additional training to be departmental or subject specific, and five of the interviewees wanted these additional trainings to be led by other teachers.

Leadership support was another system level factor assessed in this study. According to Buabeng-Andoh (2012) and the U.S. Department of Education (2016b), technologically competent school leaders are needed to help foster the transition into a more technologically advanced classroom. Moreover, the literature indicated that teachers needed strong leaders who understood the set of complex tasks, which students in the 21st century would be asked to accomplish (Buabeng-Andoh, 2012). The findings in this study align with the research on leadership support. For example, a majority of the interviewees (12 out of 17) indicated that school administrative support was an important aspect of technology adoption. Specifically, Pi (personal communication, April 24, 2019) said, "an administrator's attitude toward using the Chromebooks is going to trickle down to the teachers."

The final system level factor assessed in this study was technological complexity. Rogers (2010) outlined five technology characteristics, relative advantage, compatibility, complexity, trialability, and observability which affected teacher adoption rates. In this study the researcher also examined the relationship between the PU of the Chromebooks and teacher innovativeness. The findings of the study indicated that PU was positively correlated with teacher innovativeness. Furthermore, all 17 of the teachers interviewed described the Chromebooks as easy to use. For example, Eta (personal communication, April 17, 2019) stated, "I first taught in a school where they had one-to-one MacBooks and in my opinion the Chromebooks are easier to use." Thus, both the quantitative and qualitative data gathered in this study aligned with the literature review by suggesting that the ease of use of the Chromebooks made these devices more adoptable by school level users.

In all, the findings of this study added to the overall body of knowledge regarding the adoption and diffusion of the 1:1 Chromebook classroom in a K-12 school setting. The findings

of this study elucidated the topics discussed in the literature review. More specifically, the study provided further information on the theory of diffusion as it related to both individual and system level factors associated with teacher technology adoption rates.

Implications for Practice

According to the U.S. Department of Education (2016b), when implementing new educational technologies, teachers need strong school leaders who understand the set of complex tasks that students in the 21st century will be asked to accomplish. Moreover, school administrators need to have the vision and determination to implement the changes necessary to make sure students and teachers are successfully adopting these new technologies (Zheng et al., 2016). At the same time, when implementing these technologies leaders must be able to collaborate with their colleagues to make sure they espouse a shared vision that teachers perceive as beneficial to themselves and their students (Lim, Zhao, Tondeur, Chai, & Tsai, 2013; Northouse, 2013). While it is understood that school leaders need to support teachers as they adopt new educational technologies (U.S. Census Bureau, 2016; Zheng et al., 2016), there has been little research conducted that specifically assesses how teachers were integrating this technology into their classrooms (Neyland, 2011; Pérez-Sanagustín et al., 2016). Similarly, more research needed to be conducted into which pedagogical practices teachers should use to ensure that these technologies are fully promoting student learning and engagement (Mumtaz, 2000; Orrill et al., 2004). As such, one of the purposes of the study was to aid both school and district level administrators in determining what best practices they could use when implementing a 1:1 program. Additionally, the results of this study can be used to assess the return on investment (ROI) associated with the adoption of 1:1 Chromebook classroom.

At the individual school level, principals need to know how to support teachers as they adopt new educational technologies (Lim et al., 2013; Neyland, 2011). For example, the findings in this study indicated that there was a statistically significant relationship between teachers' ages and their level of innovativeness. This finding suggests that that teachers of all ages may need more administrative support when adopting new technologies like the Chromebooks. Another school level factor assessed in this study was administrative support. A majority of the teachers interviewed (12 out of 17) claimed that administrative support was an important factor in technology adoption. This finding indicates that administrators need to be supportive of their teachers as they adopt new educational technologies.

At the school system level, several factors related to educational technology adoption were also assessed in this study. For example, over half of the teachers interviewed (9 out of 17) liked the initial Chromebook training provided by the school system. However, eight interviewees believed that the school system needed to offer additional training, and seven teachers wanted these additional trainings to be departmental or subject specific. Moreover, five of the interviewees wanted these additional trainings to be led by other teachers. As such, this finding indicates that district administrators need to provide more subject specific trainings that are led by other teachers who have directly used the technology in their classrooms.

In addition to helping school leaders understand what best practices to use when implementing a 1:1 classroom the results of this study can also be used by tech companies and other business leaders to assess the ROI of educational technology. According to Lim et al. (2013), while considerable investments have been made to bring technologies to schools there are two significant gaps in understanding what impact these devices are having on education and learning. The first is a usage gap, and the second is an outcome gap (Lim et al., 2013). The

findings from this study could bridge these gaps by providing data on how teachers are using these devices, and identifying ways these devices enhance student learning outcomes. Moreover, this data could be used by technology leaders to enhance the argument for more technology investment in the K-12 classroom. For example, with regard to the usage gap, one key finding of this study demonstrated that a majority of teachers were using the Chromebooks as a regular part of classroom instruction (77.7% of the teachers used the devices three to five days per week). Moreover, teachers found that these devices enhanced their job performance. Thus, the findings of this study can bridge these gaps, and help school leaders better understand the ROI regarding educational technology diffusion and integration.

Overall, the findings of this study can help school level leaders, school district level leaders, and corporate educational technology leaders understand the complex diffusion process. Moreover, a number of the findings in this study can be used to help school leaders implement best practices for technology adoption. At the school level, principals need to ensure they are supporting all of their teachers as they adopt these new devices. At the district level, leaders need to make sure they are providing training sessions that are grade or subject specific, and sessions that are led by teachers who have direct knowledge of the educational technology that is being implemented. Finally, at the corporate level, the findings of this study can help to bridge some of the gaps pertaining to ROI regarding the diffusion and adoption of educational technology.

Opportunities for Future Research

As this study was being conducted the researcher noted a number of opportunities for future research. First, the findings in this study present a potential opportunity for future longitudinal studies. The study was conducted during the 2018-2019 school year, and the results

are applicable to that time period. Therefore, a longitudinal study could develop a more robust data set and provide a better understanding of the relationships assessed in this study. Moreover, data collected over several years could provide a better description of the diffusion process.

An additional opportunity associated with a longitudinal study could be the prospect of examining other variables associated with the diffusion and adoption processes. For example, future researchers might wish to study how MacBooks or tablets are adopted by teachers. Therefore, future research should investigate how these other technologies and/or other variables relate to the diffusion process.

Continued research could also help school leaders assess how the Chromebooks have been adopted by students. This study focused solely on teacher adoption rates. However, it would be valuable to assess how students are using the Chromebooks. For example, a researcher might want to study the variables associated with student adoption rates and diffusion. Data gathered from a study focused on student adoption might inform what best practices could be used to enhance student learning outcomes.

Finally, future research pertaining to technology adoption could utilize actual usage data instead of a self-reported usage metric like the TAM or PIIT scores used in this study. Straub (2009) found that research based on self-reporting demonstrated distinctly different results than research based on actual usage. Thus, prospective diffusion or adoption research could use quantitative usage data such as Google Analytics to determine system level adoption rates.

Summary of the Study

This study utilized a unique three part mixed methods approach to assess teacher adoption rates and the diffusion of a 1:1 Chromebook classroom in one rural east Tennessee

school system. This study made several important contributions to the research regarding teacher adoption rates and the diffusion of a 1:1 laptop program. First, in the quantitative portion of the study the researcher found that PEOU, PU, teachers' ages, highest level of education, and time of adoption had a statistically significant relationship with teacher innovativeness. Next, in the qualitative portion of the study, teacher interviews further elucidated the factors associated with the complex diffusion process. These one-on-one interviews indicated that teachers believed the Chromebooks were easy to use and that teacher willingness to use new technology was an important part of the diffusion process. Interviewees indicated that technology training had helped them to adopt the 1:1 classroom and that school administration support aided technology adoption. Finally, a majority of the interviewees (15 out of 17) suggested that the diffusion of the 1:1 classroom had been successful in the school system. Overall, the findings of this study can be used by teachers and school leaders to help understand how 1:1 technology is being adopted by school level users and determine what best practices can be utilized to help facilitate the diffusion of a 1:1 Chromebook classroom.

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APPENDIX A

IRB APPROVAL LETTER

THE UNIVERSITY OF TENNESSEE
CHATTANOOGA

Institutional Review Board
Dept 4915
615 McCallie Avenue
Chattanooga, TN 37403
Phone: (423) 425-5867

Fax: (423) 425-4052 instrb@utc.edu http://www.utc.edu/irb

TO: Jacob Quilliams **IRB # 19-023**
Dr. Ted Miller

FROM: Lindsay Pardue, Director of Research Integrity
Dr. Amy Doolittle, IRB Committee Chair

DATE: 2/22/2019

SUBJECT: IRB #19-023: Factors related to teacher adoption rates and the diffusion of a one to one laptop initiative in one rural public school district

Thank you for submitting your application for research involving human subjects to The University of Tennessee at Chattanooga Institutional Review Board. Your proposal was evaluated in light of the federal regulations that govern the protection of human subjects and approved via the expedited review procedure authorized by 45 CFR 46.110 and 21 CFR 56.110.

You must include the following approval statement on research materials seen by participants and used in research reports:

***The Institutional Review Board of the University of Tennessee at Chattanooga (FWA00004149) has approved this research project #* 19-023.**

Please keep in mind that all research must be conducted according to the proposal submitted to the UTC IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an Application for Changes, Annual Review, or Project Termination/Completion form to the UTC IRB. Please bear in mind that significant changes could result in having to develop a new application for submission and approval. Your protocol

will be automatically closed at the end of the proposed research period unless a change request application is submitted. No research may take place under a closed or expired protocol.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite our best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the UTC IRB as soon as possible. Once notified, we will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval.

For additional information, please consult our web page http://www.utc.edu/irb or email instrb@utc.edu.

Best wishes for a successful research project.

The University of Tennessee at Chattanooga is a comprehensive, community-engaged campus of the University of Tennessee System.

APPENDIX B

UTC IRB FORM B: APPLICATION FOR CHANGES

THE UNIVERSITY OF TENNESSEE CHATTANOOGA

Institutional Review Board

FORM B: Application for Changes, Annual Review, or Project Termination/Completion

ALL FORMS AND RESEARCH INSTRUMENTS SHOULD BE SUBMITTED BY EMAIL TO INSTRB@UTC.EDU.

Title of Research:	Factors related to teacher adoption rates and the diffusion of a one-to-one laptop initiative in one rural public school district
IRB Number:	#19-023

	Name	Department	Email
Principal Investigator	Jacob Quilliams	Education	ghm473@gmail.com
Other Investigator	UTC LEAD	LEAD	utclead@utc.edu
Other Investigator			
Faculty Advisor	Dr. Ted Miller	Education	Ted-miller@utc.edu

A. PROJECT STATUS: Please check the appropriate boxes below and provide additional information where appropriate.

☒ **Active** – Project ongoing
- ☐ No changes are planned and the project will continue as previously approved by the IRB.
- ☒ Changes are planned. *Please complete section B.*

☐ **Completed** – No further activities will be done, and the IRB file should be closed.

B. NOTIFICATION OF CHANGES: Please check the appropriate boxes below and provide additional information where appropriate. If no changes are planned or project is completed, please leave blank.

☐ **Change the project title.**
Details: *Click or tap here to enter text.*

☐ **Change(s) of principal or co-principal investigator(s), other collaborators, or change in student advisor(s).**
Details: *Click or tap here to enter text.*

☐ **Change(s) to project which will effect participation of human subjects.** *Please revise the relevant sections in the Form A and attach with this form.*
Details: *Click or tap here to enter text.*

☐ **Change(s) to informed consent forms and/or assent form(s**). *Please attach copies of new documents.*
Details: *Click or tap here to enter text.*

☐ **Additional locations for conducting project.** *Please attach permission letters from additional locations.*
Details: *Click or tap here to enter text.*

☐ **Unexpected risks to subjects or researcher(s).** *Please attach any incident reports and describe how you have or will resolve this situation.*
Details: *Click or tap here to enter text.*

☒ **Other**
Details: The principal investigator has completed the delphi study and created an interview questionnaire (see attachment A). This questionnaire will be used for one-on-one video conference interviews. All potential interviewees have completed an informed consent agreement, and agreed to be video recorded.

Signatures:

Jacob Quilliams _____ 4/9/2019 _____

Principal Investigator or Student	Date
*Faculty Advisor (for student applications)	Date

** If submitted by a faculty member, electronic (typed) signatures are acceptable. If submitted by a student, please print out completed form, obtain the faculty advisor's signature, scan completed form, and submit it via email. Only Word documents or PDF files are acceptable submissions.*

Attachment A: Interview Questionnaire

Interviewee Name: _____

Date: _____

1. In your opinion as an educator are Chromebooks easy to use, why or why not?

2. How does a teacher's willingness to try new technology relate to the adoption of the one-to-one Chromebook classroom?

3. What type of administrative support contributes to the successful adoption of a one-to-one Chromebook classroom?

4. What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?

5. What type of support could the school system offer to aid in the successful diffusion of the one-to-one Chromebook classroom?

6. As an educator, overall, how would you describe the diffusion of the one-to-one Chromebook classroom in the school system?

APPENDIX C

UTC IRB APPROVAL OF CHANGES

THE UNIVERSITY OF TENNESSEE CHATTANOOGA

Institutional Review Board

Dept 4915 615 McCallie Avenue
Chattanooga, TN 37403
Phone: (423) 425-5867
Fax: (423) 425-4052
instrb@utc.edu
http://www.utc.edu/irb

TO: Dr. Ted Miller, Jacob Quilliams **IRB # 19-023**

FROM: Lindsay Pardue, Director of Research Integrity
Dr. Amy Doolittle, IRB Committee Chair

DATE: 4/12/2019

SUBJECT: IRB #19-023: Factors related to teacher adoption rates and the diffusion of a one-to-one laptop initiative in one rural public school district

The University of Tennessee at Chattanooga Institutional Review Board has reviewed and approved the following changes for the IRB protocol listed above:

- Changes to the interview (one-on-one video conference) and the questionnaire which is further clarified in the change request application.

Please keep in mind that all research must be conducted according to the proposal submitted to the UTC IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an Application for Changes, Annual Review, or Project Termination/Completion form to the UTC IRB. Please bear in mind that significant changes could result in having to develop a new application for submission and approval. Your protocol will be automatically closed at the end of the proposed research period unless a change request application is submitted. No research may take place under a closed or expired protocol.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite our best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the UTC IRB as soon as possible. Once notified, we will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval.

For additional information, please consult our web page http://www.utc.edu/irb or email instrb@utc.edu.

Best wishes for a successful research project.

APPENDIX D

PERMISSION FROM THE RESEARCH SITE

Jacob Quilliams - Doctoral Research Proposal 2 messages

Jacob Quilliams [redacted] Fri, Dec 21, 2018 at 12:30 PM To: [redacted]
[redacted] Cc: Ted-Miller@utc.edu

December 21, 2018

[redacted] Assistant Superintendent: Curriculum & Instruction [redacted]

Dear [redacted]

The purpose of this letter is to gain preliminary approval to conduct research for my doctoral dissertation using a sample population of teachers in the [redacted]. The study will not begin until I have approval from you and the University of Tennessee at Chattanooga Internal Review Board (IRB). To this end, I will briefly cover the rationale and methodology of the proposed study.

The proposed study is designed to examine teacher adoption rates and the diffusion of a 1:1 Chromebook classroom. To examine this phenomenon, the researcher has created a three-phase mixed methods study. In phase one, teachers will be asked to complete an online survey containing thirty-seven multiple choice questions and four short answer questions. In phase two, ten teachers will be asked to voluntarily participate in a delphi study. Finally, in phase three, twenty-five teachers will be invited to voluntarily participate in one-on-one interviews.

The research sample will consist of teachers who volunteer to complete the survey instrument and/or participate in the delphi study or interviews. All teachers trained to use the Chromebook classroom will be invited to take part in the study, but participation will be voluntary as participants can decline to take part in the study at any time. Additionally, the researcher has taken the appropriate steps to ensure confidentiality for both teachers and the school system. The researcher will provide teachers with an informed consent agreement given before their participation. During the study, steps will be taken to ensure that no stress or harm will come to the participants during their participation. All information collected from the study will be handled in the strictest confidence, and the research material will only be used in support of this study.

Moreover, this research will benefit [redacted] in the following ways. First, results from the study will help provide evidence as to how teachers have adopted the 1:1 classroom over the past three years. Second, the results will help school leaders to understand what best practices can be used to facilitate current and future school technology initiatives.

Following your approval and the approval of the UTC IRB, the researcher plans to conduct this research at the beginning of the 2019 spring semester. To facilitate the data collection, the researcher will need access to teachers' school email addresses and, if possible, an email from you supporting the survey.

Thank you for your time. If you have any question regarding the research or if you would like to set up a meeting to further discuss the study, please email me at jacobquilliams[redacted] or call me at 423-364-1080 or contact Dr. Ted Miller (academic advisor) at 423-425-4540.

Sincerely, Jacob Quilliams
Jacob Quilliams Ph.D. Candidate - College of Health, Education and Professional Studies
104 Overbrook Drive
Knoxville, Tennessee 37920

[redacted] Fri, Dec 21, 2018 at 1:13 PM To: Jacob Quilliams <jacobquilliams[redacted] Cc: Ted-Miller@utc.edu

I will certainly approve your study for voluntary participation by teachers. Let me know when you need a formal statement of approval. I will be interested in hearing the results of your research. Have a wonderful holiday season.
Sincerely, [redacted]

APPENDIX E

ASSISTANT SUPERINTENDENT LETTER OF SUPPORT

Fwd: Jake Quilliams Dissertation Survey 2 messages

[redacted] Fri, Mar 1, 2019 at 3:33 PM To: [redacted], Jacob Quilliams [redacted]

Please forward this email to your teachers as you deem to be appropriate. Participation is strictly voluntary. Sincerely, [redacted] Assistant Superintendent [redacted]

Forwarded message From: **Jacob Robert Quilliams** <noreply@qualtricssurvey.com> Date: Thu, Feb 28, 2019 at 12:59 PM Subject: Jake Quilliams Dissertation Survey To:

Dear colleagues:

In fulfillment of my doctoral degree at the University of Tennessee at Chattanooga. I am asking you to take part in a short, confidential online survey (please see the link below). The survey instrument has been designed to examine teacher adoption rates and the diffusion of a 1:1 Chromebook classroom. Your participation in this study voluntary, and you can decline to take part in the study at any time.

Thank you for your time. If you have any question regarding the research, please contact me at ghm473@utc.edu or call me at 423-364-1080 or contact Dr. Ted Miller (academic advisor) at 423-425-4540.

Follow this link to the Survey: Take the Survey

Or copy and paste the URL below into your internet browser: https://utk.co1.qualtrics.com/jfe/form/SV_9pqr6mhtGLdgFI9?Q_DL=dhV6sf5kvLshW7j_9pqr6mhtGLdgFI9_MLRP_ 3f5oHR8ponM9Q2x&Q_CHL=email

Follow the link to opt out of future emails: Click here to unsubscribe

Sincerely,

Jake Quilliams UTC Learning and Leadership Doctoral Candidate

The Institutional Review Board of the University of Tennessee at Chattanooga (FWA00004149) has approved this research project # 19-023.

APPENDIX F

ONLINE SURVEY INFORMED CONSENT

FACTORS RELATED TO TEACHER ADOPTION RATES AND THE DIFFUSION OF A ONE TO ONE LAPTOP INITIATIVE IN ONE RURAL PUBLIC SCHOOL DISTRICT.

You are being invited to participate in a research study about teacher adoption rates that the diffusion of one to one (1:1) classroom in k-12 schools. This study is being conducted by the principal investigator Jacob Quilliams (423-364-1080, ghm473@utc.edu) and Dr. Ted. Miller (academic advisor) (423-425-4540, ted-miller@utc.edu) at the University of Tennessee at Chattanooga.

The questionnaire will take about 10-15 minutes to complete.

This survey is anonymous. Do not indicate your name on the survey. To ensure your anonymity the researcher will not collect your IP address. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study.
Your participation in this study is voluntary. By clicking "I consent, begin the study" you are voluntarily agreeing to participate and you are acknowledging that you are **18 years of age or older**. You are free to stop answering questions at any time or to decline to answer any particular question you do not wish to answer for any reason. If you are younger than 18, do not proceed.

Research at the University of Tennessee at Chattanooga involving human participants is carried out under the oversight of the Institutional Review Board. Address questions or problems regarding these activities to Dr. Amy Doolittle, UTC IRB Chair, email: amy-doolittle@utc.edu; phone: (423) 425-5563.

- ○ I consent, begin the study
- ○ I do not consent

APPENDIX G

DELPHI STUDY INFORMED CONSENT

UNIVERSITY OF TENNESSEE AT CHATTANOOGA

PROTOCOL TITLE: Factors related to teacher adoption rates and the diffusion of a one to one laptop initiative in one rural public school district.

Please read this consent document carefully before you decide to participate in this study.

Purpose of the research study:
The purpose of this research study is to examine teacher adoption rates that the diffusion of 1:1 classroom and add to the overall body of knowledge regarding the use of 1:1 devices in k-12 schools. To better understand the complex diffusion process the researcher is asking for ten volunteers to participate in a delphi study.

What you will be asked to do in the study:
To help with the research, I am asking you to participate in a delphi study. The delphi study is a type of focus group where individuals work together to reach a group consensus. The purpose of the delphi study is to create an interview questionnaire. Participants in the delphi study will be asked to work collaboratively online using Google Docs to create the questionnaire.

Time required:
30 minutes to 1 hour

Risks and Benefits:
The risks of the study are Potential risks to participants are inconvenience and loss of confidentiality. The time required to complete the delphi study may inconvenience teachers. To mitigate this inconvenience, participants can quit the study at any time. To mitigate the risk to participants' confidentiality teachers' names will not be used in the study. Moreover, only the principal investigator and dissertation committee will have access the results of the survey. A year after the study is complete all data containing participants names will be deleted by the principal investigator.

This research will help various stakeholders to better understand the complex diffusion process as it relates to the adaptation of a 1:1 classroom. For example, school leaders can use the results of this study to help determine what best practices can be used to promote future or current educational technology initiatives. Results from the study may also help future researchers determine other areas to investigate.

Incentive or Compensation:
In case of injury, you will be financially responsible for your treatment or care.
To incentivize participation in the study all individuals who participate in the delphi study and/or the one-on-one interviews will have a chance to win a $50.00 American Express gift card. Anyone who agrees to participate in the study will have their name put into an online random name picker. At the end of the study three names will be chosen at random to receive a gift card. The principal investigator will purchase these gift cards. Participants will be contacted by the principal investigator if they agree to take part in either the delphi study or follow-up interview using information gathered from the online survey.

Confidentiality:
Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number. The list connecting your name to this number will be kept on a secure password protected computer. When the study is completed and the data have been analyzed, the list will be destroyed. Your name will not be used in any report or publication.

Voluntary participation:
You will be excluded from the study if you are younger than 18. Your participation in this study is completely voluntary. Should you elect to discontinue participation, any information already collected will be discarded. There is no penalty or loss of benefit for choosing not to participate.

Right to withdraw from the study:
You have the right to withdraw from the study at any time without consequence or penalty.

Whom to contact if you have questions about the study:

Principal Investigator: Jacob Quilliams
Address: 104 Overbrook Drive
Knoxville, TN 37920
Phone: 423-364-1080
Email: ghm473@utc.edu

Academic Advisor: Dr. Ted Miller
Phone: 423-425-4540
Email: ted-miller@utc.edu

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you may contact Dr. Amy Doolittle, Chair of the UTC Institutional Review Board at (423) 425-5563. This research protocol has been approved by the UTC Institutional Review Board. Additional contact information is available at www.utc.edu/irb.

Agreement:
Your participation is voluntary, so if you do not wish to participate, simply select "I do not consent" on the informed consent page. Clicking "I consent to participate in the delphi study" will be considered your consent to participate. Your participation and response will be confidential and though the results of the research may be published, your name and institution will not be known.

- ○ I consent to participate in a delphi study.
- ○ I do not consent

APPENDIX H

ONE-ON-ONE INTERVIEW INFORMED CONSENT

UNIVERSITY OF TENNESSEE AT CHATTANOOGA

PROTOCOL TITLE: Factors related to teacher adoption rates and the diffusion of a one to one laptop initiative in one rural public school district.

Please read this consent document carefully before you decide to participate in this study.

Purpose of the research study:
The purpose of this research study is to examine teacher adoption rates that the diffusion of 1:1 classroom and add to the overall body of knowledge regarding the use of 1:1 devices in k-12 schools. To better understand the complex diffusion process the researcher is interviewing twenty-five teachers who have used 1:1 devices in their classrooms.

What you will be asked to do in the study:
Your participation will involve a one-on-one interview with the researcher. In this interview you will be asked to answer a series of questions regarding your use of a 1:1 classroom. These interviews will be conducted using the Zoom video conferencing software. All interviews will be recorded to assist with the accuracy of your responses. These recordings will be kept by the researcher on a secure computer that is password protected. Only the researcher will have access to these recordings and they will be destroyed by 3/31/2020. You have the right to refuse the recording.

Time required:
30 minutes to 1 hour

Risks and Benefits:
The risks of the study are Potential risks to participants are inconvenience and loss of confidentiality. The time required to complete the interview may inconvenience teachers. To mitigate this inconvenience, participants can quit the study at any time. To mitigate the risk to participants' confidentiality teachers' names will not be used in the study. Only the principal investigator and dissertation committee will have access the results of the survey. A year after the study is complete all data containing participants names will be deleted by the principal investigator.

This research will help various stakeholders to better understand the complex diffusion process as it relates to the adaptation of a 1:1 classroom. For example, school leaders can use the results of this study to help determine what best practices can be used to promote future or current educational technology initiatives. Results from the study may also help future researchers determine other areas to investigate.

Incentive or Compensation:
In case of injury, you will be financially responsible for your treatment or care.
To incentivize participation in the study all individuals who participate in the delphi study and/or the one-on-one interviews will have a chance to win a $50.00 American Express gift card. Anyone who agrees to participate in the study will have their name put into an online random name picker. At the end of the study three names will be chosen at random to receive a gift card.

The principal investigator will purchase these gift cards. Participants will be contacted by the principal investigator if they agree to take part in either the delphi study or follow-up interview using information gathered from the online survey.

Confidentiality:
Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number. The list connecting your name to this number will be kept on a secure password protected computer. When the study is completed and the data have been analyzed, the list will be destroyed. Your name will not be used in any report or publication.

Voluntary participation:
You will be excluded from the study if you are younger than 18. Your participation in this study is completely voluntary. Should you elect to discontinue participation, any information already collected will be discarded. There is no penalty or loss of benefit for choosing not to participate.

Right to withdraw from the study:
You have the right to withdraw from the study at any time without consequence or penalty.

Whom to contact if you have questions about the study:

Principal Investigator: Jacob Quilliams
Address: 104 Overbrook Drive
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Academic Advisor: Dr. Ted Miller
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Email: ted-miller@utc.edu

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you may contact Dr. Amy Doolittle, Chair of the UTC Institutional Review Board at (423) 425-5563. This research protocol has been approved by the UTC Institutional Review Board. Additional contact information is available at www.utc.edu/irb.

Agreement:
Interviews may be recorded using video devices to assist with the accuracy of your responses. These recordings will be kept by the researcher on a secure computer that is password protected. Only the researcher will have access to these recordings and they will be destroyed by 3/31/2020. You have the right to refuse the recording.

Your participation is voluntary, so if you do not wish to participate, simply select “I do not consent” on the informed consent page. Clicking “I consent to participate in the interview, and to be video recorded” will be considered your consent to participate. Your participation and response will be confidential and though the results of the research may be published, your name and institution will not be known.

- ○ I consent to participate in an interview, and to be video recorded.
- ○ I do not consent

APPENDIX I

ONLINE SURVEY

Diffusion of a 1:1 Laptop Initiative

Start of Block: SURVEY INSTRUCTION

Display This Question:

If Customize your survey in 4 easy steps. This screen is for instructional purposes only and will no... Is Displayed

Q1 **Customize your survey in 4 easy steps.** *This screen is for instructional purposes only and will not be shown to respondents.*

1. Replace the yellow highlighted text in the survey below.

[STUDY TOPIC] - Brief description about your research needs [SURVEY DURATION IN MINUTES] - Time it would take for respondents to finish the survey. [INCENTIVE] - Enter incentive details (e.g., $5 Gift Card), if you are planning to send an incentive to respondents. If you are not intending to give any incentive then remove the statement. [NAME AND EMAIL ADDRESS] - Name & email address of the contact person who would be able to address respondents queries

2. Click 'Preview survey' to see what participants will see on desktop and mobile.

3. Click 'Look & Feel' to update the survey theme if desired.

4. Go to 'Distributions' to send your survey and start collecting responses.

End of Block: SURVEY INSTRUCTION

Start of Block: Informed Consent

Q2 Factors related to teacher adoption rates and the diffusion of a one to one laptop initiative in one rural public school district. You are being invited to participate in a research study about teacher adoption rates that the diffusion of one to one (1:1) classroom in k-12 schools. This study is being conducted by the principal investigator Jacob Quilliams (423-364-1080, ghm473@utc.edu) and Dr. Ted. Miller (academic advisor) (423-425-4540, ted-miller@utc.edu) at the University of Tennessee at Chattanooga. The questionnaire will take about 10-15 minutes to complete. This survey is anonymous. Do not indicate your name on the survey. To ensure your anonymity the researcher will not collect your IP address. No one will be able to identify you or your answers, and no one will know whether or not you participated in the study. Your participation in this study is voluntary. By clicking "I consent, begin the study" you are voluntarily agreeing to participate and you are acknowledging that you are **18 years of age or older**. You are free to stop answering questions at any time or to decline to answer any

particular question you do not wish to answer for any reason. If you are younger than 18, do not proceed. *Research at the University of Tennessee at Chattanooga involving human participants is carried out under the oversight of the Institutional Review Board. Address questions or problems regarding these activities to Dr. Amy Doolittle, UTC IRB Chair, email: amy-doolittle@utc.edu; phone: (423) 425-5563.*

***The Institutional Review Board of the University of Tennessee at Chattanooga (FWA00004149) has approved this research project #* 19-023.**

- ○ I consent, begin the study
- ○ I do not consent

Skip To: End of Survey If Factors related to teacher adoption rates and the diffusion of a one to one laptop initiative in... = I do not consent

End of Block: Informed Consent

Start of Block: Block 2

Q3 I find the One to One Chromebooks cumbersome to use.

- ○ Totally Disagree
- ○ Disagree
- ○ Slightly Disagree
- ○ Neither Agree or Disagree
- ○ Slightly Agree
- ○ Agree
- ○ Totally Agree

Q4 Learning to operate the One to One Chromebooks is easy for me.

- ○ Totally Disagree
- ○ Disagree
- ○ Slightly Disagree
- ○ Neither Agree or Disagree
- ○ Slightly Agree
- ○ Agree
- ○ Totally Agree

Q5 Interacting with the One to One Chromebooks is often frustrating.

- ○ Totally Disagree
- ○ Disagree
- ○ Slightly Disagree
- ○ Neither Agree or Disagree
- ○ Slightly Agree
- ○ Agree
- ○ Totally Agree

Q6 I find it easy to get the One to One Chromebooks to do what I want it to do.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q7 One to One Chromebooks are rigid and inflexible to interact with.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q8 It is easy for me to remember how to perform tasks using the One to One Chromebooks.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q9 Interacting with the One to One Chromebooks requires a lot of mental effort.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q10 My interaction with the One to One Chromebooks is clear and understandable.

- ○ Totally Disagree
- ○ Disagree
- ○ Slightly Disagree
- ○ Neither Agree or Disagree
- ○ Slightly Agree
- ○ Agree
- ○ Totally Agree

Q11 I find it takes a lot of effort to become skillful using the One to One Chromebooks.

- ○ Totally Disagree
- ○ Disagree
- ○ Slightly Disagree
- ○ Neither Agree or Disagree
- ○ Slightly Agree
- ○ Agree
- ○ Totally Agree

Q12 Overall, I find the One to One Chromebooks easy to use.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

End of Block: Block 2

Start of Block: Block 3

Q13 Using One to One Chromebooks improves the quality of work I do.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q14 Using One to One Chromebooks gives me greater control over my work.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q15 Please select Totally Agree to this question.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q16 One to One Chromebooks enable me to accomplish tasks more quickly.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q17 One to One Chromebooks support critical aspects of my job.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q18 One to One Chromebooks increase my productivity.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q19 Using One to One Chromebooks improves my job performance.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q20 Using One to One Chromebooks allows me to accomplish more work than would otherwise be possible.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q21 Using One to One Chromebooks enhances my effectiveness on the job.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q22 Using One to One Chromebooks makes it easier to do my job.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q23 Overall, I find the One to One Chromebooks useful in my job.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

End of Block: Block 3

Start of Block: Block 4

Q24 If I heard about a new information technology, I would look for ways to experiment with it.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q25 In general, I am hesitant to try out new information technologies.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q26 Among my peers, I am usually the first to try out new information technologies.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

Q27 I like to experiment with new information technologies.

- Totally Disagree
- Disagree
- Slightly Disagree
- Neither Agree or Disagree
- Slightly Agree
- Agree
- Totally Agree

End of Block: Block 4

Start of Block: Block 5

Q28 On average how many days a week do you use Chromebooks in your classroom?

- None
- One (Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)
- Two (Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)(Partnership for 21st Century Learning)
- Three
- Four
- Five

Q29 When were you first trained to use the Chromebooks in your classroom?

- Spring 2016
- Fall 2016
- Spring 2017
- Fall 2017
- Spring 2018
- Fall 2018
- I have never been trained to use the Chromebooks in my classroom
- Other _____

Q30 How many years have you been teaching?

- ○ 0-10
- ○ 11-20
- ○ 21-30
- ○ 31+

Q31 What is your highest level of education completed?

- ○ High school
- ○ Associates
- ○ Bachelors
- ○ Masters
- ○ Specialist
- ○ Doctorate
- ○ Other _____

Q32 What is your gender?

- ○ Male
- ○ Female
- ○ Other/Not Applicable

Q33 What is your age?

- 20-29
- 30-39
- 40-49
- 50-59
- 60-69
- 70-79
- 80-89

Q34 What subject do you primarily teach?

- Elementary/General Education
- Math
- Science
- English
- Social Studies
- Art
- Physical Education
- Special Education/CDC
- Other _____

Q35 What grade do you primarily teach?

- Elementary (k-5)
- Middle (6-8)
- High (9-12)

End of Block: Block 5

Start of Block: Block 6

Q36 What characteristics of educational innovations relate to their successful adoption?

_____

Q37 What characteristics of faculty members relate to the successful adoption of one-to-one Chromebook classrooms?

_____

Q38 What school level characteristics contribute to the successful adoption of a one-to-one Chromebook classroom?

_____

Q39 What school system level characteristics contribute to the successful adoption of a one-to-one Chromebook classroom?

_____

End of Block: Block 6

Start of Block: Block 7

Q40 Are you willing to be contacted to participate in a follow-up interview or a delphi study? Anyone who agrees to participate in either the delphi study or follow-up interview has a chance to win one of three ***$50.00 gift cards***. The delphi study will consist of a focus group of teachers

who will help the principal investigator create a short interview questionnaire. Follow-up interviews will be conducted using video conferencing software to better understand how teachers are using the 1:1 classroom.

- ○ Yes, I would like to participate in the delphi study
- ○ Yes, I would like to participate in a follow-up interview
- ○ No, exit the survey

Skip To: End of Survey If Are you willing to be contacted to participate in a follow-up interview or a delphi study? Anyone... = No, exit the survey

Skip To: Q41 If Are you willing to be contacted to participate in a follow-up interview or a delphi study? Anyone... = Yes, I would like to participate in the delphi study

Skip To: Q42 If Are you willing to be contacted to participate in a follow-up interview or a delphi study? Anyone... = Yes, I would like to participate in a follow-up interview

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Q41 UNIVERSITY OF TENNESSEE AT CHATTANOOGA
PROTOCOL TITLE: Factors related to teacher adoption rates and the diffusion of a one to one laptop initiative in one rural public school district. Please read this consent document carefully before you decide to participate in this study. Purpose of the research study: The purpose of this research study is to examine teacher adoption rates that the diffusion of 1:1 classroom and add to the overall body of knowledge regarding the use of 1:1 devices in k-12 schools. To better understand the complex diffusion process the researcher is asking for ten volunteers to participate in a delphi study. What you will be asked to do in the study: To help with the research, I am asking you to participate in a delphi study. The delphi study is a type of focus group where individuals work together to reach a group consensus. The purpose of the delphi study is to create an interview questionnaire. Participants in the delphi study will be asked to work collaboratively online using Google Docs to create the questionnaire. Time required: 30 minutes to 1 hour Risks and Benefits: The risks of the study are Potential risks to participants are inconvenience and loss of confidentiality. The time required to complete the delphi study may inconvenience teachers. To mitigate this inconvenience, participants can quit the study at any time. To mitigate the risk to participants' confidentiality teachers' names will not be used in the study. Moreover, only the principal investigator and dissertation committee will have access the results of the survey. A year after the study is complete all data containing participants names will be deleted by the principal investigator. This research will help various stakeholders to better understand the complex diffusion process as it relates to the adaptation of a 1:1 classroom. For example, school leaders can use the results of this study to help determine what best practices can be used to promote future or current educational technology initiatives. Results from the study may also help future researchers determine other areas to investigate. Incentive or Compensation: In case of injury, you will be financially responsible for your treatment or care. To incentivize participation in the study all individuals who participate in the delphi study and/or the one-on-one interviews will have a chance to win a $50.00 American Express gift card. Anyone who agrees to participate in the study will have their name put into an online random

name picker. At the end of the study three names will be chosen at random to receive a gift card. The principal investigator will purchase these gift cards. Participants will be contacted by the principal investigator if they agree to take part in either the delphi study or follow-up interview using information gathered from the online survey. Confidentiality: Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number. The list connecting your name to this number will be kept on a secure password protected computer. When the study is completed and the data have been analyzed, the list will be destroyed. Your name will not be used in any report or publication. Voluntary participation: You will be excluded from the study if you are younger than 18. Your participation in this study is completely voluntary. Should you elect to discontinue participation, any information already collected will be discarded. There is no penalty or loss of benefit for choosing not to participate. Right to withdraw from the study: You have the right to withdraw from the study at any time without consequence or penalty. Whom to contact if you have questions about the study: Principal Investigator: Jacob Quilliams Address: 104 Overbrook Drive Knoxville, TN 37920 Phone: 423-364-1080 Email: ghm473@utc.edu Academic Advisor: Dr. Ted Miller Phone: 423-425-4540 Email: ted-miller@utc.edu If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you may contact Dr. Amy Doolittle, Chair of the UTC Institutional Review Board at (423) 425-5563. This research protocol has been approved by the UTC Institutional Review Board. Additional contact information is available at www.utc.edu/irb. Agreement: Your participation is voluntary, so if you do not wish to participate, simply select "I do not consent" on the informed consent page. Clicking "I consent to participate in the delphi study" will be considered your consent to participate. Your participation and response will be confidential and though the results of the research may be published, your name and institution will not be known.

***The Institutional Review Board of the University of Tennessee at Chattanooga (FWA00004149) has approved this research project #* 19-023.**

- ○ I consent to participate in a delphi study.
- ○ I do not consent

Skip To: End of Survey If UNIVERSITY OF TENNESSEE AT CHATTANOOGA PROTOCOL TITLE: Factors related to teacher adoption rates... = I do not consent

Skip To: Q43 If UNIVERSITY OF TENNESSEE AT CHATTANOOGA PROTOCOL TITLE: Factors related to teacher adoption rates... = I consent to participate in a delphi study.

Q42 UNIVERSITY OF TENNESSEE AT CHATTANOOGA
PROTOCOL TITLE: Factors related to teacher adoption rates and the diffusion of a one to one laptop initiative in one rural public school district.
Please read this consent document carefully before you decide to participate in this study.
Purpose of the research study: The purpose of this research study is to examine teacher adoption rates that the diffusion of 1:1 classroom and add to the overall body of knowledge regarding the

use of 1:1 devices in k-12 schools. To better understand the complex diffusion process the researcher is interviewing twenty-five teachers who have used 1:1 devices in their classrooms.
What you will be asked to do in the study: Your participation will involve a one-on-one interview with the researcher. In this interview you will be asked to answer a series of questions regarding your use of a 1:1 classroom. These interviews will be conducted using the Zoom video conferencing software. All interviews will be recorded to assist with the accuracy of your responses. These recordings will be kept by the researcher on a secure computer that is password protected. Only the researcher will have access to these recordings and they will be destroyed by 3/31/2020. You have the right to refuse the recording. Time required: 30 minutes to 1 hour
Risks and Benefits: The risks of the study are Potential risks to participants are inconvenience and loss of confidentiality. The time required to complete the interview may inconvenience teachers. To mitigate this inconvenience, participants can quit the study at any time. To mitigate the risk to participants' confidentiality teachers' names will not be used in the study. Only the principal investigator and dissertation committee will have access the results of the survey. A year after the study is complete all data containing participants names will be deleted by the principal investigator.
This research will help various stakeholders to better understand the complex diffusion process as it relates to the adaptation of a 1:1 classroom. For example, school leaders can use the results of this study to help determine what best practices can be used to promote future or current educational technology initiatives. Results from the study may also help future researchers determine other areas to investigate.
Incentive or Compensation: In case of injury, you will be financially responsible for your treatment or care. To incentivize participation in the study all individuals who participate in the delphi study and/or the one-on-one interviews will have a chance to win a $50.00 American Express gift card. Anyone who agrees to participate in the study will have their name put into an online random name picker. At the end of the study three names will be chosen at random to receive a gift card. The principal investigator will purchase these gift cards. Participants will be contacted by the principal investigator if they agree to take part in either the delphi study or follow-up interview using information gathered from the online survey.
Confidentiality: Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number. The list connecting your name to this number will be kept on a secure password protected computer. When the study is completed and the data have been analyzed, the list will be destroyed. Your name will not be used in any report or publication.
Voluntary participation: You will be excluded from the study if you are younger than 18. Your participation in this study is completely voluntary. Should you elect to discontinue participation, any information already collected will be discarded. There is no penalty or loss of benefit for choosing not to participate.
Right to withdraw from the study: You have the right to withdraw from the study at any time without consequence or penalty.
Whom to contact if you have questions about the study: Principal Investigator: Jacob Quilliams Address: 104 Overbrook Drive Knoxville, TN 37920 Phone: 423-364-1080 Email: ghm473@utc.edu Academic Advisor: Dr. Ted Miller Phone: 423-425-4540 Email: ted-miller@utc.edu If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you may contact Dr. Amy Doolittle, Chair of the UTC Institutional Review Board at (423) 425-5563. This research protocol has been

approved by the UTC Institutional Review Board. Additional contact information is available at www.utc.edu/irb.
Agreement: Interviews may be recorded using video devices to assist with the accuracy of your responses. These recordings will be kept by the researcher on a secure computer that is password protected. Only the researcher will have access to these recordings and they will be destroyed by 3/31/2020. You have the right to refuse the recording. Your participation is voluntary, so if you do not wish to participate, simply select "I do not consent" on the informed consent page. Clicking "I consent to participate in the interview, and to be video recorded" will be considered your consent to participate. Your participation and response will be confidential and though the results of the research may be published, your name and institution will not be known.

***The Institutional Review Board of the University of Tennessee at Chattanooga (FWA00004149) has approved this research project #* 19-023.**

- ○ I consent to participate in an interview, and to be video recorded.
- ○ I do not consent

Skip To: Q43 If UNIVERSITY OF TENNESSEE AT CHATTANOOGA PROTOCOL TITLE: Factors related to teacher adoption rates... = I consent to participate in an interview, and to be video recorded.

Skip To: End of Survey If UNIVERSITY OF TENNESSEE AT CHATTANOOGA PROTOCOL TITLE: Factors related to teacher adoption rates... = I do not consent

Q43 Thank you for your participation. Please provide the following contact information to participate in the interview or delphi study.
First Name:

_____

Q44 Last Name

_____

Q45 Phone Number with Area Code

_____

Q46 Email Address

____

End of Block: Block 7

APPENDIX J

DELPHI STUDY ROUND ONE GOOGLE FORM

Delphi Study Round 1

Colleagues, in this delphi study I am asking you to help me create an interview questionnaire. Overall, the purpose of the interview process is to garner a more in-depth understanding of how and why teachers are or are not adopting the Chromebook classroom. More broadly the researcher wants to understand the diffusion process as it relates to the adoption of the one-to-one Chromebook classroom in the school system. Below I have listed an analysis of the data gathered from the four open-ended questions from the online survey. Please, use the data to create the appropriate interview question/s for each topic. We will continue this process through multiple rounds until we reach a group consensus with regards to the questionnaire. Thank you for your time.

Your email address [redacted] will be recorded when you submit this form.

Topic1: Educational Technology Characteristics

Answer the question below. If you have additional comments or potential interview questions choose other.

1. **Topic 1: What characteristics of educational innovations relate to their successful adoption?**

   Example Question: In your opinion as an educator are Chromebooks easy to use, why or why not? *

Category	Code	Count	% Codes
Innovation Characteristics	Ease of Use	97	56.40%
Innovation Characteristics	Training	17	9.90%
Innovation Characteristics	Student	13	7.60%
Innovation Characteristics	Flexible	8	4.70%
Innovation Characteristics	Aligned with	8	4.70%
Innovation Characteristics	Cost	7	4.10%
Innovation Characteristics	Differentiated	3	1.70%
Innovation Characteristics	Willing to try new	3	1.70%
Innovation Characteristics	Buy-in	3	1.70%
Innovation Characteristics	Need for	2	1.20%
Innovation Characteristics	Research Based	1	0.60%

   - Use the example question: In your opinion as an educator are Chromebooks easy to use, why or why not?
   - Use the example question and additional question/s (choose other and type the question).
   - Do not use the example question (please choose other and provide additional feedback).
   - Other:

Topic 2: Teacher Characteristics

Answer the question below. If you have additional comments or potential interview questions choose other.

2. **Topic 2: What characteristics of faculty members relate to the successful adoption of one-to-one Chromebook classrooms? Example: How does a teacher's willingness to try new technology relate to the adoption of the one-to-one Chromebook classroom?** *

Category	Code	Count	% Codes
Teacher Characteristics	Willingness/Desire to Learn	93	49.20%
Teacher Characteristics	Flexibility	19	10.10%
Teacher Characteristics	Other	17	9.00%
Teacher Characteristics	Tech Savvy	13	6.90%
Teacher Characteristics	Ease of Use	11	5.80%
Teacher Characteristics	Youth/Age	9	4.80%
Teacher Characteristics	Innovative	8	4.20%
Teacher Characteristics	Faculty Collaboration/Support	7	3.70%
Teacher Characteristics	Open-Minded/Curious	6	3.20%
Teacher Characteristics	Tech Support	2	1.10%
Teacher Characteristics	Student Needs With Regard to Technology	2	1.10%
Teacher Characteristics	Patience	2	1.10%

- Use the example question: How does the a teacher's willingness to try new technology affect the adoption of one-to-one Chromebook classroom?
- Use the example question and additional question/s (choose other and type the question).
- Do not use the example question (please choose other and provide additional feedback).
- Other:

Topic 3: School Level Characteristics

Answer the question below. If you have additional comments or potential interview questions choose other.

3. **Topic 3: What school level characteristics contribute to the successful adoption of a one-to-one Chromebook classroom? Example: What type of administrative support contributes to the successful adoption of a one-to-one Chromebook classroom?** *

Category	Code	Count	% Codes
School Characteristics	Admin. Support	45	22.00%
School Characteristics	Faculty/Culture that is Willing to Learn	32	15.60%
School Characteristics	Training	24	11.70%
School Characteristics	Technology Support	22	10.70%
School Characteristics	Other	20	9.80%
School Characteristics	Clear Expectations	14	6.80%
School Characteristics	Collaboration With Peers	11	5.40%
School Characteristics	Technology Infrastructure	9	4.40%
School Characteristics	Student Internet Usage Policy/online discipline	9	4.40%
School Characteristics	Monetary Support	6	2.90%
School Characteristics	Time	5	2.40%
School Characteristics	Organization	4	2.00%
School Characteristics	Student Engagement	4	2.00%

- Use the example question: What type of administrative support contributes to the successful adoption of a one-to-one Chromebook classroom?
- Use the example question and additional question/s (choose other and type the question).
- Do not use the example question (please choose other and provide additional feedback).
- Other:

Topic 4: System Level Characteristics

Answer the question below. If you have additional comments or potential interview questions choose other.

4. **Topic 4: What school system level characteristics contribute to the successful adoption of an one-to-one Chromebook classroom? Example: What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?** *

Code	Count	% Codes
Training	73	32.90%
Monetary Support	40	18.00%
Tech Support	30	13.50%
Culture of Support	20	9.00%
Other	18	8.10%
Technology Infrastructure	8	3.60%
Admin. Support	7	3.20%
Innovative	7	3.20%
Planning	6	2.70%
Willingness to Try New Tech./Learn	5	2.30%
Consistency	4	1.80%
Disciplinary Policies	2	0.90%
Flexibility	2	0.90%

- Use the example question: What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?
- Use the example question and an additional question/s (choose other and type the question).
- Do not use the example question (please choose other and provide additional feedback).
- Other:

Topic 5: Diffusion of the One-to-One Classroom

Answer the question below. If you have additional comments or potential interview questions choose other.

5. **This question seeks to explore how individual teachers have experienced the adoption and diffusion of the one-to-one classroom. Example question: As an educator, overall, how would you describe the diffusion of the one-to-one Chromebook classroom in the school system?**

    - Use the example question: As an educator, overall, how would you describe the diffusion of the one-to-one Chromebook classroom in the school system?
    - Use the example question and an additional question/s (choose other and type the question).
    - Do not use the example question (please choose other and provide additional feedback).
    - Other:

APPENDIX K

DELPHI STUDY ROUND TWO GOOGLE FORM

Delphi Study Round 2

Your email address ([redacted] will be recorded when you submit this form.

1. Required

Topic 4: What school system level characteristics contribute to the successful adoption of a one-to-one Chromebook classroom? Please choose a potential interview question(s) from the options below. *

- Use question one only: What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?
- Use question two only: What type of support could the school system offer to aid in the successful diffusion of the one-to-one Chromebook classroom?
- Use both questions one and two.
- Other

APPENDIX L

INTERVIEW QUESTIONAIRE

Teacher Adoption Rates and the Diffusion of a One-to-One

Chromebook Classroom Interview Questionnaire

Interviewee Name: _____Date: _____

Introductory Statement: First, thank you for taking the time to participate in this interview. The purpose of this interview or study is the garner a more in-depth understanding of how and why teachers are or are not adopting the 1:1 Chromebook classroom. To understand these phenomena, I will be asking you a series of question analyzing the different factors that may or may not affect technology adoption. For example, I will ask you question about how you think teacher characteristics, school-level characteristics, and school system level characteristics affect technology adoption. The interview is entirely participatory, and you can stop at any time. Also, this interview is being video recorded. Is it still ok that I record this interview, YES / NO?

What grade do you currently teach? _____

How long have you been teaching? _____

1. In your opinion as an educator are Chromebooks easy to use, why or why not?

2. How does a teacher's willingness to try new technology relate to the adoption of the one-to-one Chromebook classroom?

3. What type of administrative support contributes to the successful adoption of a one-to-one Chromebook classroom?

4. What type of training could the school system offer to aid in the successful adoption of the one-to-one Chromebook classroom?

5. What type of support could the school system offer to aid in the successful diffusion of the one-to-one Chromebook classroom?

6. As an educator, overall, how would you describe the diffusion of the one-to-one Chromebook classroom in the school system?

APPENDIX M

VARIABLES ANALYSIS

	Research Question	Variable Labels	Levels of the Variable	Scale of Measurement
Dependent Variables	One, Two, Three, Four, Five	Teacher Innovativeness	Z-scores	Scale/Ordinal
Independent Variables	One	Perceived Ease of Use (PEOU)	-3 = Totally Disagree -2 = Disagree -1 = Slightly Disagree 0 = Neither Agree or Disagree 1 = Slightly Agree 2 = Agree 3 = Totally Agree	Scale/Ordinal
	Two	Perceived Use (PU)	-3 = Totally Disagree -2 = Disagree -1 = Slightly Disagree 0 = Neither Agree or Disagree 1 = Slightly Agree 2 = Agree 3 = Totally Agree	Scale/Ordinal
	Three	Demographics/ Homophily	I. Age 1. 20-29 2. 30-39 3. 40-49 4. 50-59 5. 60-69 6. 70-79 7. 80-89 II. Years of Teaching Experience 1. 0-1 2. 2-5 3. 6-10 4. 11-20 5. 20-30 6. 31+ III. Gender 1. Male 2. Female 0. Other IV. Highest Level of Education	Scale/Ordinal

			1. High School 2. Bachelors 3. Masters 4. Specialist 5. Doctorate 6. Other	
	Four	Time 1:1 First Adopted	Average Use Per week 0 1 2 3 4 5	Scale/Ordinal
	Five	Time Since Training	1. Spring of 2016 2. Fall of 2016 3. Spring 2017 4. Fall 2017 5. Spring 2018 6. Fall 2018 7. I have never been trained to use Chromebooks in my classroom.	Scale/Ordinal
	Six (Qualitative)	Diffusion	Teacher descriptions of diffusion, gathered from one-on-one interviews.	Nominal

APPENDIX N

INTERVIEW TRANSCRIPTS

Interviewee One, April 17, 2019: Alpha

The Innovation: Alpha was a middle school English language arts teacher with five years of teaching experience. He was categorized as an early adopter. Alpha stated that the Chromebooks were easy to use for both teachers and students and that this ease of use made adoption easier. For example, he said, “the Chromebooks are very easy to use compared to other educational technologies like a MacBook. The fact that they are easy to learn makes them more adoptable for both teachers and students.” He said that he uses the Chromebooks in his classroom daily.

Teacher Willingness: Alpha believed that if a teacher is more willing to use new technology, then they will use it more often. For example, he said that teachers who are less willing to try new technology use the Chromebooks as a “supplementary” aid to their classroom but do not entirely change their pedagogical practices. Furthermore, he said that in many ways, the use of the Chromebooks in his classroom had been a “transformative” experience.

Administrative Support: Alpha said that at his school, there had been "a strong technology push" from the administration. Both teachers and students were expected by the administration to use the Chromebooks. He said this had fundamentally changed the culture of the school, as everyone was expected to use the Chromebooks regularly.

Training: Alpha felt that the initial Google classroom training was “helpful,” but that the school system needed to offer more training, especially for those teachers who are struggling to adopt the Chromebook classroom. For example, he stated that his mother is a third-grade teacher in the school system and that she was struggling with trying to adopt the Chromebooks. He said that if she was unable to use the new technology, it was unlikely that her students would be able

to use it either. Overall, he believed that the school system needed to offer much more support and training for teachers as they adopt the Chromebooks.

School System Support: Concerning additional support, Alpha said that the school system should offer more IT support for schools. He said that in many cases, it was hard to get the Chromebooks fixed quickly, and the idea that students would pay for damages to computers was a "pipe dream." To compensate for this lack of technology support Alpha said that in some cases, school administrators had stepped in to fill in some of the gaps by fixing computers for their students.

Diffusion: Alpha said that in his view, the adoption of the Chromebook classroom had been "seamless." Moreover, he stated that he had not experienced any issues thus far with the roll-out of the one-to-one classroom.

Interviewee Two, April 23, 2019: Beta

The Innovation: Beta was a high school agricultural and animal sciences teacher with seventeen years of teaching experience. He was categorized as an early adopter. Beta stated that he thought the Chromebooks were easy to use as a teacher. Further, he said that his familiarity with Google Docs and Google Sheets made the adoption of the Chromebooks easier, as he already had experience using these applications. Overall, he stated that he used his Chromebook 95% of the time in his classroom.

Teacher Willingness: Beta said that a teacher's willingness to use new technology was "key" to its adoption. Conversely, he stated that some teachers were less willing to change. For example, Beta said that these teachers who are less willing to change are the same teachers who still "handwrite their tests."

Administrative Support: Regarding administrative support, Beta said that while administrators should support teachers use of technology, these leaders were not responsible for individual teacher's adoption of educational technology. Furthermore, he said that technology adoption also depends on the subject taught by teachers. For example, he said that physical education teachers probably had not fully adopted the Chromebooks because the technology was not applicable for their particular subject matter.

Training: Beta said that the initial training offered by the school system was "good," but that more training was needed for those teachers still struggling to adopt the Chromebooks. He suggested that the school system could offer smaller training classes aimed at aiding these laggards in technology adoption. He also stated that the school system needed to investigate why these teachers had not yet adopted the technology. Using the information from these investigations, school leaders could create training sessions that aligned the areas of support they required.

School System Support: Beta suggested that the school system should offer more technology support at the school level. Specifically, he said that there needed to be a "network" of teachers at the school or county level who worked with individual schools to help support technology adoption.

Diffusion: Beta said that at his school the Chromebooks were "widely" used by teachers. However, there were still teachers who had not fully adopted Chromebooks. One suggestion he had to help teachers more fully utilize the Chromebooks was to find a way for teachers to automatically migrate class grades from Google Classroom to the online grading portal called Skyward. He thought that if teachers class grades automatically posted from Google Classroom into Skyward, more teachers would adopt the Chromebooks.

Interviewee Three, April 22, 2019: Gamma

The Innovation: Gamma was a high school English language arts teacher with twenty-three years of teaching experience. She was categorized as an early adopter. Gamma thought that the Chromebooks were very easy to use. She stated that the Chromebooks were student friendly and were easily adapted to the classroom.

Teacher Willingness: Gamma thought that a teacher's willingness to use new technology was "closely" related to the adoption of the Chromebooks. Furthermore, she said that if a teacher is not willing to use the Chromebooks, they would "simply sit in the classroom and go unused."

Administrative Support: Gamma believed that school administers needed to actively seek out teachers to try new technologies and encouraging teachers to become trained to use new technologies. She stated that if administrators did not take an active role in "encouraging" the adoption of new technology, then teachers would not use the Chromebooks and the adoption would not be successful.

Training: Gamma suggested that technology trainings should help teachers overcome their fear of new technology. Explicitly, she stated that many times, teachers could learn how to use the Chromebooks from their students. However, teachers must be willing to learn and realize this is ok if they are not "the smartest person in the room" when it comes to the use of technology. Moreover, she suggested that teachers should first focus on understanding their content before they worried about using Chromebooks.

School System Support: Gamma thought that continued motivation was important for teachers and that it was important for the school system to continue to encourage teachers to use the Chromebooks. She also said that it was important for the school system to offer IT support to

teachers and schools. Additionally, she stated that in the future more would need to be done to make sure that students had access to broadband internet access at home and in schools.

Diffusion: Gamma stated that overall, she thought the distribution of the Chromebook classroom had been "very effective." She said that the decision to adopt the Chromebooks one grade level at a time was a good idea. Furthermore, she believed that if the school system had distributed Chromebooks to all schools and all grades at once, it would have been "overwhelming" and could have potentially hindered the diffusion of the one-to-one classroom.

Interviewee Four, April 23, 2019: Delta

The Innovation: Delta was a high school math teacher with 25 years of teaching experience. She was categorized as an early adopter. Delta said that the Chromebooks were easy to use. Specifically, she said that students were able to use the classroom easily, and there were online programs, like Reading Works, that made the technology easy to use for teachers.

Teacher Willingness: Delta said the teachers needed to be willing to use the Chromebooks; otherwise, they would not be used by students. Moreover, she stated that while the school district wanted teachers to adopt the Chromebooks, ultimately it is up to individual teachers to decide whether or not they will use these devices in their classrooms.

Administrative Support: Delta said that school administrators needed to offer more support to teachers in the way of technology training. She liked the idea of having support at the school level in the form of designated staff who help teachers adopt the technology. For example, one day a week, a lead technology teacher comes to her school to help teachers with technology adoption. This lead teacher demonstrates best practices and shows teachers new ways they can implement the Chromebooks in their classrooms.

Training: Delta thought the initial training provided by the school system was an excellent way to help teachers learn how to use the Chromebooks. She also suggested having more support at the school level throughout the day to help teachers learn new online platforms.

School System Support: Delta suggested that the school system should offer more departmental support for teachers adopting new technology. For example, she said that teachers could share resource at the departmental level by sharing best practices.

Diffusion: Delta said that most of the teachers at her school were "trying" to use the Chromebooks. However, she said one issue was the fact that some students did not have broadband at home. As such, she makes sure that her students have enough time in class to complete their assignments online.

Interviewee Five, April, 24, 2019: Epsilon

The Innovation: Epsilon was a middle school science teacher with thirteen years of teaching experience. She was categorized as an early majority adopter. Epsilon said that in her opinion, the Chromebooks were easy to learn how to use. Specifically, she liked that she could use the Google classroom either on her Chromebook, her desktop computer, or on her home computer.

Teacher Willingness: Epsilon said that a teacher's desire to use new technology "absolutely" related to adoption. Moreover, she stated that if teachers did not have Chromebooks in their classrooms, it would make it more difficult to do their jobs.

Administrative Support: Epsilon said that her administrator was "very supportive" of teachers using new technology. She mentioned that her administrator would usually discuss with teachers during in-service days how they could implement new technologies into their

classrooms. She also said that it was important for teachers to share best practices regarding new technology platforms.

Training: Epsilon said that while the initial training provided by the school system was good teachers still needed continuous training throughout the year. She suggested providing training manuals to help teachers with technology adoption. She also said it was important for teachers to hear from other educators so they could share best practices regarding the use of Chromebooks in their classrooms.

School System Support: One area Epsilon suggested the school system could provide more IT support to ELL students and teachers. She stated that many times, ELL students come into her class, and it can take weeks before she can assess them properly. As such, she suggested using technology to help "bridge the gap" with ELL students during that transition period.

Diffusion: Overall, Epsilon thought the diffusion of the Chromebooks classroom had gone "really well." She said the initial training provided by the school system helped her to adopt the Chromebooks. Additionally, she stated that she liked having a lead technology teacher come to the school every week to help with any IT issues.

Interviewee Six, April 19, 2019: Zeta

The Innovation: Zeta was a high school math teacher with eleven years of teaching experience. Zeta was categorized as an early adopter. Zeta said that while the Chromebooks were easy to use some teachers may be more apprehensive. Zeta stated, "I think it depends on the person's background. I personally think it is easy to use; I am also not afraid of technology. There are a lot of people who are afraid of new things."

Teacher Willingness: Zeta thought that a teacher's desire to use new technology relates to its adoption. Furthermore, he said it was important for both teachers and students to understand that technology is the future. Therefore, part of a teacher's job is to help prepare students for a technology-rich world when they join the workforce.

Administrative Support: Zeta thought it was important to have "knowledgeable" administrators who can help with technology issues. He also said it was important to have additional IT support for teachers to ensure that devices are working correctly. He gave one example of a particular issue he had in the classroom, where his login did not work for a website he used in the classroom regularly. He said it took over a week to get his login credentials to be fixed before he could resume his regular course work.

Training: Zeta thought that the best training was when "teachers are teaching teachers." For example, he suggested having personal development opportunities where subject level teachers taught other teachers best-practices for using the Chromebooks. Additionally, he thought the school system needed more lead teachers who could perform such tasks.

School System Support: Zeta said the school system needed to offer more support for new technologies like smart boards and projectors. He said that while, in many cases, the school system had placed these technologies in the classroom, they had not fully supported teachers by training them on the usage of these additional devices. As such, he thought that in many cases, these devices were not being adequately utilized.

Diffusion: Zeta said that overall, he "liked" the one-to-one classroom. The reason he liked the Chromebooks was because he said, "this is the direction the world is going." Furthermore, he thought that using the Chromebooks was necessary because students needed to understand how to use these technologies when they entered the workforce.

Interviewee Seven, April 17, 2019: Eta

The Innovation: Eta was a high school social studies teacher with seventeen years of teaching experience. She was categorized as an early adopter. Eta thought the Chromebooks were easy to use. She said the Chromebooks were "very user-friendly" compared to other educational technologies. Before teaching at her current school, she had taught in a county that used one-to-one Apple MacBooks. She said that Chromebooks were easier to use compared to the MacBooks because the Chromebooks had fewer features. Additionally, testifying to the Chromebook's ease of use, she said both of her children go to school in the school system and use Chromebooks, however, she had not had to help either of her children use their devices.

Teacher Willingness: Concerning technology adoption, Eta thought that a teacher's willingness was a "huge" factor. She said that many students today were "digital natives," whereas some, especially older teachers, were "digital immigrants." Therefore, many older teachers were afraid to use new technologies.

Administrative Support: Eta stated that when adopting new technologies, like the Chromebooks, there needed to be "whole school buy-in." Furthermore, this buy-in started with school administrators. In her opinion, school administrators played a vital role in both establishing a culture where technology was a valuable tool to be used by teachers and helping support technology adoption by providing technology support.

Training: Eta said that the initial Google training provided by the school system was good for teachers who were not aware of all that the Chromebooks had to offer. However, she thought that in the future, the school system should train teachers based on their skill level. For example, Eta suggested grouping teachers who are advanced learners together and teachers who are novice learners together in sperate training sessions.

School System Support: Eta said one area the school system could focus on could be "parent buy-in." She thought that it is essential for parents to understand why the Chromebooks were important for students to use. However, she was not sure how the school system could accomplish this task of parent buy-in.

Diffusion: Eta stated that overall, the adoption of the Chromebooks had been "very good." She liked how the Chromebooks allowed her students to access current subject level content, compared to dated textbooks. Additionally, she said her students had quickly adopted the Chromebooks and knew how to use the devices appropriately. Moreover, she liked that the Chromebooks had allowed her to go "paperless" by delivering content digitally.

Interviewee Eight, April 22, 2019: Theta

The Innovation: Theta was a middle school math teacher with fourteen years of teaching experience. She was categorized as an early adopter. She thought the Chromebooks ease of use made it easier for teachers to adopt because they understood the technology.

Teacher Willingness: Theta believed that a teacher's willingness to use new technology "absolutely" related to adoption. She gave the example of teachers who were still not using the Chromebooks because they were "uncomfortable" with the devices. She stated that these same teachers were "not willing to go out of their comfort zones" to use them.

Administrative Support: Theta said there was an expectation at her school from the school administrators to use the Chromebooks. She stated, "my administrators explicitly told teachers that the county had spent a lot of money on these Chromebooks, and that teacher lesson plans were to have a balance of both technology and paper and pencil instruction." Therefore,

teachers were expected to use the Chromebooks in their classrooms as a part of regular classroom instruction.

Training: Theta thought the school system had done "a great job," offering technology training sessions for teachers. She liked that the school system had offered "refresher" training courses throughout the year. Overall, she wanted the school system to continue to provide these training sessions.

School System Support: Theta liked having a lead technology teacher come to her school one day a week to help teachers with their technology needs. However, she thought these meetings could be more "structured." For example, Theta suggested having training sessions led by the lead technology teacher that focused on particular subjects and grade level appropriate websites, which could help teachers utilize their Chromebooks more effectively.

Diffusion: Overall, Theta said that the adoption of the Chromebooks by teachers had gone "well." She had taught a two school in the system, and she said that a majority of her colleagues used the Chromebooks regularly. However, some older teachers were "scared" of the technology and would not use the Chromebooks.

Interviewee Nine, April 25, 2019: Iota

The Innovation: Iota was a high school English language arts teacher with sixteen years of teaching experience. He was categorized as an early adopter. Iota thought that the Chromebooks were easy to use. His baggiest complaint about the device was the internal mouse pad, but he said this issue was easily remedied by using a wireless mouse.

Teacher Willingness: Iota said that a teacher's willingness to use technology is related to its adoption. He stated, "teachers who are comfortable messing around with technology have less

of an issue using technology than teachers who are uncomfortable with technology in general." To support this claim, he gave the example of older teachers who have a harder time using the Chromebooks because they are less familiar with technology in general.

Administrative Support: Iota liked that the Chromebooks allowed him to "go paperless." He said that the administer at his school is very supportive of the Chromebooks. Specifically, school administrators had done an excellent job distributing the Chromebooks to students and had ensured that there was a reliable technology infrastructure to support both students and staff.

Training: Iota liked the GAFE training initially provided by the school system. He also liked having a lead technology teacher at the school one day a week. However, he said there was an initial "learning curve" he had to overcome when he first started using the Chromebooks.

School System Support: Iota thought the school system should have a full-time technology teacher at every school to help teachers with technology issues. Moreover, he felt the school system had done "a good job with the overall roll-out of the Chromebooks."

Diffusion: Iota said the overall diffusion of the Chromebooks had been "positive." He said the Chromebooks aided him with classroom management by helping him keep track of student work. Furthermore, he stated that the Chromebooks also assisted his students by tracking their work and helping them know when assignments were due.

Interviewee Ten, April 25, 2019: Kappa

The Innovation: Kappa was a high school English language arts teacher seven years of teaching experience. He was categorized as an early adopter. Kappa described the Chromebooks as "simple" to use. Furthermore, he said that the simplicity of the Chromebooks helped both students and staff to adopt the new technology.

Teacher Willingness: Kappa thought that a teacher's willingness had "every bit of importance to do with the adoption of the Chromebooks." Moreover, he said, "the decision to adopt the Chromebooks, like any other educational tool, is ultimately up to the teacher."

Administrative Support: Kappa said that in his experience, administrators had been very "hands-off" pushing teachers to adopt the Chromebooks. The only example he gave of administrators advocating for the use of the Chromebooks was if teachers were using too much copy paper. In this case, he said that he was told by administrators to use the Chromebooks to cut down on the cost of paper.

Training: Kappa said that in addition to the training is offered currently, the school system should provide training to teachers on ways they can use the Chromebooks if students do not have access to broadband at home. He stated that in his classroom, some students do not have internet access at home. Therefore, it would be beneficial for the school system to offer training on how teachers and students could use the Chromebooks if the internet was not accessible.

School System Support: Kappa said teachers would benefit if the school system had a designated tech support teacher at each school. He suggested having a "Google guru" at each school to help teachers with technology issues.

Diffusion: Overall, Kappa thought the diffusion of the Chromebooks had been a "success." From a content perspective, Kappa had been able to "infuse" his lessons with technology using the Chromebooks. Moreover, he stated that he had almost stopped using a regular textbook, and instead relied on the Chromebooks and the internet to deliver classroom content.

Interviewee Eleven, April 24, 2019: Lambda

The Innovation: Lambda was a middle school science teacher with seven years of teaching experience. She was categorized as an early majority adopter. Lambda said that overall, the Chromebooks were easy to use.

Teacher Willingness: Lambda believed that a teacher's willingness to try new technology was related to adoption. Specifically, she said that a teacher who is more willing to try any new technology would be more likely to adopt "any new classroom technology."

Administrative Support: Lambda did not think administration support was necessary for technology adoption. Instead, Lambda believed that technology adoption was more of a personal teacher choice. She said that in her experience, school administration had not pushed teachers to adopt the Chromebooks, and that "some teachers use the Chromebooks more than others."

Training: Lambda said that she had not received any additional training from the school system other than the initial two-day training when she first learned to use the Chromebooks. However, she did say that some of her colleagues had attended a blended-learning training provided by the school system. Furthermore, she stated that in the future, she would like to receive more instruction from teachers who had experience using online applications she could apply to her content.

School System Support: Lambda said it would be good to have additional content training. She stated that there were specific online labs which she could use as a science teacher. However, according to Lambda, teachers did not have access to these resources.

Diffusion: When describing the diffusion of the Chromebooks Lambda felt that in some ways, the school system was "playing catch-up" regarding the online classroom. For, example, she stated that the school system had recently purchased a new application called Go Guardian,

which allowed teachers to actively monitor students' online progress during class sessions. In her opinion, this technology should have been adopted before the Chromebooks were distributed to teachers and students. However, she stated that this "hindsight" is also part of the standard adoption process, whereby users look for better ways to use new technologies that have been recently introduced.

Interviewee Twelve, April 30, 2019: Mu

The Innovation: Mu was a high school science teacher with twelve years of teaching experience. She was categorized as an early majority adopter. Mu said the Chromebooks were easy to use. She also thought the Chromebooks ease of use helped teachers to adopt the devices.

Teacher Willingness: Mu said that a teacher's willingness to try new technology "absolutely" aided with adoption. Furthermore, in conversations with her colleagues, she had found that while most teachers had adopted the Chromebooks, there were still some teachers who had not. She said these teachers who have not fully utilized the one-to-one classroom had not done so because it "took them too much time to remake their lesson plans" or "they are older teachers who are close to retirement." Moreover, when discussing these laggard teachers, Mu said there was a "fear factor" that was keeping them from adopting the Chromebooks.

Administrative Support: Mu said that in her experience, there had not been very much administrative support at the school level to help teachers adopt the new Chromebooks. She said that while school administration was supportive of the idea of using Chromebooks, they had not been clear when it came to teacher expectations of use. Explicitly, Mu stated that there had been no clear "vision" or "mission" when it came to teacher adoption and use. She said this lack of

clear expectations had left a gap where some teachers using the Chromebooks every day while other teachers were not using the Chromebooks in their classrooms.

Training: Mu was critical of the training provided by the school system. She said the school system needed to offer more training. Moreover, she stated that the initial training provided by the school system was "paced too quickly." She recommended offering "small session training" where teachers focused on applications there were pertinent to their subject matter.

School System Support: Mu liked that the school system support in the form of a lead technology teacher who was at her school one day a week to help teachers with technology issues. She would also like to see more support at the departmental level. For example, she said that one issue she had as a science teacher was writing formulas one the Chromebooks. Mu wanted to know if another science teacher in the county had found a way to write equations on the Chromebooks, and if that information could be shared with other science departments in the school system.

Diffusion: Mu said the lack of a clear "vision and a goal" had led to a lack of "buy-in" by both teachers and students. She recommended conducting a poll of students to see how often they were using their Chromebooks. Moreover, she said the school system needed to have a clearly defined goal when it came to teacher and student usage of the Chromebooks.

Interviewee Thirteen, April 22, 2019: Nu

The Innovation: Nu was a high school special education teacher with six years of teaching experience. She was categorized as an early adopter. Nu said the Chromebooks were

"extremely" to use. She believed the Chromebooks were easy to use because both the teachers and students had "grown-up using the technology."

Teacher Willingness: Nu thought a teacher's willingness to try new technology was related to adoption. Moreover, Nu stated that a teacher's age might also play a part in their decision to adopt the Chromebooks. She said, "we have several teachers who are about to retire who have not adopted the Chromebooks." However, Nu stated that the younger teacher in her department, herself included, had adopted the Chromebooks because "they are easy to use, and we grew up using the technology."

Administrative Support: Nu thought that all teachers and administrators needed to "be on board" regarding technology adoption. Furthermore, Nu said that school administrators played an essential role in technology adoption by serving as a "buffer" between teachers and leaders at the central office. Nu noted that as a "buffer" school administrators helped disseminate the school systems goals and provided needed support to teachers as they adopted the Chromebooks.

Training: Nu wanted more "across the board" training on how to use basic Chromebook applications. She said that while she understood how the Chromebooks worked, some of her colleagues still struggled with some of the basic Chromebook applications. Nu also wanted the school system to provide additional Chromebook training to school support staff.

School System Support: Nu wanted the school system to offer additional support on specific online applications like Go Guardian. She also said the school system needs to conduct further research before they purchase an application for teachers. For example, Nu stated, "it seems like the county finds a new program they like and purchase it without thoroughly testing the product with teachers."

Diffusion: Nu thought the diffusion of the Chromebooks had been "fairly successful." She said the Chromebooks were "great" and that she "loved" using the devices in her classroom. Moreover, as a special education teacher, she thought the Chromebooks helped her students to "focus on their assignment."

Interviewee Fourteen, April 25, 2019: Xi

The Innovation: Xi was a high school science teacher with twenty years of teaching experience. She was categorized as an early majority adopter. While she had twenty years of teaching experience, she had only taught in the current school system for one year. As such, this was her first year working with the Chromebooks. She said that based on her experience, the Chromebooks were easy to use. Furthermore, Xi stated that in the past, she had primarily used MacBooks, and in some way using a Chromebook was a "step-back" concerning the level of technology.

Teacher Willingness: Xi said that a teacher's willingness to use new technology "absolutely" related to adoption. Moreover, she stated, "attitude is everything."

Administrative Support: Xi said that administration "sets the tone for everything in the school." Administrators, in her view, were essential because they "set the goal" regarding teacher and student use of technology. Furthermore, she said that administrators need to be "patient," "provide support," and "provide reasonable expectations" for teachers as they adopt the Chromebooks.

Training: Xi said that the initial training the school system provided to new teachers was "excellent." However, she also said that the school system needed to offer a "workshop"

available to teachers regularly for additional technology training. These workshops, in her view, could be provided to teachers during their planning periods or after school as needed.

School System Support: Xi said that it was important for the school system to continue to provide "IT support." She also appreciated having a lead technology teacher at her school one day a week to help with technology issues.

Diffusion: Xi stated that teachers with more experience using the Chromebooks utilized them for than teachers who had less experience with the devices. She said that as a first-year teacher in the school system, she was still "discovering" how she could best use the Chromebooks in her classroom. Additionally, she said that one issue she had in her classroom was students coming to class without their Chromebooks charged. She thought that the school needed to do a better job at providing charging stations so students could charge their devices, and thus be prepared for class.

Interviewee Fifteen, April 24, 2019: Omicron

The Innovation: Omicron was a high school business teacher with eleven years of teaching experience. She was categorized as an early adopter. Omicron said the Chromebooks were easy to use. She stated that sometimes they were slow, but that the devices worked most of the time.

Teacher Willingness: Omicron said that a teacher's willingness to use technology "definitely" related to adoption. She also advocated for a group of "super users" to help other teachers adopt the Chromebooks. These "super users" could be teachers who were knowledgeable using the Chromebooks.

Administrative Support: Omicron, said that administrator support contributes "150%" to successful teacher adoption. Furthermore, she stated that "change is hard." To help teachers adopt the Chromebooks, she wanted a group of "super users" to be available at schools to help teachers integrate the Chromebooks and help with technology issues.

Training: Omicron said that the school system had offered "plenty of training so far." She said that she still reviews some of the material from her initial training when or if she had an issue with the Chromebooks. However, she did say that she wanted more training on archiving student work for her business classes.

School System Support: Omicron said the school system had done an excellent job providing IT support for the Chromebooks. For example, she stated that if a student's Chromebook was not working it was quickly fixed. She would like the school system to provide extra power cords for students to use in her classroom.

Diffusion: Omicron said that the diffusion of the Chromebooks has "gone well in her opinion." She again said that the school system could do a better job by providing "super users" to help teachers adopt the Chromebooks. These "super users" would be teachers who were knowledgeable and could share best practices with other teachers at the school level.

Interviewee Sixteen, April 24, 2019: Pi

The Innovation: Pi was a high school science teacher with fifteen years of teaching experience. She was categorized as an early majority adopter. Pi stated that the "in general" the Chromebooks are easy to use. She said, "Google makes the Chromebooks user-friendly." However, she did not like that the Chromebooks did not have an external mouse.

Teacher Willingness: Pi said that a teacher's willingness to try new technology was "a very important part of adoption." Furthermore, she stated that a teacher's willingness to use the Chromebooks was an indicator that they would try other educational technologies.

Administrative Support: Pi said that administrative support "absolutely" contributed to successful technology adoption. Moreover, she stated that a school leader's "attitude toward using the Chromebooks trickled down to the teachers." Pi elaborated by saying that an administrator's "positive or negative views" would also "trickle down to the teachers."

Training: Pi said that the initial training provided by the school system was "really good." She suggested that the school system could offer additional shorter trainings to help teachers with the Chromebooks. She said that sometimes she struggles to find appropriate online applications for her classes, but that short supplementary trainings by subject area would be helpful.

School System Support: Pi said that she liked the additional trainings offered by members of the blended-learning cohort. These were short training sessions taught by other teachers. Furthermore, she stated that hearing about new ways to use the Chromebooks from other teachers, versus school administrators, was "very helpful because the teachers were using these applications in the classroom, so they know what works."

Diffusion: Overall, Pi said that the diffusion of the Chromebooks had "gone well." She elaborated, by saying the Chromebooks were "a valuable tool for teaching science." She also "loved that the kids can create their own learning experience when using the Chromebooks." Moreover, she stated that many times using the Chromebooks, she "learns as much from her students as they learn from her."

Interviewee Seventeen April 19, 2019: Rho

The Innovation: Rho was a high school social studies teacher with twelve years of teaching experience. She was categorized as an early adopter. Rho stated that she thought the Chromebooks were easy to use. Moreover, she said that the "basic" design of the Chromebooks made them easier to adopt.

Teacher Willingness: Rho said that a teacher's willingness to try new technology is related to adoption. Furthermore, she stated, "if a teacher has to put more work into adopting the Chromebooks," they would be less willing to adopt the devices.

Administrative Support: Rho did not think that administrative support was necessary to adopt the Chromebooks. She stated, "it is more on the teacher to implement" the Chromebooks. She said that at her school, she did not think the administrators had a lot of experience with the Chromebooks. Therefore, the school leaders lack knowledge about how to use the devices has resulted in the administration being less strict with teachers adopting the Chromebooks.

Training: Rho was a member of the school systems blended learning cohort. She said that this cohort had been "extremely beneficial" to her. In the cohort, she had learned how she could use different online applications in her classroom. She also thought that future trainings should be led by other teachers who had prior experience using specific applications in their classrooms.

School System Support: Rho said she wanted the school system to purchase more online subscriptions to applications she had found useful in her classroom. To buy these applications, she said the school system would need to offer more monetary support to teachers.

Diffusion: Rho stated that at first, the adoption of the one-to-one classroom by teachers had "not gone very well." However, she said that overtime more teachers had adopted the Chromebooks. She liked, for example, the blended learning cohort, where she had learned more

useful information. Moreover, she thought the school system should do more to make sure that certain websites were blocked so students could not access inappropriate content during class time.

VITA

Jacob Robert Quilliams (Jake) is a native of east Tennessee. He attended Pi Beta Phi Elementary in Gatlinburg, TN, and the McCallie School in Chattanooga, TN. After graduating from the McCallie School, he attended the University of Tennessee at Chattanooga, where, in 2008 he received his Bachelor of Science with a major in political science and a minor in history. Next, Jake attended Georgia College and State University, where, in 2011 he graduated with honors and distinction earning a Masters of Arts in Teaching degree. Upon graduation, he began working at Seymour High School in Seymour, TN. Jake has worked at Seymour High School in Sevier County for the past eight years as a social studies teacher and technology coordinator. While working for the Sevier County School System he has graduated from both the Sevier County Schools Teacher Leadership Program and the Sevier County Leadership Tomorrow Program. In 2019 he was promoted to assistant principal at Seymour High School and completed his Ph.D. at the University of Tennessee at Chattanooga.