

ONE-TO-ONE MOBILE DEVICES IN RURAL SCHOOL DISTRICTS: A MIXED
METHODS STUDY INVESTIGATING THE IMPACT OF KHAN ACADEMY ON
MATHEMATICS ACHIEVEMENT AND TEACHER PEDAGOGY

A Dissertation

Presented in Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy

with a

Major in Educational Leadership

in the

Department of Graduate Education

Northwest Nazarene University

by

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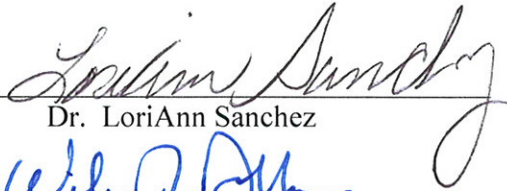
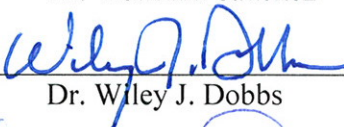

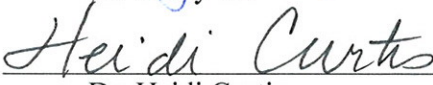
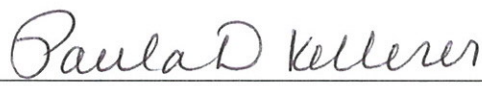
April 2016

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AUTHORIZATION TO SUBMIT DISSERTATION

This dissertation of Brady Dickinson, submitted for the degree of Doctor of Philosophy in Education with a major in Educational Leadership and titled "One-to-One Mobile Devices in Rural School Districts: A Mixed Methods Study Investigating the Impact of Khan Academy on Mathematics Achievement and Teacher Pedagogy," has been reviewed in final form.

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ACKNOWLEDGEMENTS

I am sincerely grateful to numerous individuals who have assisted and supported me during this process. First, I would like to thank the wonderful staff at Northwest Nazarene University for their support along every step in the process. Whether it is a secretary in an office, library staff, or one of the excellent professors, the personnel at NNU provide the kind of academic support necessary for students to be successful. I would like to specifically acknowledge my dissertation chair, Dr. LoriAnn Sanchez, and the individuals on my dissertation committee, in particular, Dr. Wiley Dobbs and Dr. Cindy Orr, for providing me with a foundation of support. Without you I would have never been able to reach my goals. Thank you for answering my many questions and for pushing me to stretch my thinking and learn more than I ever thought possible. Next I would like to thank Mr. Adam Johnson, Mr. Tim Little, and Mr. Levi Power for their leadership and dedication to the position of principal. Finally, I would like to acknowledge my family who provided me with support during the long hours this study required. Thank you to my wife, Holly, and children, Ryen, Amanda, Samantha, Braeden, and Emma.

DEDICATION

This dissertation is dedicated to my wife, Holly Dickinson, who has stood by me and supported me as I pursued my educational goals. I could not have completed this program without her by my side pushing me to achieve. I also wish to dedicate this work to my children, Ryen, Amanda, Samantha, Braeden, and Emma, who are my love and inspiration. Next, this dissertation is dedicated to my parents, David and Linda Dickinson, who taught me to pursue my goals with hard work and dedication. Finally, this dissertation is dedicated to my grandmother, Gloria Dickinson, who always pushed me to write and speak correctly.

ABSTRACT

Providing students with necessary intervention in the instruction of mathematics can be accomplished through the use of digital resources. Schools reaching a one-to-one (one device for every student) status have the ability to implement a digital intervention on a broad scale. For the purpose of this study, mixed methods research afforded an in-depth investigation into the impact of Khan Academy (digital intervention) embedded in a one-to-one program on student achievement, student perseverance with math, and teacher pedagogy within rural schools. The theoretical framework of educational technology integration known as Theoretical, Pedagogical, and Content Knowledge (TPACK) was woven into this study to answer the guiding research questions. While using Khan Academy in a one-to-one setting, participating students were tested twice a year utilizing the Measurement of Academic Progress (MAP) testing procedure provided by the Northwest Evaluation Association (NWEA). The testing data provided quantitative data for the study. In addition, interviews of teachers and administrators were conducted to reveal themes related to teacher pedagogy and student perseverance with mathematical problems. An analysis of MAP scores revealed that 9th- and 10th-grade high school students utilizing Khan Academy in a one-to-one program demonstrated significantly more growth when compared to national norms. The study involved 227 9th-grade and 114 10th- grade students from three rural high schools in the Pacific Northwest. Results from an analysis of means illustrated that each grade level demonstrated significantly greater growth when compared to national norms. When examined at the school level, each of the three sites once again exceeded growth norms. Further analysis of the interviews revealed a pedagogical shift directly related to the use of Khan Academy embedded in a one-to-one program. Themes related to the success of the program include the ability of Khan Academy to fill individual gaps and practice skills to mastery, the

importance of student and teacher buy-in, and the ability for students to have daily, individual access to devices. Furthermore, the interviews revealed teachers and principals did not agree on whether Khan Academy impacts student perseverance; however, a theme related to Khan Academy's ability to impact confidence with math did emerge. This study fills gaps in the existing literature regarding the academic and pedagogical impact of Khan Academy on teaching and learning. In addition, this study addresses a gap in the literature regarding rural schools' use of a digital mathematical intervention program as a means of blended learning. Implications for educational policy can result from this study given the current political climate surrounding one-to-one and blended learning deployments. This study demonstrates that when one-to-one deployments are paired with the use of Khan Academy, student achievement can be positively impacted.

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Chapter I

Introduction

In 2013, the National Assessment of Educational Progress (NAEP) report showed that 42% of tested fourth graders, 35% of tested eighth graders, and 26% of tested 12th graders demonstrated proficiency in the area of math. The same report showed that 12th-grade students in rural schools had an average score five points less than students from suburban schools. Compounding these problems is the fact that these scores had shown no significant change since 2009 (U.S. Dept. of Education, 2013). Examining the NAEP High School Transcript Study revealed that although students from all locations tend to take more than the minimum number of math classes for graduation, more rural students enter high school in lower level math courses and stop taking math courses sooner (Anderson & Chang, 2011; Nord et al., 2009).

The U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics (NCES) reports that 57% of U.S. school districts are rural, and roughly one fourth of the nation's students attend rural schools (U.S. Dept. of Education, 2013). Reeves (2003) states that rural schools face challenges caused by isolation, declining enrollment, limited population, inadequate funding, and lack of access to services. To address these issues, many rural schools have turned to the use of technology in the classroom, utilizing distance and blended learning to supplement and enrich the content as well as increase the number of available courses (Cullen, Brush, Frey, Hinshaw, & Warren, 2006; Hannum, Irvin, Banks, & Farmer, 2009; Irvin, Wallace, Claire, Farmer, & Keane, 2012; Reeves, 2003).

A trend in educational technology today is the addition of mobile devices in classrooms. Many schools have been working to reach a point where they have a device for each student. Studies refer to this scenario as being one-to-one or simply 1:1 (Dunleavy, Dexter, & Heinecke,

2007; Lei & Zhao, 2008; Sheninger, 2014). Research has revealed key elements leading to successful implementations of one-to-one programs. These features include teacher buy-in, proactive professional development, administrative vision, and adequate technical support (Bebell & Kay, 2010; Dawson, Cavanaugh, & Ritzhaupt, 2006; Penuel, 2006; Walker, Johnson, & Silvernail, 2011). Unfortunately, research findings on the impact of one-to-one deployments on student achievement and on teacher practice are inconsistent, as some studies show positive gains in achievement, and others fail to demonstrate significant gains (Burns & Polman, 2006; Carr, 2012a; Carr, 2012b; Cavanaugh, Dawson, & Ritzhaupt, 2011; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008).

Examining device implementation into mathematics instruction reveals many K-12 schools are utilizing a blended approach in which the device is used in conjunction with an intervention program allowing students to practice, explore, and gain access to support (Hein, 2013; Lewis, 2010). An example of one of the intervention programs being used today is Khan Academy. This Internet resource provides students with videos and mathematical problems they can utilize for practice in a self-paced environment (Cargile & Harness, 2015; Murphy, Gallagher, Krumm, Mislevy, & Hafter, 2014). Research on Khan Academy reveals it has become one of the most prominent organizations in K-12 education (Murphy et al., 2014). By February 2014, Khan Academy had 10 million unique users per month, representing a nearly 65% increase from 2010 (Murphy et al., 2014). Unfortunately, as with research results on one-to-one programs, findings on the blended approach's impact (including use of Khan Academy) on student achievement remains mixed (Ashby, Sadera, & McNary, 2011; Cargile & Harness, 2015; Glassett & Schrum, 2009; Hein, 2013; Kiger, Herro, and Prunty, 2012; Lewis, 2010; Li, Uvah,

Amin, & Hemasinha, 2009; Murphy et al., 2014; Rasanen, Salminen, Wilson, Aunio, & Dehaene, 2009; Rosen & Beck-Hill, 2012).

An important component of student achievement as defined by the Common Core State Standards Institute is the ability for students to persevere when solving mathematical problems (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Research suggests efforts of K-12 educators in integrating features of Khan Academy into classroom pedagogy are helping students achieve greater levels of engagement and perseverance and become self-regulated learners (Light & Pierson, 2013b). Examining these effective implementation strategies and associated pedagogical shifts are important aspects of understanding the general characteristics of classroom environments promoting perseverance as well as understanding whether pedagogical shifts are necessary to successfully implement Khan Academy in particular (Light & Pierson, 2013b; Turrou & Fernandez, 2012).

This mixed methods study investigated three fundamental topics that may transform teaching and learning in rural schools. First, quantitative data were used in the study to evaluate the effect of Khan Academy on student achievement as measured by the Northwest Evaluation Association's (NWEA) Measure of Academic Progress (MAP) test. The items on the MAP assessment are aligned on an interval called the RIT (Rausch Unit) scale (NWEA, 2011, 2013, 2014b, 2014c). Therefore, the test results are frequently referred to as the MAP RIT scores. After analyzing the quantitative data, the researcher utilized qualitative data to further explain the quantitative results. This qualitative data were gathered through interviews with teachers and administrators to investigate how and whether integrating Khan Academy into the mathematics curriculum in a one-to-one school transforms teacher pedagogy in relation to student achievement and student perseverance with problem solving. A theoretical framework known as

Technological, Pedagogical, and Content Knowledge (TPACK) was used to provide structure and cohesion to the study.

Statement of the Problem

Rural schools face educational challenges related to isolation, enrollment loss, limited population, inadequate funding, limited services, recruiting and retaining teachers, and offering a comprehensive curriculum that includes advanced coursework (Cullen et al., 2006; Hannun et al., 2009; Howley, Wood, & Hough, 2011; Irvin et al., 2012; Reeves, 2003). Hannun et al. (2009) suggest many rural districts (69.3% of rural schools) in the United States are utilizing some form of distance education in order to overcome challenges and provide students with a comprehensive educational program. Although there are numerous examples of the implementation of distance education, two thirds of rural schools indicate a need for more resources (Hannun et al., 2009). Howley et al. (2011) supports this claim by demonstrating that educators in K-12 schools located in rural areas believe resources and training are inadequate. Compounding the problem is research by Irvin et al. (2012) that reports only 50% of surveyed administrators are satisfied with the distance learning opportunities in their respective schools. Traditionally, the use of the Internet, video conferencing, and multimedia components have been used by educators in the classroom to provide access to additional resources (Hannun et al., 2009). However, further research is needed on how technology can be better used by rural K-12 educators to overcome barriers more effectively and enhance the educational experience of rural students (Cullen et al., 2006; Muilenburg & Berge, 2005).

One concern for rural schools today is in the area of mathematics. Although many rural schools offer opportunities for students, such as distance education, data from NAEP along with results from research demonstrate that rural students are at a disadvantage when compared to

students from suburban locations (Anderson & Chang, 2011; Graham & Provost, 2012; Hardre, 2012; Provasnik, et al., 2007; U.S. Dept. of Education, 2013; Roscigno & Crowley, 2001). Rural students are taking lower level math courses and are ending their math education sooner in high school (Anderson & Chang, 2011). In addition, students attending rural schools are accessing fewer AP mathematics courses such as AP Calculus and AP Statistics than their peers within larger urban school districts (Anderson & Chang, 2011).

A trend in educational technology today is the addition of mobile devices in classrooms, with many schools seeking to reach the point of being one-to-one (Dunleavy et al., 2007; Lei & Zhao, 2008; Sheninger, 2014). Mobile devices are portable, relatively inexpensive, and have the ability to transform classroom instruction as well as deliver educational content to even the most remote places (Kim et al., 2011). Having access to technology such as mobile devices is critical given the fact many rural schools rely on distance education (Hannum et al., 2009; Irvin et al., 2012). Mobile devices can supplement resources available to students in rural schools (Kim et al., 2011; Light & Pierson, 2013a; Walker et al., 2011). This is significant given a study by Kim and Bagaka (2005) that found due to access issues, rural students are utilizing computers less often in school and at home than are their urban and suburban counterparts.

Although research on the implementation of devices in one-to-one settings has been conducted, deployments have had mixed results in terms of overcoming barriers and improving student achievement in the field of mathematics (Carr, 2012a; Carr, 2012b; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008). In addition, there appears to be a gap in the research in terms of the impact of devices on rural students' achievement in mathematics. Due to the limited number of available studies, and the mixed results, the need exists for a further study

on the use of mobile devices in rural schools to overcome challenges and transform teaching and learning (Pollard & Pollard, 2004; Sheppard, 2011).

The intent of this study is to help fill the research gap. The researcher sought to analyze the impact of Khan Academy (a digital intervention), embedded into a one-to-one rural high school program, in order to answer the research questions. The first research question was quantitative:

1. Is there a significant difference in the amount of growth, measured by MAP RIT scores, demonstrated by rural students utilizing one-to-one mobile devices integrated with Khan Academy when compared to national norms?

After the analysis of data for this quantitative question, the following qualitative questions were developed:

2. What do teachers of students in one-to-one rural math classes integrated with Khan Academy perceive as the factors having the greatest impact on student growth as demonstrated by MAP RIT scores?
3. What do teachers of students in one-to-one rural math classes integrated with Khan Academy perceive as the pedagogical methods having the greatest impact on student perseverance with mathematical problem solving?

The research from this study builds on the current body of knowledge by exploring if and how the use of Khan Academy as a blended learning tool significantly impacts student achievement, student perseverance with math, and teacher pedagogy, necessitating the need for a one-to-one program utilizing a blended model.

Background

Research demonstrates an ongoing focus and concern regarding the mathematical achievement of U.S. students. In a 2013 report, the Program for International Student Assessment reported U.S. students had below average scores when compared to the other developed countries. The report demonstrated that in 2012, the U.S. was outperformed in the area of mathematics literacy by 29 other education systems, and U.S. scores were 13 points below the average (Kelly et al., 2013; U.S. Dept. of Education, 2014).

Concern over U.S. performance in math is not a new phenomenon. Push for reform has been steady since the space race began in the 1960s (Burris, 2005). The U.S. Department of Education's *A Nation at Risk* led to widespread awareness of the underachievement of U.S. students and prompted many reforms in the 1980s and 1990s (United States, 1983). In 2002, a new round of accountability was enacted when the No Child Left Behind Act went into effect. This act held states accountable for the education of all students (Burris, 2005). Today, new challenges arise, especially for underrepresented students such as those from rural schools, as the Common Core Standards are implemented and assessed by school districts across this country (Stewart & Varner, 2012).

Since the 1960s, technology use in schools has been introduced and has increased to the point that it is now widespread (Murdock, 2004; Sheninger, 2014). Computers in K-12 classrooms began to emerge in the 1970s (Murdock, 2004). Prior to this, computers were being used in college classrooms as early as the mid-1950s and early 1960s. In the 1970s, the Apple I was produced and donated to schools; however, use of personal computers in schools remained limited (Murdock, 2004). In 1981, IBM became the first mainframe manufacturer of a personal computer followed by the Apple II and Macintosh. During this time, computer games and

educational software became more frequently used by teachers, and computer-assisted instruction (CAI) was integrated into K-12 schools. As a result, computer programs designed for drill and practice became more widely used by educators (Murdock, 2004). In 1995, the educational landscape began a transformation as K-12 schools began using the Internet. The Internet expanded very quickly, ultimately becoming the world's largest digital database and an invaluable resource for schools with the capabilities and capacities to access it (Murdock, 2004). Today, "schools are approaching the tipping point in a digital transformation that will forever change the way the world learns" (Horn & Staker, 2015, p. xxvi-loc 580). The Internet is now commonplace, and schools have made considerable investments in infrastructure, software, and hardware to implement greater technology access and use for instruction (Rosen & Beck-Hill, 2012; Sheninger, 2014). Teachers have become practitioners of blended learning.

Blended learning is a teaching strategy incorporating both digital and traditional instructional delivery methods (Sheninger, 2014; Staker & Horn, 2012). In mathematics, one form of blended instruction involves the use of CAI to provide online drill and skill practice as well as problem solving in a way that gives students immediate feedback (Rasanen et al., 2009). However, the transformation of traditional methods to a fully immersed, technology-rich learning environment is not universal in the U.S. K-12 school system (Rosen & Beck-Hill, 2012). In an attempt to fully embrace technology usage in the classroom, a number of schools have launched one-to-one initiatives. Although many one-to-one deployments of devices by educators in the classroom have led to positive results in terms of student engagement and in some cases achievement, the fact remains that use is not uniform, and results based on student outcomes are mixed (Bebell & Kay, 2010; Dunleavy et al., 2007; Gulek & Demirtas, 2005; Suhr, Hernandez, Grimes, & Warschauer, 2010).

One of the most popular worldwide educational websites currently being used by students and teachers as a digital, supplemental educational tool is Khan Academy (Cargile & Harness, 2015; Murphy et al., 2014). Khan Academy, founded in 2006 by Sal Khan, provides free educational resources to students, parents, and teachers. Currently, there are more than 5,500 videos (3,500 covering the subject of math) and more than 100,000 mathematical problems. Students can select from an abundance of options within the Khan Academy menu while receiving immediate feedback on their performance as they work at their own pace (Murphy et al., 2014). Additionally, materials are now available for teachers, tutors, and parents interested in learning how Khan Academy can be used to meet educational goals (Murphy et al., 2014). Research funded by the Bill and Melinda Gates Foundation recently examined the impact of Khan Academy (Murphy et al., 2014). The research revealed that although initially designed for outside of institutional use, Khan Academy is growing in popularity as a K-12 school resource (Murphy et al., 2014). Schools now involved in Khan pilot research projects seek to incorporate innovative approaches to math instruction while meeting both instructor and student needs (Murphy et al., 2014). Although initial studies demonstrate positive results surrounding implementation of Khan Academy in practice, later studies call for further research specifically on the impact on student achievement (Cargile & Harness, 2015; Murphy et al., 2014).

Research Questions

When establishing research questions for this mixed methods study, the researcher placed importance on selecting ones that would provide the best chance of obtaining meaningful answers. Proponents of the mixed approach argue that its use allows for questions to be more fully answered due to the blending of quantitative and qualitative methods (Johnson &

Onwuegbuzie, 2004). The following questions were used to guide the research conducted in this study. The first was the quantitative question:

1. Is there a significant difference in the amount of growth, measured by MAP RIT scores, demonstrated by rural students utilizing one-to-one mobile devices integrated with Khan Academy when compared to national norms?

After analysis of the results from this first research question, qualitative research questions were used to guide the second phase of the study:

2. What do teachers of students in one-to-one rural math classes integrated with Khan Academy perceive as the factors having the greatest impact on student growth as demonstrated by MAP RIT scores?
3. What do teachers of students in one-to-one rural math classes integrated with Khan Academy perceive as the pedagogical methods having the greatest impact on student perseverance with mathematical problem solving?

Theoretical Framework

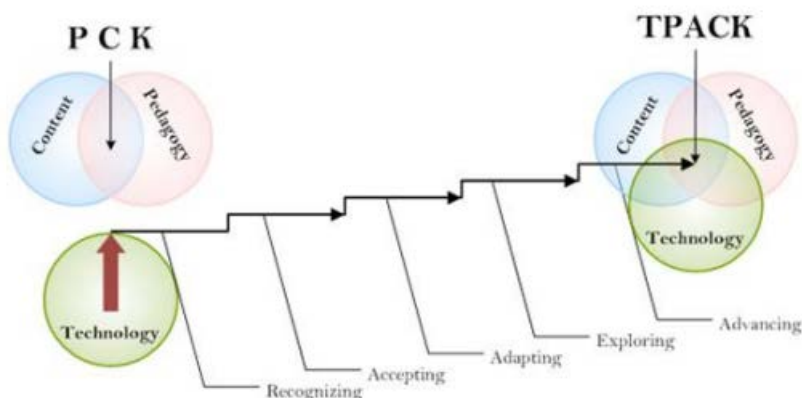
According to Ravitch and Riggan (2012), a theoretical framework is used to provide the researcher with a structure for explaining the interrelationships of the conceptual components of the study. In other words, in using a theoretical framework, the researcher connects the conceptual components of a study with the relevant literature and research in a cohesive manner for the reader. In this study, the researcher applied the TPACK theoretical framework to articulate the relationship between the implementation of Khan Academy and a transformation of teaching and learning related to technology integration.

The TPACK theoretical framework, as described by Koehler and Mishra (2009), is built on Shulman's Pedagogical Content Knowledge (PCK) construct with the addition of

technological knowledge. TPACK describes a pedagogical shift created by the overlap of technological knowledge, content knowledge, and pedagogical knowledge (Koehler and Mishra, 2009). When teachers blend technological knowledge, pedagogical knowledge, and content knowledge to transform teaching and learning and fully integrate technology into the classroom, they bring TPACK into play (Mishra & Koehler, 2006). As a result, teachers are challenged to fully understand each component and how components interrelate to transform the use of technology. “This is the kind of deep, flexible, pragmatic, and nuanced understanding of teaching with technology we involved in considering TPACK as a professional knowledge construct” (Koehler & Mishra, 2009, p. 66). The TPACK framework provides a means to examine the complex phenomenon of technology integration. It changes the dynamics of technology integration from the use of simple instructional tools to participation in a complex pedagogical shift. The TPACK framework helps educators and researchers discover and explain how technological knowledge is woven into classroom practice (Koehler & Mishra, 2009).

Figure 1 illustrates the transition from pedagogy and content knowledge to technological, content, and pedagogical knowledge. As described by Niess et al. (2009), the five stages of technology integration are recognizing, accepting, adopting, exploring, and advancing. In the first stage, teachers are able to recognize how technology supports the teaching of content. At the second level, teachers accept technology as an instructional tool and form attitudes based on how they perceive its use. In the third stage, teachers experiment with the use of technology and form opinions about whether to adopt or reject the technology usage. In the fourth stage, teachers actively explore the use of technology and integrate it into teaching (pedagogy). In the final stage, teachers evaluate the use and utilize the results to advance toward integrating technology fully into the teaching practice (Niess et al., 2009).

Figure 1

TPACK Levels

Note. Reproduced by permission of Niess et al., 2009 (Appendix A)

One of the purposes of this research was to explore themes related to implementation of Khan Academy and how it fits into the broader phenomenon of technology integration. TPACK provided a framework to explore whether the implementation of Khan Academy in a one-to-one setting can lead to a pedagogical transformation, or if Khan is simply one of many tools used by teachers as a potential resource for students needing additional practice or assistance (Agyei & Vogt, 2012; Richardson, 2009).

Description of Terms

Constant changes in technology and ever-expanding options for educators and their students make it important to create a clear understanding of terminology utilized in this study. Describing and assigning meaning to terms adds clarity in a research study (Creswell, 2012; Marshall & Rosman, 2011; Merriam, 1988; Stake, 1995; Yin, 2014). The following is a current, research-based list of terms used in this study.

Blended learning. An instructional strategy that delivers instruction partially online and partially in a traditional school setting. While online, students have an element of control over “time, place, path, and/or pace” (Staker & Horn, 2012, p. 3).

Distance education. The use of multimedia resources to provide web-based materials to students who are geographically isolated (Hannum et al., 2009).

Grit. The sustaining of interest and effort to achieve goals (Duckworth, Peterson, Matthews, & Kelly, 2007).

One-to-one. Providing every student with a portable computing device capable of accessing the Internet for the purpose of completing academic tasks (Penuel, 2006).

Online learning. An educational method that utilizes the Internet to teach content knowledge (Horn & Staker, 2015).

Pedagogy. The process and method of teaching. This includes student management, lesson planning, and assessment (Mishra & Koehler, 2006).

Perseverance. The effort related to not giving up on a problem or strategy as well as knowing when to give up on a particular strategy and seek another (Thom & Pirie, 2002).

Rural. Any area outside an area classified as urban (United States Census Bureau, 2012).

TPACK or TPCK. A model explaining how the overlap of technological, pedagogical, and content knowledge is essential to the complex implementation of instructional technology (Mishra & Koehler, 2006).

Significance of the Study

Murphy et al. (2014) concluded that although Khan Academy is a valuable digital resource for teachers and students to use as an instructional tool in a blended setting, the teacher is still central in regards to the learning process. As a result, that study called for additional

research regarding teacher pedagogy in relation to student motivation, persistence, and resourcefulness and how these elements factor into student success. Providing support to their conclusion are studies demonstrating mixed results related to the ability of blended learning programs that utilize digital components to significantly impact student achievement in math (Ashby et al., 2011; Cargile & Harness, 2015; Hein, 2013; Kiger et al., 2012; Lewis, 2010; Li et al., 2009; Murphy et al., 2014; Rasanen et al., 2009; Rosen & Beck-Hill, 2012; Ysseldyke & Bolt, 2007). Therefore, conclusive research regarding how the use of Khan Academy can positively impact student achievement is needed (Cargile & Harness, 2015; Devers, Alayan, Reaves, & Ragsdale, 2014; Murphy et al., 2014).

Adding further significance to this study are the mixed results from research related to one-to-one device deployments in K-12 schools (Carr, 2012a; Carr, 2012b; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008; Gulek & Demirtas, 2005; Mozelius, Rahuman, & Wikramanayake, 2012; Silvernail & Buffinton, 2009). Results from this study include qualitative themes related to the pedagogical shift surrounding the effective implementation of a digital intervention program in a one-to-one setting, its potential impact on student perseverance, and evidence as to its effect on student achievement. Schools and districts seeking to implement Khan Academy as a blended learning tool in one-to-one settings can use the results of this study as they seek to implement instructional technology effectively in the classroom.

Overview of Research Methods

Johnson and Onwuegbuzie (2004) reveal that mixed methods research blends qualitative and quantitative methods to a single study. This allows for the analysis of both quantitative and qualitative data to answer identified research questions. Creswell (2012) argues this method is stronger than completing qualitative or quantitative research in isolation. This study utilized the

explanatory sequential mixed methods design by which quantitative data were collected first. Once these results were analyzed, qualitative data were collected to explain the quantitative results (Creswell, 2012). For this study, quantitative data were collected and analyzed as the primary measure of student achievement, while qualitative data were used to examine teacher pedagogy and student perseverance.

The quantitative method involved the collection of anonymous ex post facto results from a series of three NWEA MAP tests conducted by the rural high schools participating in this study. To ensure results were anonymous and thus protect the identity of students, all student names were redacted. The MAP RIT scores were analyzed to determine the average amount of growth students demonstrated over the school year. This average was then statistically compared to the November 2015 national norms to determine if results from the three rural high schools significantly deviated from national norms. Utilizing a form of standardized test scores to demonstrate achievement was an important component used to counter criticism that educational research lacks empirical evidence (Bebell, O'Dwyer, Russell, & Hoffman, 2010). The use of standardized scores strengthens the findings by substantiating the claims with data from a widely used instrument such as NWEA's MAP tests.

The qualitative method involved a phenomenological study in order to understand the experience of the teachers and administrators implementing one-to-one devices in blended learning settings within rural K-12 public schools (Creswell, 2013). Data were collected by interviewing seven high school math teachers and three administrators from three rural schools. Permission for the interviews was granted by the superintendent and principal as well as the individual teachers. The sample was purposeful given the fact teachers and administrators with a shared experience are a necessary component of a phenomenological study. Participants for the

study included 9th- and 10th-grade students, their teachers, and administrators from three rural high schools in the Pacific Northwest. Once completed, interviews were transcribed and coded by hand. Analysis of the interviews was conducted in order to identify themes related to elements of Khan Academy that have the greatest impact on student achievement and students' willingness to persevere while engaged in the process of seeking solutions to mathematical problems.

Chapter II

Review of Literature

Introduction

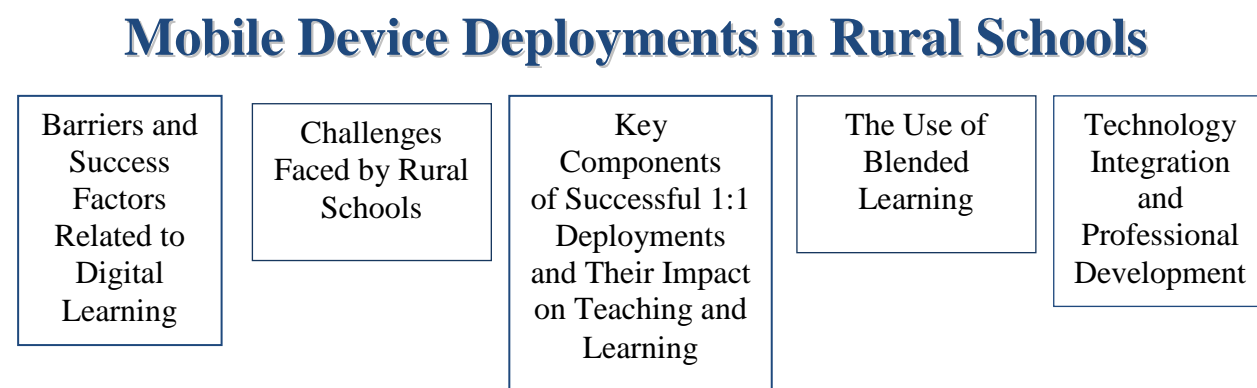
Successful integration of mobile devices to transform teaching and learning requires teachers and school leaders to fully embrace the use of technology in their pedagogy in order to maximize student understanding of the content (Bebell & Kay, 2010). In practice, this requires what Mishra and Koehler (2006) describe as the overlap of content, pedagogical, and technological knowledge.

Research has been conducted related to successful technology integration, which includes studies on the deployment of digital devices in schools, as well as how technology can be used to overcome challenges related to rural communities (Babell & Kay, 2010; Cullen et al., 2006; Hannum et al., 2009; Howley et al., 2011; Irvin et al., 2012; Kim et al., 2011; Walker et al., 2011). This chapter's literature review provides greater understanding of how mobile devices and distance learning are utilized to overcome challenges faced by rural K-12 schools in the United States. It examines the following five categories: (1) barriers and success factors related to digital learning, (2) challenges faced by rural schools, (3) components of successful one-to-one deployments (including the impact on student achievement in mathematics), (4) the use of blended learning in schools (specifically the use of Khan Academy), and (5) successful technology integration and professional development. It also explains Mishra and Koehler's theoretical framework known as TPACK. Figure 2 shows the categories reviewed by the researcher. The conclusion of this chapter presents an overview and suggests future studies.

The current research covered in this literature review builds a foundation for answering this study's research questions, which include whether rural schools utilizing Kahn Academy within a one-to-one program demonstrate higher achievement in math and have increased student perseverance. Secondly, if they do have higher achievement, what are the pedagogical factors having the greatest impact?

Figure 2

Categories of Literature Review



TPACK: Theoretical Framework

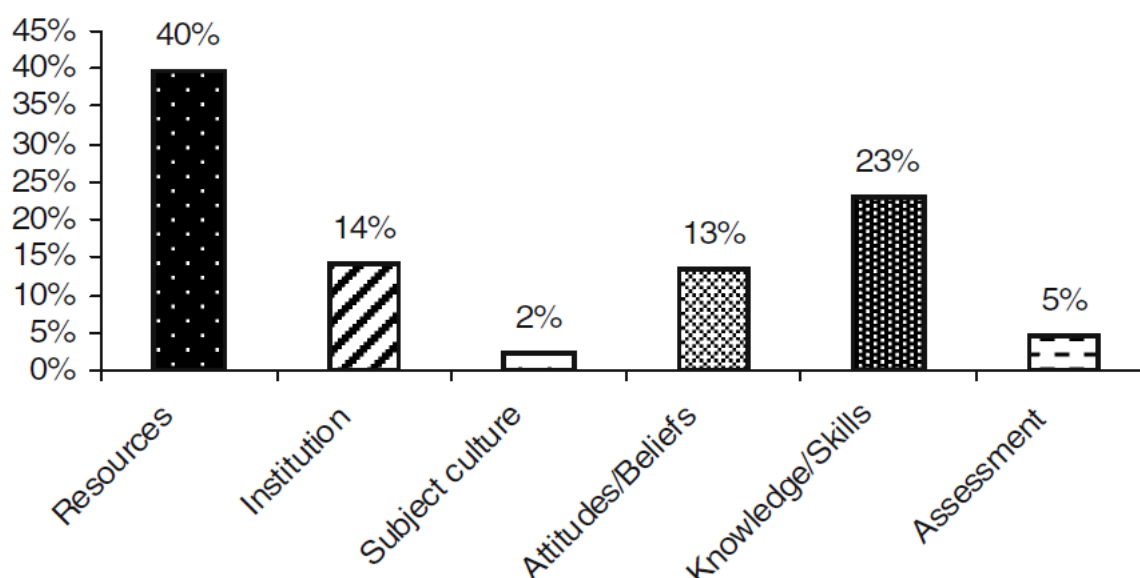
Barriers and Success Factors Related to Digital Learning

Beyond the challenge of funding for technology, there are a number of other identified challenges to successful technology integration in schools including training, access to devices, lack of infrastructure, and resistance to change. Several studies have been conducted to identify barriers to overcome. (Alhomod & Shafi, 2013; Anthony, 2012; Ertmer, Ottenbreit-Lefwich, & York, 2007; Kopcha, 2012; Muilenburg & Berge, 2005). There is not agreement in the research as to the ranking of the barriers; however, there seem to be common elements that emerge as a result of the review of the studies. After an extensive study of existing literature by Alhomod and Shafi (2013), eleven success factors of digital learning programs emerged. At the conclusion of

the study by Alhomod and Shafi (2013), the top five identified factors were (1) adequate training for users, (2) organization commitment, (3) administrative support, (4) technical support, and (5) positive attitude of those using the technology. In a 2007 review of studies on integrating technology into K-12 teaching and learning, Hew and Brush identified resources, institution (school leadership), culture, attitudes and beliefs, knowledge/skills, and assessment requirements as the top barriers to technology integration. Figure 3 shows the barriers most frequently referred to in studies.

Figure 3

Barriers to Technology Integration



Note. Reproduced by permission of Hew & Brush, 2007, p. 226 (Appendix B)

Kopcha (2012) builds on this research by reporting barriers as access, vision, and professional development. Kopcha determined teacher attitude and beliefs were key in successfully overcoming challenges to integrating technology in the classroom. Muilenburg and Berge (2005) provided additional insight by conducting research to identify the most common barriers identified by teachers and students. The study added to the body of research by showing

that although cost, technical support, time, and learner motivation all rank near the top, the barrier most critical to overcome is the lack of social or peer interaction in many technological programs. This factor was further supported by Irvin et al. (2012) who reported K-12 students prefer distance education with synchronous components. In contrast, Ertmer et al. (2007) provided evidence that although extrinsic barriers are necessary to overcome, it is also important to focus on intrinsic barriers. Ertmer's study demonstrated that staff internal motivation and personal beliefs are the most influential factors related to successful integration of technology. The study suggests intrinsic factors such as confidence and commitment affect the teacher's ability to be an effective user more than extrinsic factors such as resources and time (Ertmer et al., 2007).

Other important issues to consider when examining barriers emerge from studies related to the "digital divide" created by what Marc Prensky (2001) refers to as "digital natives" (students) and "digital immigrants" (teachers) (p. 2). Fortunately, research indicates the divide is no longer as dramatic as it once was. Waycott, Bennett, Kennedy, Dalgarno, and Gray (2009) conducted a study demonstrating teachers and students are utilizing many of the same technological resources. The findings of this study confirm that an achievement gap caused by differences in exposure to technology is no longer significant (Waycott et al., 2009). Teachers and students are utilizing technological processes regularly as part of daily life. Kim and Bagaka (2005) further revealed that the difference between teachers and students tends to relate more to students' utilizing technology for personal use as opposed to academic purposes.

Although the divide between teachers and students seems to have narrowed, a gap in relation to access does exist between rural and urban students. A study by Kim and Bagaka (2005) demonstrated that students in urban and suburban homes had more access to computers

than did rural students. In addition, rural students spent significantly less time using computers than did their urban/suburban counterparts. This finding raises questions as to whether rural schools are maximizing technological opportunities through the use of devices and other available technological resources or if there are other factors related to the divide. In addition, it raises questions about whether allowing rural students to take devices home can increase the use of technology in their homes (Kim & Bagaka, 2005).

Challenges Faced by Rural Schools

Rural schools face challenges caused by isolation, loss of enrollment, a small population base, inadequate funding, and limited access to necessary services (Reeves, 2003). As a result, there is a variety of strategies, including the use of technology, rural schools utilize to overcome these and other challenges. Studies reveal that when technology, such as the use of mobile devices, is implemented successfully, it is capable of connecting students to the world beyond their rural communities (Kim et al., 2011; Walker et al., 2011). This second topic of the literature review involves examining current use of technology by rural schools to overcome challenges and barriers unique to these schools.

According to the NCES, in 2010-2011 there were 9,765,385 students enrolled in rural schools. This number accounts for nearly 20% of the nation's total public school enrollment. Numerous studies have been conducted regarding challenges faced by rural schools as well as how technology has been used to overcome some of these challenges (Cullen et al., 2006; Hannum et al., 2009; Irvin et al., 2012).

During the era of No Child Left Behind, many rural schools utilized technology, including distance learning, to increase achievement and overcome the challenge of attracting and retaining highly qualified teachers as required by the law (Cullen et al., 2006; Reeves, 2003).

Hannum et al. (2009) provided insight by demonstrating how rural schools utilized distance education to provide access to advanced and enrichment classes due to the fact that rural schools often lacked the staff to offer these courses. Results of the study demonstrated 85% of rural schools had used distance education at some time and 69.3% were currently using it (Hannum et al., 2009). On average, 12% of the students were reported to have taken distance education courses and 89% were estimated to complete the courses. In addition to these data, the study also showed 81% of school administrators reported the need for distance education courses to provide electives and advanced courses (Hannum et al., 2009).

A number of studies have focused specifically on the unique barriers to technology integration faced by rural schools (Hannum et al., 2009; Howley et al., 2011; Irvin et al., 2012). Hannum et al. (2009) conducted research that revealed the most common barriers include adequate funding, issues related to scheduling, and challenges related to the delivery of distance education courses. Howley et al. (2011) revealed rural teachers felt access to technology was inadequate as was the training they received on use. On the other hand, the study also demonstrated rural elementary teachers felt barriers diminished when attitudes toward technology were more positive, professional development was more extensive, and the available technology was up to date (Howley et al., 2011). These studies demonstrate that rural schools face many of the same challenges encountered by urban schools; however, because many rural schools rely on distance education to overcome challenges unique to rural schools, the need for further technology integration is critical (Irvin et al., 2012).

A Cullen et al. (2006) study revealed several themes for rural K-12 schools to address to successfully overcome barriers. These themes addressed issues related to teachers' perceptions as well as the vision, goals, and culture of the organization. In addition, themes related to technical

support also emerged. An important finding from this research was that in order for new technology initiatives to be successful, teachers need to feel part of the decision-making process. Teachers desire active participation in making decisions about how the technology will be used to overcome barriers and desire to be involved in the creation of the various evaluation components (Cullen, 2006).

In conclusion, although research in this section demonstrates rural schools rely on digital learning, further research is needed to investigate the factors that prevent rural schools from maximizing distance education to overcome barriers and improve achievement (Hannum et al., 2009). This study sought to examine if and how the use of Khan Academy in a one-to-one program led to improved achievement and how participants maximized its use to achieve results. It sought to demonstrate strategies rural high schools can implement to overcome challenges associated with rural math achievement.

Key Components of Successful 1:1 Deployments

The next component of this literature review explores the common elements of successful one-to-one device deployments in K-12 schools and their impact on student learning. These elements of success show how rural schools can most effectively incorporate devices into the culture of the school in order to overcome challenges and transform teaching and learning.

A number of studies have been conducted in schools participating in one-to-one programs (Bebell & Kay, 2010; Cavanaugh et al., 2011; Dawson et al., 2006; Dunleavy et al., 2007; Inan & Lowther, 2010; Light & Pierson, 2013a; Oliver, Mollette, & Corn, 2012; Penuel, 2006; Russell, Bebell, & Higgins, 2004; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Suhr et al., 2010; Walker et al., 2011). These studies were conducted to determine if the deployments integrating technology into the classroom and the implementation of one-to-one programs were

successful in meeting student outcomes. The elements leading to successful deployments and their impact on teaching and learning emerge from a study by Bebell and Kay (2010) on the Berkshire Wireless Learning Initiative. The researchers utilized a pre/post comparative model to determine the impact of a one-to-one program over a three-year period. In particular, they aimed to identify significant changes in teacher pedagogy, as well as the impact on student achievement, engagement, and research skills. One research goal was to identify if a one-to-one deployment increased technology usage due to students' not having to share resources. The study revealed that access to laptops by students and teachers, combined with professional development, support, and a proactive organizational structure, indeed changed teaching and learning in a positive way. It is important to note that the study also showed the burden of change resided with the teacher's willingness to adapt or embrace the use of technology in the classroom. The researchers concluded that teachers control how and when students utilize technology and as a result, teachers must make the commitment to adapting their teaching practices (Bebell & Kay, 2010; Inan & Lowther, 2010). Dunleavy et al. (2007) provided further insight by discovering that devices by themselves do not automatically lead to positive results; high-quality professional development is also necessary. In addition, studies show that although the devices create management issues for the teachers, a one-to-one setting enhances the use of devices in a number of identified areas. These areas include the use of devices to complete homework, conduct formative and summative assessments, differentiate instruction, develop a structure allowing for pacing flexibility, obtain quicker access to digital resources, create forums for student-to-student communication, reduce off-task behavior (because every student has access), utilize a framework for a network of communication, and conduct inventory management (Donovan, Green, & Hartley, 2010; Dunleavy et al., 2007; Lei & Zhao, 2008).

In terms of linking educational outcomes to the implementation of technology in the classroom, a study by Penuel (2006) was intended to synthesize findings from research and evaluate studies on the effect of one-to-one initiatives from a range of countries. The goal was to identify the factors related to the success of implementation. In the synthesis, the researchers identified high-quality research sites that analyzed implementation or reported outcomes of one-to-one initiatives. Findings were synthesized using a narrative approach. After narrowing the list of articles based on appropriateness, the researchers selected 46 articles to analyze. Then, a 2-3 page summary was produced for each article, outlining the score of the one-to-one initiative, the technology involved, demographics of the schools in each study, data related to implementation, and data related to the outcomes. The study demonstrated that one-to-one initiatives focused on one of four outcomes. These were improving achievement, making access more equitable, increasing economic competitiveness, and transforming the quality of instruction. The study also found that teacher attitudes and beliefs were influential in the success of the program, and professional development focused on helping teachers integrate technology into their instruction was most effective. A finding supported by other studies as well (Burns & Polman, 2006; Inan & Lowther, 2010; Penuel, 2006). Despite this finding, Burns and Polman (2006) specifically call for additional research surrounding teacher attitude and belief in relation to a successful one-to-one program.

Other important implications of implementation emerged from research conducted by Walker et al. (2011) which examined Maine's 2010 one-to-one device program. The purpose of the study was to analyze the benefits and challenges of the program. For the study, interviews were conducted with 60 individuals including teachers, principals, technology coordinators, and students. The results of the study showed that 1) implementing a one-to-one program requires the

dedication of significant staff time and resources, 2) schools often have a long ways to go to become fully integrated, 3) lack of training has a significant impact on the use of technology with technology support identified as being critical, 4) teachers who most frequently use devices often describe themselves as self-taught, 5) the percentage of students coming to class with a device is directly tied to the successful integration of devices within the school, and 6) community support strengthens a one-to-one program (Walker et al., 2010). This study supports the argument that one-to-one programs take significant planning and buy-in from the staff and community.

Beyond questions related to successful integration of devices into classroom practices come questions regarding whether devices in a one-to-one setting actually lead to increased learning (Carr, 2012a; Carr, 2012b; Dunleavy et. al, 2007; Dunleavy & Heinecke, 2008; Gulek & Demirtas, 2005; Lei & Zhao, 2008; Lemke, Coughlin, & Reifsneider, 2009; Mozelius et al., 2012; Shapley et al., 2010; Sheppard, 2011; Suhr et al., 2010). Lemke et al. (2009) conducted a meta-analysis on technology use and concluded student learning results are mixed. This study demonstrated that a critical component to student learning is related to implementation fidelity combined with a pedagogical shift (Lemke et al., 2009). The qualitative study by Dunleavy et al. (2007) demonstrated the most common uses of laptops in a one-to-one setting, as well as factors for successful implementation. The study examined student learning and found that when it came to achievement, results were mixed. Lei and Zhao (2008) supported this conclusion through a study involving pre and post surveys of teachers, parents, and students from a school implementing a one-to-one program. The researchers in this study concluded that users felt the devices enriched content; however, further research on the impact on achievement was necessary. In a study by Shapley et al. (2010), researchers conducted comparative research of

schools participating in a laptop immersion program with schools not involved in the program. Results of the study demonstrated although the success of the implementation varied, the greatest impact on learning correlated to the amount of time students were able to spend on the devices outside of the school day. Sheppard (2011) carried out a study in which students' test scores were analyzed and compared after students read passages using iPads and traditional books. The results demonstrated that although the level of engagement favored the use of iPads, there was no significant difference in scores. The study concluded by calling for more research.

An example of a study that found positive results from mobile device usage was one conducted by Suhr et al. (2010). Researchers compared test scores of fourth graders that participated in a laptop program against scores of students that did not. The students' third-grade scores served as the baseline score, and fifth-grade scores served as the posttest. For the study, test scores of 54 students from the laptop program were compared to scores from 54 students not in the program. Teachers participating in the program utilized the laptops for 45% of class time with the most common usage being writing and looking up information on the Internet. Students also created multimedia presentations using a variety of programs. After completing an analysis to address other factors, researchers determined that laptop and non-laptop students started on a level playing field prior to entering the laptop program. Upon analyzing posttest scores, the researchers learned that although there was not a significant difference in scores during the first year, the non-laptop group experienced a decline in scores the following year, while the laptop group did not. The net difference was almost 12%. The researchers concluded that when new technologies such as laptops are deployed in a one-to-one program, there is a steep learning curve for teachers and students. In this study, teachers reported that by the second year, they could focus less on core competencies and more on teaching content (Suhr et al., 2010).

A second study demonstrating positive results of a one-to-one program was conducted by Cengiz and Demirtas (2005). This research examined the achievement of students in a middle school laptop program compared to the achievement of students who chose not to participate. Students choosing to enter the program enrolled in classes in which all students had access to individual laptops. The baseline data collected by the researchers demonstrated no significant difference between the two groups of students prior to implementation of the laptop program. Researchers collected data over a three-year period. The results of the study found students in the program had better grades and scored 6-8% higher on the state's standardized test than students not in the program (Cengiz & Demirtas, 2005).

Examining mathematics explicitly reveals a similar trend of mixed results (Carr, 2012a; Carr, 2012b; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008; Mozelius et al., 2012; Park, 2008; Silvernail & Buffinton, 2009). Mozelius et al. (2012) demonstrated that one-to-one technology can have a positive impact on formal learning in the subjects of math and English. This study, which focused on rural schools in Sri Lanka, demonstrated that a strong commitment among teachers and parents had a direct correlation to success. In contrast, Silvernail and Buffinton (2009) conducted research on a one-to-one school in which staff received significant professional development but failed to implement learned strategies with fidelity. In this case, although students demonstrated growth in the subjects for which teachers utilized the strategies, the students failed to show significant growth in math where strategies were not fully implemented. In addition, studies by Carr (2012a, 2012b), Dunleavy & Heinecke (2008), and Grimes and Warchauer (2008) found either no, or very small, significant increases in mathematics achievement related to the use of devices in one-to-one programs.

Means (2010) revealed a final factor related to the use of data in relation to the evaluation of programs. This study demonstrated the importance of utilizing data from technological reports to drive instruction. When studying schools with significant achievement gains, researchers learned 78% of teachers in schools reporting high gains looked at student data reports weekly and used the data to ensure fidelity of technology use. This study supports the argument that tracking data and utilizing the data to drive instruction provide teachers and students with concrete evidence of success or failure.

In summary, access to technology by itself does not guarantee positive outcomes (Donovan et al., 2010; Dunleavy et al., 2007). The research points to attitudes and beliefs of teaching staff, training (whether preservice or from professional development), and organizational structure as having the greatest impact on the success of the one-to-one deployments (Bebell & Kay, 2010; Dawson et al., 2006; Penuel, 2006; Walker et al., 2011). The studies demonstrate when schools can create an organizational culture of use, teachers have positive perceptions of the program and feel supported. And when staff members have proper training, there is a greater chance of positive outcomes. Studies also demonstrate that due to the mixed results related to student achievement, more research is needed on the topic (Carr, 2012a; Carr, 2012b; Dunleavy et. al, 2007; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008; Lei & Zhao, 2008; Means, 2010; Mozelius et al., 2012; O'Dwyer, Russell, Bebell, & Seeley, 2008; Park, 2008; Shapley et al., 2010; Sheppard, 2011; Silvernail & Buffinton, 2009; Suhr et al., 2010).

The Use of Blended Learning

Blended learning is quickly becoming a common instructional practice as schools experience a digital transformation (Horn & Staker, 2015; Sheninger, 2014). Unfortunately,

studies demonstrate that results, in terms of student achievement (including achievement in math) have been mixed (Ashby et al., 2011; Cargile & Harness, 2015; Glassett & Schrum, 2009; Hein, 2013; Kiger et al., 2012; Lewis, 2010; Li et al., 2009; Murphy et al., 2014; Rasanen et al., 2009; Rosen & Beck-Hill, 2012; Ysseldyke & Bolt, 2007). When the focus of blended learning is on achievement, it is more likely to yield positive student outcomes than when it is viewed as a tool related to managing teacher responsibilities (Ellis, Steed, & Applebee, 2006). Murphy et al. (2014) completed research specifically on the use of Khan Academy as a tool for intervention. The results of this study showed students and teachers had positive perceptions regarding the use of the program, and students who used the program generally had higher grades in math. Unfortunately, because of the number of variables, a strong correlation between achievement and the use of Khan Academy could not be made, justifying the need for further research. In addition, Devers et al. (2014) completed a study in which students completed a pretest, watched Khan Academy videos, and then completed a posttest. Although the students demonstrated significant growth, the researchers concluded that more research on learning from Khan Academy is needed. Finally, in a study by Cargile and Harness (2015), participants purported the belief that Khan Academy has the potential to positively impact math instruction and achievement; however, due to the lack of empirical evidence, the researchers called for additional studies.

An important study demonstrating the ability of a one-to-one program utilizing digital content to improve math achievement was the study by Rosen and Beck-Hill (2012). In this study, researchers examined the impact of a one-to-one program paired with The Time to Know Program on reading and math achievement, student attendance and discipline, differentiated teaching, and student motivation and attitudes. Results demonstrated the program significantly

improved student achievement, reduced student absenteeism, and reduced discipline issues in the classroom.

Other studies demonstrating a positive relationship between the use of blended learning and student achievement include Lewis (2010) and Kiger et al. (2012). Lewis conducted a quasi-experimental study on the use of the program SuccessMaker as a Computerized Assisted Instructional (CAI) program for fourth-grade mathematics. The result of this study demonstrated the use of the program did have a significant impact (positive) on student achievement (Lewis, 2010). Kiger et al. (2012) conducted experimental research on the use of a Mobile Learning Intervention (MLI) known as Everyday Math (along with other web applications for math) within third-grade classrooms. For this study, some classrooms utilized traditional methods such as flashcards, while others utilized the MLI. The results of the study showed the students utilizing the MLI demonstrated significantly more growth ($M=54.5$, $s=14.8$ compared to $M=46.3$, $s=12.5$) on the posttest compared to the students using traditional methods (Kiger et al., 2012).

An important consideration when exploring student achievement is the ability of a blended learning program to promote perseverance in problem solving. According to the Common Core State Standards Institute's Standards for Mathematical Practice, proficient students are able to understand problems and persevere in solving them. They plan out a course of action to solve a problem and then monitor and adjust their plan based on progression towards a solution. They are able to explain the meaning of a problem and are able to identify a starting point (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). According to the National Council of Teachers of Mathematics, students are more likely to persist with mathematical problem solving in classrooms where they explore,

discuss, and experience trial and error (2000). Research has been conducted through the University of Pennsylvania's Duckworth Lab regarding the importance of grit (persistence). Research demonstrates people exhibiting high levels of grit have higher grade point averages, have higher standardized test scores, change careers less often, and finish challenging tasks at higher rates than people with low grit scores (Duckworth et al., 2007). Other studies have demonstrated that perseverance is actually a better predictor of achievement than intelligence (Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2010; Murayama, Pekrun, Lichtenfeld, & Hofe, 2013; Rojas, Usher, & Toland, 2013).

A study by Turrou and Fernandez (2012) demonstrates the importance of the classroom environment in creating an atmosphere of perseverance. The study demonstrated that teacher interactions designed to challenge students to be active participants rather than passive receivers of knowledge are critical to helping students learn to persevere. It also demonstrated the importance of student-to-student interaction in which classroom norms promote the formation of arguments and the willingness to respond to others. Consequently, Turrou and Fernandez's study emphasizes the need for educators to create a classroom climate that promotes and fosters the practice of perseverance skills in students. The question for this dissertation is whether the use of Khan Academy in a one-to-one setting builds attributes in students related to greater perseverance.

The use of blended interventions to increase student grit is supported by research. Studies demonstrate that the implementation of interventions can develop perseverance as a skill (Lyon, 2014; Rojas et al., 2013). A study by Light and Pierson (2013b) demonstrated the ability of Khan Academy to increase student engagement with math. During the study, student discussions increased, students needing additional resources to grapple with problems had a resource, and

students were more likely to tutor each other. In addition, the study suggested that the use of Khan Academy helps students to become self-regulated learners as they take control of their learning. The program is designed so that students receive instant feedback and self-monitor their progress.

Conversely, other studies have failed to demonstrate significant differences in achievement associated with the use of a blended learning program. Hein (2013) conducted research comparing the use of a blended model to traditional methods. In this study, not only did students report that face-to-face instruction held their attention better, but students in the blended classrooms failed to outscore those using traditional methods on the state's standardized test. In addition, Rasanen et al. (2009) conducted research on the impact of a CAI on kindergartners identified as having low numeracy skills. This study demonstrated mixed results by showing students improved in the area of number comparison, but not in other areas of number skills. Milliner (2012) obtained positive qualitative results from a study but did not find a significant difference in test scores between students who participated in a program providing technology for classroom use and those who did not participate in the program.

Another study by Park (2008) found that simply adding technology to classrooms does not guarantee positive results. In this study, students using technology to learn math on their own outperformed students in classrooms where they completed organized activities on a macro level (Park, 2008).

In summary, although the utilization of computerized math interventions in a blended setting has become popular, results in terms of student achievement are mixed. Consequently, further research is needed to identify the components of successful blended programs as well as the components impeding success (Ashby et al., 2011; Cargile & Harness, 2015; Hein, 2013;

Kiger et al., 2012; Lewis, 2010; Li et al., 2009; Murphy, et al., 2014; Park, 2008; Rasanen et al., 2009; Rosen & Beck-Hill, 2012; Ysseldyke & Bolt, 2007). Results of such research will provide schools with information that can be used when developing implementation strategies.

Specifically related to Khan Academy as a blended tool, studies targeting student achievement and citing empirical evidence are needed (Cargile & Harness, 2015; Murphy, et al., 2014).

Technology Integration and Professional Development

Studies have shown an essential component of successful technology integration is for staff to receive meaningful professional development and training aligned to teacher needs, attitudes, and beliefs (Alhomod & Shafi, 2013; Cullen et al., 2006; Dawson et al., 2006; Dunleavy et al., 2007; Efe, 2011; Kim, Kim, Lee, Spector, & DeMeester, 2013; Kopcha, 2012; Silvernail & Buffinton, 2009; Swanson, 2013). To facilitate technology integration, successful professional development should provide training focused on learner use instead of on the nuts and bolts of technology (Alhomod & Shafi, 2013).

Dawson et al. (2006) conducted research on the impact of professional development on teacher pedagogy within one-to-one schools implementing laptops through a grant. For the assessment, two direct observations were conducted. The first observation was conducted early in the grant cycle, and the second was conducted at the end after teachers participated in professional development. The greatest changes occurred in the areas of student attention, interest, and engagement. In addition, the research found a significant decrease in independent seat work and a dramatic shift towards the use of the computer as a learning tool. The study concluded that professional development had a positive effect on the success of the implementation.

In addition to knowledge related to technology use, teacher attitudes and beliefs also play an important role in the success of implementation (Kopcha, 2012; Vanatta & Fordham, 2004). In a study by Vannatta and Fordham (2004), teacher dispositions as predictors of technology use were examined. One hundred seventy-seven teachers completed a 71-question survey. The survey was designed to measure teacher self-efficacy, philosophy, flexibility in terms of change, issues surrounding professional development, and the availability of technology. A six-point Likert scale was used, and the mean and standard deviation of each question was calculated. A forward multiple regression was conducted, and results demonstrated that the best predictor of technology use is a combination of training, time spent on technology outside of the work setting, and a willingness to change.

To study teacher attitudes and their use of technology to overcome barriers faced within their schools, Kopcha (2012) conducted a case study into teacher perceptions of the barriers to technology integration after two years of situated professional development. Barriers included access, vision, and professional development. Teachers reported that these barriers were related to the limited amount of available time, limited access to resources, and insufficient training. During the two-year study, teachers shifted from a mentoring model to learning communities. In order to collect data, the researcher asked teachers to participate in interviews and surveys designed to measure changes in perception. The study demonstrated that offering professional development directly aligned to teachers' needs and knowledge has a greater chance of leading to a successful implementation. Kopcha (2012) determined that because teacher attitudes and beliefs are central to a successful implementation, it is imperative to provide intentional training designed to address teachers' perceived challenges of technology integration.

Research also demonstrates that teachers with a strong background in technology usage are more likely to utilize technology in the classroom (Efe, 2011; Rakes, Fields, & Cox, 2006). Thus, when rural schools hire staff, it may be imperative to select staff who have already received training and are comfortable using technology for personal use. Efe (2011) conducted a study on student teachers entering the field as science teachers. The study showed that student teachers with more experience using educational technology believed more in its value and had greater intentions of using it with their students. Research also demonstrates that lack of experience can be overcome by proper support and training. Cullen et al. (2006) noted a dramatic change in teacher usage after teachers were issued devices and were given focused training designed to be provided when and where it is most needed.

Finally, Silvernail and Buffinton (2009) demonstrated in order for professional development to have a chance to positively impact student achievement (in this case math), teachers must implement the learned strategies with fidelity. In this particular study, learned strategies were implemented in language arts but not mathematics. The result was significant improvement of ELA scores but not math scores. The opportunity to impact math does exist as demonstrated by Pierce and Ball (2009), who showed that math teachers are generally positive about the use of technology to increase motivation and enjoyment, as well as to challenge students to complete real world problems; however, professional development needs to focus on positive implementation strategies in order to overcome the perceived barriers of cost and time (Pierce & Ball, 2009).

In summary, results from the studies included in this section emphasize the importance of teacher attitudes and beliefs, fidelity of implementation, as well as teachers' comfort level with technology when implementing new types. Research supports the idea that professional

development must focus on teachers' attitudes and beliefs as opposed to primarily focusing on basic knowledge and technological skills (Lin, 2008; Wachira, Keengwe, & Onchwari, 2008).

The studies demonstrate that the transformation of teaching and learning happens at the classroom level, and in order for this transformation to occur, teachers must embrace the changes.

Theoretical, Pedagogical, and Content Knowledge (TPACK)

The TPACK framework is built on Shulman's original Pedagogical Content Knowledge (PCK) construct to explain how teachers' understanding of educational technologies overlaps with PCK in order for teachers to effectively teach with technology (Koehler & Mishra, 2009). The TPACK framework has evolved over time. Koehler & Mishra (2009) provide a complete description of the framework, which includes the combination and overlap of content, pedagogical, and technological knowledge to create the dynamics necessary for instructional technology to be successfully integrated into teaching.

Understanding the TPACK framework requires an understanding of each component. Content knowledge refers to the subject knowledge of the teachers and includes comprehending the concepts, theories, and practices towards developing such knowledge (Koehler & Mishra, 2009). The knowledge included in each subject area varies, and often there is disagreement surrounding the body of knowledge. Koehler and Mishra (2009) argue that not having a solid base of content knowledge can be problematic for students and teachers. Incorrect information might be taught to students, which would lead to a misunderstanding of the content. Master teachers generally understand this challenge and seek to overcome it by constantly reviewing material to ensure it is in line with current research and knowledge (Koehler & Mishra, 2009).

The second component of the framework is pedagogical knowledge (PK). This refers to a teacher's knowledge of the components making up the practice of teaching, including an understanding of how students learn, the use of classroom management practices, effective lesson planning, and the use of assessment. In addition, it includes understanding a range of teaching practices and methods. Teachers come from a variety of teacher preparation programs and have developed their skills through a combination of practice and training (Koehler & Mishra, 2009). Therefore, they use a variety of pedagogical methods to teach subject knowledge. Master teachers focus on using multiple teaching methods designed to help students' master content (Koehler & Mishra, 2009).

The third component of Shulman's framework is known as pedagogical content knowledge, or PCK. Here pedagogy and content knowledge come together to create a situation in which teachers present the content knowledge by utilizing methods best suited to the content. Teachers utilize PCK when they determine the best method to use for teaching specific content (Koehler & Mishra, 2009).

The final components of TPACK are technology knowledge (TK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK). All of these concepts refer to the ability of teachers to develop a comprehensive knowledge of technology and then utilize the ever changing world of technological tools and resources to transform the way content is taught and learned. Knowledge of these technological uses provides teachers with the foundation to fully integrate technology instruction into the classroom. This said, it is the combination of all three knowledge types that truly transforms the way teachers teach and students learn (Koehler & Mishra, 2009).

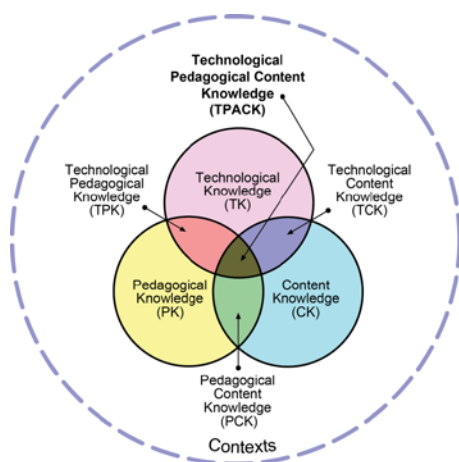
Figure 4 illustrates the concept of TPACK. The diagram demonstrates TPACK is realized when all three types of knowledge are simultaneously integrated into instruction. According to Koehler and Mishra:

Each situation presented to teachers is a unique combination of these three factors, and accordingly, there is no single technological solution that applies for every teacher, every course, or every view of teaching. Rather, solutions lie in the ability of a teacher to flexibly navigate the spaces defined by the three elements of content, pedagogy, and technology and the complex interactions among these elements in specific contexts. (Koehler & Mishra, 2009, p. 66)

As a result, the framework demonstrates the conditions for technology to be fully integrated into classroom instruction. In addition, the model shows it is not enough to simply utilize technological elements in instruction. Instead, content knowledge, pedagogical knowledge, and technological knowledge must be fully embedded if teaching and learning are truly to be transformed (Mishra & Koehler, 2006; Koehler & Mishra, 2009).

Figure 4

The TPACK Framework



Note. Reproduced by permission of the publisher, © 2012 by tpack.org (Appendix C)

Examining studies involving the TPACK framework reveals several findings. In a study by Archambault and Crippen (2009), teachers in an online environment showed the most confidence in the areas of content and pedagogy. These teachers were less confident, or even hesitant, when dealing with technological issues. The researchers suggested this could point to the need for more preservice training as well as professional development. Building on the impact of preservice training, Agyei and Vogt (2012) conducted a study surrounding training utilizing the collaborative design model to promote the integration of technology. They demonstrated that a shift can be made from viewing technology as a simple tool, to the use of technology to build students' understanding of mathematic content.

Addressing the issue of professional development, Richardson (2009) demonstrated through a qualitative study that there is a need for professional development to help teachers connect math and technology with pedagogy. In other words, professional development should address making the change from using technology to demonstrate concepts, to using technology for exploration, discovery, and higher level understanding. Doering, Veletsianos, Scharber, and Miller (2009) conducted research on professional development surrounding TPACK and the effect it has on teacher practices. The study concluded that professional development on TPACK is favorably viewed by teachers and leads to increased utilization of the framework. Koh, Chai, and Tsai (2014) concluded that experience and teaching level impact confidence levels with TPACK and as a result, professional development needs to address the fact there are various levels of confidence among the staff. Polly (2011) recognized this fact and stressed that professional development must be differentiated based on teacher needs. In other words, it needs to address the fact teachers are at various levels of development in each component of TPACK.

In addition, Polly (2011) stressed the need for continued support after training. This fact demonstrates the positive impact the framework has on technology integration.

Finally, work continues on the design of a tool capable of measuring a teacher's development of TPACK. A study on the design of a mechanism by Schmidt et al. (2009) led to an instrument to be used with preservice teachers. The researchers identified that more work is needed to validate the tool, but the survey had promising results. The goal of the research team was to administer the survey during preservice programs in hopes of identifying when and under what circumstances each type of knowledge is developed. It is hoped the data will provide insight into teachers' development of TPACK, which in turn will help institutions implement strategies designed to better develop TPACK (Schmidt et al., 2009).

Call for Research

Although the literature indicates that technology has had a positive impact on the attempt of rural schools to overcome barriers inherent to rural communities (Cullen et al., 2006; Hannum et al., 2009; Howley et al., 2011; Irvin et al., 2012; Walker, 2011), the literature also shows evidence of the need for further research. This review has revealed the need for more research regarding overcoming barriers to successful implementation, the ability of technology (in this case mobile devices) to transform the teaching of mathematics, and whether devices paired with an intervention program truly impact student achievement in math (Lewis, 2010; Rasanen, 2009).

In the area of overcoming barriers and impacting practice, Hannum et al. (2009) state it is particularly important to investigate what prevents some rural schools from expanding the use of distance education and how best to overcome those barriers. In addition, Hannum et al. (2009) conclude that additional research should target how to make distance education more effective in

order to ensure better learning outcomes. Rakes et al. (2006) state that a challenge for future research is to examine specific ways technology influences classroom practices and how the availability of technology resources contributes to the use of constructivist practice. Dunleavy et al. (2008) call for research on how master teachers use technology in one-to-one settings. Finally, Burns and Polman (2006) call for further research on the impact teachers beliefs and practices have on the success of one-to-one deployments.

When it comes to questions regarding the impact of devices on student achievement, Dunleavy and Heinecke (2008) specifically invite more research due to mixed results. In another study, Cavanaugh et al. (2011) conducted research on the impact of mobile devices on student achievement in 11 districts participating in Florida's laptop program. The study results were inconsistent, and thus researchers called for further research regarding the ability of mobile device use to positively impact student learning. In addition, Carr (2012a, 2012b) and Grimes and Warchauer (2008) specifically indicate the need for added research with an emphasis on math because studies fail to show significant gains correlated to use of devices for math instruction. Furthermore, Kiger (2012), Rasanen et al. (2009), and Murphy et al. (2014) call for more research on the impact of blended learning on mathematics achievement while Cargile and Harness (2015) call for research providing empirical evidence of student achievement related to Khan Academy. Additionally, Drysdale, Graham, Spring, and Halverson (2013) invite more research on blended learning in K-12 settings due to the fact the majority of studies on blended learning have occurred at the college level. Finally, in terms of rural schools, Kim et al. (2011) indicate future studies on rural school achievement are necessary to pinpoint the true effect of mobile technology because it is difficult to isolate all the factors potentially contributing to student achievement.

In summary, researchers agree further research is necessary regarding the use of mobile devices to overcome challenges faced by rural schools. As a result, the work conducted in this study focused on the impact of Khan Academy, a mathematics intervention program, embedded in a one-to-one program on a rural school. Best practices in teacher pedagogy and student achievement were investigated as they relate to this blended learning tool in order to determine if utilization in a one-to-one setting raised student achievement, increased student perseverance with problem solving, and permeated teacher pedagogy according to the TPACK framework.

Conclusion

The following five themes are a result of the literature review:

1. There are barriers schools must overcome to fully integrate technology, such as mobile devices, into schools (Alhomod & Safi, 2013; Anthony, 2012; Kopcha, 2012; Muilenburg & Berge, 2005). Specifically, the literature indicates common barriers of lack of resources, negative attitudes and beliefs of staff, lack of a common vision, inadequate or ineffective professional development, challenges with scheduling, and the lack of social interaction (Ertmer et al., 2007; 2012; Hew & Brush, 2007; Howley et al., 2011; Irvin et al., 2012; Kopcha, 2012; Muilenburg & Berge, 2005; Pierce & Ball, 2009).
2. Rural schools face unique challenges that must be overcome. Studies demonstrate that because many rural schools are utilizing some form of distance education, the need to overcome the challenges are critical for success (Hannum et al., 2009; Howley et al., 2011; Irvin et al., 2012). Rural schools face isolation, shrinking enrollment, limited population, inadequate resources, and limited access to necessary services (Reeves, 2003). These factors often make it difficult for rural schools to attract and retain highly

qualified teachers as well as provide materials for advanced or specialized courses (Cullen et al., 2006; Hannum et al., 2009; Irvin et al., 2012).

3. Key components of successful device deployments can be identified by examining successful one-to-one deployments (Bebell & Kay, 2010; Cavanaugh et al., 2011; Dawson et al., 2006; Dunleavy et al., 2007; Inan & Lowther, 2010; Light & Pierson, 2013a; Penuel, 2006; Shapley et al., 2010; Suhr et al., 2010; Walker et al., 2011). Research demonstrates that increased professional development, support, and organizational structure (vision and leadership) are pivotal to success (Bebell & Kay, 2010; Dawson et al., 2006; Penuel, 2006; Walker et al., 2011). Studies show mixed results regarding the ability of device use to raise achievement, and more research is necessary to determine if and how devices can improve student learning (Carr, 2012a; Carr 2012b; Cengiz & Demirtas, 2005; Dunleavy & Heinecke, 2008; Glassett & Schrum, 2009; Grimes & Warchauer, 2008; Gulek & Demirtas, 2005; Lei & Zhao, 2008; Milliner, 2012; O'Dwyer et al., 2008; Pollard & Pollard, 2004; Shapley et al., 2010; Sheppard, 2011; Silvernail & Buffinton, 2009; Suhr et al., 2010).
4. Blended learning utilizing a mobile math intervention has the ability to lead to higher student achievement (Kiger et al., 2012; Lewis, 2010; Rosen & Beck-Hill, 2012). Although results are mixed, a number of studies demonstrate the positive impact of a computerized math intervention (Kiger et al., 2012; Lewis, 2010; Murphy, 2014; Rosen & Beck-Hill, 2012; Ysseldyke & Bolt, 2007). In particular, Khan Academy has become a popular tool and research has shown a positive effect on students' perceptions of learning through the use of the program, but researchers call for further

research into the long-term impact on student achievement (Cargile & Harness, 2015; Murphy et al., 2014).

5. The research demonstrates that because teachers control how and when technology is used in the classroom, professional development designed to foster positive attitudes and beliefs is an essential component of a successful deployment (Alhomod & Shafi, 2013; Cullen et al., 2006; Dawson et al., 2006; Efe, 2011; Kim et al., 2013; Kopcha, 2012; Lin, 2008; Pierce & Ball, 2009). Additionally Vannatta and Fordham (2004) point to teachers' willingness to engage in change as an important predictor of technology use.

A sixth area within the literature review, a description of the TPACK theoretical framework, outlined the context used in this study to determine the impact that mobile computing devices, paired with the use of Khan Academy as a mathematics intervention, has on teaching and learning in rural schools (Koehler and Mishra, 2009). This model provides educators with a theoretical model for use when seeking to integrate technology into the classroom in meaningful ways. The overlapping types of knowledge provide a strong framework for answering this study's research questions.

The themes resulting from this literature review, along with the call for additional research, provide the context for this study. This review demonstrates the challenges facing rural high schools and the potential for technology to help overcome barriers to success in math achievement. As a result, the focus of this study was on if and how Khan Academy (a blended tool) used in a one-to-one setting positively effects student achievement in math. Chapter III explains the design and methodology of the study.

Chapter III

Design and Methodology

Introduction

Creswell (2012) outlines the important steps in research design and methodology, which include determining the research design, identifying the participants, choosing an appropriate type of data collection, explaining the analytical methods to be used, and defining the limitations of the study. This chapter discusses the research design utilized for this study and details the methods used to collect and analyze data related to the integration of Khan Academy into one-to-one programs in rural high schools. It also includes an explanation of the participants and limitations of the study.

In this dissertation study, research questions, examined through the TPACK framework, were used as a guide in order to explore in great detail the impact of Khan Academy in rural high schools. The three central questions investigated in this study included:

1. Is there a significant difference in the amount of growth, measured by MAP RIT scores, demonstrated by rural students utilizing one-to-one mobile devices integrated with Khan Academy when compared to national norms? (quantitative)
2. What do teachers of students in one-to-one rural math classes integrated with Khan Academy perceive as the factors having the greatest impact on student growth as demonstrated by MAP RIT scores? (qualitative)
3. What do teachers of students in one-to-one rural math classes integrated with Khan Academy perceive as the pedagogical methods having the greatest impact on student perseverance with mathematical problem solving? (qualitative)

Research Design

This mixed methods study, utilizing an explanatory sequential design, investigated the impact of integrating Khan Academy into the high school math curriculum of three one-to-one rural high schools in the Pacific Northwest. Creswell (2012) states that a mixed methods research design provides researchers with the ability to collect and analyze both quantitative and qualitative data in order to make conclusions related to results of the study. Creswell states that “mixed methods research is a good design to use if you seek to build on the strengths of both quantitative and qualitative data” (Creswell, 2012, p. 535). Because this was an explanatory sequential study, quantitative data were collected and analyzed first. Once this analysis was completed, qualitative questions were developed to further explain the results.

Quantitative research served as the primary method to study student achievement. Data were collected to measure growth related to the implementation of Khan Academy as a blended program. Ex post facto results from NWEA’s MAP tests were collected from each student and analyzed in order to reveal whether students demonstrated significantly more growth than national norms. MAP testing was selected due to its use by participating schools within a Khan Academy pilot. The use of standardized scores addressed the need for empirical data, which is lacking in research on educational technology (Bebell et al., 2010).

The qualitative style of research utilized for this study was phenomenology. According to Creswell (2013), a phenomenological study “describes the common meaning for several individuals of their lived experiences of a concept or a phenomenon” (p. 76). In order to study the central phenomenon surrounding teachers’ perceived impact of Khan Academy on two key areas, data were collected by interviewing participants. The key areas were teacher pedagogy and

student perseverance. According to Creswell (2012), general interviews can be structured in ways that will not restrict opinions or views of those being interviewed.

Based on the quantitative results, the first qualitative research question regarded the factors having the greatest impact on student achievement. Interview questions were related to the pedagogical use of Khan Academy and the attributes of its use that had the greatest impact on transforming teaching and learning. The TPACK theoretical framework provided the foundation for analysis to determine whether use of Khan Academy lead to a pedagogical transformation, or was simply one of many tools used by teachers in a more traditional setting.

The second research question was related to teachers' perceptions of student perseverance. English and Horowitz (2002) argue that retrospective questioning is effective because participants often overestimate their knowledge prior to implementation of a program. Therefore, this style of questioning was used to identify teacher perceptions regarding the effectiveness of Khan Academy at increasing student perseverance with mathematical problem solving. Teachers were asked to reflect on student perseverance prior to and after implementation of Khan Academy to determine if Khan Academy embedded in a one-to-one program positively impacted high school students' perseverance with math. In addition, participants were asked to identify the factors related most to student perseverance. Participants were given a definition of *grit* as it relates to student perseverance as a basis for reflection (Duckworth & Quinn, 2009).

Participants

The focus of this study was on three rural high schools in the Pacific Northwest participating in a Khan Academy pilot program. The three participating schools were selected from the pilot, which involved 173 teachers and more than 10,000 students from 47 schools in 33 districts (Phillips & Cohen, 2015). All of the pilot schools were required to submit grant

applications describing how the pilot would be implemented in the school. Grant awards to the selected schools totaled more than \$1.5 million for devices, infrastructure, and other expenses. The pilot did not specify exactly how schools were to implement Khan Academy; instead schools were encouraged to be innovative. From the pilot, rural one-to-one schools were identified and contact was made with administration regarding their level of interest in participating in this study. Prior to data collection, teachers and administrators were emailed, inviting them to participate in the study.

Pilot schools received grants based on their focus on personalized learning, willingness to be innovative, ability to demonstrate a bottom-up program, having support of both IT and administrators, and willingness to receive customized support. Requirements for participants included 1) utilizing Khan Academy for at least one hour a week, 2) utilizing NWEA's Map tests, 3) participating in one professional development session focused on Khan Academy, 4) completing a weekly survey, and 5) participating in an online discussion forum known as Edmodo. The original pilot started at the beginning of the 2013 school year, and a second round of grants was awarded for the 2014-2015 school year (Phillips & Cohen, 2015). The three pilot schools selected for this study were included based on their rural status and integration of a one-to-one program in their mathematics classrooms.

Participants for this dissertation study included 9th- and 10th-grade students as well as their teachers and administrators from three rural schools participating in the Khan pilot. The administrator of each school was contacted regarding his or her interest in participating in the study. Each administrator submitted a letter granting permission to participate (Appendices D, E, and F). The three participating schools were Washington High School, Adams High School, and Jefferson High School (pseudonyms). All three high schools were rural schools with one-to-one

devices in their mathematics classrooms. Each school utilized Khan Academy for math instruction and conducted MAP testing during the 2014-2015 school year to measure student growth as required by the pilot. The three schools ranged in student population from a low of 56 to a high of 839. Each school's population was comprised of at least half economically disadvantaged students, with Caucasian and Hispanic being the two largest ethnicities. Table 1 provides specific demographic information for each school.

Table 1

Participant Demographics

Demographics	Washington	Adams	Jefferson
Students	56	839	249
Locale	Rural: Remote (42)	Town: Remote (33)	Rural: Distant (42)
Free/Reduced Lunch	70%	50%	62%
Percent Caucasian	47%	57%	67%
Percent Hispanic	49%	40%	32%

Note. Source: CCD Public school data 2013-2014, 2014-2015 school years. U.S. Department of Education Institute of Education Sciences National Center for Education Statistics

The total number of 9th- and 10th-grade students that participated in the quantitative study was 341. This included 227 ninth-grade and 114 10th-grade students. Due to the use of ex post facto data, student consent was not necessary. For the qualitative interviews, a total of seven teachers and three administrators volunteered to participate. Each signed a participant consent form (Appendix G) prior to being interviewed. Table 2 shows a breakdown of the participants for each school.

Table 2

Breakdown of Participants

Participants	Washington	Adams	Jefferson
Ninth-Grade Students	16	161	50
10 th -Grade Students	13	62	39
Math Teachers	1	5	1
Administrators	1	1	1

Data Collection

Both quantitative and qualitative data were collected for this mixed methods study. Because this study utilized an explanatory sequential design, quantitative data were collected first. Following analysis of the quantitative data, qualitative data were collected to further explain the quantitative results.

In order to collect quantitative data, 2014-2015 ex post facto results from the MAP tests for all 9th- and 10th-grade students from the three high schools were collected. All student names were redacted from the study in order to preserve confidentiality. Students participated in fall and spring testing, and the scores allowed the researcher to analyze mean growth between testing periods, as well as how the students compared to national norms.

NWEA's MAP tests are interim assessments that can be used to measure growth, predict achievement on standardized tests, and provide data to educators to personalize instruction and evaluate programs (NWEA, 2014c). The tests are designed to reveal which skills students have

mastered, as well as areas the student needs to improve. The items on the MAP assessment are aligned on an interval called the RIT scale (NWEA, 2011, 2013, 2014b, 2014c). MAP test questions are assigned RIT values based on their degree of difficulty, and the values are established through an arduous calibration method by which each question is thoroughly field tested with thousands of students. Because MAP tests are given multiple times a year, they are specifically designed to measure growth (NWEA, 2013, 2014c).

Table 3 shows the 2015 national growth norms (RIT values) in the area of math. These scores are based on testing from fall to spring (NWEA, 2015).

Table 3

2015 High School Growth Norms (MAP)

Grade	Mean	Standard Deviation
9	3.1	2.38
10	2.3	2.67

Note. Source: NWEA, 2015

After a student's RIT score is calculated, it is converted into a percentile rank to classify the score as low, low average, average, high average, or high based on the percentile score (NWEA, 2012a). In addition, examining scores from fall to spring testing reveals the amount of growth achieved by the student.

NWEA has completed work to ensure MAP tests are both valid and reliable (NWEA 2004, 2011, 2014a, 2014b, 2014c). A mix of test-retest and parallel forms are used to establish reliability. Both are spread over a 7-12 month period, and the test and retest are similar only in the content covered and testing format. Regarding the Pearson product-moment correlation coefficient (r), MAP test coefficients generally fall within a range of .80 and .90 for each grade

level (NWEA, 2004). The second form of reliability relates to across-test items or internal consistency. To ensure this form of reliability, NWEA utilizes the marginal reliability coefficient, which combines measurement error at a variety of points on the achievement scale to a single index (NWEA, 2004, 2011). Of important note is the fact that NWEA's researchers continue to conduct annual studies to ensure reliability. In addition, because the MAP test is tightly targeted with questions that adjust the difficulty up and down based on student response, scores have a low standard error of measurement, which decreases after each question (NWEA, 2014a; 2014c).

NWEA's research team conducts ongoing validity studies involving construct validity and measurement invariance. In addition, ongoing studies are conducted to ensure the MAP test is aligned to comprehensive state tests in order to demonstrate that RIT scores accurately predict performance on state achievement tests (NWEA, 2014b). A recent study by Wang, McCall, Jiao, and Harris (2013) examined reading and math tests from a variety of grade levels from 10 states. The results of this study demonstrate that MAP constructs are defined well and have a similar pattern across grade levels. NWEA also has shown that MAP tests are valid predictors of achievement on the ACT. In a 2011 Linking Study, NWEA reported a correlation of .87 between MAP and ACT scores. This study involved 26,000 students from 140 schools who took both the ACT and MAP tests (NWEA, 2012b). In addition, a 2015 study verified the accuracy of MAP scores to demonstrate college readiness related to benchmarks identified by corresponding ACT scores (Thum & Matta, 2015).

The second phase of this study involved the collection of qualitative data. To collect data, a total of seven teachers and three administrators were interviewed utilizing a semi-structured format to collect qualitative data to identify general themes. Interview questions designed to gain

insight into the quantitative results were created and utilized for both teachers and administrators (Appendices H and I). Prior to data collection, initial interview questions were piloted with two math teachers and two school administrators to validate the instrument. These pilots led to minor changes to questions to ensure questions were clear and would yield data related to the common experience of participants surrounding student achievement and perseverance.

For the interviews, purposeful sampling was used due to the focus on math. All math teachers from the three sites utilizing Khan Academy volunteered to be interviewed. The type of purposeful sampling selected for this study was homogeneous sampling because all the participants shared the characteristic of utilizing Khan Academy in a one-to-one setting. Initial semi-structured interviews were conducted in a location selected by each participant and lasted from 45 to 60 minutes. A follow-up interview was also conducted with several participants to further explore or clarify topics. Each interview was recorded using a voice recorder and transcribed. Once complete, inductive coding by hand was used to identify themes surrounding the central phenomenon (Creswell, 2012). In order to address methodological rigor, the researcher made validity a primary focus. Creswell (2013) recommends research engage in two validation procedures. For this study, triangulation and member checking were utilized. In terms of triangulation, multiple sources of data were used as participants from more than one school were interviewed in an attempt to reach saturation. In this case, staff members from three schools with a variety of positions and backgrounds participated in the study. Furthermore, staff included teachers and administrators in order to gain insight from different perspectives. For the process of member checking, a preliminary analysis from each interview was provided to each participant to ensure accuracy (Creswell, 2013). In addition to these processes, a thorough review

of the literature was undertaken, the phenomenological method was adhered to, and extensive notes were collected. Table 4 provides a summary of the data collected and analyzed.

Table 4

Synopsis of Data Collection

Data Collection	Method
MAP RIT scores	Quantitative
Interviews of teachers	Qualitative
Interviews of administrators	Qualitative

Analytical Methods

To complete the quantitative analysis related to student achievement, a z test was performed utilizing SPSS to determine if the grade-level mean growth for each teacher's students in 2014-2015 was significantly different than the average growth according to the national norm. In addition, the same test was conducted on the total grade-level population of each school, and again on all students participating in the study. Completing the z test on the school and cohort level was important given the small student numbers in individual classrooms (n) that are inherent to rural schools. When n numbers are less than 30, it is important to ensure steps are taken to address the fact that small numbers could misrepresent the total population (Hart, Poston II, & Perry, 1980). Table 5 shows the breakdown of test groupings. In order to establish significance, a probability level of .05 was set to ensure a low probability of the score's being due to chance.

Table 5

z Test Breakdown

<i>z tests</i>
Ninth-grade students from each teacher's classes
10 th -grade students from each teacher's classes
All ninth graders from the school
All 10 th graders from the school
All ninth graders in the study
All 10 th graders in the study

To complete the qualitative analysis, transcribed transcripts were read several times, and responses relating directly to advantages provided by Khan Academy, teacher pedagogy, and student perseverance were coded utilizing an inductive coding method. The results of this process lead to a total of 93 codes (Appendices J and K). According to Creswell (2013), "coding involves aggregating the text or visual data into small categories of information" (p. 184). Because this was a phenomenological study, information was coded as it related to each participant's experience (Creswell, 2013). Once initial codes were developed and utilized, similar codes were classified by category, and the top 10 categories were identified based on both the total number of times the code appeared as well as how many participants were associated with each code (Appendix L). According to Miles and Huberman (1994), counting codes is an effective method of analysis when drawing conclusions. Themes emerge from experiences that occur frequently and in a specific ways. Consequently, the quantity and frequency come from counting codes (Miles & Huberman, 1994). This process of aggregating

common codes led to the identification of broad themes (Creswell, 2013). Preliminary findings were shared with participants (member checking) and edits were made in order to accurately represent the view of each participant (Appendix M). Next, the data were used to produce a narrative discussion which summarized the findings from this data analysis (Creswell, 2013). All data were protected in password protected electronic files as approved by the Human Research Review Committee for Northwest Nazarene University (Appendix N).

Limitations

Although mixed methods research is stronger than quantitative and qualitative research done alone, one limitation of the mixed methods approach is the large amount of data it requires (Creswell, 2012). In addition, care must be taken in data analysis because comparing data collected with separate methods can be challenging. It is also difficult for researchers to resolve inconsistencies in data that arise (Tashakkori & Teddlie, 2003).

Apart from issues related to the selected method, because this study involved only three schools, the demographics may not be representative of other more diverse schools. As a result of this relatively small sample, further longitudinal studies comparing student achievement of students utilizing Khan Academy to those not using the program is necessary. Additionally, the focus of this study is on rural schools. Results could be different in urban or suburban schools. Further, the amount of time students use Khan Academy may be a factor relating to perseverance. Because perseverance was examined only during the timeframe of this study, it is unclear how continued use of the program might impact perseverance.

Another limitation is the fact that this study involved 9th- and 10th-grade students in Algebra I or a remedial Algebra course. Results could be different in upper-level math courses. Finally, a limitation is the fact that teachers did not utilize Khan Academy in identical ways, as

this was not a requirement of the Khan pilot. There were variations in the amount of time and uses.

Finally, given the fact some teachers had fewer than 30 students, drawing conclusions regarding the level of significance at the classroom level raises questions regarding whether the sample represents the total population (Hart et al., 1980). As a result, tests were also run at the school and cohort level in order to address this issue and strengthen the findings.

Chapter IV

Results

Introduction

Research demonstrates mixed results in terms of whether blended learning with programs such as Khan Academy leads to higher achievement (Ashby et al., 2011; Glassett & Schrum, 2009; Hein, 2013; Kiger et al., 2012; Lewis, 2010; Li et al., 2009; Murphy et al., 2014; Rasanen, 2009; Rosen & Beck-Hill, 2012; Ysseldyke & Bolt, 2007). Research on one-to-one deployments also has had mixed results concerning student performance (Carr, 2012a; Carr, 2012b; Dunleavy et al., 2007; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008; Lei & Zhao, 2008; Means, 2010; Mozelius et al., 2012; O'Dwyer et al., 2008; Park, 2008; Shapley et al., 2010; Sheppard, 2011; Silvernail & Buffinton, 2009; Suhr et al., 2010). Consequently, this study had two goals. The first goal was to determine quantitatively if the use of Khan Academy in one-to-one rural high schools led to higher math achievement as measured by the NWEA Map test. The second goal was to examine the phenomenological experience (qualitative) of teachers and administrators to reveal the pedagogical shifts leading to the results.

The first (quantitative) question guiding this study stated:

1. Is there a significant difference in the amount of growth, measured by MAP RIT scores, demonstrated by rural students utilizing one-to-one mobile devices integrated with Khan Academy when compared to national norms?

After analysis of the results from this question, the following qualitative research questions were developed to guide the second phase of the study:

2. What do teachers and administrators of students in one-to-one rural math classes integrated with Khan Academy perceive as the factors having the greatest impact on student growth as demonstrated by MAP RIT scores?
3. What do teachers and administrators of students in one-to-one rural math classes integrated with Khan Academy perceive as the critical elements surrounding Khan Academy's ability to impact student perseverance with mathematical problem solving?

Understanding these elements could prove beneficial to rural high schools looking to implement a blended educational technology tool such as Khan Academy into their math curricula in an attempt to raise student achievement.

Chapter III outlined the methods for data collection. These methods provided the data that are the focus of the remainder of this chapter. These methods included:

- Use of 2014-2015 ex post facto NWEA MAP scores from three rural high schools. Included were the results from 341 students from seven teachers' classrooms. Results were used to determine if students demonstrated significantly more growth than the November 2015 national norm as defined by NWEA (NWEA, 2015).
- Interviews with seven teachers to identify both the perceived pedagogical methods contributing to results, and elements related to Khan Academy's ability to impact student perseverance with math in a one-to-one setting.
- Interviews with three administrators to determine both the perceived pedagogical methods contributing to results and elements related to Khan Academy's ability to impact student perseverance with math.

This chapter outlines the results of the data collection process and utilizes the TPACK model as the guiding theoretical framework.

Results for Question 1: 2014-2105 Ex Post Facto NWEA Map Test Results

To answer the first research question, 2014-2015 ex post facto MAP test scores were collected from participating sites. These scores included 9th- and 10th-grade scores for both the fall and spring tests. The difference between recorded scores for each student revealed the amount of growth demonstrated by each student. The resulting data were entered into IBM SPSS Software, Version 20, in order to calculate the descriptive statistics necessary for the z test.

The null hypothesis for this study stated the mean for the participating students would fall within NWEA's November 2015 normal range of growth for 9th-grade ($M = 3.10$; $s = 2.38$) and 10th-grade ($M = 2.30$; $s = 2.67$) students based on each participant's grade level (NWEA, 2015). This hypothesis appeared as H_0 ; $\mu = \text{sample}$ falls within the normal growth for 9th- or 10th-grade students. The first alternative hypothesis was that the sample means would exceed normal growth for 9th- or 10th-grade students. This hypothesis was written as H_1 ; $\mu = \text{sample}$ exceeds the normal growth for 9th- or 10th-grade students. Finally, a second alternative hypothesis stated that sample means would demonstrate less than normal growth for 9th- or 10th-grade students. This hypothesis was written as H_2 ; $\mu = \text{sample}$ growth is significantly less than normal growth for 9th- or 10th-grade students.

Utilizing z tests, designed to determine if a representative sample mean is significantly different from the greater population, conclusions were drawn regarding how 9th- and 10th-grade students in the participating rural high schools performed compared to national norms (Tanner, 2012). First, all of the students from the three sites were combined into their corresponding grade levels. The z test for 9th-grade ($M = 8.66$; $z = 35.20$) and 10th-grade ($M = 9.42$; $z = 28.47$) students demonstrated the mean growth exceeded the national norms ($p < 0.05$) for each cohort

of students (see Table 6). As a result, the null hypothesis was rejected, and the first alternative was accepted.

The second test involved the completion of a z test for each school. The means revealed that 9th- and 10th-grade students from each of the three participating schools once again demonstrated significantly greater growth ($p < 0.05$) when compared to the norm. As a result, the null hypothesis was again rejected and the first alternative was accepted. Table 6 shows the results of the z test for 9th- and 10th-grade students from each site as well as the overall performance by each grade level.

Table 6

z Scores by School

School	Students	Mean Growth	z Score	Growth to Norm
<i>9th-grade</i>				
Washington High School	16	4.75	2.77	Exceeded
Jefferson High School	50	21.24	53.90	Exceeded
Adams High School	161	5.14	10.88	Exceeded
All 9 th -grade students	227	8.66	35.20	Exceeded
<i>10th-grade</i>				
Washington High School	13	10.54	11.13	Exceeded
Jefferson High School	39	16.15	32.39	Exceeded
Adams High School	62	4.95	7.82	Exceeded
All 10 th -grade students	114	9.42	28.47	Exceeded

Note. If z is greater than ± 1.96 , the value is statistically significant at $p = 0.05$

The next z test examined the mean growth for each teacher's individual classrooms. It is important to note that several teachers had fewer than 30 students which is a limiting factor inherent to rural schools. This relatively small sample size could have had an impact on individual findings which is why tests were also run at the school and cohort level (Hart et al., 1980). The results of the test showed that the 9th-grade means from six of the seven teachers' classes (86%) demonstrated significantly greater growth ($p < 0.05$) when compared to the norms, while in the 10th-grade, five of seven teachers (71%) exceeded norms. Further examination revealed five of the seven teachers showed significant growth for both 9th- and 10th-grade students, one had 9th-grade students who exceeded growth but 10th-grade students who fell within the normal range, and one had students whose mean growth fell within the normal range for both grade levels. Table 7 shows results of the z test for each teacher.

Table 7

z Scores by Teacher (pseudonyms)

Teacher	Students	Mean Growth	z Score	High School	Growth to Norm
<i>9th-grade</i>					
Sam Erickson	16	4.75	2.77	Washington	Exceeded
Carol Nelson	15	6.53	5.58	Adams	Exceeded
Riley James	36	4.47	3.45	Adams	Exceeded
Sally Smith	43	6.95	10.61	Adams	Exceeded
Michelle Jones	24	2.33	-1.59	Adams	Norm
Mike Harding	43	4.98	5.18	Adams	Exceeded
Jennifer Roy	50	21.24	53.90	Jefferson	Exceeded

	<i>10th-grade</i>				
Sam Erickson	13	10.54	11.13	Washington	Exceeded
Carol Nelson	10	3.10	0.95	Adams	Norm
Riley James	8	9.5	7.63	Adams	Exceeded
Sally Smith	13	6.38	5.51	Adams	Exceeded
Michelle Jones	15	2.20	-0.15	Adams	Norm
Mike Harding	16	5.06	4.14	Adams	Exceeded
Jennifer Roy	39	16.15	32.39	Jefferson	Exceeded

Note. If z is greater than ± 1.96 , the value is statistically significant at $p = 0.05$

Because of this data, it can be concluded that the majority (71%) of teachers exhibited significant growth for both 9th- and 10th-grade students. For these teachers, because growth exceeded norms, the null hypothesis was rejected, and the first alternative was accepted. For one teacher at Adams High School (14% of the sample), the 9th-grade mean exceeded the norm while the 10th-grade mean fell within the normal range. In this case, the null hypothesis was rejected for the 9th-grade, and the first alternative was accepted. On the other hand, the 10th-grade mean failed to reject the null hypothesis. For another teacher, again at Adams High School, both group means fell within the normal range. In this case, the results failed to reject the null hypothesis for either group. It is important to note that in all instances, the second alternative stating students would demonstrate significant growth below the norm failed to be accepted.

Results for Question 2: Factors Related to Success

The second phase of an explanatory sequential study calls for the collection of qualitative data to explore the quantitative results (Creswell, 2012). Because the majority of z tests revealed students demonstrated significantly more growth than the norm, the first qualitative question

asked: What do teachers of students in one-to-one rural high school math classes integrated with Khan Academy perceive as the factors having the greatest impact on student growth as demonstrated by NWEA MAP RIT scores? Utilizing a total of 10 volunteers (three principals and seven teachers), the researcher conducted 10 semi-structured interviews and utilized follow-up questions to gather data. Interviews were recorded, transcribed, and coded to identify perceptions of teachers and administrators related to the implementation of the Khan Academy pilot within their schools. Participants had diverse backgrounds and a range of educational experience. It is hard to identify the common phenomenological experiences of all the participants without thoroughly examining the personal experience of each individual with Khan Academy. A greater understanding of each participant's use of Khan Academy and perception of its value allowed for the formation of conclusions regarding the common themes in the participants' responses. As suggested by Marshall and Rossman (2011), pseudonyms were used to ensure anonymity of participants and research sites. Table 8 illustrates the demographics and position of the participants.

Table 8

Participant Synopsis

Pseudonym	Role	Age	Gender	Race	Years in Position
Mr. Richard Warren	Principal	32	M	White	2
Mr. Bryce Carter	Principal	36	M	White	2
Mr. Gary Fisher	Principal	41	M	White	3
Ms. Sally Smith	Teacher	44	F	White	17
Ms. Michelle Jones	Teacher	64	F	White	31

Mr. Mike Harding	Teacher	55	M	White	23
Ms. Carol Nelson	Teacher	35	F	White	1
Ms. Riley James	Teacher	50	F	White	28
Mr. Sam Erickson	Teacher	66	M	White	2
Ms. Jennifer Roy	Teacher	44	F	White	6

The participants included three principals who had been in the role for 2 to 3 years with a mean age of 36. None of the principals had a background with teaching math, and each expressed their lack of experience with the subject. Regarding the Khan Academy pilot in the school, each principal played a supportive role in the implementation of the grant; however, none of them actually participated in the writing of the grant. Each principal conducted observations of the teachers in his building who were responsible for utilizing Khan Academy, and each understood the requirements of the grant. The principals were very familiar with their 2014-2015 NWEA MAP scores and expressed satisfaction with the level of achievement demonstrated by students.

Participating teachers ranged from a 31 year veteran to a beginning teacher in her second year. The mean age was 51, and the mean experience was 15 years. Five of the participating teachers completed a traditional route to becoming a classroom teacher. One teacher was on a temporary certificate and was working towards certification, and one finished a program 6 years prior after being a stay-at-home mom. The diversity of experience with Khan Academy was apparent, as several teachers expressed frustrations with the program while others championed its use. Of the seven teachers, two had some negative experiences with using online tools such as Khan Academy, and the other five were generally positive. In addition, teachers used the

program in different ways depending on whether they used it primarily for remediation or for practicing skills related to delivering curriculum content.

The structure of the grant and the identified needs of the students influenced the use of Khan Academy in the classroom. Table 9 shows the 10 most common inductive codes related to experiences surrounding the utilization of Khan Academy. Appendix L demonstrates the combined codes utilized for each category in the table. These codes evolved into the themes related to the exploration of Khan Academy's impact on student achievement as measured by the NWEA Map test.

Table 9

Top 10 Code Groups, by Frequency, Related to Pedagogy from Interviews

Codes	Number of Responses
Khan supplements teacher-directed curriculum.	111
Khan is a remediation tool that fills gaps in learning.	73
Khan provides students with a means to practice skills.	45
Teacher buy-in is critical for success.	35
Teachers help students overcome frustrations and develop buy-in.	33
Students have control-time and pace.	30
Having 1:1 provides daily individual access to devices.	25
Khan allows teachers to differentiate.	23
Khan supports mastery learning.	21
Khan provides extensions for students.	20

Participants described several critical components of Khan Academy used for content delivery. According to the participants, with Khan Academy, teachers have the option of

assigning "missions" that are broad and cover a variety of topics within a given subject (i.e. Geometry). A second option for teachers is to utilize the recommendation feature to assign students specific skills. These skills can be remedial in nature or can be aligned with the teacher's current instruction. A final option is for students to work in *The World of Math*. In this feature, students work through mathematical concepts ranging from simple arithmetic to complex college-level problems. With each of these options, teachers can decide if students must correctly complete five or 10 problems before the system designates the concept as "practiced." Participants in this study all selected five as the required number of correct answers.

The program builds from a basic understanding to mastery by revisiting concepts and progressing from level 1, to level 2, to mastery. There are features by which students can earn badges and energy points based on usage. To assist students, Khan Academy includes a video library with thousands of instructional videos. In addition, there is a hint feature to provide students with help to common questions.

Participants in this study utilized a variety of features; however, all of the participants primarily used the recommendation feature. One notable exception was Ms. Roy at Jefferson High School. She not only utilized the recommendation feature, she also required her students to complete skills in *The World of Math*. Her use of the program was more extensive than the other participants, and her mean MAP scores exceeded those of the other participants.

Concerning pedagogy, participants identified Khan Academy as a useful supplemental tool, but stopped short of saying use of the program transformed their curricula. All of the participants indicated that they remained in control of curricula regarding pace, topic, and lesson design but described ways in which Khan Academy served as an instructional tool incorporated

into the teaching practice. In addition, although Khan Academy provided an extensive collection of video resources, none of the participants used the videos for primary instruction.

Ms. Smith of Adams High School had been teaching for 16 years before becoming involved in the Khan pilot. She served as the lead teacher for the pilot at Adams High School and incorporated the program daily as a supplement to her classroom instruction. Ms. Smith was hesitant to allow the program to dictate the curriculum and provide daily instruction. Instead she relied on her district's curriculum calendar to drive the topics of instruction. For Ms. Smith, "It couldn't encompass my classroom" as "I still taught everything that I assigned in Khan." For her, Khan Academy changed her pedagogy and led to her students' demonstrating significant growth; however, the program served as a supplemental tool to her school-designated curriculum. Ms. Roy had a similar experience claiming, "It is definitely a tool that I use, but I still do a lot of other things that I did before. So it is a huge tool I use that I didn't have before which I think has really helped the students." As for the videos, Ms. Smith stated, "I still didn't show videos to the whole group because it bored them...It is a hand on a blackboard. They hated it." Mr. Harding stated, "It is a work in progress. So some of the videos to be honest were terrible. I know that some of the videos are no more than a teacher at a whiteboard." None of the participants required students to watch the videos for in- or out-of-class instruction; however, they indicated some students would use them for extra help on problems.

When describing the use of Khan Academy, eight of the participants stressed the importance of Khan Academy's ability to fill gaps in student learning. As previously stated, teachers most frequently used the recommendation feature to target basic skills students had failed to develop. Mr. Harding of Adams High School found Khan Academy to be very effective at giving students practice in areas where gaps existed. As a result, he used Khan Academy for

20 minutes each day specifically to build upon skills students in his Algebra I class were lacking.

According to Mr. Harding:

I mean I think I am relying on it exclusively for remediation where before I would take a struggling kid and we would go through worksheets again, which were horrible for kids anyway. So that area has changed. I am really relying on it for those struggling low-level kids. I think this is a real tool. I think it's something that can help.

Mr. Erickson, who in 2014-2015 was the only math teacher at Washington High School, had a similar experience with the recommendation feature and found the greatest student growth came when he switched from having students use Khan Academy to practice the skills focused on in class and instead started having them use it to practice basic skills. He told students, "I don't want you doing Algebra I or Algebra II. I want you doing arithmetic, and I want to see how you grow in arithmetic."

Multiple participants pointed to Khan Academy's ability to address learning gaps as the program's greatest advantage and identified this fact as the reason students' demonstrated significant growth on the MAP test. Mr. Fisher, Principal of Jefferson High School, complimented Ms. Roy for her use of the program saying, "I feel that finding those gaps was a big thing in our district." Ms. Roy explained how her students went back and practiced topics that required further practice. According to Ms. Roy, "You don't know what they missed in grade school because they were sick with the flu for a week." For her, "Khan really helped fill in holes."

Another common use of Khan Academy by participants was for the practice of skills taught in class by the teacher. Ms. Smith started using Khan Academy primarily as a tool to target basic skills, until one day she became frustrated by her students' inability to grasp the use

of the quadratic formula. As a trial, she decided to assign the quadratic formula to her students utilizing the recommendation feature, which requires students to correctly answer five questions in a row before moving on. Although the students were frustrated by having to complete five in a row to demonstrate they knew how to do it instead of just moving on from the skill, their effort paid off. Reflecting back Ms. Smith recalled, "I saw an immediate rise in my summative assessment on that unit. Like we went from Ds and Fs in one class that I felt had spent wasted time, to a C average which was huge growth." Ms. Nelson and Ms. Jones, colleagues of Ms. Smith at Adams High School, replicated this practice. In each case, the teacher provided direct instruction to students and then utilized Khan Academy as the assignment through use of the recommendation or mission feature, which required students to answer five questions in a row correctly before moving on.

Although Ms. Roy used Khan Academy in a similar format, her perspective varied in that she recognized it often provided students with practice that challenged them to utilize what they had learned in a slightly different manner. For her:

I assign specific things to go along with the thing I taught so they had extra practice. Where maybe in the curriculum they did a lot of the same kind of problems over and over, Khan Academy asked about the same type of problems in different ways so hopefully they had a deeper understanding because you never know how they will be asked.

The final use of Khan Academy described by participants was for students who mastered the concept being taught in class and as a result, were ready to move on to new topics. Mr. Fisher questioned, "What do you do with a kid that has the concept and is waiting for the other students to catch up?" Ms. Roy illustrated, "We do so much for the lower kids. We have all the

interventions and the upper kids are just bored." Consequently, multiple participants pointed to the ability of Khan Academy to push advanced students to learn concepts beyond those thought in class. They expressed their excitement with seeing students getting into the program and working on skills and concepts beyond the regular curriculum. Unlike the other uses, for this use, participants reported students utilized the videos as well as the hint feature to learn concepts.

Multiple participants expressed the individual nature of the program as a benefit to its use. Classes often contain students with a broad range of abilities and backgrounds, making it tough to address the individual needs of each student. The ability to use Khan Academy to simultaneously meet differing needs was an advantage. According to Mr. Harding of Adams High School, who had worked for a number of rural school districts during his 23 years of teaching, "I know I keep harping on this but those low-level kids are all at such different levels, and Khan meets that. You know, it helps fill that hole that many of them have at that level." Ms. Roy stated, "I have 150 students, so it is hard to give them individually, impossible to give students individually a review on things they have practiced." Ms. Smith expanded on the concept by pointing out that "someone can do it in five problems, and they are fine, and I am not going to worry about them, and others will need 25 and still won't have it. I like the individual that way."

Mr. Warren, principal of Washington High School, expressed the difficulty he faces with meeting the needs of students in "Grand Canyon" classes where the gap in student ability is large due to the limited course offerings in his small school. In relation to the use of Khan Academy, Mr. Warren explained how "they tried to differentiate by spending more time with various groups but, it wasn't differentiation in the way technology allows."

Another advantage participants noted regarding Khan Academy is the way it is designed to promote mastery learning. Whether students are practicing a current skill or trying to master an essential skill requiring additional practice, the mastery structure of the program was seen as an advantage. Because the program requires students to correctly answer multiple questions in a row before moving on, students must be able to demonstrate they understand the concept instead of simply completing an assignment. For Ms. Roy:

The shift with Khan is it is not just what is the answer, but I have to learn how to get the answer because it will ask again...I try to focus on the mastery instead of just getting the assignment done. Maybe I did before, but it is just like more conscious with this mastery base.

Concerning being one-to-one with devices, all of the participants identified this as essential to the success of the program. All participants indicated use would have been inconsistent had teachers been forced to schedule times for students to utilize devices. In addition, each student having access to his or her own device was identified as being paramount due to the individuality of the program. When asked about using Khan Academy without one-to-one access, Mr. Harding responded:

That would be horrible! I don't know how you would do it. To me in this building it wouldn't work without. I have to have it. If they had to share a laptop, I think it would be bad. Thank goodness we didn't try that.

Participants felt the one-to-one ratio allowed students to master concepts individually while giving teachers the peace of mind knowing students had immediate and constant access to devices.

Finally, participants discussed student and teacher attitude or "buy-in" to the use of the program as an important issue related to the success of the Khan Academy pilot. Teachers expressed student frustration with having to correctly answer multiple questions in a row before being allowed to move on. Missing the fifth question and having to start over often lead to complaints from the pupils. Ms. Nelson stated, "But for those that struggle, they would do the first four right and then miss one and start over. They would get so frustrated with themselves." Also, because Khan Academy requires answers to be in a precise format, students would often have problems marked wrong due to the way they wrote the answer. For example, according to Mr. Harding, if a student put "1x" instead of "x," the system might mark it wrong. Participants noted this led to a learning curve for teachers and students that often resulted in complaints from students. For some participants, student buy-in improved over time as students became more familiar with the program. For Ms. Jones, a teacher at Adams High School who struggled with technology use, "If they liked it they liked it. If they hated it, it was torturous. It was like pulling teeth to get them to try." Ms. Jones and Ms. Nelson both expressed significant frustration with student buy-in to the use of the program and were also the two teachers who had classes that failed to exceed normal growth.

Concerning teacher buy-in, several participating teachers as well as the three principals described teacher attitude towards the program as being critical to its success. When reflecting on her class growth scores compared to others' scores, Ms. Smith commented that "some are not willing to try new things. It's hard for them and they have dropped it." Principal Carter of Adams High School agreed, saying about teachers, "It doesn't matter what it is, if they have a poor attitude about it, it is a waste of time." He went on to state that in regards to veteran teachers, "For some of them to really grab a hold of it and buy into it completely and find how to use it

effectively in their classrooms has been tough." For him, an essential component to success is "not being afraid to just totally try something different."

Results for Question 3: Perseverance

The same participants that were interviewed to reveal themes related to the second research question were also asked questions related to Khan Academy's ability to positively increase perseverance with mathematical problem solving. Table 10 demonstrates the themes that emerged from the interviews and reveals there was not agreement surrounding the ability of the program to directly impact perseverance. Specifically, five participants indicated Khan Academy did not affect perseverance, and the other five reported it did, at some level, have an impact.

Table 10

Top 5 Codes Related to Khan and Perseverance from Interviews

Code	Number of responses
Khan builds confidence	15
Khan does not affect perseverance	5
Khan positively effects perseverance	3
Khan somewhat effects perseverance	2

Of the 10 participants interviewed for this study, five of the participants indicated the use of Khan Academy in a one-to-one setting had at least some impact on student perseverance. In his discussion on Khan Academy's impact on perseverance, Mr. Erickson recalled:

The kids that had a little stick-to-it-ness, perseverance, whatever you want to call it, it helped them because they could see if they could battle through, they could succeed.

There was a reward for their grit. I think if you don't reward grit it will go away.

Participants such as Ms. Roy discussed how the necessity for students to answer five in a row encouraged students to persevere with a concept. She "thought if nothing else this is one of the best things to teach students not to give up and try different ways." She talked about one of her students who worked over 30 problems on Khan Academy while attempting to correctly answer five in a row. Ms. Roy exclaimed, "This is Awesome! Just the attitude of not quitting and being willing to do it."

The other five participants in the study perceived Khan Academy as failing to significantly impact student perseverance with math. These participants identified external factors impacting perseverance and discussed the belief that Khan Academy did not significantly address these issues. For example, Ms. James of Adams High School argued that one of the problems with perseverance is the instantaneous culture in which we live. Her perception of students was, "If they have a question, well let's just google and figure it out. They don't persevere doing anything anymore." Her colleague, Ms. Jones, agreed and argued, "The low-end kids, all of them are used to instant gratification, being entertained and it is difficult to get them to think." Principal Warren argued it is classroom climate that impacts perseverance more than Khan Academy. For him, "If the teacher accepts 'if you don't understand leave it blank and come to class and we will work through it,' that becomes the norm...It is where the standard is set."

Although there was disagreement regarding the ability of Khan Academy to positively impact student perseverance with math, six participants noted Khan Academy's capacity to affect

student confidence with mathematical problem solving as the factor related most to perseverance. Ms. Roy felt strongly about this point and described a student who, after working through problems to get her five problems right, exclaimed, "I can do math!" Ms. Roy explained that the student "was surprised and that was good because it gave her that confidence she needed to go on and try some harder things." She further explained that when students enter her high school, they lack confidence in math and she has to find ways to build confidence. Multiple participants discussed how the format of Khan Academy is designed to build confidence. Whether students earned badges or energy points or completed the necessary five in a row, participants indicated the program could positively impact a student's belief in his or her ability to do math. Principal Fisher argued:

...because of how the program is set up. Because it, again, it adapts to what they do and don't know, and if they struggle on a section it will adapt and come back to something that helps build the foundation to continue. It gives them a little success until they get the concepts. So in a sense it does help with perseverance.

Themes

The identification of major themes and subthemes is described by Creswell (2013). The top 10 combined codes (see Table 9, page 67) were distilled into four major themes regarding the use of Khan Academy to promote student achievement. Table 11 shows the codes related to student achievement and how they were combined into the four themes.

Table 11

Student Achievement Themes Derived from Top Interview Codes

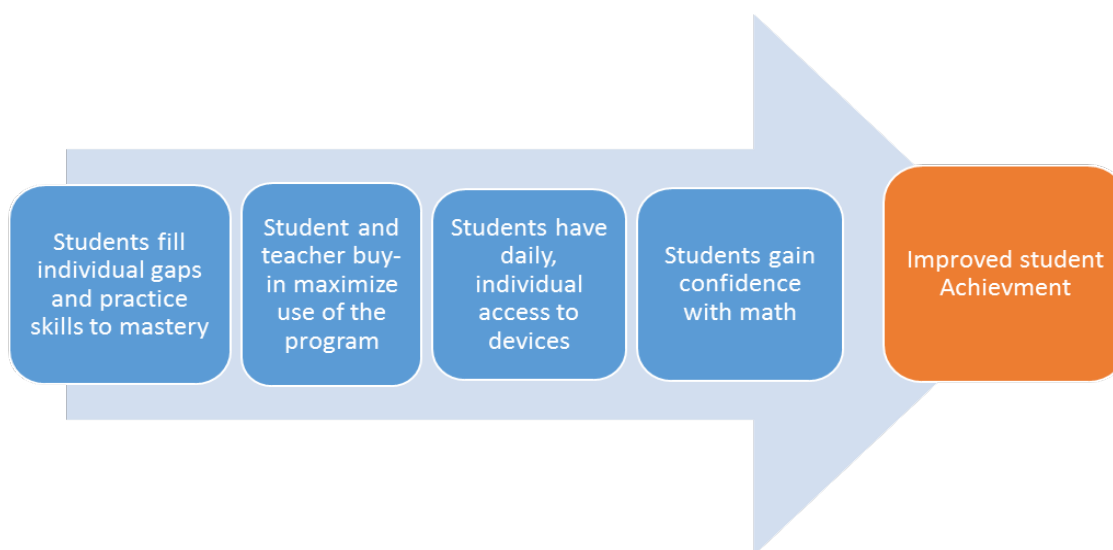
Theme	Codes
Students fill individual gaps and practice skills to mastery.	Khan supplements teacher-directed curriculum
	Khan is a remediation tool that fills gaps

	in learning.
	Khan supports mastery learning.
	Khan provides students with a means to practice skills.
	Khan provides extensions for students.
	Students have control-time and pace.
	Teacher buy-in is critical for success.
Student and teacher buy-in maximize use of the program.	Teachers help students overcome frustrations and develop buy-in.
Students have daily, individual access to devices.	Having 1:1 provides daily individual access to devices.
Students gain confidence with math.	Khan builds confidence.

Figure 5 illustrates these themes graphically as they relate to student achievement. Three of the themes that emerged were related to research question #2 which sought to explain the elements of Khan Academy perceived as the underlying reasons for student growth that exceeded national norms. A fourth theme emerged as a result of questions associated with research question #3 which dealt with Khan Academy's ability to impact perseverance.

Figure 5

Themes from Interview Data



The first theme, that Khan's structure permits students to fill individual gaps and practice skills to mastery, relates to the ability of the program to be used pedagogically to have students work on individual learning gaps, practice skills currently being taught by the teacher, or work on advanced concepts beyond those taught in class. In all three instances, the program promotes mastery learning due to the nature of questioning. Participants pointed to this structure as essential to improved student achievement because students have to demonstrate proficiency with a concept instead of skipping it and moving on.

The second theme relates to the importance of student and teacher buy-in to the success of the program. Interviews revealed some teachers struggled with the utilization of the digital resource. This was especially true for veteran staff identified as being resistant to change. In addition, students became frustrated by having to answer multiple questions correctly. Furthermore, Khan Academy requires answers to be in a specific format, which some students found challenging. Overcoming student frustration and motivating students in a positive way was identified as an important component of a successful program. Teachers able to accomplish this task viewed the program more favorably, leading to the emergence of this theme.

The third theme relates to the importance of having daily, individual access. Participants discussed the importance of every student's having access to a device due to the individual nature of the program. In addition, teachers stated that if they did not have daily access within their classrooms, they would have been far less likely to fully utilize the program due to scheduling issues within the building. All participants stressed the importance of one-to-one access in the pilot.

The final theme relates to perseverance. Even though there was not agreement on Khan Academy's ability to positively impact perseverance, participants indicated Khan Academy has

the ability to improve confidence with math. Participants indicated confidence is an important aspect of student success with math, and the structure of Khan Academy promotes student confidence with mathematical problem solving. Analysis of these four themes is expanded in Chapter V.

Conclusion

This chapter provided a summary of the quantitative and qualitative data collected to examine the impact of Khan Academy on student achievement in one-to-one rural high schools. A z test revealed 9th- and 10th-grade students from the research sites significantly exceeded November 2015 normal growth on the NWEA Map test. Qualitative data were consequently collected to explain further these quantitative results. Themes arising from semi-structured interviews demonstrated Khan Academy was used by participants to individually master remedial skills, practice content presented by the teacher, and access content beyond the curriculum. Furthermore, the themes illustrated the importance of student and teacher buy-in, the importance of being one-to-one with devices, and the ability of Khan Academy to increase student confidence in math. Finally, participants did not agree on whether Khan Academy increased student perseverance with math.

Data from this chapter is expanded upon in Chapter V to discuss further how the elements of Khan Academy are positively impacting student achievement and ways teachers can utilize Khan Academy in a one-to-one setting to increase math achievement in rural high schools.

Chapter V

Discussion

Introduction

A popular blended tool utilized by schools today in an attempt to positively impact math achievement is Khan Academy (Cargile & Harkness, 2015; Murphy et al., 2014). Although the program is widely used, the need for further research is necessary regarding the impact of its use, specifically on student achievement (Cargile & Harkness, 2015; Murphy et al., 2014). As a result of this need, questions were investigated in this study utilizing the TPACK model as the theoretical framework to determine whether use of Khan Academy in a one-to-one setting had a positive impact on the academic achievement of rural high school math students, and if so, what pedagogical factors had the greatest impact. In addition, due to the importance of perseverance in problem solving, the issue of Khan Academy's ability to positively impact perseverance was explored (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

The questions guiding this study were:

1. Is there a significant difference in the amount of growth, measured by MAP RIT scores, demonstrated by rural students utilizing one-to-one mobile devices integrated with Khan Academy when compared to national norms?
2. What do teachers and administrators of students in one-to-one rural math classes integrated with Khan Academy perceive as the factors having the greatest impact on student growth as demonstrated by MAP RIT scores?

3. What do teachers and administrators of students in one-to-one rural math classes integrated with Khan Academy perceive as the critical elements surrounding Khan Academy's ability to impact student perseverance with mathematical problem solving?

Chapter V provides an interpretation of the results of the study and how these results relate to the TPACK framework for educational technology integration. In addition, recommendations for further research and implications for professional practice are also discussed.

Summary of Results

This study investigated the impact of Khan Academy on student achievement and perseverance in math. As a result, research involved exploring test results to reveal student achievement as well as the factors related to success or failure. The study utilized the explanatory sequential design as the basis for research. According to this design, the researcher begins with quantitative data and utilizes qualitative data to further explain the results (Creswell, 2012). Quantitative data were collected and analyzed first to identify whether students demonstrated significant growth. Based on the results, interview questions were developed to further explain the results (see Appendices H and I).

This study involved 9th- and 10th-grade students from Adams High School, Jefferson High School, and Washington High School (pseudonyms). All three rural sites participated in a Khan Academy pilot during the 2014-2015 school year and tested students in the fall and spring on NWEA's MAP test. Ex post facto MAP test scores were collected, and the difference between fall and spring scores revealed the amount of growth for each student. To collect qualitative data, a series of semi-structured interviews were conducted with teachers and administrators to

identify perceptions of factors related to the pedagogical elements having the greatest impact on student achievement and perseverance. Participants were solicited after information on the details of the study was shared with math teachers and administrators from the three schools.

Given the investment made by schools on educational technology, ensuring the use of this technology actually leads to greater student achievement is important in terms of justifying the expense. All of the participating schools received grant funds as a part of a Khan Academy pilot in order to purchase devices and conduct MAP testing. Researchers continue to explore the effectiveness of one-to-one programs as well as the effectiveness of blended tools on student achievement (Ashby et al., 2011; Burns & Polman, 2006; Carr, 2012a; Carr, 2012b; Cavanaugh et al., 2011; Dunleavey & Heinecke, 2008; Glassett & Schrum, 2009; Grimes & Warchauer, 2008; Hein, 2013; Kiger et al., 2012; Lewis, 2010; Li et al., 2009; Murphy et al., 2014; Rasanen et al., 2009; Rosen & Beck-Hill, 2012). Student achievement must justify the expense of digital resources as well as the time spent using them in instruction.

Quantitative data. NWEA Map test scores were used in this study to measure student achievement in math. The 2014-2015 ex post facto data for 9th- and 10th-grade rural students were collected from three participating high schools ($n = 341$). Fall and spring scores from 9th-grade students ($n = 227$) and 10th-grade students ($n = 114$) were analyzed in order to determine the amount of growth exhibited by each student. Mean growth was determined utilizing IBM SPSS Statistical Software, Version 20.

Data from three z tests were utilized to analyze the amount of growth. For the first test, students from the three sites were combined into their corresponding grade levels. The test for 9th- and 10th-grade students demonstrated that the mean growth exceeded the national norms ($p < 0.05$) for each cohort of students. The second test involved the completion of a z test for each

school. The means revealed 9th- and 10th-grade students from each of the three participating schools once again demonstrated significantly greater growth ($p < 0.05$) when compared to the norm. Table 6 (page 62) illustrates the breakdown of mean growth for each participating school and grade level.

The third z test examined the mean growth for each teacher's individual classrooms. Despite the fact $n < 30$ for several teachers (two of seven 9th grade and six of seven 10th), conclusions were made due to small classes being inherent to rural schools. The results of the test showed 9th-grade means from six of the seven teachers' classes (86%) demonstrated significantly greater growth ($p < 0.05$) when compared to the norms, while in the 10th grade, five of seven teachers (71%) exceeded norms. Table 7 (page 63) shows the breakdown for each classroom. Table 3 (page 52) illustrates the norms.

The results of the three z tests indicate use of Khan Academy in a one-to-one setting positively impacted student achievement of 9th- and 10th-grade students in participating schools. In 86% of participating teachers' classrooms, the 9th-grade students exceeded the November 2015 national norm for growth as measured by the NWEA MAP test. Of these same teachers, 71% demonstrated significant growth with their 10th-grade students. Consequently, it can be concluded that in both cases, a majority of participants demonstrated significant growth. Once combined, results indicated 9th- and 10th-grade students from each school, as well as each group as a whole, experienced significant growth. Qualitative data were analyzed to discover contributing factors.

Qualitative data. To collect data for this phenomenological study, the researcher conducted individual, semi-structured interviews using specific questions designed to obtain insight into the experiences of participants (Creswell, 2013; Marshall & Rossman, 2011). For the

qualitative portion of this mixed method study, volunteer teachers and principals from the three research sites participated in face-to-face, semi-structured interviews, and then several follow-up questions were asked to clarify and expand upon answers given by participants. All interviews were transcribed and read multiple times to ensure accuracy. Next, transcripts were coded by hand (Appendix J). Analysis of these codes illustrated many identical and similar themes which were combined to ultimately reveal 10 top codes (Appendix L).

The top codes were further distilled into four major themes regarding the use of Khan Academy to promote student achievement. Table 11 (p. 77) shows the codes related to student achievement and how they were combined into the four themes. Figure 5 (page 78) represents the four themes graphically. These themes will be discussed in this chapter utilizing the TPACK framework and existing literature for analysis.

Discussion of the Study Themes in Relation to TPACK and Previous Research

As demonstrated in Table 11 (p. 77), analysis of the qualitative data revealed four themes related to the Khan Academy and student achievement. Understanding these themes in terms of the common phenomenological experience of the participants, as well as how they relate to prior research builds upon the body of knowledge associated with the use of Khan Academy to improve student achievement. In addition, the themes demonstrate how K-12 math teachers in rural high schools integrated Khan Academy in relation to the TPACK theoretical framework.

Theme one: Students fill individual gaps and practice skills to mastery. The ability of Khan Academy to fill individual gaps and practice skills to mastery is the first theme of this study. Participants shared the common experience of utilizing Khan Academy pedagogically to target basic skills, skills taught in class, or skills beyond the scope of the curriculum. In each case, the classroom teacher continued to provide face-to-face instruction as the primary delivery

method but utilized Khan Academy for students to practice skills to mastery. The TPACK theoretical framework combines pedagogical knowledge, content knowledge, and technological knowledge to fully integrate educational technology. TPACK relates to a pedagogical shift created by the overlap of these types of educational knowledge (Koehler and Mishra, 2009). When teachers blend technological knowledge, pedagogical knowledge, and content knowledge to transform teaching and learning and fully integrate technology into the classroom, they demonstrate TPACK (Mishra & Koehler, 2006). Although all participants perceived Khan Academy as a supplemental tool, participants used it in the three different ways to pedagogically align its use with student needs and bring TPACK into play.

Use of Khan Academy by participants in this study was similar to sites in other research studies. In a study by Cargile and Harkness (2015), teachers used the program while maintaining whole class instruction more traditional in nature. It was not used for instruction outside of the school day to create time in the classroom for other projects or activities. Participants in the study for this dissertation continued to utilize primarily face-to-face instruction and rarely employed the instructional videos to deliver content. Instead, participants relied on the practice features to target skills.

Using blended tools such as Khan Academy is quickly becoming a common instructional practice as schools rely more on digital tools (Horn & Staker, 2015; Sheninger, 2014). Unfortunately, research demonstrates that results, in terms of student achievement (including math), have been mixed (Ashby et al., 2011; Glassett & Schrum, 2009; Hein, 2013; Kiger et al., 2012; Lewis, 2010; Li et al., 2009; Murphy et al., 2014; Rasanen, 2009; Rosen & Beck-Hill, 2012; Ysseldyke & Bolt, 2007). Research demonstrates that when the focus of blended learning is on achievement, the method is more likely to lead to positive student outcomes as opposed to

simply being a tool for managing teacher responsibilities (Ellis et al., 2006). In the case of participants for this study, Khan Academy was perceived as a supplemental tool capable of positively impacting student achievement. None of the participants mentioned managing teacher responsibilities during the interviews. Instead, all referred to the program as an instructional tool to fill gaps in learning, practice skills to mastery, or provide an avenue for students to explore topics beyond the course curriculum.

Khan is a remediation tool that fills gaps in learning. The first pedagogical use identified by participants was the use of Khan Academy to fill gaps in student learning. These gaps related primarily to basic skills the participants argued should have been mastered before entering high school. Research by Murphy et al. (2014) focused on the use of Khan Academy as a tool for intervention. The results of this study demonstrated teachers had positive perceptions regarding the utilization of the program, and students who used the program generally had higher grades in math. Unfortunately, because of the number of variables, a strong correlation between achievement and use of Khan Academy could not be made (Murphy et al., 2014). In fact, “although KA is enormously popular, to date, almost no empirical data exist on its use and effectiveness” (Cargile & Harkness, 2015). As a result, a goal of this dissertation research was to utilize quantitative results to demonstrate achievement and then examine teacher perceptions of the components of Khan Academy directly impacting outcomes.

Participants in this study reported one of the most critical aspects of Khan Academy concerning student achievement was its ability to provide students with a means to fill gaps in their learning. According to the teachers and administrators in this study, missing basic math skills leads to learning gaps, making it difficult for students to master more complex concepts. Participants also discussed the challenge created by students having a variety of holes and the

difficulty of developing an individualized practice for each student. According to Mr. Harding of Adams High School, “It is hard to meet this kid and this kid in the same class when gaps between these two kids are worse. It has been a new phenomenon but it is new, and it’s bigger. This gap is big.” Khan Academy’s ability to target these skills and fill individual gaps in student learning was perceived as one of the most critical components of improved student achievement on the NWEA Map test.

According to Mr. Harding, the students who demonstrated the most growth were the ones he assigned to work on basic skills through Khan Academy instead of allowing them to struggle with concepts they couldn’t do as a result of not mastering basic skills. According to Mr. Harding:

The ones that were on the mission and worked on it, they improved some, but the kids who I pulled out and said, ‘I don’t want you doing Algebra II/Algebra I. I want you doing arithmetic and I want to see how you grow in arithmetic.’”

Mr. Harding reported that it was these students he saw the most progress with and discussed how the use of Khan Academy helped overcome the challenge created when students are missing a variety of skills. In considering the individual nature of the program, Mr. Harding stated, “It helps fill that hole that many of them have at that level.”

To target skills, math teachers at the research sites utilized the recommendation feature to assign students practice and also challenged students to work in “missions” or a feature known as *The World of Math*. According to the participants, this allowed students to work on a variety of skills aligned to their individual needs. Unfortunately, there is a lack of available research regarding the utilization of Khan Academy as a tool for remediation of basic skills (Cargile & Harkness, 2015). This study helps to fill this gap by demonstrating improved student

achievement from classrooms utilizing the program in this manner. According to Mr. Harding, in the past he would use worksheets for students to practice missing skills. Now he exclusively uses Khan Academy through the remediation feature. Ms. Roy of Washington High School also used the recommendation feature to target skills while also challenging students to master other skills through the *World of Math* feature. A majority of participants reported students were more engaged in the program and more likely to work through the problems. According to Ms. Roy's principal, Mr. Fisher, "I think they like that fact because they feel like it gives success." Finally, Principal Warren of Jefferson High School attributed his students' success on the NWEA Map test to the use of Khan Academy to target gaps. He believes:

Exposure definitely helped. Students' practicing makes a difference. Khan is wonderful for identifying holes....Seems like students come in and by the time they are in seventh or eighth grade they have significant goals from what they missed somewhere. Math is hard if you don't have basic understanding. Khan is a tool to bridge those gaps."

Khan supports mastery learning. An important feature of Khan Academy identified by participants is that it promotes mastery learning by requiring students to demonstrate understanding by completing multiple problems before being allowed to move on. Teachers felt this was much more effective than paper and pencil assignments on which students often skip concepts.

Research on mastery learning dates back more than three decades to work completed by Bloom (1984). His research showed the value of individual tutoring and mastery learning. In fact, he demonstrated 98% of students individually tutored outperformed students not receiving tutoring. He went on to show that 84% of pupils involved in mastery activities showed greater achievement compared to students in activities designed for large group instruction (Bloom,

1984; Cargile & Harkness, 2015). Khan Academy supports both elements as demonstrated by the participants in this study who used the program to target and master remedial skills. Ms. Smith of Adams High School reported that one of the biggest shifts for her regarding use of Khan Academy was a change in her focus to mastery learning. When talking about her students she explained how her focus changed to, "Show me that you can master that; show me you can do five on Khan. I was like wow! There is something to mastery learning. I feel like, I know you know you are getting it."

Principal Fisher summed up the perception of participants regarding this first theme in the following statement:

We have this big test in 10th grade and how do I reach all these gaps these kids have? So this was a big part of that adaptive Khan work. Find those gaps and work on those skills without the teacher having to differentiate instruction totally for each kid."

For him and the other participants, the perception was that the nature of Khan Academy, which allowed students to fill individual gaps and practice skills to mastery, was paramount to the significant growth demonstrated by students on the NWEA Map test.

Khan provides students with a means to practice skills. Another component of this theme is that Khan Academy is an instructional tool by which students can practice skills taught in class by the classroom teacher. Like its capability to fill gaps, Khan Academy's structure provides an effective means for students to practice skills taught by the teacher. Participants identified how it promotes mastery by challenging students to answer multiple problems correctly before allowing the student to move on and recognized this as an important attribute of the program.

In Devers et al. (2014) students demonstrated growth after viewing instructional videos in Khan Academy. Unlike Devers, all of the participants in this study reported they preferred to use face-to-face instruction as opposed to the videos provided by Khan Academy. None of the participants identified the videos as pedagogically significant in terms of providing primary instruction to their students. Instead, participants relayed that students and teachers preferred face-to-face instruction followed by the use of Khan Academy for practice through the use of the recommendation feature or missions.

According to research, pairing math instruction with a digital component can have a positive impact on student achievement (Lewis, 2010; Kiger et al., 2012; Rosen & Beck-Hill, 2012). On the other hand, simply adding technology to classrooms does not guarantee positive results (Park, 2008). Students do better when there is face-to-face instruction that accompanies digital tools (Hein, 2013). Interviews of participants in the study revealed that in each case, the teacher relied on face-to-face instruction followed by practice by using Khan Academy. Ms. Smith of Adams High School discussed how she did not rely on Khan Academy for instruction. She stated that students did not like the videos on Khan Academy for initial instruction and instead preferred learning skills from her. The other participants shared this perception, and all supplemented their own instruction with Khan Academy.

Khan allows teachers to differentiate. Using digital tools such as Khan Academy to supplement instruction is changing the way content is delivered to students (Cargile & Harkness, 2015). A strength of Khan Academy is that it is structured so that students can individually practice skills to mastery in a self-paced environment (Cargile & Harkness, 2015). This individual nature allows teachers to differentiate to meet the needs of students. For Mr. Warren, Principal at Jefferson High School, the ability to differentiate was an important attribute. As a

principal of a small rural high school with only one math teacher, Mr. Warren has the challenge of reaching all students when the ability levels are more diverse than in schools with more options for students. Mr. Warren explained how Khan Academy allowed his teacher to spend more time with various groups in ways that are impossible without the technology. In Mr. Warren's opinion, repetition and practice were essential, and Khan Academy provided his teacher with the means to provide students with this necessary practice.

This study demonstrated that teachers and administrators perceived Khan Academy as a useful supplementary tool for giving students an effective way to practice skills taught by the teacher to mastery. This perception is supported by the growth demonstrated by students in the quantitative portion of this study.

Khan provides extensions for students, and students have control-time and pace. A final use of Khan Academy identified by participants was to challenge more advanced students with new curriculum beyond the subjects covered in class. Research demonstrates Khan Academy improves student engagement (Murphy et al., 2014). For the participants in this study, keeping students engaged who have already mastered the skills being taught in the classroom is always a challenge. Khan Academy provides a means by which teachers can differentiate in order to challenge these upper-end students who, participants argue, have often been ignored. In this case, students did utilize the videos as well as the hint feature to learn content. Mr. Warren expressed the importance of this feature during his interview saying that Khan Academy allowed students to explore topics they found interesting. According to Mr. Warren, "Khan gives students control of when they want to learn, how they want to learn, and what they want to learn." Students in his school are encouraged to be on Khan Academy during their free time throughout

the day and are challenged to utilize the program at home as well. Students are encouraged to explore further and choose what they want to learn.

Ms. Roy spoke of a bright student in her math class who was not challenged by the content presented in class. She talked about how this student made it his goal to master all of the *World of Math* by the time he graduates from high school. The student started with the Kindergarten level and began working his way through. According to Ms. Roy, "So I thought that was great. When you can get kids excited about math that is a good thing." For her, Khan Academy opened up new possibilities for her advanced students. In speaking of her advanced kids, Ms. Roy reflected, "I just explain it once, and we go through problems and boom they got it, and they are just bored. Now students are free to explore new topics that were not available to them before." According to Ms. Roy, "It has opened up a whole new world of possibilities with math. It is not just the one lesson they have to do and stick with."

In talking about the challenges created by having advanced students sitting idle, Principal Fisher commented, "What do you do with a kid that has the concept and is waiting for the other kids to catch up? So that's also how we have seen some students take that information and be able to increase their knowledge and keep pushing themselves without necessarily sitting and waiting." Ms. Jones went on to relay that she "found that the really good kids would fly through, and a lot of them had gotten further than we ever did on their own without even--I mean they started where we did, but they got further."

This study expands on the available research about Khan Academy's ability to be used pedagogically to challenge students ready to move on to more advanced concepts within the traditional classroom setting. Current research is lacking in this area, and as a result, this study provides insight into the perceptions of teachers using the program in this way and demonstrates

empirically that significant growth can occur. The lack of available research shows the need for further research into this area.

Theme two: Student and teacher buy-in maximize use of the program. The second theme emerging from this study regarding the attributes of Khan Academy having the greatest impact on the quantitative results of the study is the necessity of teacher and student buy-in to the program. Participants reported some high school teachers and students resisted certain aspects of Khan Academy. Research demonstrates teacher attitudes and beliefs play a significant role in the success of implementation (Kopcha, 2012; Penuel, 2006; Vanatta & Fordham, 2004). As a result, multiple studies have shown an essential component of successful technology integration is for staff to receive meaningful professional development and/or training aligned to teacher needs, attitudes, and beliefs (Alhomod & Shafi, 2013; Cullen et al., 2006; Dawson et al., 2006; Dunleavy et al., 2007; Efe, 2011; Kim et al., 2013; Kopcha, 2012; Silvernail & Buffinton, 2009; Swanson, 2013).

Administrators interviewed for this study all stressed the importance of teacher attitude concerning the success of the program and discussed challenges associated primarily with veteran teachers. This theme emerged from several interviews with teachers as well. In addition, educators discussed challenges they faced with students' resisting the use of Khan Academy and the attempts they made to overcome these challenges. As a result, these themes emerged as major components related to the quantitative results.

Teacher buy-in is critical for success. Research demonstrates that because teachers control how and when students utilize technology, they must make the commitment to adapting their teaching practices for there to be successful technology integration (Bebell & Kay, 2010; Inan & Lowther, 2010). Vanatta and Fordham (2004) specifically identified a willingness to

change as the primary predictor of technology use by teachers. Furthermore, Ertmer et al. (2007) provides evidence that although extrinsic barriers are necessary to overcome, it is also important to focus on intrinsic barriers. Ertmer's study demonstrated that internal motivation and personal beliefs are the most influential factors related to successful integration of technology. The study suggests intrinsic factors such as confidence and commitment affect the teacher's ability to be effective users more than extrinsic factors such as resources and time (Ertmer et al., 2007).

Interviews of participants for this dissertation demonstrated alignment to these findings through common perceptions surrounding the implementation of the Khan Academy pilot. As stated by Principal Warren, "If teachers are cynical or not fully committed in supporting implementation, then students will pick up on that attitude and the success of the program will be limited."

Principal Carter of Adams High School took over the job two years before this study and inherited a Khan Academy pilot in his school. He was not involved in the writing of the grant for the program and did not have a background in math instruction. Mr. Carter discussed some of the challenges with teacher buy-in. He spoke specifically about the benefit of one of his teachers, Ms. Smith. He explained how her buy-in and promotion of the program was what kept her colleagues engaged with the Khan Academy pilot. Mr. Carter had some veteran teachers at Adams High School that had been teaching for many years. In discussing new initiatives, he described the challenges associated with change when staff have a negative view of the change. According to Mr. Carter, "If they have a poor attitude about it, it is a waste of time." He spoke of how at the beginning of the pilot, it was hard for his veteran staff to make the switch to a digital tool. According to Mr. Carter:

You know we have some veteran folks in that department. There's some years of experience down in the math department. So for some of them to really grab a hold of it

and buy into it completely and find how to use it effectively in their classrooms has been tough. They think it doesn't work.

He went on to discuss his frustration "to not see the full potential of what it can do with certain teachers." For Mr. Carter, it has been a process of developing buy-in from the staff over time. For him, staying proactive and leaning on his supportive teachers was important. Mr. Carter relayed, "So you just try to stay positive and give them what they need and clear up concerns they have."

Ms. Smith was the teacher in Mr. Carter's school who took the lead on the Khan Academy pilot. She too discussed the challenges of getting all of her department to buy in to the use of the program. She talked about how she continually discussed the positive nature of the program and provided the necessary support for her colleagues to be successful. According to Ms. Smith, "...if you were never willing to try or to learn to try new things and stuff like that it's hard for them."

The interviews revealed teachers at Adams High School had the most struggles associated with teacher buy-in when compared to the other sites. Despite the challenges, the quantitative results demonstrated the school had significant growth on the NWEA Map test; however, Adams High School was the only school to have individual teachers not show significant growth (Table 7, page 63). The two teachers with means failing to demonstrate significant growth beyond the norm were Ms. Nelson and Ms. Jones (see Table 7, page 63). The interviews revealed these instructors did not have favorable views of the pilot and had an adverse perception of Khan Academy's usefulness. Ms. Nelson was hired late in the summer of 2013 and didn't have much time to prepare for her classes. She used Khan Academy but felt like she was mandated to use it as opposed to choosing how and when to use it. When asked to reflect on her

negative experience she stated, “I think it was because I was thrown into it and I wasn’t familiar. It just didn’t work well.” She went on to say, “For the most part it wasn’t the greatest experience but I think a lot of it was I was a brand new teacher. Seriously, the kids did not like it.” Ms. Nelson was excited to learn that despite her experience, her 10th-grade students exceeded the norm. When asked about her 9th-graders, she stated, “I had a tough group of kids. This year is much easier.” The other teacher with means failing to exceed the norm was Ms. Jones. Ms. Jones was in her 31st year of teaching and struggled with technology use. She used Khan Academy within her classroom but admitted she did not use it as extensively as other teachers in the building. Her kids also failed to buy in. According to Ms. Jones:

“I had some lulu kids last year. Some kids that were capable that didn’t do a thing. Every year every class is so different. Last year both my Algebra I classes--there were just quite a few yo-yos in there and it effected everyone and maybe it was part of the success or non-success of Khan.”

An example demonstrating the opposite was revealed by examining Jefferson High School. For Principal Fisher, having a positive mindset was essential to success. Mr. Fisher’s teacher, Ms. Roy, demonstrated the most growth of any teacher in the pilot (see Table 7, page 63). Reflecting on the reasons for Ms. Roy’s success, Mr. Fisher commented, “You know, her willingness to jump in and buy in and commit to above and beyond what is expected is a big reason.” He felt this attitude inspired her students, and feedback from parents provided support.

Yea, I hear parents and students that come up from the eighth grade to the freshman year. Just the email and conversation about just how well the kids are doing in math and they never have done well before, and they enjoy and understand it. They get it now and just

thank you! Holly is the reason for that. Just the dedication that ok, how to make this engaging is the biggest thing and Khan is a big part of that.

Teachers help students overcome frustrations and develop buy-in. A second component of this theme that emerged from the interviews was the challenge of overcoming student negativity about the program. Participants in the study reported a number of elements of Khan Academy that students found frustrating requiring teachers to remain positive with the program.

The first frustration identified by students was the requirement to correctly complete multiple problems in a row. The mastery format of Khan Academy requires students to demonstrate proficiency by being able to consecutively complete problems correctly. All of the participants in this study indicated they required students to achieve five correct responses before moving on. Teachers reported students became frustrated when they missed the fifth problem and had to start over. Instead of allowing the frustrations to cause students to quit, participants reported they had to encourage students to keep working. Ms. Roy discussed this challenge stating:

I became popular on number 4 because they wanted to get number 5 right and some would be frustrated because they would do four and then miss the fifth and I would say, “You just need a little more practice.”

All of the participants stated they had to keep encouraging those students who had to start over, and students frequently would argue with them while expressing frustration.

The second challenge identified by students was the requirement to answer questions in exactly the correct format. The nature of the program requires answers be written in a precise way that often led to frustrations by students who felt they had the right answer but merely expressed it differently. Several participants reported they too struggled to input answers in the

format designated by Khan Academy but indicated it was just something students had to overcome.

Finally, participants discussed the belief frustrations could be related to the implementation of a new program to high school students. At each research site, the students had experienced limited exposure to Khan Academy in the middle school, and participants questioned how students would perceive the program in the future as more and more teachers utilized the program at the middle school level. Ms. Nelson felt some resistance was due to this situation. She stated, “I think it’s because it was different. I mean for how many years have they had paper assignments.” Participants also relayed the fact that student attitude generally improved as the year progressed. According to Mr. Erickson of Washington High School, students were negative about the program during the first semester because they viewed the program as just another requirement. In the second semester,

....they saw that it benefitted them, then they were excited to do it. I had students who were not good students, who other teachers told me, “That kid is always on Khan Academy. He is on there all the time.”

For Principal Fisher, the key was school climate. He believes it is important to create a mindset by which students understand the importance of everything they do. For Mr. Fisher,

The kids understand what and why they are doing it and how important it is and why we need the data. I think the kids try to work their best, and then we celebrate. It's not just something, okay today we got to do a test and does it count?...I think it is the culture of our building. All our test scores- ISATS, MAP, everything we do well and I think it is how we approach it in general.

Theme three: Students have daily, individual access to devices. Many rural high schools have turned to the use of technology, using distance and blended learning to supplement and enrich the content as well as increase the number of available courses (Cullen et al., 2006; Hannum et al., 2009; Irvin et al., 2012; Reeves, 2003). Many rural schools are working to reach a point where a digital device is available to each student in the classroom. This scenario is called being one-to-one or simply 1:1 (Dunleavy et al., 2007; Lei & Zhao, 2008; Sheninger, 2014).

Participants in this study were all from one-to-one rural high schools receiving funding through a Khan Academy grant to purchase devices and provide MAP testing. Unfortunately the research on one-to-one deployments is inconsistent in terms of student achievement, with a number of studies revealing significant gains while others demonstrate the opposite (Burns & Polman, 2006; Carr, 2012a; Carr, 2012b; Cavanaugh et al., 2011; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008). As a result, this study sought first to identify if utilizing Khan Academy in a one-to-one setting positively impacted rural student achievement in math, and if so, what advantage one-to-one provided.

Having 1:1 provides daily individual access to devices. Participants in this study identified being one-to-one as paramount to the success of the Khan Academy pilot. As a matter of fact, all of the participants stated that had they not been one-to-one, the pilot would have failed. Participants identified two reasons for this condition. First, participants explained that scheduling labs is problematic while having devices in the classroom provides daily access the teacher can count on to be available. Secondly, participants stated that due to the individual nature of Khan Academy, it is critical for every student to have access to his or her own device. Sharing devices would not have had the same impact.

Every participant in this study identified significant challenges associated with implementing a digital intervention without the tools available in the classroom. Kim and Bagaka (2005) demonstrated rural students spend significantly less time using computers than do their urban/suburban counterparts. Opportunities such as the Khan Academy pilot provide rural high schools with a means of changing this condition. Ms. Smith, a teacher at Adams High School, discussed the importance of having devices readily available in her classroom. She stated, “I like the one-to-one because once you have procedures set up, they are set. It's not like, ‘Oh today is screw-off day because we have computers.’” Principal Fisher described the days when teachers had to schedule labs two or three weeks in advance and the problems it caused by having to plan lessons around when the lab was available. Now he states, “If they are accessible, and you can use them anytime you want, it is easier to plug it into your lessons.”

At Jefferson High School, every student has access to his or her own Chromebook throughout the day. In addition, students that make a deposit are allowed to take the device home. In reflecting on the impact of being one-to-one, Mr. Erickson described how having to schedule lab time would change the whole way he taught his class. Having constant access meant students could be working on Khan Academy throughout the day. According to Mr. Erickson:

How would you just go down to the computer lab and just work on it? You wouldn't have that opportunity to do that. But where they each have their own device there were no excuses. There were no reasons they couldn't.

For Ms. Roy at Jefferson High School, the constant access allowed her to utilize fully her time for math. She explained:

One of the deals in here is that they always have to work on math. They are never done. Even if they are done with the test or homework, there is always Khan Academy they can

use, and sometimes by the end of the test I have every kid on there and maybe they are just reviewing or finishing an assignment they haven't done, but having it one-to-one is just nice. If I had to share and plan, there would be days that kids that could be getting on there and I wouldn't have them or they were out of my classroom.

The second reason participants gave that being one-to-one is essential to success was that Khan Academy is so individual in nature. Because students work at various speeds and have different needs, the participants reported that sharing devices would have been ineffective. Research by Bebell and Kay (2010) on a one-to-one program demonstrated being one-to-one increased technology usage in the classroom because students did not have to share resources. Data collected from the interviews of participants revealed similar results. Ms. Roy explained that it is important for students to have their own devices because some students require more time than others to work through the tasks. Mr. Harding of Adams High School used Khan Academy to fill gaps and explained how having students share devices would have been counterproductive to working on individual gaps.

Because previous studies on one-to-one deployments have revealed mixed results related to student achievement, researchers have called for further studies on the topic (Carr, 2012a; Carr, 2012b; Dunleavy et. al, 2007; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008; Lei & Zhao, 2008; Means, 2010; Mozellus et al., 2012; O'Dwyer et al., 2008; Park, 2008; Shapley et al., 2010; Sheppard, 2011; Silvernail & Buffinton, 2009; Suhr et al., 2010). This study adds to the body of knowledge by demonstrating the components of a one-to-one program paired with Khan Academy that led to significant achievement.

Theme four: Students gain confidence with math. The third research question sought to answer whether Khan Academy positively impacts perseverance, or grit, with problem

solving. Research demonstrates people exhibiting high levels of grit have higher grade point averages, have higher standardized test scores, change careers less often, and finish challenging tasks at higher rates than people with low grit scores (Duckworth et al., 2007). Other studies have demonstrated perseverance is actually a better predictor of achievement than intelligence (Duckworth et al., 2010; Murayama et al., 2012; Rojas et al., 2013).

Khan builds confidence. Although participants did not agree on its ability to directly affect perseverance, the perception of Khan Academy's ability to positively impact confidence emerged as the top theme related to Khan Academy's ability to impact perseverance. Participants indicated that building confidence with math is important in terms of student achievement and perseverance. Although establishing a correlation between confidence and perseverance was outside the scope of this study, six of the 10 participants identified confidence building as an important attribute of Khan Academy during initial interviews regarding the topic of perseverance.

Examining literature reveals the term *self-efficacy* as a concept rooted in research that encompasses confidence. Whereas confidence refers to the strength of belief, self-efficacy refers to a belief in one's capabilities (Bandura, 1997). Research clearly indicates self-efficacy is a positive predictor of achievement in math (Cheema & Galluzzo, 2013; Fast et al., 2010; Malpass, O'Neil, & Hocevar, 1999; Pajares & Miller, 1994; Schunk, 1984).

A study into the gender gap in math achievement revealed anxiety and self-efficacy directly relate to the difference in math achievement. In terms of predicting achievement in math, the study found that after race, self-efficacy was the second highest factor. Socioeconomic status ranked third and math anxiety ranked fourth (Cheema & Galluzzo, 2013). As a result, the argument can be made that studies designed to predict math achievement must account for self-

efficacy, as it appears to have a significant impact. Participants from the study for this dissertation indicated that frequently, students lacked confidence, and this often led to lower achievement. Ms. Roy from Jefferson High School discussed a student who was putting a great deal of effort into improving her math skills and was very excited the first time she passed a test, even though she only earned a D. She went on to talk about how this student finally got a 100% on her last test. According to Ms. Roy, “It was a huge thing for her, and it was confidence.”

Although self-efficacy is an important component, students must also be motivated and able to apply themselves when faced with a challenging problem (Bandura, 1993). Participants from this study agree. For example, Ms. Roy stated, “So I think confidence and work ethic and desire to learn are the three main things. If you have those it doesn’t matter how low you are.” For her, each of these components is a part of perseverance, and Khan Academy is a tool used to positively impact confidence.

A study demonstrating the importance of the development of self-efficacy was conducted by Fast et al. (2010). Researchers concluded self-efficacy could be positively influenced by the creation of a classroom environment promoting mastery (Fast et al., 2010). This finding supports the theme from this study related to use of Khan Academy to promote mastery learning. Participants perceived the ability of Khan Academy to challenge students to master concepts as an important component of increasing student confidence with math. Ms. Smith from Adams High School talked about her perception that confidence positively impacts perseverance and her focus on use of mastery learning with Khan Academy. For her, the focus moved from following her pacing calendar to ensuring students mastered concepts and increased their confidence with math.

As discussed, research clearly demonstrates a positive relationship between self-efficacy and student achievement; however, there appears to be additional factors impacting perseverance (Bandura, 1993). Because the results from this study were inconclusive in terms of Khan Academy's ability to directly impact perseverance, further research is needed. Participants from this study agreed confidence impacts perseverance and indicated Khan Academy does improve confidence.

Conclusions

The conclusions that can be drawn from this mixed methods study answer the following three questions for which the study was designed:

Question 1. Is there a significant difference in the amount of growth, measured by MAP RIT scores, demonstrated by rural students utilizing one-to-one mobile devices integrated with Khan Academy when compared to national norms? The quantitative portion of this study utilized ex post facto data to determine if students at participating sites using Khan Academy in a pilot project for math instruction demonstrated significant growth on the NWEA Map Test. Fall and spring scores from 9th-grade students ($n = 227$) and 10th-grade students ($n = 114$) were analyzed in order to determine the amount of growth exhibited by each student. Mean growth was determined utilizing IBM SPSS Statistical Software, Version 20.

Data from three z tests were utilized to analyze the amount of growth. For all tests, NWEA's November 2015 norm was utilized and significance was determined at $p < 0.05$ (NWEA, 2015). The results of the three z tests indicate use of Khan Academy in a one-to-one setting positively impacted student achievement of 9th- and 10th-grade students in participating schools. In 86% of participating teachers' classrooms, the 9th-grade students exceeded the November 2015 national norm for growth as measured by the NWEA MAP test. Of these same

teachers, 71% demonstrated significant growth with their 10th-grade students. Consequently, it can be concluded that in both cases, a majority of participants demonstrated significant growth. Once combined, results indicated 9th- and 10th-grade students from each school, as well as each group as a whole, experienced significant growth.

Question 2. What do teachers and administrators of students in one-to-one rural math classes integrated with Khan Academy perceive as the factors having the greatest impact on student growth as demonstrated by MAP RIT scores? Semi-structured interviews with administrators and teachers were conducted to gather data for answering this question. The data revealed several themes. The common perceptions of participants were that the program's pedagogical uses, teacher and student buy-in, and the essential nature of a one-to-one program were the most necessary components leading to improved student achievement. These findings are significant given the mixed results of studies on one-to-one programs (Burns & Polman, 2006; Carr, 2012a; Carr, 2012b; Cavanaugh et al., 2011; Dunleavey & Heinecke, 2008; Grimes & Warchauer, 2008). Providing additional significance is the lack of data on the success of Khan Academy (Cargile & Harkness, 2015; Murphy et al., 2014). The experiences of teachers and administrators for this study add to the body of literature because they demonstrate the pedagogical uses of Khan Academy in a one-to-one setting that relate most to improved student achievement of rural high school students.

Pedagogical uses are important to student achievement. Participants in this study identified three pedagogical uses leading to improved performance. These included utilization of the program to fill gaps in student learning, use for practice of current skills to mastery, and use to allow students to explore concepts beyond the course curriculum. The available research on this topic focuses on the utilization of Khan Academy's videos for instruction, as well as the

ability of Khan Academy to impact student engagement (Cargile & Harkness, 2015; Devers et al., 2014, Light & Pierson, 2013b; Murphy et al., 2014). Although teachers in this study were appreciative of the videos provided by Khan Academy, they did not identify the videos as the most essential feature of Khan Academy. Instead, the use of the program for practice through the recommendation feature, missions, and exploration through the World of Math were seen as components having the greatest impact. At the time of this study, there were no peer reviewed studies specifically examining the uses detailed by the participants in this study. As a result, the voices of teachers and administrators involved in the Khan Academy pilot add to the body of knowledge. The TPACK Framework demonstrates the importance of blending technological, pedagogical, and content knowledge to effectively utilize educational technology (Agyei & Vogt, 2012; Koehler & Mishra, 2009, Niess et al., 2009; Richardson, 2009). Teachers must use their knowledge in these three areas to ensure the digital tools are used pedagogically to have the greatest impact on mastery of content.

Teacher and student buy-in are important to student achievement. Teacher and student buy-in to the program emerged as an essential element of the Khan Academy pilot. Participants discussed resistance to change by some veteran staff and the potential negative impact that can result. Scholars indicate teacher buy-in is critical to the success of implementation (Kopcha, 2012; Penuel, 2006; Vanatta & Fordham, 2004). In addition, studies show the importance of teacher attitudes to success (Alhomod & Shafi, 2013; Burns & Polman, 2006; Cullen et al., 2006; Dawson et al., 2006; Dunleavy et al., 2007; Efe, 2011; Hew & Brush, 2007; Inan & Lowther, 2010; Kim et al., 2013; Kopcha, 2012; Penuel, 2006; Silvernail & Buffinton, 2009; Swanson, 2013). Administrators involved in this study agreed and argued this was the single most important component to the success of the implementation of the Khan Academy pilot.

Although studies have been completed on this topic as it relates to one-to-one deployments, research is silent as it relates to Khan Academy. As a result, the voices of participants in this study add to the body of available knowledge.

Concerning students, the study revealed there are components of Khan Academy rural high school students found frustrating. In particular the requirements to correctly answer multiple questions in a row and the fact the program requires solutions to be formatted in a precise manner were identified as challenging for students. Consequently, staff had to remain positive and encourage students to work through frustrations. Here again, because previous research is silent on these frustrations, these findings add to the body of knowledge.

One-to-one use is important to student achievement. Regarding the utilization of a one-to-one program, participants argued this attribute of the pilot was essential to the success of the program. Participants reported that due to the individual nature of the program, sharing resources would not have been as effective. Also, due to the logistical challenges surrounding reserving lab time or mobile labs, having devices readily available in the classroom allowed for the greatest flexibility in lesson planning. In addition, being one-to-one ensured maximum utilization of the program by students. Research on one-to-one deployments is mixed in terms of impact on student achievement (Carr, 2012a; Carr, 2012b; Dunleavy et. al, 2007; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008; Lei & Zhao, 2008; Means, 2010; Mozelius et al., 2012; O'Dwyer et al., 2008; Park, 2008; Shapley et al., 2010; Sheppard, 2011; Silvernail & Buffinton, 2009; Suhr et al., 2010). As a result, this study adds to the body of available knowledge by demonstrating components of a successful deployment of a one-to-one program specifically paired with a digital intervention tool.

Question 3. What do teachers and administrators of students in one-to-one rural math classes integrated with Khan Academy perceive as the critical elements surrounding Khan Academy's ability to impact student perseverance with mathematical problem solving? Participants were asked to reflect on Khan Academy's ability to positively impact student perseverance or grit. Research on grit shows persistence to be an important component of achievement and actually is a better predictor of success than intelligence (Duckworth et al., 2010; Murayama et al., 2012; Rojas et al., 2013). The use of blended interventions to increase student grit is supported by research showing the use of digital interventions can develop perseverance as a skill (Lyon, 2014; Rojas et al., 2013). Unfortunately, participants in this study did not agree on the ability of Khan Academy to directly impact perseverance. On the other hand, interviews revealed a perception that the use of Khan Academy affected confidence as it relates to perseverance. The voice of participants adds to the body of knowledge by demonstrating the ability of Khan Academy to positively impact confidence with math. Confidence was reported to be an important element related to student achievement and is one of the factors impacting perseverance (Bandura, 1993).

Success involves multiple components. The question regarding the components of a successful one-to-one program implementing the Khan Academy pilot within rural high schools that this study researched is complex. Teachers and administrators brought a wealth of knowledge and experience, and each participant viewed implementation in a slightly different manner. Teachers made pedagogical decisions based on what they believed would be the most effective in terms of improving student achievement (TPACK). They utilized programs they had positive attitudes toward and overcame challenges associated with program implementation. As shown by participants in this study, there are multiple factors working together to impact student

achievement. These factors blend to demonstrate how Khan Academy, utilized in a one-to-one program, can significantly impact student achievement in a positive way by contributing to significant growth by rural high school students on the NWEA Map test.

Recommendations for Further Research

Due to a lack of empirical data on the success of Khan Academy, it is important to continue studying its use (Cargile & Harness, 2015; Murphy et al., 2014). While this study adds to the body of knowledge by showing perceptions of rural teachers and administrators surrounding the successful implementation of a one-to-one program involving Khan Academy, further research is critical regarding use of digital resources to increase student achievement in math.

This study demonstrated significant achievement by rural high school students using Khan Academy in a one-to-one setting. Further quantitative research is needed to provide additional support for this finding. At the time of this study, very little evidence was available demonstrating Khan Academy's ability to positively impact student achievement (Cargile & Harness, 2015; Murphy et al., 2014). Adding to the body of knowledge in this area will be important if arguments supporting the use of Khan Academy are to be strengthened.

Due to the fact participants in this study did not utilize Khan Academy videos as a significant component of their pedagogy, it would be enlightening to explore whether other successful implementations showed similar uses. Because the pilot program did not define the use of Khan Academy, it was used by participants in varying amounts of time and in a variety of ways. As a result, further research on the pedagogical uses of Khan Academy may yield additional or different results. Murphy et al. (2014) demonstrated that although research reveals

the ability of Khan Academy to impact engagement, questions still surround how its pedagogical use relates to student achievement. Continued research will build upon this body of knowledge.

One of the pedagogical uses of particular interest is the use of Khan Academy by students ready to move on to, or interested in exploring, additional topics. Research by Light and Pierson (2013b) demonstrated the ability of Khan Academy to inspire students to be self-regulated learners. Participants in this study discussed how Khan Academy was often used by students desiring to explore new topics. Additional research with these students may reveal other significant results.

This study focused on rural high schools utilizing Khan Academy in a one-to-one setting. Further research could study the impact of Khan Academy within other settings such as urban and suburban schools. Furthermore, studies on the use of Khan Academy in schools not one-to-one to could reveal additional components leading to success or failure.

Due to the fact participants did not agree on Khan Academy's ability to directly impact perseverance, more research on this topic is needed. At the time of this study, there were no peer reviewed studies available demonstrating a positive correlation between perseverance and use of Khan Academy. There are multiple factors impacting perseverance (Bandura, 1993). Participants of this study reported that Khan Academy's ability to impact confidence was one of these factors. Further studies will need to be completed to explore this topic further to better understand possible correlations with Khan Academy.

Another limitation of this study is the fact participating schools utilized the program in their lower-level math courses. All courses were either Algebra I or lower. As a result, further research is needed surrounding the use of Khan Academy in upper-level math courses. Although students in this study were able to demonstrate significant growth on the NWEA Map test, it

would be enlightening to explore results in upper-level math courses to see if growth trends are similar.

A final recommendation for additional research is to explore the impact of Khan Academy on a variety of demographic groups. This study did not examine issues related to gender, race, or socioeconomic status. Examining results of studies emphasizing various groups may reveal that Khan Academy has a greater impact on the achievement of some groups over others and may uncover additional components leading to success or failure of the program.

Implications for Professional Practice

Research into the use of Khan Academy to positively impact student achievement is limited (Cargile & Harness, 2015; Murphy et al., 2014). The results of this study will be helpful to any rural high school exploring strategies to increase growth in math scores. Better understanding the components of a successful implementation can help rural high schools like the ones from this study implement a successful program. Additionally, proactive professional development designed to target pedagogical strategies and teacher attitudes and beliefs could help meet this goal.

Research on one-to-one deployments have demonstrated mixed results (Carr, 2012a; Carr, 2012b; Dunleavy et. al, 2007; Dunleavy & Heinecke, 2008; Grimes & Warchauer, 2008; Lei & Zhao, 2008; Means, 2010; Mozellus et al., 2012; O'Dwyer et al., 2008; Park, 2008; Shapley et al., 2010; Sheppard, 2011; Silvernail & Buffinton, 2009; Suhr et al., 2010). One-to-one programs require a significant commitment of district resources to purchase devices for student use. Participants from this study relied heavily on their one-to-one status for the success of the program. Schools implementing one-to-one programs can use this research to show how

pairing the device deployment with a digital intervention tool can lead to the success that justifies the expense.

As school districts explore mastery learning, tools such as Khan Academy become common due to their support of this style of learning (Cargile & Harness, 2015). The participants of this study discussed the individual nature of the program and its ability to fill gaps and promote practice of skills to mastery. They also discussed the importance of Khan Academy use by students wanting to explore new topics. Implementing strategies designed to help every student achieve is important for schools as the new Common Core Standards are implemented and assessed by districts across the country (Stewart & Varner, 2012). Teachers and administrators in this study were all concerned with student achievement growth and showed how Khan Academy can be used to achieve this goal.

Rural high schools continue to face many challenges related to isolation (Reeves, 2003). To address these issues, many rural high schools have turned to the use of technology, utilizing distance and blended learning to supplement and enrich the content as well as increase the number of available courses (Cullen et al., 2006; Hannum et al., 2009; Irvin et al., 2012; Reeves, 2003). This study provides rural high schools with data surrounding a successful implementation of Khan Academy. The data are important as rural high schools continue to work to narrow the achievement gap and improve math scores.

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Appendix A

Permission To Use Figure 1

Hi Brady,

Yes of course you can use this image as long as you cite the publication where it is:

Niess, M. L., Ronau, R. N., Shafer, K. G., Driskell, S. O., Harper S. R., Johnston, C., Browning, C., Özgün-Koca, S. A., & Kersaint, G. (2009). Mathematics teacher TPACK standards and development model. *Contemporary Issues in Technology and Teacher Education* [Online serial], 9(1). Retrieved from <http://www.citejournal.org/vol9/iss1/mathematics/article1.cfm>

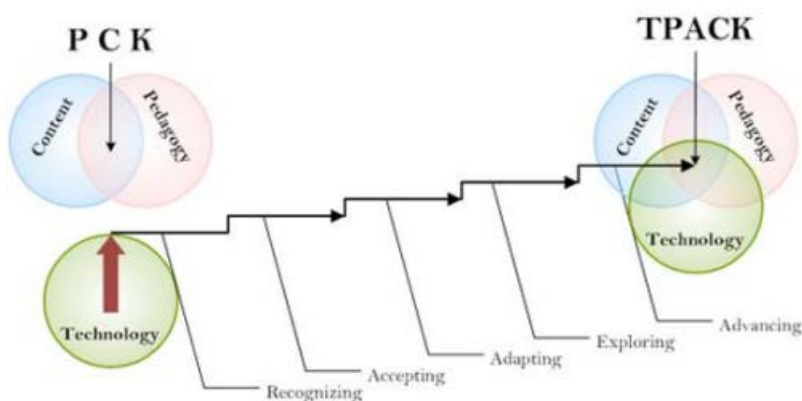
My best to you as you pursue this line of research.

Maggie Niess

On Nov 10, 2014, at 7:36 AM, Dickinson, Brady <dickinsonbr@tfsd.org> wrote:

Good morning Dr. Niess,

My name is Brady Dickinson and I am a doctoral student at Northwest Nazarene University in Nampa, Idaho. I am conducting research on the impact of Khan Academy on teacher pedagogy and I am utilizing TPACK as my theoretical framework. The reason I am contacting you is because I would like to use the following image in my dissertation.



Please let me know if this is acceptable.

Thank you for your time,

Brady D. Dickinson, Director
Operations and Educational Technology

<image002.png>

Maggie Niess
Professor Emeritus Mathematics Education
Oregon State University
267 Weniger Hall
Corvallis, OR 97331-6507
niessm@onid.orst.edu
541-737-1818
FAX: 541-737-1683

Appendix B

Permission To Use Figure 3

As long as you cite us, you should be fine.

Tom

Thomas Brush
Barbara B. Jacobs Chair in Education and Technology Chair, Instructional Systems Technology
Department School of Education Room 2276 Indiana University
201 N. Rose Ave.
Bloomington, IN 47405

Phone: 812-856-8458

On 10/7/14 9:52 PM, "ETS" <ets@indiana.edu> wrote:

>***Please note***

>

>This email was sent by an online form and the identity of the sender
>cannot be verified because this is a public anonymous form. The sender
>indicated the following contact information:

>

>Email Address: dickinsonbr@tfsd.org

>First Name: Brady

>Last Name: Dickinson

>

>The comment/inquiry follows:

>

>Dr. Brush,

>

>I am working on my dissertation and would like to include the chart
>from Hew & Brush, 2007, p. 226 in my study. What do I need to do to
>secure permission?

>

>Thank you for your time!

>

>

Appendix C

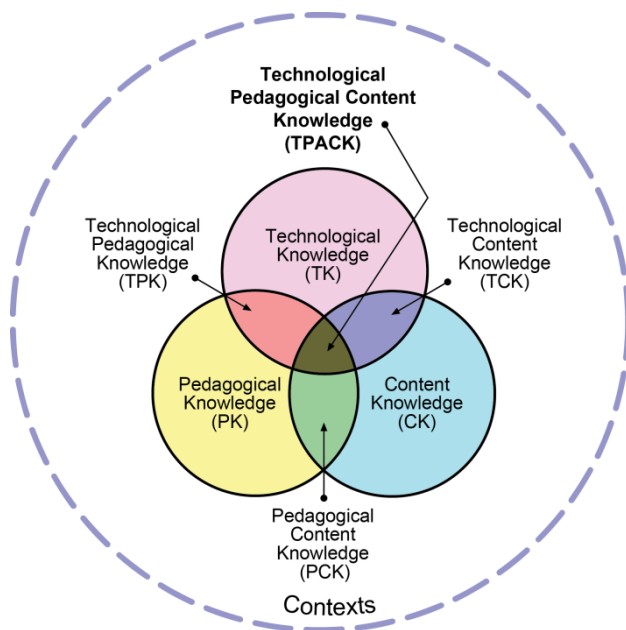
Permission To Use Figure 4

Using the image in your own works

Others are free to use the image in non-profit and for-profit works under the following conditions.

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If those conditions are met, there is no need to contact tpack.org, Matthew Koehler, or Punya Mishra. We hereby grant permission to use the image under the above stipulations.



Appendix D

Signed Consent

September 25, 2014

Northwest Nazarene University
Attention: HRRC Committee
Helstrom Business Center 1st Floor
623 S. University Boulevard
Nampa, Idaho 83686

RE: Research Proposal Site Access for Mr. Brady Dickinson

Dear HRRC Members:

This letter is to inform the HRRC that Administration at _____ School District has reviewed the proposed dissertation research plan including subjects, intervention, assessment procedures, proposed data and collection procedures, data analysis, and purpose of the study. Mr. Brady Dickinson has permission to conduct his research with staff and students at _____ Middle School/High School in _____ School District. The authorization dates for this research study are July 2015 to April 2016.

Respectfully,

Principal

Appendix E

Signed Consent

Office of the Principals

November 3, 2014

Northwest Nazarene University
Attention: HRRRC Committee
Helstrom Business Center 1st Floor
623 S University Boulevard
Nampa, Idaho 83686

RE: Research Proposal Site Access for Mr. Brady Dickinson

Dear HRRRC Members:

This letter is to inform the HRRRC that Administration at _____ School District has reviewed the proposed dissertation research plan including subjects, intervention, assessment procedures, proposed data and collection procedures, data analysis, and purpose of the study. Mr. Brady Dickinson has permission to conduct his research with staff and students at _____ High School in the _____ School District. The authorization dates for this research study are July 2015 to April 2016.

Respectfully,

Appendix F

Signed Consent

November 10, 2014

Northwest Nazarene University
Attention: HRRC Committee
Helstrom Business Center 1st Floor
623 S University Boulevard
Nampa, Idaho 83686

RE: Research Proposal Site Access for Mr. Brady Dickinson

Dear HRRC Members:

This letter is to inform the HRRC that Administration at _____ School District has reviewed the proposed dissertation research plan including subjects, intervention, assessment procedures, proposed data and collection procedures, data analysis, and purpose of the study. Mr. Brady Dickinson has permission to conduct his research with staff and students at _____ High School in the _____ School District. The authorization dates for this research study are July 2015 to April 2016.

Respectfully,

Appendix G

Informed Consent

A. PURPOSE AND BACKGROUND

Brady Dickinson, PHD candidate, in the Department of Graduate Education at Northwest Nazarene University is conducting a research study related to the impact of the Khan Academy imbedded into a one-to-one device program on student achievement, teacher pedagogy, and student perseverance. We appreciate your involvement in helping us investigate how to better serve and meet the needs of Northwest Nazarene University students.

You are being asked to participate in this study because you are a healthy volunteer, over the age of 18.

B. PROCEDURES

If you agree to be in the study, the following will occur:

1. You will be asked to sign an Informed Consent Form, volunteering to participate in the study.
2. You will be asked to answer questions related to demographics. This should take approximately 5 minutes to complete.
3. You will be interviewed and will answer a set of questions as well as participate in a discussion on the use of the Khan Academy as it relates to pedagogy and student perseverance. This interview will be audio taped and will last 30-45 minutes.
4. You will be asked to confirm the data collected as a result of the interview. This will be completed via email.

These procedures will be completed at a location mutually decided upon by the participant and principal investigator and will take a total time of about 60 minutes.

C. RISKS/DISCOMFORTS

1. Some of the discussion questions may make you uncomfortable or upset, but you are free to decline to answer any questions you do not wish to answer or to stop participation at any time.
2. For this research project, the researchers are requesting demographic information. Due to the make-up of [REDACTED] population, the combined answers to these questions may make an individual person identifiable. The researchers will make every effort to protect your confidentiality. However, if you are uncomfortable answering any of these questions, you may leave them blank.

3. Confidentiality: Participation in research may involve a loss of privacy; however, your records will be handled as confidentially as possible. No individual identities will be used in any reports or publications that may result from this study. All data from notes, audio tapes, and disks will be kept in a locked file cabinet in the Department and the key to the cabinet will be kept in a separate location. In compliance with the Federalwide Assurance Code, data from this study will be kept for three years, after which all data from the study will be destroyed (45 CFR 46.117).

D. BENEFITS

There will be no direct benefit to you from participating in this study. However, the information you provide may help educators to better understand how a digit math intervention program that is imbedded into a one-to-one program can transform teaching and positively impact student achievement in math.

E. PAYMENTS

There are no payments for participating in this study; however, each participant will receive a \$5 gift card as a way of saying “thank you” for your participation in this study.

F. QUESTIONS

If you have questions or concerns about participation in this study, you should first talk with the investigator. Brady Dickinson can be contacted via email at bdickinson@nnu.edu, via telephone at 208-731-6472 (H) / 208-733-6900 (W) or by writing: 647 Smithwick Rd., Twin Falls, Idaho 83301. You can also reach the dissertation chair for this study, Dr. LoriAnn Sanchez, at 208-467-8457, via email at lsanchez@nnu.edu or by writing Northwest Nazarene University, Wiley Learning Center, Suite 101 A, Nampa, Idaho 83686.

Should you feel distressed due to participation in this, you should contact your own health care provider.

G. CONSENT

You will be given a copy of this consent form to keep.

PARTICIPATION IN RESEARCH IS VOLUNTARY. You are free to decline to be in this study, or to withdraw from it at any point. Your decision as to whether or not to participate in this study will have no influence on your present or future status as a student at Northwest Nazarene University.

I give my consent to participate in this study:

Signature of Study Participant

Date

I give my consent for the interview and discussion to be audio taped in this study:

Signature of Study Participant

Date

I give my consent for direct quotes to be used in this study:

Signature of Study Participant

Date

Signature of Person Obtaining Consent

Date

**THE NORTHWEST NAZARENE UNIVERSITY HUMAN RESEARCH REVIEW COMMITTEE
HAS REVIEWED THIS PROJECT FOR THE PROTECTION OF HUMAN PARTICIPANTS IN
RESEARCH.**

Appendix H

Interview Questions: Teachers

Brady D. Dickinson
Interview Protocol: Teacher

Time of Interview:
Date:
Place of Interview:
Participant Age:
Participant Gender:
Participant Ethnicity

Purpose: The purpose of this interview is to gather data related to administrator and teacher perceptions of the impact of Khan Academy on pedagogy and student perseverance.

1. Is it okay if I record this interview?
2. Can you give me a brief background of your experience with math instruction?
3. As part of Khan Academy pilot, can you explain the ways you have implemented Khan Academy into your teaching practices?
4. In what ways, if any, has the use of Khan Academy impacted your knowledge of classroom technology usage?
5. In what ways, if any, has the use of Khan Academy impacted your content knowledge?
6. In what ways, if any, has the use of Khan Academy impacted your pedagogy?
7. Are there any practices that you can identify and explain that have changed since implementing Khan Academy?
8. Do you feel the use of Khan Academy has transformed the way you teach math or is it simply one of many tools students use to assist in their learning? Why or why not?

9. In your opinion, how has being one-to-one impacted your use of Khan Academy?
10. In your opinion, how has Khan Academy impacted your use of one-to-one devices?
11. In your opinion, what are the factors related to whether or not students persevere when it comes to solving mathematical problems?
12. Thinking back to before you implemented Khan Academy, have you noticed a change in your student's willingness to persevere with mathematical problem solving since implementing Khan Academy in your classroom?
13. If yes, what evidence do you have to support this?
14. If yes (#12), what do you perceive to be the reasons for the change? If no,
15. Are there educational challenges you associate with the fact that you teaching in a rural school?
16. What impact, if any, has the use of Khan Academy in a one-to-one setting had on overcoming the challenges created by teaching in a rural school?

Appendix I

Interview Questions: Administration

Brady D. Dickinson
Interview Protocol: Administrator

Time of Interview:
Date:
Place of Interview:
Participant Age:
Participant Gender:
Participant Ethnicity

Purpose: The purpose of this interview is to gather data related to administrator and teacher perceptions of the impact of Khan Academy on pedagogy and student perseverance.

1. Is it okay if I record this interview?
2. Can you give me a brief background of your experience with math instruction?
3. As part of Khan Academy pilot, can you explain the ways your teachers have implemented Khan Academy into their teaching practices?
4. In what ways, if any, has the use of Khan Academy impacted your knowledge of classroom technology usage?
5. In what ways, if any, has the use of Khan Academy impacted your teacher's content knowledge?
6. In what ways, if any, has the use of Khan Academy impacted your teacher's pedagogy?
7. Have you observed changes to classroom practices since implementing Khan Academy? If so, what are they?
8. Do you feel the use of Khan Academy has transformed the way your teachers teach math or is it simply one of many tools students use to assist in their learning?

9. In your opinion, how has being one-to-one impacted the use of Khan Academy in your school?
10. In your opinion, how has Khan Academy impacted the use of one-to-one devices in your school?
11. In your opinion, what are the factors related to whether or not students persevere when it comes to solving mathematical problems?
12. Have you noticed a change in your student's willingness to persevere with mathematical problem solving since implementing Khan Academy in your school?
13. If yes, What evidence do you have to support this?
14. If yes (#12), what do you perceive to be the reasons for the change?
15. Are there educational challenges you associate with the fact that you are in a rural school?
16. What impact, if any, has the use of Khan Academy in a one-to-one setting had on overcoming the challenges created by teaching in a rural school?

Appendix J
Codes Used for Analysis

Category	Code	Abrev
Admin	Teacher attitude key to success	ATT
Khan Advantages	Fills gaps-remediation tool	GAP
Khan Advantages	Opportunity for students to practice	A-PRAC
Khan Advantages	Individuality-can be tailored for each student	I
Khan Advantages	Student controls pace	P
Khan Advantages	Supports mastery learning	MAST
Khan Advantages	Student has control	C
Khan Advantages	Allows teacher to differentiate	DIF
Khan Advantages	Aligned with new style of teaching math	NEW
Khan Advantages	Student controls time	T
Khan Advantages	Engagement of students	ENG
Khan Advantages	Some students learn better online	SPREF
Khan Advantages	Khan teaches a little different or asks in a different way	DIFFER
Khan Advantages	Flexibility for teachers	TFLEX
Khan Advantages	Privacy for students-other's don't see them struggle	PRIV
Khan Advantages	Asks questions in a different way from teacher	QUEST
Khan Advantages	Flexibility for students	SFLEX
Khan Frustrations	Having to start over missions	SO
Khan Frustrations	Students resistant to change	FIGHT
Khan Frustrations	Students like after use	LIKE
Khan Frustrations	Grading	GRAD
Khan Frustrations	Desire face-to-face	F2F
Khan Frustrations	Videos are bad	VID
Khan Frustrations	Changes to missions	CHANGE
Khan Frustrations	Students can't get 5 in row and quit	QUIT
Khan Uses	Supplementary role	SUP
Khan Uses	Teacher assigns practice in weak areas	U-PRAC
Khan Uses	F2F instruction and then Khan	F-K
Khan Uses	Explore-extensions for kids ready to move on	EXP
Khan Uses	F2F instruction and Khan is assign	ASSIGN
Khan Uses	Teacher uses recommendations to push	EXPAND

	beyond instruction	
Khan Uses	Teacher drives the curriculum	TEACHER
Khan Uses	Students use for additional instruction	ADINS
Khan Uses	Scheduled time in class	TIC
Khan Uses	Students use for additional practice	S-PRAC
Khan Uses	Target basic skills	TAR
Khan Uses	Use when finished-free time	FREE
Khan Uses	Reward kids for energy points	POINTS
Khan Uses	Remediation	REM
Khan Uses	Can be used in classes with large gap between high and low students	H-L
Khan Uses	Rotation Model	ROT
Khan Uses	Having second teacher in room-step by step instructions	SBS
Khan Uses	Extra credit	EC
Khan Uses	Khan teaches lesson and teacher monitors-use of missions	KTEACH
Khan Uses	Khan used as the curriculum	KHAN
Needs	Funding	FUND
Needs	Trainings	TRAIN
One-to-one	1-1 individual access to device (student)	ACCESS
One-to-one	1-1 management issues	MAN
One-to-one	1-1 schedule-access to device (classroom)	SCHED
One-to-one	1-1 rural resource-another teacher	RR
Other	Teacher didn't like using the program-doesn't see value	DISLIKE
Other Challenges	Tech issues	TECH
Other Challenges	Some students don't like online	SOME
Other Challenges	Availability or access to technology	AVAIL
Other Challenges	Student's cheat	CHEAT
Other Challenges	Student lack of motivation biggest reason for achievement-not Khan	LACK
Other Challenges	Students depend on teacher-don't trust video	TRUST
Other Challenges	Students without tech can't do at home	W/O
Perseverance	Building confidence	CONF
Perseverance	No effect on perseverance	P-N
Perseverance	Understands importance of education	IMPORT
Perseverance	Has effect on perseverance	P-Y
Perseverance	Tech hurts perseverance-promotes instant access	TNEG
Perseverance	Work ethic	WE
Perseverance	Expectations from teacher	EXPEC

Perseverance	Expectations from home	HOME
Perseverance	Has some effect on perseverance	P-SW
Perseverance	Climate of school/classroom	CLIM
Perseverance	No basic skills/ability-won't start	ABIL
Perseverance	Desire to learn	DESIRE
Perseverance	No history of success	HIST
Perseverance	Learn how to fail and celebrate	FAIL
Professional Development	Khan Academy	PD-K
Professional Development	Blended	PD-B
Professional Development	Mentor	PD-M
Professional Development	Technology	PD-T
Professional Development	One-to-one	PD-1
Rural Schools	Limited course offerings	LIM
Rural Schools	Limited staffing	STAF
Rural Schools	Poverty	POV
Rural Schools	Teacher uses Khan as a personal resource	TEACH
Rural Schools	Lack of resources	RES
Rural Schools	Many rural parents are not highly educated	EDPAR
Rural Schools	Teacher has high expectations	EXPECT
Rural Schools	Lack of access to technology	MISSING
Rural Schools	Diversity	DIV
Teacher Challenges	Tech knowledge	TK
Teacher Challenges	Student buy-in	SBI
Teacher Challenges	Teacher buy-in	TBI
Teacher Challenges	Resistant to change-veteran	VET-RES
Teacher Challenges	Limited experience	LE
Teacher Challenges	Resistant to change	RESIST

Appendix K

Code Frequency

Category	Code	Abrev	Frequency- total mention	Frequency- Number of participants (x/10)
Khan Advantages	Fills gaps-remediation tool	GAP	34	8
Khan Uses	Supplementary role	SUP	26	9
Khan Uses	Teacher assigns practice in weak areas	U-PRAC	26	7
Khan Uses	F2F instruction and then Khan	F-K	22	8
Khan Advantages	Opportunity for students to practice	A-PRAC	21	9
Khan Advantages	Supports mastery learning	MAST	21	8
Khan Uses	Explore-extensions for kids ready to move on	EXP	20	7
Khan Uses	F2F instruction and Khan is assign	ASSIGN	19	5
Khan Uses	Teacher uses recommendations to push beyond instruction	EXPAND	19	5
One-to-one	1-1 individual access to device (student)	ACCESS	16	9
Perseverance	Building confidence	CONF	15	6
Khan Uses	Teacher drives the curriculum	TEACHER	14	10
Khan Uses	Students use for additional instruction	ADINS	14	5
Khan Frustrations	Having to start over missions	SO	14	7
Khan Frustrations	Students resistant to change	FIGHT	13	8
Khan Advantages	Individuality-can be tailored for each student	I	13	7
Khan Advantages	Student controls pace	P	13	5
Teacher Challenges	Tech knowledge	TK	12	6
Rural Schools	Limited course offerings	LIM	12	5
Professional Development	Khan Academy	PD-K	12	10
Rural Schools	Limited staffing	STAF	11	8
Khan Uses	Scheduled time in class	TIC	11	10
Khan Advantages	Student has control	C	11	5

Other Challenges	Tech issues	TECH	10	6
One-to-one	1-1 management issues	MAN	10	5
Khan Uses	Students use for additional practice	S-PRAC	10	4
Khan Frustrations	Students like after use	LIKE	10	6
Teacher Challenges	Teacher buy-in	TBI	9	5
Teacher Challenges	Resistant to change-veteran	VET-RES	9	4
One-to-one	1-1 schedule-access to device (classroom)	SCHED	9	8
Khan Uses	Target basic skills	TAR	9	5
Teacher Challenges	Student buy-in	SBI	8	7
Khan Advantages	Allows teacher to differentiate	DIF	8	4
Teacher Challenges	Resistant to change	RESIST	7	3
Khan Advantages	Aligned with new style of teaching math	NEW	7	5
Professional Development	Blended	PD-B	6	3
Perseverance	Understands importance of education	IMPORT	6	4
Khan Uses	Use when finished-free time	FREE	6	5
Khan Frustrations	Grading	GRAD	6	6
Khan Advantages	Student controls time	T	6	2
Admin	Teacher attitude key to success	ATT	6	4
Teacher Challenges	Limited experience	LE	5	5
Rural Schools	Poverty	POV	5	4
Perseverance	No effect on perseverance	P-N	5	5
Khan Uses	Reward kids for energy points	POINTS	5	3
Khan Frustrations	Desire face-to-face	F2F	5	4
Khan Frustrations	Videos are bad	VID	5	4
Rural Schools	Teacher uses Khan as a personal resource	TEACH	4	3
Rural Schools	Lack of resources	RES	4	2
Professional Development	Mentor	PD-M	4	4
Perseverance	Tech hurts perseverance-promotes instant access	TNEG	4	2
Perseverance	Work ethic	WE	4	2
Other	Teacher didn't like using the program-doesn't see value	DISLIKE	4	2
Needs	Funding	FUND	4	4
Needs	Trainings	TRAIN	4	3
Khan Uses	Remediation	REM	4	2
Khan Advantages	Engagement of students	ENG	4	2
Perseverance	Has effect on perseverance	P-Y	3	3

Perseverance	Expectations from teacher	EXPEC	3	3
Perseverance	Expectations from home	HOME	3	3
Perseverance	Climate of school/classroom	CLIM	3	2
Khan Advantages	Some students learn better online	SPREF	3	3
Khan Advantages	Khan teaches a little different or asks in a different way	DIFFER	3	2
Rural Schools	Many rural parents are not highly educated	EDPAR	2	2
Professional Development	Technology	PD-T	2	2
Perseverance	Has some effect on perseverance	P-SW	2	2
Perseverance	No basic skills/ability-won't start	ABIL	2	2
Other Challenges	Some students don't like online	SOME	2	2
Khan Uses	Can be used in classes with large gap between high and low students	H-L	2	2
Khan Uses	Rotation Model	ROT	2	2
Khan Uses	Having second teacher in room-step by step instructions	SBS	2	1
Khan Frustrations	Changes to missions	CHANGE	2	2
Khan Frustrations	Students can't get 5 in row and quit	QUIT	2	2
Khan Advantages	Flexibility for teachers	TFLEX	2	2
Khan Advantages	Privacy for students-other's don't see them struggle	PRIV	2	1
Khan Uses	Extra credit	EC	2	2
Rural Schools	Teacher has high expectations	EXPECT	1	1
Rural Schools	Lack of access to technology	MISSING	1	1
Rural Schools	Diversity	DIV	1	1
Perseverance	Desire to learn	DESIRE	1	1
Perseverance	No history of success	HIST	1	1
Perseverance	Learn how to fail and celebrate	FAIL	1	1
Other Challenges	Availability or access to technology	AVAIL	1	1
Other Challenges	Student's cheat	CHEAT	1	1
Other Challenges	Student lack of motivation biggest reason for achievement-not Khan	LACK	1	1
Other Challenges	Students depend on teacher-don't trust video	TRUST	1	1
Other Challenges	Students without tech can't do at home	W/O	1	1
One-to-one	1-1 rural resource-another	RR	1	1

	teacher			
Khan Uses	Khan teaches lesson and teacher monitors-use of missions	KTEACH	1	1
Khan Advantages	Asks questions in a different way from teacher	QUEST	1	1
Professional Development	One-to-one	PD-1	0	0
Khan Uses	Khan used as the curriculum	KHAN	0	0

Appendix L

Top Combined Code Categories

	Frequency- total mention	Frequency- Number of participants (x/10)
Supplementary role-teacher controls curriculum		
Supplementary role	26	9
F2F instruction and then Khan	22	8
Teacher drives the curriculum	14	10
Scheduled time in class	11	10
F2F instruction and Khan is assign	19	5
Teacher uses recommendations to push beyond instruction	19	5
Remediation tool fills gaps in student learning		
Fills gaps-remediation tool	34	8
Teacher assigns practice in weak areas	26	7
Target basic skills	9	5
Remediation	4	2
Gives students a means to practice skills		
Opportunity for students to practice	21	9
Students use for additional instruction	14	5
Students use for additional practice	10	4
Teacher Buy-in		
Teacher attitude key to success	6	4
Teacher didn't like using the program-doesn't see value	4	2
Teacher buy-in	9	5
Resistant to change-veteran	9	4
Resistant to change	7	3
Teachers help students overcome frustration (buy-in)		
Students resistant to change	13	8
Some students don't like online	2	2
Student buy-in	8	7
Students like after use	10	6

Student control		
Student controls pace	13	5
Student has control	11	5
Student controls time	6	2
1:1 provides daily individual access to devices		
1-1 individual access to device (student)	16	9
1-1 schedule-access to device (classroom)	9	8
Differentiation for high and low-ability to individualize		
Individuality-can be tailored for each student	13	7
Allows teacher to differentiate because of Khan's ability to be individual	8	4
Can be used in classes with large gap between high and low students	2	2
Supports mastery learning		
Supports mastery learning	21	7
Extensions for kids ready to move on		
Explore-extensions for kids ready to move on	20	7

Appendix M

Member Checking Email

Date:

Dear—

I hope that things are going well for you and your students. I want to start by once again thanking you for participating in my study entitled One-to-One Mobile Devices in a Rural School District: A Mixed Method Study Investigating the Impact of the Khan Academy on Mathematics Achievement and Teacher Pedagogy. The purpose of this email is to share with you some of the themes that resulted from the interviews I conducted. Please let me know if these accurately depict our conversation (obviously this represents a compilation from 10 interviews so there will be some differences). If you have any suggestions, modifications, or questions please let me know by Monday, November 2nd, 2015.

The purpose of this study was to explore the common experience of teachers involved in the Khan Pilot that relate to the student achievement demonstrated by students on NWEA map tests. The guiding research questions in this study were:

1. Is there a significant difference in the amount of growth, measured by MAP RIT scores, demonstrated by rural students utilizing one-to-one mobile devices integrated with the Khan Academy when compared to national norms?
2. What do teachers and administrators of students in one-to-one rural math classes integrated with the Khan Academy perceive as the factors having the greatest impact on student growth as demonstrated by MAP RIT scores?
3. What do teachers of students in one-to-one rural math classes integrated with the Khan Academy perceive as the pedagogical methods having the greatest impact on student perseverance with mathematical problem solving?

After reading, re-reading and coding the transcripts of the interviews the results demonstrated the themes listed below. Again, each of you uses the program a little different and has a little different experience. My goal was to capture the most common themes.

Advantages of using Khan:

- Allows teachers to individualize instruction to meet student's needs
- Ability to provide students with a tool for practice
- Promotes mastery of concepts
- Ability to use for remediation to target basic skills (fill gaps) students have failed to master

- Ability to differentiate instruction for high and low achieving students.
- Ability to fill learning gaps
- Ability to provide advanced students with an opportunity to move beyond the concepts covered in class

The one-to-one advantage:

- One to one is critical to effective use of the Khan Academy in the classroom
 - Provides individualized access to Khan
 - Teachers have constant/daily access with the classroom

Pedagogical Uses:

- Khan is used primarily as a supplementary tool to standard face to face instruction.
- Work on Khan generally follows instruction by the classroom teacher and is primarily used by teachers/students for three purposes:
 - To practice skills taught by the teacher (missions and/or recommendations)
 - To practice basis skills students have failed to master or have gaps in their learning (recommendations)
 - Teachers use Khan to challenge students ready to move on with advanced/additional material

Frustrations

- Students get frustrated with having to put answer in the exact format required by Khan
- There is a learning curve in terms of technology use
- When students don't buy in they fight the teacher on use

Overcoming Rural Challenges:

- Khan Academy provides a resource for math teachers with a wide range of high and low achieving students- common in rural schools due to limited staffing and course offerings

Climate

- Teachers and students having success leads to "buy in" which is critical to the effective use of the Khan Academy

Perseverance

- There is not agreement regarding whether or not use of the Khan Academy positively affects perseverance with math.
- The trait of Khan that relates to perseverance is its ability to increase confidence with math.

If you think I have missed the mark in any area, or have questions or comments please do not hesitate to contact me. I want to make sure my student accurately reflects your common experience. Students from all sites exceeded the norm scores represented by the NWEA Map test and I hope these themes help to tell the story. Thanks again for participating in my study. It would not have been possible without you!

Brady Dickinson
(208) 731-6472
dickinsonbr@tfsd.org

Appendix N

HRRC Permission

RE: [Northwest Nazarene University] Submission Protocol #1532015 - ONE-TO-ONE MOBILE DEVICES IN A RURAL SCHOOL DISTRICT: A MIXED METHOD STUDY INVESTIGATING THE IMPACT OF KHAN ACADEMY ON MATHEMATICS...

Inbox x

Northwest Nazarene
University mperson@nnu.edu **via** email.submittable.com
to me

Mar 10

Dear Brady,

The HRRC has reviewed your protocol: Protocol #1532015 - ONE-TO-ONE MOBILE DEVICES IN A RURAL SCHOOL DISTRICT: A MIXED METHOD STUDY INVESTIGATING THE IMPACT OF KHAN ACADEMY ON MATHEMATICS ACHIEVEMENT AND TEACHER PEDAGOGY. You received "Full Approval". Congratulations, you may begin your research. If you have any questions, let me know.

Northwest Nazarene University
Melanie Person
HRRC Member
623 S University Blvd
Nampa, ID 83686

You can go here to view the submission:
<http://nnu.submittable.com/user/submissions/3741817>

Appendix O

Protecting Human Research Participants

Protecting Human Subject Research Participants

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Brady Dickinson** successfully completed the NIH Web- based training course “Protecting Human Research Participants”.

Date of completion: 06/04/2014

Certification Number: 1481397

Appendix P
Confidentiality Form

Confidentiality Form

Mrs. Holly Dickinson will serve as Research Associates for the study entitled One-to-One Mobile Devices in a Rural School District: A Mixed Method Study Investigating the Impact of The Khan Academy on Mathematics Achievement and Teacher Pedagogy. All information and data gathered from this survey will remain confidential. The window of data collection for this study will be September 01, 2015 – May 1, 2016. The role of the Research Associates is to transcribe qualitative interviews and code the quantitative data.

Thank you,

Holly Dickinson
First and Last Name

8/27/15
Date

Holly Anne Dickinson
Signature

647 Smithwick Rd Twin Falls, ID 83301
Address, City, State, ZIP