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# Connected Classroom: A Program Evaluation of the Professional Development Program of a One-To-One Educational Technology Initiative in South Carolina

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# Connected Classroom: A Program Evaluation of the Professional Development Program of a One-To-One Educational Technology Initiative in South Carolina

By
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## Approval Page

This dissertation was submitted by Kelly J. Grant under the direction of the persons listed below. It was submitted to the Gardner-Webb University School of Education and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Gardner-Webb University.

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**Abstract**

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The purpose of this study was to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. A mixed-method research design was used to perform a logic model of program evaluation. Teacher self-reported proficiency in basic device usage, student productivity, student multimedia usage, and academic communication were gathered before the professional development program began and collected again at the 1-year mark. Data from both administrations were analyzed to determine the impact of professional development on teacher self-reported proficiency of technology integration. The researcher collected qualitative data during focus groups on the perceived barriers to professional learning and supportive conditions that allowed teachers to benefit from the professional development sessions offered by the district.

This study found that teachers benefited from the professional development sessions offered by the district as part of their one-to-one technology initiative. Statistically significant gains were found in all measured areas of teacher self-reported instructional proficiency and 12 of 16 areas of mobile device proficiency. This study also highlights differences in teacher proficiency across various demographic categories.

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# Chapter 1: Introduction

## Introduction

The gap between the technological proficiencies of students and teachers continues to grow. Prensky (2001, 2009) stated that the students of today could be referred to as "digital natives" and teachers as "digital immigrants" while also noting that students feel like they must "power down" while at school. The push to integrate new technologies into the classroom continues with the demands of the 21st century tools that are being developed at break-neck speeds. This push forced Prensky (2009) to reexamine his premise of natives and immigrants and look toward a "digital wisdom" that can be created to transform the profession of education.

Across the United States, student and teacher access to technology is at an all-time high with a national average of 1.7 computers per student currently in a classroom for student use (Gray, Thomas, & Lewis, 2010). This access has been many years in the making with schools originally purchasing computers for centrally located laboratories with limited access. This laboratory model has existed for several decades. However, with the availability of lighter and more portable technology such as iPods, iPads, tablets, and the like, coupled with increasing levels of internet access at home, districts have been able to transition towards the ability to utilize devices more than several times during the course of a week (Kozma, 1991; Penuel, 2006). While access to technology is at an all-time high, only one of six students reported in a national technology survey that their school provided access on a one-to-one level on a regular basis (Herold, 2014).

Many districts across the United States have increased technology access for students by not only providing students a device while at school but allowing these devices to be taken home to extend their educational usage beyond the walls of the school. These initiatives are more commonly known as one-to-one (Topper & Lancaster, 2013). These initiatives are growing across the country (Penuel, 2006). It was reported that the state of Iowa saw the number of one-to-one programs double in 1 school year (Sauers, 2012). Several studies have reviewed the efficacy of these expensive programs with experts noting the importance of students and teachers moving past a mere mastery of the technology and toward "the improvement of the process and environment in which teaching and learning occur" (Bebell & O'Dwyer, 2010, p. 12). This improvement is the goal of Koehler, Mishra, and Cain (2013) in their technology, pedagogy, and content knowledge (TPACK) framework. In its simplest form, this framework seeks to bridge the gap between a teacher's pedagogical skill set, their knowledge of the subject being taught, and the blending of this knowledge set in a technology-rich environment (Koehler et al., 2013).

Professional development has long been a staple of teacher practice. It has been used as a way to hone the skills of teachers after they have completed teacher education programs. In a review of the literature, it was reported that the single greatest factor affecting the use of technology in student learning was teacher professional development (Sivin-Kachala & Bialo, 2000). One study found that the level of implementation of technology in the classroom was statistically significant ($r=.47$) in relation to the professional development teachers received (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010). The amount and quality of professional development has also been shown to improve the technology integration of teachers with an advanced background in technology. One study showed a significant difference in the technology knowledge (TK) and integration after professional development in a one-to-one program for teachers in the 20- to 30-year-old age category, an age group that encompasses some of Prensky's digital natives (Sauers, 2012). This sentiment is echoed in the research of others who have found strong links between teacher professional development, high-quality teaching, student achievement, and future earning potential of students immersed in an environment that is both technology-rich and grounded in sound teaching practices (Hanushek, Kain, O'Brien, & Rivkin, 2005; Heck, 2007). With an increase in technology in the schools and a student body that comes with a depth of TK capital, a new research base is developing that seeks to redefine high-quality professional development. This research has led schools and districts to create a distributed approach to professional development that moves past seminar-style workshops to site-specific programs with an emphasis on assessment of impact over participant satisfaction (Cifuentes, Maxwell, & Bulu, 2011; Darling-Hammond, 1999; Phelps & Graham, 2008). Despite this research, it has been noted by several authors that state departments of education have reported professional development training in the area of technology as inadequate (Lawless & Pellegrino, 2007).

**Problem Statement**

Technological advancements are requiring teachers to go beyond using technology to substitute traditional pedagogical methods and forcing them to redefine a new skill set for the delivery, facilitation, and assessment of content and curriculum. The problem is evident: With the push to transform student learning at increasingly higher levels with new technologies, schools and districts are tasked with providing the support and training on new technologies. This training should blend an environment that is technology-heavy with a pedagogical base that may have been rooted in best practices from an era when students and staff did not have the plethora of options available today. Research has shown that a significant barrier to technology integration is a lack of training and professional development (Sauers, 2012). This need has been well-documented. Numerous researchers have studied one-to-one programs and their impact on student achievement. These researchers have noted that some programs have shown gains in student achievement while others have not (Weston & Bain, 2010). The common theme from most research on one-to-one programs and technology integration is the need for high-quality professional development for teachers and administrators to ensure fidelity of program implementation (Corn, Huff, Halstead, & Patel, 2011; Hastings, 2009; Penuel, 2006; Weston & Bain, 2010).

**Purpose of the Study**

The purpose of this study was to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. The International Society for Technology in Education (ISTE) released an online research-based tool for gauging the preparedness of districts and schools wishing to adopt a one-to-one model of technology integration (Frisbee, 2014). This framework listed 14 essential conditions that need to be met in order to facilitate a smooth and effective transition to a school environment that is rich in technology (Essential Conditions, 2014). These conditions are aligned to ISTE's technology standards for students, teachers, and administrators (Williamson & Redish, 2009). The areas included in ISTE's essential conditions include: shared vision, technical support, empowered leaders, curriculum framework, implementation planning, student-centered learning, consistent and adequate funding, assessment and evaluation, equitable access, engaged communities, skilled personnel, support policies, ongoing professional learning, and supportive external context (Essential Conditions, 2014). The district identified three measures of success for the professional learning plan. These measures included technology proficiency survey data, TPACK growth, and collaboration outside of school. For the purposes of this study, only data from the proficiency survey and focus-group responses were used to measure outcomes.

A logic model of program evaluation was utilized to identify the resources, activities, and outputs while measuring the outcomes of the professional development program (Lawton, Brandon, Cicchinelli, & Kekahio, 2014). When properly presented, a logic model of program evaluation conveys the underlying theories of the program designers (Lawton et al., 2014). The logical links between an organization's resources (inputs), the activities completed, and their measurable outcomes are often presented in a visual form to simplify both the planning and evaluation processes (Lawton et al., 2014). The logic model was chosen because of its applicability to educational research practices and the ability to link planning with measurable outcomes (Lawton et al., 2014).

**Research Questions**

Adhering to the logic model of program evaluation, the research questions of this study focused on the desired outcomes of the professional development portion of the connected classroom initiative. Those questions are

1. To what extent did the district's professional development program change teachers' perceptions of their technology proficiency within the district's key learning components (device basic skills, collaboration with the device, productivity with the device, and using multimedia tools with the device)?
2. To what extent did the district's professional development program change teachers' perceptions of their ability to use the devices instructionally with students in the classroom within the district's key learning components (device basic skills, collaboration with the device, productivity with the

device, and using multimedia tools with the device)?

3. What areas within the district's key learning components (device basic skills, collaboration with the device, productivity with the device, and using multimedia tools with the device) had the greatest and least gains by teachers?
4. Were there differences in teachers' perceptions of the technology proficiency after participating in year 1 of the professional learning program related to specific teacher demographics including age of the teacher, years of experience, and type of school?
5. What conditions contributed to greater teacher proficiency and use of devices instructionally in the classroom?

**Setting**

This study took place in a school district in South Carolina that is evenly split between rural and suburban areas with nearly 6,900 students. Approximately 31% of the students receive subsidized lunch. Eighty-two percent of the students are Caucasian with 10% listed as African American and 3% listed as Hispanic. The district has performed well in most accountability measures and has maintained an excellent rating from the state of South Carolina for the last 5 school years. Forty-three percent of the district teaching staff is made up of teachers in their first 10 years in the profession; 31% of teachers have 11 to 19 years of experience; and 26% of teachers yield more than 20 years in the classroom. According to a district-administered survey, internet connectivity at home is readily available in most of the district's middle- and high-income families, but there is documented limited high-speed internet availability in the rural areas on the northwest side of the district. This data is important for the setting of the study as it describes the context and working conditions of district teachers. The 31% subsidized lunch population is a district-wide number with some schools well above and well below this level. It is of note that three of the six elementary schools encompassing the more rural areas and downtown sections of the district qualify for Title I status.

Considerable funds were allocated by the school board to support the connected classroom initiative from a personnel and infrastructure standpoint. The largest investment made was a lease agreement with Apple. The district will spend $1.4 million per year to equip every student in kindergarten through eighth grade with an Apple iPad and every high school student with a MacBook Air. Student devices are refreshed every 3 years under the terms of their agreement with Apple. An additional one-time $560,000 was spent on AirServer software for displaying information from teacher devices, additional internet bandwidth, and an internet filtering system to maximize access to the network while protecting students from unauthorized content. The district spent $85,000 on charging and security lock boxes for iPads that remained at school, mainly serving students in prekindergarten through second grade. Over $150,000 was spent on surplus iPads and MacBook Pro laptops to replace damaged items and supply new-to-the-district students with a device when they enroll during the middle of the year. Three instructional technology integration specialists were hired at a cost of $210,000 to support teacher and student use. This step was essential to the professional development plan as the original technology coaches, along with the newly created position of director of instructional technology, worked extensively with the Apple embedded education specialist to structure site-based professional development activities geared toward the needs of individual teachers and departments. The district opted to create a self-insurance pool for student-damaged mobile devices. Each student in Grades 3-12 could opt to take their device home if he/she could pay a $50 fee that covered one accidental breakage per school year. The district facilitated a payment plan for parents who needed to pay the fee over time. Students on free or reduced lunch could also apply for a hardship to decrease or waive the fee. These funds created a self-insurance pool to leverage collected funds against future liabilities.

Nationally, one-to-one programs are reported to cost roughly $100 to $400 per student per year depending on the existing structure of the district's technology usage (Greaves, Haynes, Wilson, Gielniak, & Peterson, 2012). The first year of connected classroom will cost approximately $350 per student with a yearly recurring cost at current levels projected to cost $232 per student.

**Program Description**

The connected classroom initiative focused on two main components of a one-to-one student-to-electronic device program in the school district. As mentioned above, considerable resources were allocated to purchase and upgrade the hardware needed to facilitate the transition to a one-to-one environment, and additional resources and personnel were used in the professional development of teachers and staff. For the purposes of this study, only the professional development program of connected classroom will be evaluated using the logic model.

Connected classroom started with a strategic plan to enhance student learning with an influx of technology into the district's schools. This strategic plan guided district leaders to develop their own version of a one-to-one model. Four learning outcomes of the connected classroom initiative were identified that aligned with the existing district core values. Creativity, collaboration, problem solving, and digital citizenship were chosen as the areas in which all teachers would facilitate student work and serve as a framework for creating connected classroom lessons. These areas were included in the original framework for 21st century skills that needed to be taught in schools (Lemke, 2002). Research has shown that these four areas are identified as some of the leading themes in supporting successful one-to-one integration for teachers and students (Chou, Block, & Jesness, 2012; Jones, 2014).

The professional development program began with a small group of 33 teachers who piloted the one-to-one initiative. These teachers applied for the program and were hand selected to represent a cross section of grade level and content areas. The pilot program occurred during the 2013-2014 school year. This group of educators met on a monthly basis to receive direct instruction in new technologies. The initial connected classrooms were transitioned into the one-to-one role in the beginning of the school year. Connected teachers integrated new strategies as they learned and developed a common knowledge network that would be the basis for district-wide professional development.

In December 2013, a survey (Appendix A) was distributed to all district teachers to assess their technology proficiency on iPads and MacBooks and their preferred learning venues for future professional development. This survey was administered by K-12 Insight, a psychometrics firm contracted by the district for many of its data collection needs. Four areas of focus were targeted by the district in the survey which research has shown can be significant barriers to technology integration in the classroom (Gray et al., 2010; Lawton et al., 2014; Prensky, 2001, 2009; Sivin-Kachala & Bialo, 2000). Essentially, the district asked teachers to rate themselves in terms of their perceived ability to use the technology in a classroom setting (device usage), teaching students to use their device for productivity of school work, teaching students to use multimedia to create and present, and academic communication in the classroom.

Prensky's (2001, 2009) description of "digital natives" is not currently a majority of the teaching workforce for a typical school district. This fact was evident in preprogram survey data conducted by the district which showed that teachers lacked many of the basic skills necessary to use their district-issued device. Table 1 highlights the subset of items from the initial survey that showed weakness in teacher-reported proficiency with their mobile devices.

Table 1

*Teacher Self-Reported Device Proficiency*

| Survey Item | Highly Skilled | Intermediate | Novice | Never Used |
|---|---|---|---|---|
| Word processing with Pages | 11% | 22% | 23% | 44% |
| Word processing with Word 2010 or 2013 | 51% | 41% | 6% | 2% |
| Presenting with Keynote | 4% | 11% | 25% | 60% |
| Presenting with PowerPoint 2010 or 2013 | 44% | 36% | 17% | 3% |
| Spreadsheet design with Excel 2010 or 2013 | 10% | 33% | 45% | 12% |
| Spreadsheet design with Numbers on a mobile device | 1% | 10% | 28% | 61% |
| Note taking on a mobile device | 16% | 32% | 33% | 19% |
| Library media apps | 10% | 23% | 28% | 28% |
| Photo capture and editing | 20% | 36% | 36% | 8% |
| Video recording and editing | 11% | 28% | 44% | 17% |
| Use of special device features like speak selection or guided access | 3% | 17% | 39% | 41% |
| Managing content with cloud storage | 4% | 14% | 43% | 39% |
| Using iBooks (dictionary, sticky notes, highlighter) | 8% | 21% | 35% | 36% |
| Using online student response tools | 3% | 13% | 33% | 51% |
| Using online learning management tools for class discussion | 3% | 13% | 32% | 52% |

These data are consistent with a study by Barrett-Greenly (2014) that showed teachers with a basic knowledge of technology benefited from a targeted professional development program aimed at preparing teachers for technology integration with an iPad cart model of deployment. Barrett-Greenly reported that 50% of teachers in their study self-reported as proficient in selecting and utilizing new technology. Results from this program showed that even experienced members benefited from a targeted professional development approach (Barrett-Greenly, 2014).

The ability to use a device for basic functions does not guarantee that a teacher will be able to effectively utilize these devices for implementation in a manner that is consistent with the TPACK framework (Koehler et al., 2013; Koh, Chai, & Tsai, 2013, 2014). TK, pedagogical knowledge (PK), and content knowledge (CT) are the three components of Koehler et al.'s (2013) TPACK framework of technology integration. This framework highlights the interconnectedness of the types of knowledge teachers may possess and how each can be developed to enhance technology integration in the classroom. To move beyond basic functions, teachers must possess the ability to teach students how to use their mobile device to produce schoolwork (O'Hara, Pritchard, Huang, & Pella, 2013). In a national survey, a large majority of students stated that mobile device usage has the ability to make learning more fun, offers the ability to best reach their goals, and changes the landscape of education in the future (Herold, 2014). This same study revealed that students believe they understand mobile devices and mobile device usage better than their teachers with 56% of elementary students reporting more knowledge and 75% of high school students reporting more knowledge than their teachers (Herold, 2014). Teachers must tap into this expertise and willingness to transform the traditional classroom into a digital classroom. District teachers reported weakness in the ability to teach students how to use their mobile device for schoolwork production. Table 2 highlights the subset of questions from the district survey related to teacher perceptions of how they utilize technology to have students demonstrate learning.

Table 2

*Teacher Self-Reported Proficiency in Providing Students the Opportunity to Demonstrate Learning with Various Technologies*

| Survey Item | Highly Skilled | Intermediate | Novice | Never Used |
|---|---|---|---|---|
| Word processing with Pages | 7% | 19% | 22% | 52% |
| Word processing with Word 2010 or 2013 | 41% | 36% | 14% | 10% |
| Spreadsheet design with Excel 2010 or 2013 | 7% | 23% | 41% | 29% |
| Spreadsheet design with Numbers on a mobile device | 2% | 8% | 31%% | 59% |
| Conducting online research using an internet browser and library apps | 29% | 36% | 21% | 14% |
| Note taking on a mobile device | 9% | 20% | 35% | 35% |
| Library media apps | 8% | 20% | 33% | 38% |
| Use of special device features like speak selection or guided access | 3% | 14% | 34% | 49% |
| Managing content with cloud storage | 3% | 11% | 36% | 50% |
| Using iBooks (dictionary, sticky notes, highlighter) | 6% | 19% | 30% | 45% |

The district reported that teachers were also deficient in their ability to have students create and present knowledge using multimedia applications on mobile devices. When combined with proper guidance and teaching methodologies, student-created multimedia projects have been shown to significantly impact achievement (Wojtanowski, 2012). This research is also supported in a longitudinal study over a 15-year period that covered a variety of subject areas and the use of technology. This analysis showed a moderate effect size when technology was incorporated into traditional methods (Lee, Waxman, Wu, Michko, & Lin, 2013). Table 3 highlights the initial survey questions covering teacher self-reported proficiency in having students create and present knowledge with multi-media, and the results are consistent with many of the other areas of weakness for district teachers.

Table 3

*Teacher Self-Reported Proficiency in Student Creation and Presentation of Knowledge Using Multimedia Applications*

| Survey Item | Highly Skilled | Intermediate | Novice | Never Used |
|---|---|---|---|---|
| Presenting with Keynote | 4% | 10% | 22% | 64% |
| Presenting with PowerPoint 2010 or 2013 | 33% | 34% | 20% | 14% |
| Photo capture and editing | 16% | 32% | 33% | 19% |
| Video recording and editing | 10% | 24% | 37% | 29% |

The fourth area of focus for district leaders was student and teacher academic communication, specifically the use of online student response tools and learning management software. Learning management systems offers the teacher the opportunity to interact with students, students to interact with each other, and the ability to differentiate and tailor an academic program to individual needs (Watson & Watson, 2007). Watson and Watson (2007) pointed out that a learning management system is simply the vessel by which content and curriculum are delivered. Learning management systems offer teachers and students a platform to interact on schoolwork and, when appropriate, students to interact with each other in discussions and collaborative projects.

Student response systems are electronic devices that allow students the opportunity to respond to teacher questions or assessments from their seat without the need to talk or write. A teacher will prepare questions ahead of time and ask students to respond on their device. In recent years, technology has allowed for mobile devices to be used as an online student response tool. Researchers have noted that this interaction is ideal for formative assessments and checks for understanding because of student concerns of peer reaction (Latham & Hill, 2014). District teachers rated themselves low on the use of both learning management systems and student response systems. Table 4 highlights the survey items that covered both areas.

Table 4

*Teacher Self-Reported Proficiency in Student Communication*

| Survey Item | Highly Skilled | Intermediate | Novice | Never Used |
|---|---|---|---|---|
| Using online student response tools | 3% | 15% | 30% | 52% |
| Using online learning management tools for class discussion | 2% | 13% | 30% | 55% |

With the information from the initial survey, district technology staff and connected classroom teachers created a series of professional development programs centered around the four areas with content integration woven into the academic communication area. This series of professional development programs was part of an initial 10 hours of training that were required of all site-based administrators and teachers in the connected classroom pilot year of 2013-2014.

In January 2014, a district-wide professional development day was held at a central location, and all district teachers were required to attend. This initial event kicked off the yearlong technology-focused professional development portion of the connected classroom initiative. Teachers had the ability to complete four of the required 10 hours of training during the event. The TPACK model provided the theoretical framework for all professional development activities and sessions (Koehler et al., 2013). This framework provided the district with a model to develop teacher professional learning opportunities that blended their already rich knowledge of content and pedagogy with the 21st century tools that would be available to all district students (Kirkland, 2014). The remaining 6 hours of training for the 2013-2014 school year were completed in various afterschool hours, planning periods, and summer professional learning opportunities for teachers and administrators.

**Technology Staffing**

The district also transitioned technology teachers into the role of technology coach and facilitator and hired additional district-level coaches to support the transition. This strategic staffing took buy in from principals at all levels. The technology teacher, especially in the elementary level, was treated as an exploratory-related art teacher and part of the regularly scheduled rotation. Transitioning this class out of the exploratory-related arts schedule required flexibility and a willingness to change old practices on the part of principals at the elementary and middle school level. Transitioning and training these building-level coaches were important parts of the funding mechanism to ensure high-quality professional development on an ongoing basis in the schools. As part of their lease agreement, the school district negotiated the use of an embedded Apple educational specialist to assist the technology coaches in providing professional development opportunities for administrators and teachers. The Apple embedded specialist was a professional educator hired by Apple to train teachers and staff on the use of Apple products in their roles as educators. The district's 10 schools and district office staff shared the expertise of the Apple embedded specialist and a train the trainer model was most often utilized to disseminate information in the most efficient ways possible.

The district's plan for professional development parallels many of the best practices listed by ISTE in their Project RED (Greaves et al., 2012). These best practices are similar to the Digital Conversion of the Mooresville Graded School District in Mooresville, North Carolina. Mooresville Graded School District has been nationally recognized for their innovative approach to one-to-one technology integration while increasing academic achievement (Plummer, 2012). Mooresville followed a similar process to the connected classroom initiative by giving teachers and administration technology before students to allow them to take control of their own professional learning. The professional development program began before student devices were delivered and continued with site-based programs during the school year, including nine early release days and a large-scale voluntary summer institute for teachers (Greaves et al., 2012).

**Participants**

The targeted population of this study consisted of the teaching staff of the school district in which the professional development program was implemented during the

2013-2014 and 2014-2015 school years. The school district is equally divided between rural and suburban schools and is located in the upstate of South Carolina. As mentioned earlier, 47% of the participants have more than 10 years of classroom experience. Teachers at the continuing contract level compromise 84% of the district. Teachers holding advanced degrees make up 64% of the district instructional staff which is slightly higher than the state of South Carolina average of 60%. Written permission from the superintendent was obtained for this study.

**Logic Model**

A logic model of program evaluation was used for this study. The logic model was utilized to highlight the connection between district needs as they relate to the problem statement and the activities of the district to address these needs. Data were analyzed from a survey administered prior to implementation of the professional development plan and 1 year after implementation of the professional development program to determine the degree to which teachers improved in their self-reported proficiency in the four technology outcomes by district leaders. The district's goal was to move teacher self-reported proficiencies from low to high status in four outcome areas: low teacher self-reported proficiency in using technology as a teaching tool in the areas of basic device use, teaching students how to use technology to produce work, teaching students how to use multimedia to create or present knowledge, and using technology to facilitate communication and content integration. The identified needs guided the efforts of the district to develop the following inputs: hire additional coaches, develop courses that were content and or grade-level specific, ensure courses focused on the needs of adult learners and adhered to the TPACK model of technology integration, and ensure teachers had some accountability to completing the courses prior to getting their devices

(Koehler et al., 2013). The output of the program was a systematic professional development plan which included a large-scale day-long professional development for all district teachers, district staff-led sessions at afterschool learning sessions, “flipped” learning activities for teachers, school-wide directed technology learning sessions, summer professional development sessions, and the creation of master lesson plans for deployment of student devices. Prior to receiving their devices for students in a one-to-one teaching model, teachers were required to complete a total of 10 hours of professional development before the beginning of the 2014-2015 school year. The district kicked off this required training with a day-long professional development event called “Tech Fest” led by the pilot one-to-one teachers. The beginning of the school year in August 2014 saw a program shift from district-centered programming to site-based and grade-level specific trainings with technology coaches and the Apple embedded specialist. Program outcomes were measured on the net gains in teacher self-reported technology proficiency in the identified focus areas (basic device usage, multimedia usage, productivity tools usage, and communication/content integration) as measured by a reissued technology proficiency survey at the end of the first year of professional development. Additionally, the study examined outcomes in terms of changes in attitudes of teachers toward conditions that contributed to their proficiency and their use of technology in the classroom as an instructional tool as measured by focus-group questions after the first year of the connected classroom professional development program.

## Definitions

**One-to-one.** An initiative by a school or district to provide each student with a personal computing device to use both at school and their home (Topper & Lancaster, 2013).

**Connected classroom.** Initiative launched by the district being studied. For the purposes of this study, only the professional development portion of this program was evaluated.

**Logic Model of Program Evaluation.** Evaluation model used for this study. Utilized to show the logical links between the documented needs, inputs, and outputs while evaluating the measurable outcomes of a program (Lawton et al., 2014).

**TPACK.** A theoretical framework of technology integration that seeks to form connections between technology, pedagogical constructs, and educational CK (Kirkland, 2014).

## Summary

The purpose of this study was to evaluate the impact of the first year of a multi-year district-wide professional development program geared towards the one-to-one rollout of Apple products for each student and teacher in the district. A logic model of program evaluation was used to link program needs to inputs and outputs. The outcomes were measured using both quantitative and qualitative data.

# Chapter 2: Review of Literature

## Introduction

The purpose of this study was to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. The need to provide supplemental professional development for teachers in the area of technology has been documented by many researchers (Lawless & Pellegrino, 2007; Prensky, 2001; Sivin-Kachala & Bialo, 2000). This review of the related literature presents the work of researchers in the area of educational technology from a historical perspective, the need for and types of professional development, leadership models that support teacher development, the TPACK theoretical framework, and ISTE essential conditions for leveraging technology in an educational setting, and various studies of one-to-one initiatives and their implications.

## Historical Perspectives

> Today the world of the learner is almost unbounded. He must acquire facts relating to a bewildering variety of places and things; he must acquire appreciations of far-reaching interrelationships. The curriculum and methods of teaching must undergo a continuous appraisal. New subject matter and new devices for instruction are being scrutinized for their potential contributions to the learning process. (Devereux, 1933, p. 1)

Interestingly, this quote is not from a researcher in the world of education since the advent of the personal computer or even the internet. This quote is attributed to research about the "educational talking picture" an early form of multimedia for school use (Devereux, 1933, p. 1). It is of importance to note that throughout the history of education in the United States, most researchers in the field of technology have stood firm in their position that instructional media are supplements to the role of the teacher and not intended to supplant the role of the professional educator (Reiser, 2001).

The early part of the 1900s saw an emergence of several pioneering pieces of educational technology in the form of slides and the film (Reiser, 2001). It is noted by Reiser (2001) that the adoption of this technology was far and wide with some researchers claiming that the way students are taught would be radically changed within a decade. The films of this era saw a decline in popularity through the Second World War until the educators of the nation saw the importance of training films in the war effort and their ability to train large numbers of soldiers in an efficient manner (Saettler, 1990).

The 1950s ushered in a new era in technological advancements with the Federal Communication Commission allocating 242 television channels in 1952 for educational programming (Saettler, 1990). By 1960, more than 50 channels had been created nationwide with the sole purpose of broadcasting educational material (Blakely, 1979). Much of the push for educational television and its inclusion in the classrooms of the United States can be attributed to grants received through the Ford Foundation (Gordon, 1970). When funding for these programs was shifted away from schools and educational purposes, the role of television as an educational medium was diminished (Gordon, 1970). A more recent resurgence in the world of educational television occurred in 1989 when the Whittle Corporation created a program called Channel One (Thompson & Others, 1992). Although, perceived as controversial by many in the field of education, nearly 12,000 secondary schools in the United States were broadcasting Channel One by the 1992-1993 school year. The program provided a secondary school with a 19-inch color television for every classroom, VCR equipment, a satellite dish, and a daily 12-

minute news program (Whitmore, 1993). The 12-minute news program included 2 minutes of commercial programming which prompted protests from parents and educators alike for trading a captive audience for free school equipment (Thompson & Others, 1992; Whitmore, 1993).

Researchers have noted that one of the most significant advancements in the world of educational technology is the use of personal computers in the classroom (Abramovich, 2012). An early experiment into the use of computers in the educational environment occurred in 1985 with the Apple Corporation sponsoring an initiative called Apple Classroom of Tomorrow (Apple Computer, Inc., 1991). This program could be considered the first one-to-one program in the field of education. Apple selected five schools in the United States that represented a variety of community makeups and grade levels (Apple Computer, Inc., 1991; Baker, 1993; Reilly, 1992). The Apple Classroom of Tomorrow initiative was created with the goals of measuring educational and human outcomes over technological advancements and creating a bank of professional knowledge from the initial 45 educators that could be shared with peers (Baker, 1993).

Another example of a public-private partnership in the realm of educational technology was the Microsoft and Toshiba Anytime, Anywhere initiative of the mid-1990s. This laptop program serviced 53 elementary, middle, and high schools in both public and private settings; and schools represented a variety of previous experience with technology that ranged from no current technology usage to some of the most progressive technology schools of the time (Walker & Rockman, 1997). Data collected by Walker and Rockman (1997) before the program began showed that 74% of teachers reported using technology in the classroom for word processing and 58% for creating presentations. The Anytime, Anywhere initiative collected data from teachers on their self-reported teaching styles and methodologies. Interestingly, teachers reported nearly doubling the amount of time they spent on project-based learning from 35% to over 60% while decreasing the amount of time they viewed as engaging in traditional teaching methods (Walker & Rockman, 1997). Another observed phenomenon was the fact that many students were playing the role of teacher when it came to the new technologies introduced (Walker & Rockman, 1997). This program predated Prensky's (2001) assertion of the "Digital Native," and many of the middle and high school students in this program would be considered "Digital Immigrants" in Prensky's original work.

Educational technology and education have changed with the major technological advancements of the past century. Many educational scholars have asserted that each new technology will drastically alter the paradigm of traditional student and teacher interactions. While altering many of the traditional pedagogies, most technology advancements have failed to alter the chief role of a classroom teacher in the facilitation of learning for students.

**One-to-One**

A one-to-one initiative is a program by which a school provides each student with a personal computing device to be used at both school and home for educational purposes (Cottone, 2014; Topper & Lancaster, 2013). One-to-one initiatives have been a nationwide phenomenon over the past decade and a half with many districts reporting the initiatives as being a major line item in their yearly budgets (Holcomb, 2009). As of 2011, it was reported that nearly 3,000 schools nationwide were implementing a one-to-one computing environment (McLester, 2011). The results have been mixed with some researchers pointing to both the positives and negatives of their popularity and acceptance in academia.

It has been said that improved student engagement with curriculum will enhance the quality of instruction (Schlechty, 2002). One-to-one initiatives seek to transform the landscape of education by providing students a way in which to interact and engage with their coursework in ways never before imagined. One example of this transformation is Project K-Nect in North Carolina. This project sought to provide a smart phone with mathematics content preloaded for every student enrolled in the math courses at several high-poverty high schools (Rivero, 2012). The results showed that average scores on end-of-course testing were increased by 20% (Rivero, 2012). These results are mirrored in a meta-analysis of literature by Sivin-Kachala and Bialo (2000) that noted gains across all subjects and grade levels with respect to technology integration. The results have been mixed with Wenglinsky (2006) reporting that high school students scoring lower on a nationally normed achievement test after the introduction of a one-to-one laptop initiative with a significant relationship existing between the amount of time spent on the laptop and a corresponding drop in scores.

Project One-on-One was a multiyear laptop learning initiative in the state of Louisiana that began in 2005 (Nicholas, 2007). Research efforts on this program focused on student achievement as evidenced by test scores, student technology proficiency, and student attitudes towards technology. Nicholas (2007) reported teachers in Project One-on-One received training on basic device usage, internet safety, Louisiana specific technology integration training program called INTECH, iSafe, World Book software, and two follow-up sessions as part of their initial INTECH series. This contrasted the work of connected classrooms and many other districts that have incorporated many of the steps recommended in ISTE's Essential Conditions (2014) that called for a differentiated plan of professional learning with a sustained follow-up. The results from the Project One-on-One program indicated no overall positive gains in student test scores, but the researcher indicated that this could be due to the influx of displaced students in the aftermath of Hurricane Katrina (Nicholas, 2007). The researcher did note that student technology proficiency and positive attitudes toward technology did increase from pre to postprogram survey data (Nicholas, 2007).

Western Massachusetts was the location for a one-to-one pilot program called the Berkshire Wireless Learning Initiative. This initiative provided a laptop computer to every middle school student in several public and private schools (Bebell & Kay, 2010). Results from this program were overwhelmingly positive. Student achievement data were presented for public school students, as they were the only students required to take the Massachusetts standardized test. Test results showed test scores were significantly higher for students immersed in the one-to-one environment when compared to their peers in neighboring schools. Bebell and Kay (2010) also reported that teachers dramatically altered their teaching practices to best make use of the technology. Teachers also reported students were more engaged, developed greater research skills, and showed a greater mastery of material as a result of the technology immersion (Bebell & Kay, 2010).

One of the first large scale one-to-one initiatives started in 2002 with the state of Maine investing $37 million to provide a laptop for every student and teacher in seventh and eighth grades (McLester, 2011). This investment was a controversial shift toward an unproven method of transforming education. Early results yielded promise that Maine's investment in the Maine Learning Technology Initiative would pay off in increased student achievement on standardized state testing (Muir, Knezek, & Christensen, 2004). Maine's program started with a focus on the underlying learning that would take place, not simply on the integration of technology (Fletcher, 2009; McLester, 2011; Muir et al., 2004). Teachers received ongoing professional development to keep up to date on the latest applications and their educational purposes. School leaders, principals, and assistant principals received training twice a year from Apple educational specialist (Fletcher, 2009). Fletcher (2009) noted that many principals stated that not enough attention was brought to them on how to lead technology-rich environments, and they felt out of the loop when deciding on professional development choices for their staff. This was also noted in a review of the Henrico County, Virginia, school system where professional development was product-driven and did not focus on the learning process (Jones, 2007).

Mooresville, North Carolina, is another example of a system-wide one-to-one program. This program started in the fall of 2007 with their pilot program at the local high school. This program quickly expanded and is often heralded as one of the most successful one-to-one initiatives in the country (Cottone, 2014; Introduction: Project RED: An education revolution, 2012; Plummer, 2012). Much like connected classroom, Mooresville placed a heavy focus on professional development. Ongoing and site-based professional development that was relevant to each school's population supplemented large-scale summer events that have evolved into learning opportunities for educators outside of Mooresville's system (Hayes & Greaves, 2013; Plummer, 2012). The results of Mooresville's efforts have been dramatic. Test score data reveal that Mooresville has risen from 38th in the state of North Carolina to third in the matter of a few years. Graduation rates are up and per-pupil spending is among the lowest in the state despite the increased expenditure on technology (Plummer, 2012). Mooresville's success has applicability to connected classroom in that both school districts share a similar size, socioeconomic makeup and proximity to a major urban center.

**Professional Development**

According to research, professional development for teachers is the single greatest factor influencing student use of technology in the classroom for learning (Sivin-Kachala & Bialo, 2000). Recent research has noted that less than 24% of teachers receive more than 9 hours of professional development in the area of technology per year (Matherson, Wilson, & Wright, 2014). Literature on the subject also highlights the connection between high-quality professional development and improved student achievement (Darling-Hammond, 1999; National Commission on Teaching, 1996). Despite this body of research, most state educational agencies and researchers note that professional development on the use of technology in the classroom is inadequate (Lawless & Pellegrino, 2007).

Research on best practices in professional development of educators has led to several conclusions based on literature from a variety of sources. Professional development has been shown to be most effective when activities are chosen that are time-intensive, innovative in technology use, actively engaging, and relevant to content area while encompassing peer learning, and focused on student learning (Loucks-Horsley, 1996; Porter, Garet, Desimone, Yoon, & Birman, 2000; Renyi, 1996).

Several researchers in the realm of professional development have argued against some of the best practices that many educators have held in recent years (Pianta, 2011; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). These practices include traditional professional development sessions centered around learning the mechanics of a new program, the basics a new computer or device, and various other skills that are often taught in isolation with no applicability to practice embedded in the trainings. These researchers present the case that professional development initiatives should be more focused on student-teacher interactions, shorter in duration, or built upon building level relationships among coaches or mentors (Yoon et al., 2007).

Many districts have transitioned their technology teachers into the role of technology coach for their schools. The research to support the creation of these new positions mirrors many of the points made by Yoon et al. (2007). Sugar and Tryon (2014) researched the professional development needs of teachers with regards to technology integration. These researchers found that coaching or virtual coaching through online interactions would be an effective way to sustain an effort by schools to maintain a high level of intensive professional development to meet the needs of teachers in an ever-changing technology-rich environment (Sugar & Tryon, 2014). ISTE (2015) noticed the trend of districts transitioning many of their technology positions into the role of coaches which prompted the organization to develop a set of standards for technology coaches. In a case study of two elementary schools undergoing a technology initiative, it was found that technology coaches and peer coaches were the favored method for receiving technology professional development (Salomon, 2015). Gann (2012) noted the importance of a coach in providing professional learning for staff. The author also noticed a shift in the delivery of content to students and a change in the way professional development is handled in schools today. Principals and district administrators have asked for more professional development to take place during the school day and for the focus to shift to more job-embedded sessions that model some of the practices that coaches are teaching (Gann, 2012).

With research in hand that points to best practices in the realm of professional development and the positive link between teacher professional development and technology integration in the classroom, many educators are not translating what they are learning into their practices. One study showed teachers were not implementing new learning after postprogram surveys showed a high level of understanding and willingness to implement program objectives (Doherty, 2011). This has led several researchers to examine the sequential areas of professional development that identify key program characteristics, teacher outcomes from the program, and sustained teacher change (Lawless & Pellegrino, 2007; Smolin & Lawless, 2011). These forms of evaluation of professional development are echoed by the work of Desimone (2009) who called for an end of participant satisfaction data and a shift toward evaluating the instructional practice change and student outcomes after professional development. Research on high-quality technology-centered professional development indicated that over 65% of professional development activities were evaluated on participant satisfaction through questionnaires and interviews (Gaytan & McEwen, 2010). These researchers also noted that only 20% utilized a pretest-posttest model centered on teacher self-efficacy or proficiency, and 15% evaluated their programs with case studies. The remaining studies utilized a variety of videotaping, journaling, and various scales developed by program evaluators (Gaytan & McEwen, 2010). Gaytan and McEwen (2010) proposed that while determining satisfaction and proficiency should be collected, student outcomes should be the primary factor in determining the outcome of a professional development program. This recommendation parallels many of the points made by others in the field (Desimone, 2009; Lawless & Pellegrino, 2007).

Technology professional development presents its own unique set of challenges and opportunities for teachers. In part one of a four part series, Harris (2008a) outlined many of the required components of a quality, research-based educational technology professional development program. The researcher highlights nine conditions of high-quality technology professional development. These nine conditions indicated that professional development should be conducted in the school setting, linked to school initiatives, concrete, planned and conducted by teachers, differentiated to teacher ability levels, centered on goals derived by teachers, taught in a hands-on model with reciprocal feedback encouraged, sustainable over longer periods of time, and provide for timely technical support (Harris, 2008a).

Harris (2008c) detailed five categories of educational technology professional development in part two of a series devoted to the practice. These five categories each contain various models, and the author suggested a review of the learner's styles and goals should be considered when choosing models for the delivery of professional development. These five categories include instructor organized lessons, individualized learning, collaborative models, data-based inquiry, and sessions for the development of materials (Harris, 2008c).

Instructor-organized lessons are commonplace in the world of professional development. These types of lessons can take many shapes and can be scaffold from a direct instruction model to a more facilitative model and to a participant-driven creation session (Harris, 2008c). This type of model was used in a district studied by Jones (2007) that transitioned to a one-to-one environment and utilized instructor-organized lessons in their train the trainer model of sustained professional development. This model proved successful to district leaders. Technology coaches front loaded 3 days of technology-focused training to teachers before the school year began and provided follow-up sessions on a three-times-per-month basis. Additionally, teachers met regularly in professional learning communities to discuss ways in which they could best integrate technology and provided peer feedback. Jones (2007) also noted the importance of principals in their initiative. Principals were trained on proper evaluation of technology integration and were regularly required to rate teachers on a four-tiered model of technology integration to provide coaches with feedback on future targeted needs.

Individualized learning is often the most common type of learning that takes place for new technologies in the classroom. However, Harris (2008b) noted that this is not the optimal environment for professional learning. The author suggested that a blended approach to individualized learning should supplant efforts to truly individualized learning with a tiered approach that draws upon many of the other learning categories.

Harris (2008b) noted that collaborative learning is the most desirable but often the most difficult of the categories to implement for schools. Drawing upon the work of other researchers, Harris (2008b) and Jones (2007) noted that greater gains can be achieved when teacher collaborative models are utilized. Much like the professional learning communities model, collaborative models can take the form of mentoring and coaching with a focus on peer interactions (Huffman & Hipp, 2003). In its ideal form, the collaborative model draws upon classroom observations of teachers who have mastered technology integration by less-experienced teachers. The author is quick to note that this can be achieved in a virtual environment where available. An online knowledge base is growing with websites like PBS leading the way in providing the content (Harris, 2008c).

Data-driven approaches to professional development involve teachers or groups of teachers and outside researchers collecting data on projects and new technologies used in the classroom. This action research is used to look at best practices and solve pedagogical problems (Harris, 2008c). This type of effort can combine many of the other models for technology professional development, but its scope and sequence move past traditional reflections on professional practice and seek to redefine or solve problems in teaching practices as they relate to technology integration (Harris, 2008c).

The fifth category of professional development is the material creation approach. This model can take two different forms. The first form calls upon the students to co-create materials with their teachers. The teachers serve as the content expert and facilitator, and students serve as the technical expert (Harris, 2008c). This supports the work of Prensky (2009) who casted students in the role of technology expert and teachers as technology novices. Prensky's notion was challenged by the work of Salomon (2015) who found no significant difference in the impact of a technology integration professional development between teachers categorized as "digital natives" versus teachers categorized as "digital immigrants." The second form of the materials approach is centered on online professional learning spaces such as wikis and other shared sites where teachers and technology professionals work together to solve problems and create digital tools for use in the classroom (Harris, 2008c).

Part three of Harris's (2008b) series highlighted many of the steps that should be addressed in planning educational technology professional development. A key to successful planning is the matching of program goals with the proper category or model of professional development. Harris (2008b) also highlighted the different populations that will exist in any school building or system when introducing new technologies or programs. Planning must be purposeful when addressing the needs of the differing populations in a school district. Teachers on the forefront of trying new programs and pioneering change are often referred to as innovators (Harris, 2008b). These innovators are always willing to take the lead and try new initiatives when they believe in the promise of the new technologies. These innovators are followed by two larger groups of teachers known as early adopters and early majority. Harris (2008b) noted that laggards will be the last group to buy in to new technologies and can often be the most difficult to convert because of past experiences with changes to the curriculum and other school initiatives.

In the final article in the educational technology professional development series, Harris (2008d) discussed the need to evaluate program effectiveness. The author suggested that all attempts to evaluate technology professional development should begin with a thorough review of program goals and the alignment of activities to these goals. The connected classroom program began with a review of needs by district personnel and this needs assessment informed planning sessions to create programs. The evaluation of this program will look at teacher self-reported proficiency in the district-identified areas of concern from the initial survey. This is consistent with the recommendations of Harris (2008d) to evaluate outcomes over participant satisfaction with a particular program.

There have been several attempts at large-scale technology-focused professional development programs in the United States. One of the original programs started in 1997 as the Multimedia Instructional Networked Teaching Strategies which later became known as Enhancing Missouri's Instructional Networked Teaching Strategies or eMINTS (Martin, Strother, Weatherholt, & Dechaume, 2008; Stanfill, 2010). This statewide initiative started with a pilot of six school districts and expanded statewide after 2 years of implementation. The program has since evolved over the past decade into a national program and was recognized by ISTE as the first professional development program to fully integrate their national educational technology standards (Stanfill, 2010). The eMINTS program is a 2-year process in which teachers engage in over 250 hours of online and face-to-face professional development that includes more than 10 visits to each teacher's classroom by a certified eMINTS instructional specialist (Martin et al., 2008).

Program effectiveness has been a hallmark of the eMINTS program since its inception. The program uses external program evaluators every year who examine a variety of data points (Martin et al., 2008). Student achievement has been measured using both standardized state tests and Northwest Education Associates Measures of Academic Progress (MAP) test scores. Teacher mastery of the program goals is derived through an examination of portfolio artifacts that teachers maintain during their program. Student data has consistently shown that students taught by an eMINTS educator performed at higher levels than their peers in non-eMINTS districts (Martin et al., 2008). This is consistent with the work of other researchers when examining one-to-one programs with a robust professional development program component (Hayes & Greaves, 2013; Moss, 2012; Plummer, 2012; Sauers, 2012). An examination of artifacts and teacher interviews were utilized to show teacher mastery of the eMINTS curriculum. Teachers in the eMINTS program were more likely to create lessons that utilized technology as a teaching strategy and not merely to increase student productivity, a key component of the eMINTS program (Martin et al., 2008). Martin et al. (2008) also found that some teachers in the eMINTS program expressed difficulty in creating lessons that called for inquiry-based learning with technology. Another key component of one program evaluation of eMINTS showed that teachers who rated themselves highly on receiving quality professional development from the program also reported calling for less technical support from others during the school year. This has applicability to connected classroom and various other one-to-one programs with the increased cost of additional technology staff and coaches.

Another goal of educational researchers in the realm of professional development has been the implementation of technology professional development that is embedded into teacher education programs at the university level. Australian researchers implemented an instructional technology integration program geared towards mathematics instruction for preservice teachers (Bate, Day, & Macnish, 2013). The results showed significant increases in the attitudes, teacher performance, and confidence level in technology integration. This program also noted a sustainability of practice in a 1-year postprogram follow-up (Bate et al., 2013). These results contrasted by the work of Doherty (2011) that found although teachers reported the ability to utilize technology integration tools after professional development sessions, teachers failed to implement these tools in a 3-month follow-up visit from researchers.

In a study of technology integration professional development, researchers analyzed the level of technology integration using an observation model before and after professional development (Wang, Hsu, Reeves, & Coster, 2014). Researchers found a significant increase in the amount of technology integration across cohort levels versus the control group in their study. Wang et al. (2014) also noted higher standardized test scores for both cohorts with one cohort having a statistically significant higher set of scores when compared to the control group. Teacher interviews also revealed themes across the board that pointed to conditions that aided in overcoming traditional barriers to technology integration. These conditions included free tools that could easily be accessed at home for student use, extended contact hours spent in professional development, training on the use of "flipped" classrooms and learning management systems, alignment to common core state standards, and the creation of professional learning committees (Wang et al., 2014).

**Leadership**

Leadership plays an integral role in the change process for any organization. With respect to technology integration at the K-12 level, it has been found that leadership is the single biggest factor in determining the effectiveness of technology use in the classroom (Ritchie, 1996; Schrum & Levin, 2009). Several researchers have noted the need for school leaders, specifically principals and assistant principals, to take the lead in initiating change, tracking progress, motivating staff, providing support, engaging in professional development and, most importantly, modeling the use of technology in their position (Cakir, 2012; Ertmer et al., 2002).

In a study conducted by Ertmer et al. (2002), researchers looked at the professional development of school administrators and their perceptions of their role in the implementation of technology in their schools. This research found that all administrators who took part in a technology-focused professional development session agreed that they played a vital role in the implementation of technology in their building; however, they did differ on their perceived role of technology leader in their building. This can be attributed to the multitude of managerial and leadership styles exhibited by principals of today. These same administrators felt that professional development was an integral part of their own use and offered the ability to lead effectively and model appropriate use for their teachers (Ertmer et al., 2002). The administrators showed statistically significant higher results in self-reported technology competencies after a semester-long online professional development course. This course modeled many of the best practices of the time and was of the appropriate length and scope for research-backed theories of professional development (Ertmer et al., 2002; Harris, 2008a; Ivers, 2001). In contrast to this model, several researchers have found that leaders do not need to be nor should they be expected to hold expertise in all areas of technology (Spillane, Halverson, & Diamond, 2001). This model of technology leadership requires principals and assistant principals to know the strengths of their team and leverage personnel to achieve school goals.

This research is supported by the research of Dawson and Rakes (2003) which found principals to be the key change agent in schools as they make a digital conversion. However, principals often cited a lack of time or background knowledge to participate in professional development for technology integration. Teachers overwhelmingly reported the need for leadership to be active participants and co-learners in new initiatives. In their study of K-12 principals using a questionnaire on their previous 12 months of technology professional development and their respective school's technology integration scores, Dawson and Rakes found statically significant results with regard to the types and amount of professional development of principals. The researchers identified four types of professional development that principals reported as attending during the previous 12 months. These areas included basic technology usage, internet applications, classroom technology integration, and principal specific technology training. The data showed that the majority of principals (58%) received a large portion of their training at the highest two levels of classroom integration and principal specific training (Dawson & Rakes, 2003). The results also indicated that with increased principal training, school technology integration scores went up. The greatest gains were witnessed from the lowest training time principal group of less than 13 hours in the year to the next group of principals who received between 13 and 26 hours of training. These results led the researchers to recommend ongoing and higher order training for school leaders (Dawson

& Rakes, 2003).

**TPACK**

In the current state of technology integration in the classroom, two paradigms share the framework through which most technological innovations in education are presented (Kirkland, 2014). Researchers have identified Puentedura's (2006) SAMR and the TPACK models as exemplars of best practice in technology integration (Matherson et al., 2014).

SAMR is progression by which many teachers, when instructed and guided properly, will integrate technology at increasingly dynamic levels (Puentedura, 2006). The SAMR model is a four-tiered model with two distinct levels of progression. In its lowest level, teachers begin with substituting their traditional pedagogical methods with technology taking the place of a traditional medium of delivery. As teachers progress, they move towards more augmentation of lessons where a redesign has taken the place to enhance the content delivery. The first two stages are referred to as enhancement with the final two stages representing a transformation of teaching style. In the transformation stages, teachers begin by modifying their lessons with technology playing a significant role. Teachers who have utilized technology to create new methods of delivery and assessment, which would not be possible without the aid of technology, are said to have redefined their teaching style to incorporate and fully take advantage of new technologies (Kirkland, 2014; Puentedura, 2006).

The TPACK framework is the work of Koehler et al. (2013) and highlights the connections between technology and a teacher's knowledge or pedagogy and content. This framework is an extension of the work done by Shulman (1986) which made the case for the natural blending of CK with the appropriate pedagogy for reaching students.

The researchers proposed that the technology portion of TPACK would always change as new technologies are introduced. The processes by which teachers develop competency with new technologies can be varied as teachers bring different background knowledge and the rapid pace with which new technologies are developed (Koehler et al., 2013).

Since the creation of TPACK, many researchers have studied the implications of its application and the practicality of measuring TPACK in a teaching staff (Koehler et al., 2013). In an analysis of research on the measurement of TPACK, several themes emerged as possible ways to measure a teacher's progression towards TPACK (Koehler, Shin, & Mishra, 2012). These measurement instruments included self-reported data, interviews, performance assessments, questionnaires, and observations. The authors noted that these studies sought to measure TPACK but offered little to no information on the validity or reliability of their measures (Koehler et al., 2012).

The developers of TPACK offered three distinct pathways upon which TPACK could be developed by teachers, with each pathway dependent upon the current level of expertise in each of the three areas of TPACK (Koehler et al., 2013). Teachers who rate highly on the pedagogical content knowledge (PCK) scale should be offered opportunities to select the best technologies to fit the learning goals of their students. Teachers who exhibit higher levels of pedagogical and technology related knowledge benefit from professional development sessions that are targeted to using their current skills and assess their content areas. Teachers may also develop their technology pedagogical knowledge (TPK) and their PCK simultaneously. The simultaneous development can be accomplished by professional development that is centered on solving problems and creating curricular pieces that are rich in content integration and technology. The three areas of TPACK integration as outlined by the developers were further broken down into TK, CK, PK, PCK, technology content knowledge (TCK), and TPK. These areas have been corroborated in research studies that have found the six types of knowledge to be significant factors in a teacher's progression toward true TPACK utilization (Koh et al., 2013).

**The Essential Conditions**

ISTE is considered a leader in the world of technology integration in education. Researchers at ISTE have written technology integration standards for students, teachers, and administrators. ISTE provides many resources to educators to successfully transition their schools into technology-rich environments. One of these tools is referred to as the Essential Conditions (2014) for successful technology integration. ISTE has identified 14 conditions of effective implementation of technology initiatives, including one-to-one programs in K-12 schools. These conditions are aligned to ISTE's technology standards for students, teachers, and administrators (Williamson & Redish, 2009). The areas included in ISTE's essential conditions include shared vision, technical support, empowered leaders, curriculum framework, implementation planning, student-centered learning, consistent and adequate funding, assessment and evaluation, equitable access, engaged communities, skilled personnel, support policies, ongoing professional learning, and supportive external context (Essential Conditions, 2014).

Assessment and evaluation of any learning initiative is a vital component to its success or failure. This is especially true for technology learning initiatives. The connected classroom program's strategic plan highlights three areas of growth to be monitored on a regular basis. ISTE recommends collecting metrics on teacher proficiency and professional development (Essential Conditions, 2014; Williamson & Redish, 2009). Essential Conditions (2014) also recommend a thorough and ongoing review of technologies used in schools to determine their applicability to students' current and future uses.

With regard to this program evaluation, another important factor in ISTE's Essential Conditions is the skilled personnel in a building or school system (Williamson & Redish, 2009). This model is supported in literature by researchers who have found the availability of skilled personnel at the building level to be a primary contributor to technology implementation success (Skoretz & Childress, 2013; Topper & Lancaster, 2013; Tweed, 2014). Many schools, including connected classroom schools, have created student task forces to leverage student knowledge to aid teachers and students with technology-related problems. This practice is supported by Prensky's (2009) notion of students supporting the school environment with their technological expertise.

Research has shown that it takes an average of 30 hours of focused professional learning to develop proficiencies in new programs for teachers (Harris, 2008a). Many professional development programs are not designed to offer 30 or more hours of training, and the feasibility of a large-scale operation involving entire schools would prove to be impossible. The nature of technology also prohibits this type of intense training. Moore's law loosely states that technology doubles every 2 years (Technology trends: Following Moore's law, 2014). This type of advancement prompted ISTE to call for ongoing professional learning as part of its essential conditions (Essential Conditions, 2014). ISTE recommended districts and schools offer a wide variety of professional learning opportunities that meet the needs of a wide group of teachers as well as providing supportive structures to ensure proper implementation (Williamson & Redish, 2009). This ongoing process is part of the coaching model employed by the connected classroom program. Building-level technology coaches, along with district-level coaches offer courses to teachers, allow them time to begin implementation, and then follow up with classroom visits to ensure the continuity of message and curriculum from teacher to student.

**Basic Device Usage**

In a 2011 University of Delaware program, teachers were recruited to complete an iPad institute that provided direct instruction on basic usage, educational implementation, and a set of 30 iPads for use in their classroom (Barrett-Greenly, 2014). Data from this program indicated that teachers benefited from the basic usage portion of the institute, and teachers reported a greater understanding of basic TPACK principals that were introduced in the summer program (Barrett-Greenly, 2014).

This data and program model were supported in research by a similar program with college faculty at West Point Military Academy. West Point has long been a leader in technology integration by first offering every cadet a desktop computer in their dorm room beginning in 1986 (Efaw, 2005). Department chairs, realizing a need to prepare faculty for a generation of college students well versed in technology, designed a three-tiered professional development program for faculty with the first phase focusing on basic device usage and common programs available to faculty and students. Efaw (2005) noted this was born out of a need derived from instructor turnover and the rate at which technology programs changed. This program model also allowed for a peer mentor relationship to continue professional learning throughout the semester. The West Point program also modeled many of the essential conditions of successful technology integration proposed by ISTE (Essential Conditions, 2014).

**Student Productivity**

The goal of any professional development program for teachers is the increased knowledge of a particular program and its application to increase student learning. While many of the professional development programs aimed at one-to-one initiatives aim to increase teacher knowledge, the primary goal of these programs should be the transfer of teacher use to student productivity. In a joint effort by California public K-12 educators and state universities, a professional development program and grant proposal effort sought to establish a baseline of teacher proficiency in technology and levels of technology integration in the classroom (Ivers, 2001). This program tied funding of technology initiatives to professional development efforts. The results from this study found that teachers who considered themselves as intermediate on the proficiency scales greatly benefited from professional development and increased their levels of technology integration at a far greater rate than their peers (Ivers, 2001).

In a qualitative study of a one-to-one initiative, one researcher found that teachers in a one-to-one environment with established supports and professional development but with a lack of administrative push, technology integration suffered and was inconsistent at best (Jones, 2014). This study reported that teachers willing to seek out help from district technology staff found greater success in implementing technology into the classroom.

**Student Multimedia Usage**

Multimedia can take many forms in an educational environment. While many previous advances in multimedia have been focused on improving static forms of material presentation, the emergence of personal computing in the classroom has born a new interactive form of multimedia in the form of games and applications that require user input (Moreno & Mayer, 2007). Born out of a constructivist view of education, the work of Moreno and Mayer (2007) sought to isolate the instructional design principles that should be utilized when designing educational applications for interactive multimedia. This work has applicability for educational settings because of the one-to-one environment and the wealth of applications and multimedia available to students. Researchers in Australia looked at interactive multimedia when they developed an iPad-based game that covered the social studies curriculum (Masek, Murcia, & Morrison, 2012). These researchers found that to increase the likelihood that students will learn, they needed to be engaged in the application. They found when creating an iPad application with interactive multimedia, the students wanted the process to be fun to increase time on task (Masek et al., 2012).

Students of today consume multimedia material outside of school at a rapid rate (Prensky, 2009; Warschauer, 2005). Warschauer (2005) found that students in a one-to-one environment rich with multimedia educational materials spent more time on task, reported having more fun while learning, and were more actively engaged than their counterparts in a non one-to-one classroom environment. Researchers have also reported that today's students and their thirst for multimedia content and socially connected classrooms will push a rapid transformation of the educational paradigms of the past (Bloemsma, 2014; Prensky, 2009; ZEMKE, 2001). Despite this prediction that technology and interactive multimedia will transform education, the use of computer-based multimedia is not a new phenomenon. Researchers in the early 1980s looked at the benefits and potential of computer-based multimedia in the classroom. Kulik, Bangert, and Williams (1983) found that a curriculum supplemented with computer-based multimedia increased student performance and translated into an 88% increase in teaching time due to the efficiency of content integration.

In a study of the use of multimedia applications on the academic achievement of students in a science course, researchers presented the same science material to two sets of similar students (Ercan, 2014). Pretest data indicated no significant difference between the academic achievement levels of both the control and experimental groups. Posttest data indicated that students in the experimental group or group that received the multimedia instruction scored significantly higher than the control group that was taught with more traditional methodologies (Ercan, 2014). Ercan (2014) theorized that this large effect size was due to the intuitive nature of the software application used and the ability of the multimedia software to select the next appropriate item in the learning sequence. This study also highlighted a significantly higher positive attitude toward science instruction for students in the experimental group (Ercan, 2014). This research supported earlier findings that showed web-based and multimedia applications to significantly increase student interest and positive attitudes towards learning (Hwang, Wu, & Ke, 2011; Su, 2008).

Multimedia technology has also been shown to increase student creativity and problem-solving skills. A study in a Malaysian university setting examined the creation of a curricular piece that required university-level students to create a multimedia presentation on Malaysian culture (Neo & Neo, 2013). The results of this study highlighted that students were able to better map out cognitive processes while engaging in multimedia design. The researchers also noted higher levels of self-efficacy and motivation when students interacted with multimedia for the creation of projects (Neo & Neo, 2013).

Producing work and increasing engagement is the first part of a multi-piece puzzle for teachers. The assessment of these new multimedia student pieces was the focus of a study on the professional development needs of teachers in connecting assessment and instruction of multimedia projects (Ostenson, 2012). Photography quality, aesthetics, transitions, audio/video quality, and organizational elements are a few of the many qualities that Ostenson (2012) reported as necessary in the evaluation process of multimedia work. The researcher also noted the importance of reflection and requiring students to bridge the cognitive processes that lead to their choice of media. The researcher noted that assessment training would be required for teachers skilled in the use of multimedia for student work production (Ostenson, 2012).

Multimedia applications and mobile technology have value outside of the regular education classroom. In a recent review of research, Kagohara et al. (2013) reported finding nearly 50 published studies on the efficacy of iPods, iPads, and other mobile devices in special education setting. This literature review pointed toward the many positives that educators have found as an assistive technology device for students with disabilities and English language learners (Kagohara et al., 2013). This research was also found to support the work of special education teachers when using a multimedia iPad application for an English language acquisition intervention (Rivera, Mason, Moser, & Ahlgrim-Delzell, 2014).

**Academic Communication**

A primary tool for the students of today to gather and evaluate information is their mobile device (Martinez & Schilling, 2010; Prensky, 2009; Warschauer, 2005; ZEMKE, 2001). This device can also be used for communication with peers and educators. One-to-one leaders identified learning management systems and online student response systems as a focal point for their professional development series to increase academic communication and student collaboration around learning.

A learning management system is a software platform that aids teachers and students by facilitating communication, organizing content, providing an avenue to guide learning, and informing parents of student progress (Nasser, Cherif, & Romanowski, 2011; Watson & Watson, 2007). Many international school systems have utilized these systems in an approach to reach more students in rural or displaced areas during wartime (Nasser et al., 2011). Watson and Watson (2007) stated that as the world of education evolves from an industrial age mentality where students are treated in similar methods to a more differentiated model, learning management systems will play an increasingly larger role as they allow teachers to tier instruction and activities to meet the varied levels of proficiency in their classroom.

A student response system is a means by which a teacher can elicit responses to questions from a large group of students in a short period of time (Latham & Hill, 2014). Before one-to-one models became prevalent, teachers were required to upload questions into proprietary software to be used with handheld devices that were specific to the teacher's interactive whiteboard. With a mobile device in the hands of every student, teachers are able to utilize a multitude of software applications to meet the needs of their assessment and content area. This instantaneous feedback allows teachers to gauge understanding, assess quickly and accurately, and provide feedback to students (Latham & Hill, 2014).

Today's students have demonstrated a desire to have their curriculum designed in a way that is unique to their technological capabilities (Bloemsma, 2014; Prensky, 2009; ZEMKE, 2001). Research on the use of student response systems has reported that students are more likely to answer questions with an online student response system because it alleviates many of the social pressures students may feel when responding in class (Latham & Hill, 2014). This is echoed in the research of Norwegian educators who found students preferred student response systems and believed it both helped their learning and facilitated peer tutoring in large class settings (Arnesen, Korpas, Hennissen, & Stav, 2013). Irish researchers found similar results when looking at student attitudes toward student response systems. These researchers noted that students reported higher levels of classroom engagement than peers not using student response systems (Heaslip, Donovan, & Cullen, 2014). Rabinowitz, McKethan, and Kernodle (2013) reported that instructors found similar success by increasing participation in lectures and saving time in classroom management by incorporating formative assessments into their teaching methods.

Researchers opposed to the immersion of technology in education have often pointed to the potential of mobile devices to hinder communication skills and academic collaboration in the classroom (Walmsley, 2014). Several researchers have found that technology, specifically iPads and other mobile devices, increase the facilitation of collaborative work when a strong infrastructure and teacher professional development plan has been followed (Falloon, 2015; Oliver & Corn, 2008). Falloon (2015), in a 3-year study of classrooms fully immersed in iPad usage, found that students reported greater collaboration than their non one-to-one peers and that the collaboration was extended beyond the school day because of cloud-based applications that allowed for the sharing of information from home. Oliver and Corn (2008) reported that in a multi-year pilot of a one-to-one program involving mobile tablets, administrators reported no increase in collaborative work with the technology but significant gains in the subsequent year. The researchers proposed that this could have been from an increase in teacher knowledge of how to establish collaborative work in the second year.

**Summary**

The purpose of this study was to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. This review of literature has given a synopsis of related literature on most aspects of the district's program that included their theoretical framework for the design of their professional development activities, as well as the history of technology education, educational technology professional development, basic device usage, student use of multimedia, student productivity with mobile devices, academic communication through the use of learning management systems, online student response systems, and one-to-one initiatives and their relative success. One-to-one technology has been shown to be both effective in raising student test scores as well as increasing student engagement and research skills (Bebell & O'Dwyer, 2010; Bebell & Kay, 2010; Bernhardt, 2013; McLester, 2011; Plummer, 2012). This type of success is the goal of district leaders with their connected classroom environment. Connected classroom puts a focus on learning outcomes of creativity, collaboration, problem solving, and creating digital citizens through a focused professional development program that was grounded in the TPACK theoretical framework (Koehler et al., 2012; Koh et al., 2014; Matherson et al., 2014).

# Chapter 3: Methodology

## Introduction

The purpose of this study was to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. This program was evaluated using a logic model of program evaluation. When properly presented, a logic model of program evaluation conveys the underlying theories of the program designers (Lawton et al., 2014). The logical links between an organization's resources (inputs), the activities completed, the outcomes of these activities, and their measurable outcomes, are often presented in a visual form to simplify both the planning and evaluation processes (Lawton et al., 2014). The logic model was chosen because of its applicability to educational research practices and the ability to link planning with measurable outcomes (Lawton et al., 2014).

A mixed-methods approach was used to examine the impact of the professional development program of connected classroom. Both quantitative and qualitative data were gathered from a district-administered survey that was developed by K-12 Insight (Appendix A). Survey questions aided in gathering data on teacher self-reported proficiency in the areas of basic device usage, increasing student productivity on their devices, integrating multimedia, and facilitating student communication with their device. Quantitative data were examined in the preexperimental design model of one-group pretest/posttest design that is represented by $O_1$ X $O_2$ (Dawson, 1997). Dawson (1997) noted that this approach is widely used in the realm of education and is used to compare a single group, on the same measure, after a treatment has been applied. The qualitative portion of this study employed a descriptive research design. Focus-group questions

(Appendix B) allowed teachers to describe their attitudes toward technology integration after their first year of professional development in the connected classroom program. These questions allowed district leaders to determine the impacts of their program across the entire district and provide a knowledge base for future programs that is rooted in research-based best practices for evaluation of professional development programs (Desimone, 2009; Lawless & Pellegrino, 2007; Smolin & Lawless, 2011).

**Problem Statement**

Technological advancements are requiring teachers to go beyond using technology to substitute traditional pedagogical methods and forcing them to redefine a new skill set for the delivery, facilitation, and assessment of content and curriculum. The problem is evident: With the push to transform student learning at increasingly higher levels with new technologies, schools and districts are tasked with providing the support and training on new technologies. This training should blend an environment that is technology heavy with a pedagogical base that may have been rooted in best practices from an era when students and staff did not have the plethora of options available today. Research has shown that a significant barrier to technology integration is a lack of training and professional development (Sauers, 2012). This need has been well-documented. Numerous researchers have studied one-to-one programs and their impact on student achievement. These researchers have noted that some programs have shown gains in student achievement, while others did not (Weston & Bain, 2010). The common theme from most research on one-to-one programs and technology integration is the need for high-quality professional development for teachers and administrators to ensure fidelity of program implementation (Corn et al., 2011; Hastings, 2009; Penuel, 2006; Weston & Bain, 2010).

The widening gap between the technological capabilities of students and the pedagogies of yesterday has reached a tipping point (Prensky, 2009). Education has reached a paradigm-shifting era that is leading to a new culture. This new transformative culture has led the district staff to create a professional development program that was designed around the four areas of focus from the baseline data collected and grounded in the framework of TPACK (Koehler et al., 2013).

**Research Questions**

The logic model of program evaluation for this study examined the outcomes of the connected classroom professional development program. Outcomes were measured in five research questions that encompassed both quantitative and qualitative data sources.

**1. "To what extent did the district's professional development program change teachers' perceptions of their technology proficiency?"** Survey data were collected to show changes in teacher self-reported proficiency in the areas of word processing, presentation software, spreadsheet management, using the internet for research, note taking on a mobile device, library and media applications, photo and video editing, special device features like guided access and speak selection, cloud data storage, iBooks, online student response options, and online learning management tools. Survey items included a four-point Likert scale with the following answer choices: never used the technology, novice, intermediate, and highly skilled (Hartley, 2014). This question utilized the basic premise of Barrett-Greenly's (2014) study of a professional development program geared toward teachers engaged in a pilot one-to-one iPad program. This study showed that all teachers, especially those who considered themselves to be expert users, benefited from a targeted professional development program on technology integration (Barrett-Greenly, 2014).

Program data concerning the first research question was presented in table format. The table highlighted the median scores of items concerning basic device usage, the first focus area for connected classroom. Likert scale items were coded with the response of highly skilled reported as 4, intermediate reported as 3, novice reported as 2, and never used the technology reported as 1.

The researcher utilized these data as a baseline for initial performance before the applied treatment of year 1 of a multi-year technology professional development. The survey was administered by K-12 Insight after the first year of professional development, January 2015, to obtain a second data point or posttest data for the purposes of this study. Data were entered from both trials into SPSS to ascertain the descriptive statistics of mean and median. The Likert scale data collected by connected classroom is considered ordinal because an exact difference between the various levels of proficiency cannot be determined. The nature of ordinal data prevents the researcher from running most parametric tests. The Wilcoxon Signed Rank test was performed on like pairs of data, or data from the same teacher who completed both the pretest and posttest survey. These matched pairs were analyzed to determine if the change in scores from pretreatment survey to posttreatment survey could be attributed to the applied treatment, or chance (Taheri & Hesamian, 2013). The Wilcoxon Signed Rank test was chosen because of the type of data collected by the district. The median scores of both survey administrations were analyzed for symmetrical distribution of scores between groups, one of the central conditions for conducting the Wilcoxon Signed Rank test.

**2. "To what extent did the district's professional development program change teachers' perceptions of their abilities to use the devices instructionally with**

**students in the classroom?"** Survey data were collected to show changes in teacher self-reported proficiency as it relates to using technology as a teacher tool in facilitating student work in the areas of word processing, presentation software, spreadsheet management, using the internet for research, and note taking on a mobile device. Survey data also highlighted the area of providing students the opportunity to use multimedia technology applications to demonstrate learning. Survey items included a four-point Likert scale with the following answer choices: never used the technology, novice, intermediate, and highly skilled. Herold (2014) noted the importance of using technology to enhance the curriculum and the desire of students to have teachers who replaced traditional teaching methods with a new skill set that complements the capabilities of today's student. Research shows that multimedia has played an important role in education, even before the invention of the personal computer (Mishra, Koehler, & Kereluik, 2009; Thornburg, 2014). Interestingly, when combined with proper pedagogical methodologies, student use of multimedia has been shown to have a positive impact on student performance (Wojtanowski, 2012). An analysis of multiple studies on technology integration points to a moderate degree of effect on student achievement when multimedia is used to supplement traditional teaching methods (Lee et al., 2013).

Program data concerning the second research question were presented in table format. These tables highlighted the median scores of items concerning the facilitation of student use of technology in the classroom and proficiency in teaching students how to utilize multimedia applications to demonstrate learning. Likert scale items were coded with the response of highly skilled reported as 4, intermediate reported as 3, novice as 2, and never used the technology as 1.

The researcher utilized this data as a baseline for initial performance before the applied treatment of year 1 of a multi-year focused technology professional development. The survey was administered by K-12 Insight after the first year of professional development, January 2015, to obtain a second data point or posttest data for the purposes of this study. Data were entered from both trials into SPSS to ascertain the descriptive statistics of mean and median. The Likert scale data collected by connected classroom are considered ordinal because an exact difference between the various levels of proficiency cannot be determined. The nature of ordinal data prevents the researcher from running most parametric tests. The Wilcoxon Signed Rank test was performed on like pairs of data, or data from the same teacher who completed both the pretest and posttest survey. These matched pairs were analyzed to determine if the change in scores from the pretreatment survey to posttreatment survey could be attributed to the applied treatment, or chance (Taheri & Hesamian, 2013). The Wilcoxon Signed Rank test was chosen because of the type of data collected by the district. The median scores of both survey administrations were analyzed for symmetrical distribution of scores between groups, one of the central conditions for conducting the Wilcoxon Signed Rank test.

**3. "What areas within the district's key learning components (device basic skills, collaboration with the device, productivity with the device, and using multimedia tools with the device) had the greatest and least gains by teachers?"** Effect size (r value) was calculated for each item analyzed with the Wilcoxon Signed Rank test. Effect sizes were averaged for multiple items that cover similar concepts. Effect size was calculated as $r=Z/\sqrt{N}$ with N representing the total number of responses from both the pretest and posttest together. The Z score was calculated by SPSS.

**4. "Were there differences in teachers' perceptions of the technology**

**proficiency after participating in year 1 of the professional learning program related to specific teacher demographics including age of the teacher, years of experience, type of school?"** Data from the initial K-12 Insight survey were used to establish a baseline of self-reported proficiency for each teacher in the district. The data were further broken down by levels of teaching experiences to determine if statistically significant changes occurred at the various levels of teacher experience. The Kruskal-Wallis H test was performed in SPSS to determine if changes in teacher perception of technology proficiency differed across teachers in their first 10 years of teaching, teachers in the 11 to 20 years of experience range, and teachers with greater than 20 years of experience. The Kruskal-Wallis H test was performed in SPSS to determine if differences in teacher proficiency levels were significantly different between teachers in the age ranges of 20s, 30s, 40s, 50s, and 60s. Data from the pretest and posttest survey were used to examine the differences in teacher change from elementary, middle, and high school. The Kruskal-Wallis H test was performed in SPSS to examine differences across school types.

**5. "What conditions contributed to greater teacher proficiency and use of devices instructionally in the classroom?"** Focus-group questions (Appendix B) were administered to a random sample of teachers in various grade levels to gauge teacher attitudes after the initial year of professional development in connected classroom. Informed consent (Appendix C) was obtained from all focus-group participants. An explanation letter (Appendix D) was given to focus group participants to explain the research aims of the focus group. The focus-group questions allowed teachers to discuss their level of satisfaction with the professional development program and any conditions that supported or hindered the implementation of the one-to-one learning environment.

Responses were coded by themes and presented in a frequency distribution table.

**Summary**

The purpose of this study was to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. Research has shown that professional development that is specifically focused on technology integration can increase teacher knowledge, increase the levels and types of integration, and raise student achievement (Sauers, 2012; Sawchuk, 2010; Shapley et al., 2010; Sivin-Kachala & Bialo, 2000; Walker & Rockman, 1997). A mixed-method approach was utilized in the logic model of program evaluation. The logic model was chosen because of its flexibility in identifying inputs and outputs and measuring the impact through quantifiable outcomes (Lawton et al., 2014). Quantitative data analysis was conducted on Research Questions 1-4 using SPSS to run the Wilcoxon Signed Rank test and Kruskal-Wallis H test; while qualitative data were used to identify teacher attitude themes, and frequency data were reported.

# Chapter 4: Results

## Introduction

Student technology access and usage is at an all-time high in the United States (Gray et al., 2010). Technology has the ability to alter the educational paradigm of today in ways never imagined. Many schools, districts, and even entire states have devoted resources to the development of initiatives where every student receives a mobile device for educational uses both inside and outside of the normal school day. These programs are often referred to as one-to-one programs (Topper & Lancaster, 2013). However, the addition of technology alone cannot provide the types of innovations necessary to bridge the gap from traditional pedagogy to 21st century teaching (Warschauer, 2005; Warschauer, Grant, Real, & Rousseau, 2004). This transformation takes a targeted approach that addresses all aspects of a technology initiative from the initial vision to planning and execution (Essential Conditions, 2014). This targeted approach at the school and district level can take the form of a technology-focused professional development program. Research states that teacher professional development is the best predictor of student technology use in the classroom (Sivin-Kachala & Bialo, 2000). It is also noted in a national survey of educators that less than 24% of teachers reported receiving less than 9 hours of professional development per calendar year in technology integration.

The purpose of this study was to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. ISTE released an online research-based tool for gauging the preparedness of districts and schools adopting a one-to-one model of technology integration (Frisbee, 2014). This framework listed 14 essential conditions needed to facilitate a smooth and effective transition to a technology-rich school (Essential Conditions, 2014). These conditions are aligned to ISTE's technology standards for students, teachers, and administrators (Williamson & Redish, 2009). The areas included in ISTE's essential conditions include shared vision, technical support, empowered leaders, curriculum framework, implementation planning, student-centered learning, consistent and adequate funding, assessment and evaluation, equitable access, engaged communities, skilled personnel, support policies, ongoing professional learning, and supportive external context (Essential Conditions, 2014). The district identified three measures of success for the professional learning plan. These measures included a technology proficiency survey data, TPACK growth, and collaboration outside of school. For the purposes of this study, only data from the technology proficiency survey and teacher open response questions were used to measure outcomes.

This chapter presented the results from the measured outcomes of this logic model program evaluation using data for each district-identified area of focus as it related to teacher technology proficiency and teacher ability to utilize mobile devices instructionally with their students. Focus-group data were presented in a frequency distribution table to highlight supportive conditions and barriers to implementation of the district's connected classroom one-to-one initiative.

**Participants**

The district employed approximately 494 full-time teachers. During the course of connected classroom, 255 teachers participated in both the preprogram technology proficiency survey and the postprogram technology proficiency survey. Elementary teachers represented 153 of the respondents, middle school teachers accounted for 43 responses, and high school teachers represented 59 respondents. A total of 50 teachers participated in five focus groups with 14 high school representatives, 12 middle school representatives, and eight each from three different elementary schools. The focus-group participants represented a cross sampling of differing grade levels and subject areas and were invited to attend by school technology coaches.

**Research Question 1: Technology Proficiency**

The first research question asked to what extent did the professional development program change teacher perceptions of their technology proficiency. Data were taken from both administrations of the technology proficiency survey to establish a baseline (pretest) and posttest results after year 1 of the professional learning model. The survey was specific to each grade level's district-issued mobile device (iPads K-8 and MacBook Airs 9-12). Questions utilized a four-point Likert scale with responses ranging from never used the technology, novice, intermediate, and highly skilled. For the purposes of coding for SPSS, never used the technology was coded as 1, novice was coded as 2, intermediate was coded as 3, and highly skilled was coded as 4.

Descriptive statistics of mean and standard deviation from both the pretest and posttest technology proficiency survey for each item related to Basic Device Usage and teacher self-reported proficiency are presented in Table 5.

Table 5

*Teacher Self-Reported Proficiency in Basic Device Usage Descriptive Statistics*

| Survey Item | Mean (Pretest) | Standard Deviation (Pretest) | Mean (Posttest) | Standard Deviation (Posttest) |
|---|---|---|---|---|
| Conducting research using the internet and various library applications | 3.20 | .829 | 3.31 | .797 |
| Use of special device features like speak selection or guided access | 1.8 | .805 | 2.1 | .853 |
| Managing content with cloud storage | 1.84 | .801 | 2.16 | .811 |

Data from survey items related to teacher self-reported technology proficiency in Basic Device Usage from both administrations of the technology proficiency survey were entered into SPSS to ascertain the descriptive statistics. The same data points were also entered into SPSS to run a Wilcoxon Signed Rank test. The Wilcoxon Signed Rank test determined if the changes from the pretreatment data to posttreatment data were statistically significant. Table 6 highlights the changes in teacher self-reported proficiency in basic device usage.

Table 6

*Teacher Self-Reported Proficiency in Basic Device Usage*

| Survey Item | Mean (Pretest) | Mean (Posttest) | Z-Score | Significance Level (p) |
|---|---|---|---|---|
| Conducting research using the internet and various library applications | 3.2 | 3.31 | -1.663 | .096 |
| Use of special device features like speak selection or guided access | 1.8 | 2.1 | -4.245 | .000 |
| Managing content with cloud storage | 1.84 | 2.16 | -4.364 | .000 |

These data points showed mixed results for connected classroom goals of increasing teacher proficiency in basic device usage. Special features and cloud storage showed statistically significant gains while conducting online research, the highest initial area in basic device usage, did not show statistically significant gains.

In teacher basic device proficiency, the next area of focus for connected classroom sought to develop teachers' abilities to manage student communication and collaboration. Two technology proficiency survey items focused on teacher device proficiency in the area of student communication and collaboration. Table 7 highlights descriptive statistics for both items.

Table 7

*Teacher Self-Reported Communication and Collaboration Proficiency Descriptive Statistics*

| Survey Item | Mean (Pretest) | Standard Deviation | Mean (Posttest) | Standard Deviation |
|---|---|---|---|---|
| Using online student response tools | 1.69 | .803 | 2.15 | .913 |
| Using online learning management tools for class discussion | 1.65 | .811 | 2.15 | .895 |

The same data points were also entered into SPSS to run a Wilcoxon Signed Rank test. The Wilcoxon Signed Rank test determined if the changes from the pretreatment data to posttreatment data were statistically significant. Table 8 presents the changes in teacher self-reported proficiency in communication and collaboration.

Table 8

*Teacher Self-Reported Communication and Collaboration Proficiency*

| Survey Item | Mean (Pretest) | Mean (Posttest) | Z-Score | Significance level (p) |
|---|---|---|---|---|
| Using online student response tools | 1.69 | 2.15 | -5.863 | .000 |
| Using online learning management tools for class discussion | 1.65 | 2.15 | -6.085 | .000 |

These data showed that connected classroom teachers reported statistically significant results with regard to their proficiency with device communication and collaboration. However, teachers still reported a mean posttest score of 2.15 which could be considered on the lower end of the proficiency scale.

The third area of device proficiency that the connected classroom professional learning model focused on was device productivity. The technology proficiency survey contained five items relating to teacher productivity with mobile devices. These areas included word processing and spreadsheet management with Apple and Microsoft products as well as note taking applications. Table 9 presents the descriptive statistics of mean and standard deviation for both administrations of the technology proficiency survey for teacher self-reported proficiency with productivity tools.

Table 9

*Teacher Self-Reported Proficiency in Productivity Tools Descriptive Statistics*

| Survey Item | Mean (Pretest) | Standard Deviation | Mean (Posttest) | Standard Deviation |
|---|---|---|---|---|
| Word processing with Pages | 1.92 | .988 | 2.27 | .833 |
| Word processing with Word 2010 or 2013 | 3.45 | .656 | 3.56 | .623 |
| Spreadsheet design with Numbers on a mobile device | 1.55 | .762 | 1.78 | .781 |
| Spreadsheet design with Excel 2010 or 2013 | 2.42 | .847 | 2.51 | .831 |
| Note taking on a mobile device | 2.49 | .935 | 2.98 | .836 |

The same data points were also entered into SPSS to run a Wilcoxon Signed Rank test. The Wilcoxon Signed Rank test determined if the changes from the pretreatment data to posttreatment data were statistically significant. Table 10 compiles the changes in teacher self-reported proficiency in productivity tools.

Table 10

*Teacher Self-Reported Proficiency in Productivity Tools*

| Survey Item | Mean (Pretest) | Mean (Posttest) | Z-Score | Significance Level (p) |
|---|---|---|---|---|
| Word processing with Pages | 1.92 | 2.27 | -4.361 | .000 |
| Word processing with Word 2010 or 2013 | 3.45 | 3.56 | -1.957 | .050 |
| Spreadsheet design with Numbers on a mobile device | 1.55 | 1.78 | -3.566 | .000 |
| Spreadsheet design with Excel 2010 or 2013 | 2.42 | 2.51 | -1.235 | .217 |
| Note taking on a mobile device | 2.49 | 2.98 | -5.858 | .000 |

These data points showed mixed results for connected classroom goals of increasing teacher proficiency in productivity tools. The Microsoft products of Word and Excel did not show statistically significant results. Teachers initially reported a relatively high level proficiency in both Microsoft products on the preassessment before connected classroom professional development. Apple's Pages enjoyed a large increase in teacher reported proficiency as well as note taking with mobile devices.

The fourth area of device proficiency that connected classroom placed a focus on was the use of multimedia applications. The technology proficiency survey contained six items related to teacher proficiency with multimedia applications. These items included presentation with Apple and Microsoft products, library media applications, Apple iBooks, photography, and video editing software. Table 11 compiles descriptive statistics from the multimedia application subset of questions on the technology proficiency survey.

Table 11

*Teacher Self-Reported Proficiency in Multimedia Applications Descriptive Statistics*

| Survey Item | Mean (Pretest) | Standard Deviation | Mean (Posttest) | Standard Deviation |
|---|---|---|---|---|
| Presenting with Keynote | 1.57 | .818 | 2.29 | .829 |
| Presenting with PowerPoint 2010 or 2013 | 3.23 | .801 | 3.32 | .764 |
| Library media apps | 2.10 | .915 | 2.32 | .948 |
| Photo capture and editing | 2.71 | .842 | 2.92 | .771 |
| Video recording and editing | 2.34 | .873 | 2.60 | .782 |
| Using iBooks (dictionary, sticky notes, highlighter) | 1.98 | .917 | 2.31 | .859 |

The same data points were also entered into SPSS to run a Wilcoxon Signed Rank test. The Wilcoxon Signed Rank test determined if the changes from the pretreatment data to posttreatment data were statistically significant. Table 12 presents the changes in teacher self-reported proficiency in multimedia applications.

Table 12

*Teacher Self-Reported Proficiency in Multimedia Applications*

| Survey Item | Mean (Pretest) | Mean (Posttest) | Z-Score | Significance Level (p) |
|---|---|---|---|---|
| Presenting with Keynote | 1.57 | 2.29 | -8.487 | .000 |
| Presenting with PowerPoint 2010 or 2013 | 3.23 | 3.32 | -1.325 | .185 |
| Library media apps | 2.10 | 2.32 | -2.759 | .006 |
| Photo capture and editing | 2.71 | 2.92 | -3.177 | .001 |
| Video recording and editing | 2.34 | 2.60 | -3.667 | .000 |
| Using iBooks (dictionary, sticky notes, highlighter) | 1.98 | 2.31 | -4.267 | .000 |

Multimedia application self-reported proficiency offered mixed results. Teachers reported a very high level of initial self-reported proficiency with Microsoft Power Point, and this program did not show statistically significant growth. The Apple products of Keynote and iBooks showed the greatest area of growth.

**Research Question 2: Instructional Proficiency**

The second research question asked, "to what extent did the professional development program change teachers' perceptions of their abilities to utilize district-issued mobile devices instructionally with students?" It should be noted that the key difference between Research Questions 1 and 2 had to do with transferability of skills acquired through the professional learning model from being able to use the devices for themselves as teachers to using the devices instructionally with students with greater facility. Data were taken from both administrations of the technology proficiency survey to establish a baseline (pretest) and posttest results on teacher self-reported proficiencies after year 1 of the connected classroom professional learning model. Questions on the survey were specific to each grade band's district issues device. Questions utilized a four-point Likert scale with responses ranging from never used the technology, novice, intermediate, and highly skilled. For the purposes of coding for SPSS, never used the technology was coded as 1, novice was coded as 2, intermediate was coded as 3, and highly skilled was coded as 4.

Descriptive statistics of mean and standard deviation from both the pretest and posttest technology proficiency survey for each item related to Basic Device Usage and teacher self-reported instructional proficiency are presented in Table 13.

Table 13

*Teacher Self-Reported Instructional Proficiency in Basic Device Usage Descriptive Statistics*

| Survey Item | Mean (Pretest) | Standard Deviation (Posttest) | Mean (Posttest) | Standard Deviation (Posttest) |
|---|---|---|---|---|
| Conducting research using the internet and various library applications | 2.77 | 1.008 | 3.06 | .878 |
| Use of special device features like speak selection or guided access | 1.69 | .831 | 2.04 | .861 |
| Managing content with cloud storage | 1.63 | .770 | 2.02 | .803 |

The same data points were also entered into SPSS to run a Wilcoxon Signed Rank test. The Wilcoxon Signed Rank test determined if the changes from the pretreatment data to posttreatment data were statistically significant. Table 14 presents the changes in teacher self-reported instructional proficiency with basic device usage.

Table 14

*Teacher Self-Reported Instructional Proficiency in Basic Device Usage Descriptive Statistics*

| Survey Item | Mean (Pretest) | Mean (Posttest) | Z-Score | Significance Level (p) |
|---|---|---|---|---|
| Conducting research using the internet and various library applications | 2.77 | 3.06 | -3.774 | .000 |
| Use of special device features like speak selection or guided access | 1.69 | 2.04 | -4.691 | .000 |
| Managing content with cloud storage | 1.63 | 2.02 | -5.644 | .000 |

Teachers' self-reported instructional proficiency with basic device usage as it relates to their ability to transfer use to students in the instructional arena achieved statistically significant results on all survey items. Teachers reported high levels of proficiency on both administrations of the technology proficiency survey in the area of conducting research using the internet and library applications.

In the area of instructional proficiency, the next area of focus for connected classroom sought to develop teachers' abilities to manage student communication and collaboration. Two technology proficiency survey items focused on teacher instructional proficiency in the area of student communication and collaboration. Table 15 presents descriptive statistics for both items.

Table 15

*Teacher Self-Reported Communication and Collaboration Instructional Proficiency Descriptive Statistics*

| Survey Item | Mean (Pretest) | Standard Deviation | Mean (Posttest) | Standard Deviation |
|---|---|---|---|---|
| Using online student response tools | 1.69 | .850 | 2.23 | .951 |
| Using online learning management tools for class discussion | 1.60 | .800 | 2.18 | .975 |

The same data points were also entered into SPSS to run a Wilcoxon Signed Rank test. The Wilcoxon Signed Rank test determined if the changes from the pretreatment data to posttreatment data were statistically significant. Table 16 compiles the changes in teacher self-reported proficiency in communication and collaboration.

Table 16

*Teacher Self-Reported Communication and Collaboration Instructional Proficiency*

| Survey Item | Mean (Pretest) | Mean (Posttest) | Z-Score | Significance level (p) |
|---|---|---|---|---|
| Using online student response tools | 1.69 | 2.23 | -6.364 | .000 |
| Using online learning management tools for class discussion | 1.60 | 2.18 | -6.575 | .000 |

Teachers reported statistically significant gains in both areas of instructional proficiency of student communication and collaboration. The posttest scores in communication and collaboration were still in the lower range of scores and consistent with the same items in teacher device proficiency.

The third area of instructional proficiency that connected classroom focused on was device productivity. The technology proficiency survey contained five items relating to instructional productivity with mobile devices. These areas included word processing and spreadsheet management with Apple and Microsoft products as well as note taking applications. Table 17 presents the descriptive statistics of mean and standard deviation for both administrations of the technology proficiency survey for teacher self-reported proficiency with productivity tools.

Table 17

*Teacher Self-Reported Instructional Proficiency in Productivity Tools Descriptive Statistics*

| Survey Item | Mean (Pretest) | Standard Deviation | Mean (Posttest) | Standard Deviation |
|---|---|---|---|---|
| Word processing with Pages | 1.72 | .920 | 2.24 | .890 |
| Word processing with Word 2010 or 2013 | 3.08 | .955 | 3.30 | .841 |
| Spreadsheet design with Numbers on a mobile device | 1.51 | .703 | 1.76 | .827 |
| Spreadsheet design with Excel 2010 or 2013 | 2.09 | .919 | 2.29 | .885 |
| Note taking on a mobile device | 2.05 | 1.097 | 2.29 | .885 |

The same data points were also entered into SPSS to run a Wilcoxon Signed Rank test. The Wilcoxon Signed Rank test determined if the changes from the pretreatment data to posttreatment data were statistically significant. Table 18 compiles the changes in teacher self-reported proficiency in instructional productivity tools.

Table 18

*Teacher Self-Reported Instructional Proficiency in Productivity Tools*

| Survey Item | Mean (Pretest) | Mean (Posttest) | Z-Score | Significance Level (p) |
|---|---|---|---|---|
| Word processing with Pages | 1.72 | 2.24 | -6.286 | .000 |
| Word processing with Word 2010 or 2013 | 3.08 | 3.30 | -2.87 | .004 |
| Spreadsheet design with Numbers on a mobile device | 1.51 | 1.76 | -3.917 | .000 |
| Spreadsheet design with Excel 2010 or 2013 | 2.09 | 2.29 | -2.649 | .008 |
| Note taking on a mobile device | 2.05 | 2.29 | -3.457 | .001 |

All areas of teacher use of instructional productivity tools with students showed statistically significant gains. Teachers reported higher levels of proficiency in using Microsoft Word as an instructional tool in the initial technology proficiency survey and still reported statistically significant results in the posttreatment survey at the .004 level.

The fourth area of device proficiency that connected classroom focused on was the use of multimedia applications. The technology proficiency survey contained six items related to teacher instructional proficiency with multimedia applications. These items included presentation with Apple and Microsoft products, library media applications, Apple iBooks, photography, and video editing software. Table 19 presents descriptive statistics from the subset of questions from the technology proficiency survey that covered multimedia applications.

Table 19

*Teacher Self-Reported Instructional Proficiency in Multimedia Applications Descriptive Statistics*

| Survey Item | Mean (Pretest) | Standard Deviation | Mean (Posttest) | Standard Deviation |
|---|---|---|---|---|
| Presenting with Keynote | 1.52 | .821 | 2.32 | .955 |
| Presenting with PowerPoint 2010 or 2013 | 2.87 | 1.027 | 3.16 | .873 |
| Library media apps | 1.91 | .913 | 2.20 | 1.011 |
| Photo capture and editing | 2.47 | 1.100 | 2.83 | .823 |
| Video recording and editing | 2.10 | .911 | 2.60 | .867 |
| Using iBooks (dictionary, sticky notes, highlighter) | 1.79 | .886 | 2.19 | .918 |

The same data points were also entered into SPSS to run a Wilcoxon Signed Rank test. The Wilcoxon Signed Rank test determined if the changes from the pretreatment data to posttreatment data were statistically significant. Table 20 presents the changes in teacher self-reported instructional proficiency in multimedia applications.

Table 20

*Teacher Self-Reported Instructional Proficiency in Multimedia Applications*

| Survey Item | Mean (Pretest) | Mean (Posttest) | Z-Score | Significance Level (p) |
|---|---|---|---|---|
| Presenting with Keynote | 1.52 | 2.32 | -8.408 | .000 |
| Presenting with PowerPoint 2010 or 2013 | 2.87 | 3.16 | -3.900 | .000 |
| Library media apps | 1.91 | 2.20 | -3.784 | .000 |
| Photo capture and editing | 2.47 | 2.83 | -5.043 | .000 |
| Video recording and editing | 2.10 | 2.60 | -6.135 | .000 |
| Using iBooks (dictionary, sticky notes, highlighter) | 1.79 | 2.19 | -4.850 | .000 |

In the area of multimedia application, teachers' self-reported proficiency to use these applications with students offered statistically significant results in all measured categories. Teachers reported a very high level of initial self-reported proficiency with Microsoft Power Point and digital photography editing and showed significant gains in both areas.

**Research Question 3: Highest Gain Areas**

The third research question asked the areas in which teachers showed the largest gains in self-reported proficiency. The data were broken down by both basic technology proficiency and instructional proficiency in the areas of basic device usage, productivity, communication, and multimedia presentation. Data from the Wilcoxon Signed Rank test were utilized to determine effect size (r) and calculated by $r=Z/\sqrt{N}$ with N representing the total number of responses from both the pretest and posttest together. For the purposes of this study, an effect size (r) smaller than .1 was not statistically significant, an r greater than .1 was considered small, an r greater than .3 was considered medium, and an r greater than .5 was considered large.

Teachers were asked in the technology proficiency survey to rate their technology proficiency in three areas of basic device usage. Table 21 reports the calculated effect sizes for teacher proficiency in basic device usage.

Table 21

*Teacher Self-Reported Proficiency in Basic Device Usage Effect Size*

| Survey Item | Effect Size | r value |
|---|---|---|
| Conducting research using the internet and various library applications | Null | .073 |
| Use of special device features like speak selection or guided access | Small | .187 |
| Managing content with cloud storage | Small | .193 |

Connected classroom basic device usage for teachers showed mixed results. The area of "conducting research using the internet" did not show significant results in effect size while the use of "special device features and managing with cloud storage" showed small effect sizes. The average effect size for the basic device category usage was 0.151.

The next area of focus for connected classroom was teacher proficiency with communication and collaboration tools. Table 22 reports the calculated effect sizes for teacher proficiency in communication and collaboration tools.

Table 22

*Teacher Self-Reported Communication and Collaboration Proficiency Effect Size*

| Survey Item | Effect Size | r value |
|---|---|---|
| Using online student response tools | Small | .259 |
| Using online learning management tools for class discussion | Small | .269 |

The area of teacher proficiency in communication and collaboration showed statistically significant results in both "using online student response tools" and "online management tools for discussion." The effect sizes were small and showed an average of 0.264.

Teacher self-reported proficiency with productivity tools was the third area of focus for connected classroom. The technology proficiency survey contained five items pertaining to productivity tools. Table 23 reports the calculated effect sizes for teacher proficiency in productivity.

Table 23

*Teacher Self-Reported Proficiency in Productivity Tools Effect Size*

| Survey Item | Effect Size | r value |
|---|---|---|
| Word processing with Pages | Small | .193 |
| Word processing with Word 2010 or 2013 | Null | .086 |
| Spreadsheet design with Excel 2010 or 2013 | Small | .157 |
| Spreadsheet design with Numbers on a mobile device | Null | .054 |
| Note taking on a mobile device | Small | .259 |

Teacher productivity proficiency showed mixed results with Microsoft Excel and Word showing no statistically significant results. The remaining items in productivity tools including “use of Pages, use of spreadsheet design,” and “use of note-taking applications” showed small effect sizes with an average effect size of 0.149.

The fourth area of focus for the connected classroom professional learning model was teacher proficiency with multimedia applications. This area contained the largest number of technology proficiency survey items. Table 24 reports the calculated effect sizes for teacher proficiency with multimedia applications.

Table 24

*Teacher Self-Reported Proficiency in Multimedia Applications Effect Size*

| Survey Item | Effect Size | r value |
|---|---|---|
| Presenting with Keynote | Medium | .375 |
| Presenting with PowerPoint 2010 or 2013 | Null | .058 |
| Library media apps | Small | .122 |
| Photo capture and editing | Small | .140 |
| Video recording and editing | Small | .162 |
| Using iBooks (dictionary, sticky notes, highlighter) | Small | .188 |

Teacher proficiency in multimedia application offered mixed results. The area of Microsoft PowerPoint did not see a statistically significant gain; the areas of "library media applications, photo capturing and editing, video recording and editing, and using iBooks" saw small effect size gains; "presenting with Keynote" saw medium effect size gains. The average effect size for this focus area was a .174.

Technology proficiency survey data on teacher self-reported proficiency offered insight into professional learning gains from connected classroom. Most areas indicated small relative gains. Apple's Keynote software showed the greatest gains with an effect size of 0.375. Communication and collaboration indicated the greatest average gains with an average effect size of 0.264.

Teachers were asked in the technology proficiency survey to rate their technology proficiency in three areas of basic device usage and their ability to utilize these areas instructionally. Table 25 presents the calculated effect sizes for teacher instructional proficiency in basic device usage.

Table 25

*Teacher Self-Reported Instructional Proficiency in Basic Device Usage Effect Size*

| Survey Item | Effect Size | r value |
|---|---|---|
| Conducting research using the internet and various library applications | Small | .164 |
| Use of special device features like speak selection or guided access | Small | .207 |
| Managing content with cloud storage | Small | .249 |

Connected classroom instructional basic device usage for teachers showed positive results. All areas indicated minimal growth with a small effect size. The average effect size for instructional basic device usage was 0.206.

The next area of focus for the connected classroom professional learning model was teacher instructional proficiency with communication and collaboration tools. Table 26 reports the calculated effect sizes for teacher proficiency in communication and collaboration tools.

Table 26

*Teacher Self-Reported Communication and Collaboration Instructional Proficiency Effect Size*

| Survey Item | Effect Size | r value |
|---|---|---|
| Using online student response tools | Small | .281 |
| Using online learning management tools for class discussion | Small | .291 |

The area of teacher proficiency in communication and collaboration showed statistically significant results in both “using online student response tools” and “using online learning management tools for classroom discussion." The growth effect sizes were small and showed an average of 0.286.

Teacher self-reported proficiency with productivity tools was the third area of focus for connected classroom. The technology proficiency survey contained five items pertaining to productivity tools. Table 27 presents the calculated effect sizes for teacher proficiency in productivity.

Table 27

*Teacher Self-Reported Instructional Proficiency in Productivity Tools Effect Size*

| Survey Item | Effect Size | r value |
|---|---|---|
| Word processing with Pages | Small | .278 |
| Word processing with Word 2010 or 2013 | Small | .127 |
| Spreadsheet design with Excel 2010 or 2013 | Small | .173 |
| Spreadsheet design with Numbers on a mobile device | Small | .117 |
| Note taking on a mobile device | Small | .259 |

Teacher productivity instructional proficiency showed positive results with all survey items reporting small effect sizes. The average effect size of all items was 0.191.

The fourth area of focus for the connected classroom professional learning model was teacher instructional proficiency with multimedia applications. This area contained the largest number of technology proficiency survey items. Table 28 presents the calculated effect sizes for teacher instructional proficiency with multimedia applications.

Table 28

*Teacher Self-Reported Instructional Proficiency in Multimedia Applications Effect Size*

| Survey Item | Effect Size | r value |
|---|---|---|
| Presenting with Keynote | Medium | .372 |
| Presenting with PowerPoint 2010 or 2013 | Small | .172 |
| Library media apps | Small | .167 |
| Photo capture and editing | Small | .223 |
| Video recording and editing | Small | .271 |
| Using iBooks (dictionary, sticky notes, highlighter) | Small | .214 |

Multimedia application instructional proficiency offered positive results. The average effect size for this focus area was a .236. Much like teacher proficiency, "Apple's Keynote software" offered the greatest gains when examined for instructional proficiency. "Video recording and editing" also offered an effect size on the higher range of small with an r value of .271.

Technology proficiency survey data on teacher self-reported instructional proficiency offered insight into professional learning gains from connected classroom. Most areas offered small relative gains. Much like teacher basic proficiency, Apple's Keynote software offered the greatest gains with an effect size of 0.372. Additionally, the focus area of communication and collaboration demonstrated the greatest average gains with an average effect size of 0.286.

**Research Question 4: Technology Proficiency and Demographics**

The fourth research question asked if there were differences in the self-reported technology proficiency levels of teachers after the first year of the connected classroom professional development program, relative to teachers' age, years of experience, and type of school.

The first area of focus for the connected classroom professional learning program was teacher basic device usage. The technology proficiency survey contained three items relating to teacher proficiency in basic device usage. Data from the second administration of the technology proficiency survey provided posttest results utilized in determining differences between groups of teachers based on age, years of experience, and school type. Table 29 provides the mean sum of ranks from the posttest administered to teachers across various age ranges; while Table 30 summarizes basic device usage data and used the Kruskal-Wallis H test across the age ranges of teachers in their 20s, 30s, 40s, 50s, and 60s to analyze significance. The Kruskal-Wallis H test was utilized because of the type of data collected by the researcher. The Kruskal-Wallis H test can be considered a nonparametric equivalent to a one-way analysis of variance or ANOVA. The corresponding degrees of freedom are related to the number of groups tested minus one to maintain the grand mean of scores.

Table 29

*Basic Device Usage Kruskal-Wallis H Test Mean Ranks by Teacher Age Ranges*

| Survey Item | 20s | 30s | 40s | 50s | 60s |
|---|---|---|---|---|---|
| Conducting research using the internet and various library applications | 127.66 | 119.63 | 130.93 | 112.94 | 129.47 |
| Use of special device features like speak selection or guided access | 140.78 | 154.35 | 107.85 | 102.69 | 99.06 |
| Managing content with cloud storage | 148.54 | 134.96 | 113.87 | 108.82 | 113.81 |

Table 30

*Basic Device Usage Kruskal-Wallis H Test by Teacher Age Ranges*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Conducting research using the internet and various library applications | 4 | 2.915 | .572 |
| Use of special device features like speak selection or guided access | 4 | 29.034 | .000 |
| Managing content with cloud storage | 4 | 10.817 | .029 |

Conducting research using the internet and various library applications was the only area where no statistically significant differences existed among the different age groups tested. Teachers in the 20- and 30-year-old age ranges fared better than their peers in the older age ranges on most measures.

Teacher self-reported proficiency levels in basic device usage were also examined for differences in teacher experience level. Teachers were divided into three groups with the first group containing teachers in the first 10 years of their career, teachers in years 11 through 20, and teachers with greater than 21 years of experience. Table 31 provides the mean sum of ranks from the posttest administered to teachers across various experience levels, while Table 32 presents basic device usage data analyzed using the Kruskal-Wallis H test across the various experience levels.

Table 31

*Basic Device Usage Kruskal-Wallis H Test Mean Ranks by Teacher Experience Levels*

| Survey Item | First 10 Years | Years 11-20 | Greater Than 21 Years |
|---|---|---|---|
| Conducting research using the internet and various library applications | 116.39 | 133.53 | 125.13 |
| Use of special device features like speak selection or guided access | 135.29 | 121.20 | 106.31 |
| Managing content with cloud storage | 129.90 | 123.63 | 109.43 |

Table 32

*Basic Device Usage Kruskal-Wallis H Test by Teacher Experience Levels*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Conducting research using the internet and various library applications | 2 | 4.027 | .259 |
| Use of special device features like speak selection or guided access | 2 | 9.505 | .023 |
| Managing content with cloud storage | 2 | 3.899 | .273 |

Use of special device features was the only area where statistically significant differences existed among the different experience level groups. Special device features showed statistically significant results because of the stark contrast in reported ability of teachers in their first 10 years of experience versus the more experienced groups.

Teacher self-reported proficiency levels in basic device usage were also examined for differences in school type. Teachers were divided into three groups by the primary type of school in which they taught (elementary, middle, and high school). Table 33 provides the mean sum of ranks from the posttest administered to teachers across various building levels, while Table 34 summarizes the basic device usage data analyzed using the Kruskal-Wallis H test across the various school types.

Table 33

*Basic Device Usage Kruskal-Wallis H Test Mean Ranks by School Type*

| Survey Item | Elementary School | Middle School | High School |
|---|---|---|---|
| Conducting research using the internet and various library applications | 112.75 | 132.63 | 143.12 |
| Use of special device features like speak selection or guided access | 133.14 | 128.68 | 93.68 |
| Managing content with cloud storage | 124.53 | 123.60 | 116.52 |

Table 34

*Basic Device Usage Kruskal-Wallis H Test by School Type*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Conducting research using the internet and various library applications | 2 | 10.155 | .006 |
| Use of special device features like speak selection or guided access | 2 | 15.082 | .001 |
| Managing content with cloud storage | 2 | .643 | .725 |

Cloud storage management did not produce statistically significant differences among school types. It should be noted that cloud storage had scores that were moderately lower than the other items in this category and these lower scores were consistent across school types. In pairwise analysis, elementary teachers reported a much lower level of proficiency with using the internet for research than their peers in secondary education.

The second area of focus for connected classroom was teacher communication and collaboration. The technology proficiency survey contained three items relating to instructional proficiency in communication and collaboration. Data from the second administration of the technology proficiency survey provided posttest results utilized in determining differences between groups of teachers based on age, years of experience, and school type. Table 35 presents the mean sum of ranks from the posttest administered to teachers across various age levels; while Table 36 summarizes the basic device usage data analyzed using the Kruskal-Wallis H test across the age ranges of teachers in their 20s, 30s, 40s, 50s, and 60s for the purposes of determining if there were differences among teacher proficiency according to their age.

Table 35

*Teacher Communication and Collaboration Kruskal-Wallis H Test Mean Ranks by Teacher Age Ranges*

| Survey Item | 20s | 30s | 40s | 50s | 60s |
|---|---|---|---|---|---|
| Using online student response tools | 141.32 | 134.55 | 120.01 | 113.37 | 92.56 |
| Using online learning management tools for class discussion | 138.86 | 136.25 | 124.05 | 108.20 | 92.75 |

Table 36

*Teacher Communication and Collaboration Kruskal-Wallis H Test by Teacher Age Ranges*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Using online student response tools | 4 | 8.995 | .061 |
| Using online learning management tools for class discussion | 4 | 10.413 | .034 |

Using online learning management systems accounted for the only area in teacher communication and collaboration that exhibited statistically significant results across teacher age ranges. This was due to the low levels of proficiency reported by teachers in their 50s and 60s compared to their counterparts in their 20s and 30s.

The data from teacher communication and collaboration was also examined by teacher experience level. Table 37 presents the mean sum of ranks from the posttest administered to teachers across various experience levels; while Table 38 summarizes the results from the Krusal-Wallis H test as it relates to teacher experience levels from teachers in their first 10 years of teaching, teachers in years 11 through 20, and teachers with 21 or more years of teaching experience.

Table 37

*Teacher Communication and Collaboration Kruskal-Wallis H Test Mean Ranks by Teacher Experience Level*

| Survey Item | First 10 Years | Years 11-20 | Greater Than 21 Years |
|---|---|---|---|
| Using online student response tools | 125.97 | 130.20 | 112.22 |
| Using online learning management tools for class discussion | 129.35 | 127.53 | 111.27 |

Table 38

*Teacher Communication and Collaboration Kruskal-Wallis H Test by Teacher Experience Level*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Using online student response tools | 2 | 4.524 | .210 |
| Using online learning management tools for class discussion | 2 | 5.038 | .169 |

When examined for differences between teacher experience levels, no area in teacher communication and collaboration displayed statistically significant results. Teachers with more than 21 years of experience scored the lowest on these measures.

The data from teacher communication and collaboration was also examined by type of school. Table 39 presents the mean sum of ranks from the posttest administered to teachers across various building levels; while Table 40 summarizes the results from the Krusal-Wallis H test as it relates to teachers in elementary, middle, and high schools.

Table 39

*Teacher Communication and Collaboration Kruskal-Wallis H Test Mean Ranks by School Type*

| Survey Item | Elementary School | Middle School | High School |
|---|---|---|---|
| Using online student response tools | 115.01 | 135.30 | 133.72 |
| Using online learning management tools for class discussion | 115.57 | 125.24 | 141.86 |

Table 40

*Teacher Communication and Collaboration Kruskal-Wallis H Test by School Type*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Using online student response tools | 2 | 5.034 | .081 |
| Using online learning management tools for class discussion | 2 | 6.444 | .040 |

The online learning management tool area was the only item in communication and collaboration that showed statistically significant differences between school types. The largest difference in online learning management systems existed between elementary and high schools. These two school levels represented the lowest frequency users (elementary) and the highest frequency users (high school) of online learning management tools.

Teacher proficiency with productivity tools was the third focus area for connected classroom. The technology proficiency survey contained five items relating to teacher proficiency in productivity tools. Data from the second administration of the technology proficiency survey provided posttest results utilized in determining differences between groups of teachers based on age, years of experience, and school type. Table 41 presents the mean sum of ranks from the posttest administered to teachers across various age ranges; while Table 42 summarizes basic device usage data analyzed using the Kruskal-Wallis H test across the age ranges of teachers in their 20s, 30s, 40s, 50s, and 60s for the purposes of determining if there were differences among teacher proficiency according to their age.

Table 41

*Teacher Proficiency with Productivity Tools Kruskal-Wallis H Test Mean Ranks by Teacher Age Ranges*

| Survey Item | 20s | 30s | 40s | 50s | 60s |
|---|---|---|---|---|---|
| Word processing with Pages | 132.74 | 133.18 | 127.46 | 106.25 | 109.86 |
| Word processing with Word 2010 or 2013 | 145.40 | 145.08 | 113.20 | 111.31 | 86.97 |
| Spreadsheet design with Excel 2010 or 2013 | 146.36 | 137.71 | 115.76 | 115.26 | 93.86 |
| Spreadsheet design with Numbers on a mobile device | 148.82 | 133.54 | 116.98 | 104.78 | 123.97 |
| Note taking on a mobile device | 153.48 | 136.81 | 119.97 | 110.96 | 80.78 |

Table 42

*Teacher Proficiency with Productivity Tools Kruskal-Wallis H Test by Teacher Age Ranges*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Word processing with Pages | 4 | 19.317 | .001 |
| Word processing with Word 2010 or 2013 | 4 | 7.777 | .100 |
| Spreadsheet design with Excel 2010 or 2013 | 4 | 10.099 | .039 |
| Spreadsheet design with Numbers on a mobile device | 4 | 12.038 | .017 |
| Note taking on a mobile device | 4 | 17.360 | .002 |

Microsoft Word was the only item in teacher proficiency with productivity tools that did not indicate statistically significant results across teacher age ranges. Differences did exist across Microsoft Word especially in relation to teachers in their 60s, but these differences did not translate into statistically significant results.

The data from teacher proficiency with productivity tools was also examined by teacher experience level. Table 43 presents the mean sum of ranks from the posttest administered to teachers across various age ranges; while Table 44 summarizes the results from the Krusal-Wallis H test as it relates to teacher experience levels from teachers in their first 10 years of teaching, teachers in years 11 through 20, and teachers with 21 or more years of teaching experience.

Table 43

*Teacher Proficiency with Productivity Tools Kruskal-Wallis H Test Mean Ranks by Teacher Experience Level*

| Survey Item | First 10 Years | Years 11-20 | Greater Than 21 Years |
|---|---|---|---|
| Word processing with Pages | 129.93 | 131.77 | 103.21 |
| Word processing with Word 2010 or 2013 | 123.40 | 134.47 | 114.43 |
| Spreadsheet design with Excel 2010 or 2013 | 131.64 | 121.01 | 113.78 |
| Spreadsheet design with Numbers on a mobile device | 133.39 | 115.72 | 114.93 |
| Note taking on a mobile device | 126.72 | 128.51 | 113.51 |

Table 44

*Teacher Proficiency with Productivity Tools Kruskal-Wallis H Test by Teacher Experience Level*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Word processing with Pages | 2 | 7.714 | .021 |
| Word processing with Word 2010 or 2013 | 2 | 3.709 | .157 |
| Spreadsheet design with Excel 2010 or 2013 | 2 | 4.475 | .209 |
| Spreadsheet design with Numbers on a mobile device | 2 | 3.132 | .157 |
| Note taking on a mobile device | 2 | 2.026 | .363 |

Apple's word processing software, Pages, was the only item that displayed significant differences across teachers of differing experience levels. This difference was noted with stark contrasts between teachers in the first 20 years of experience versus those teachers with greater than 21 years of experience.

The data from teacher productivity tools was also examined by type of school. Table 45 presents the mean sum of ranks from the posttest administered to teachers across various school types; while Table 46 summarizes the results from the Krusal-Wallis H test as it relates to teachers in elementary, middle, and high schools.

Table 45

*Teacher Proficiency with Productivity Tools Kruskal-Wallis H Test Mean Ranks by School Type*

| Survey Item | Elementary School | Middle School | High School |
|---|---|---|---|
| Word processing with Pages | 120.71 | 118.51 | 136.38 |
| Word processing with Word 2010 or 2013 | 121.85 | 138.02 | 116.59 |
| Spreadsheet design with Excel 2010 or 2013 | 115.18 | 126.40 | 140.14 |
| Spreadsheet design with Numbers on a mobile device | 118.19 | 138.06 | 125.65 |
| Note taking on a mobile device | 127.42 | 124.06 | 113.34 |

Table 46

*Teacher Proficiency with Productivity Tools Kruskal-Wallis H Test by School Type*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Word processing with Pages | 2 | 2.809 | .245 |
| Word processing with Word 2010 or 2013 | 2 | 3.201 | .202 |
| Spreadsheet design with Excel 2010 or 2013 | 2 | 5.930 | .052 |
| Spreadsheet design with Numbers on a mobile device | 2 | 3.190 | .203 |
| Note taking on a mobile device | 2 | 1.855 | .395 |

There were no statistically significant differences across teacher productivity tools when examined across school types. Spreadsheet design and manipulation with Excel provided the largest differences across school types with elementary teachers reporting the lowest proficiency.

Teacher proficiency with multimedia tools was the last focus area for connected classroom. The technology proficiency survey contained six items relating to teacher proficiency in multimedia tools. Data from the second administration of the technology proficiency survey provided posttest results utilized in determining differences between groups of teachers based on age, years of experience, and school type. Table 47 presents the mean sum of ranks from the posttest administered to teachers across various age ranges; while Table 48 provides basic device usage data analyzed using the Kruskal-Wallis H test across the age ranges of teachers in their 20s, 30s, 40s, 50s, and 60s for the purposes of determining if there were differences among teacher proficiency according to their age.

Table 47

*Teacher Proficiency with Multimedia Tools Kruskal-Wallis H Test Mean Ranks by Teacher Age Ranges*

| Survey Item | 20s | 30s | 40s | 50s | 60s |
|---|---|---|---|---|---|
| Presenting with Keynote | 154.78 | 137.31 | 113.69 | 111.74 | 95.72 |
| Presenting with PowerPoint 2010 or 2013 | 143.00 | 132.79 | 125.96 | 93.34 | 133.75 |
| Library media apps | 120.48 | 130.62 | 120.62 | 120.44 | 114.28 |
| Photo capture and editing | 136.26 | 135.73 | 122.32 | 103.34 | 119.97 |
| Video recording and editing | 145.92 | 136.35 | 127.06 | 92.64 | 104.58 |
| Using iBooks (dictionary, sticky notes, highlighter) | 130.48 | 130.92 | 119.80 | 113.17 | 123.68 |

Table 48

*Teacher Proficiency with Multimedia Tools Kruskal-Wallis H Test by Teacher Age Ranges*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Presenting with Keynote | 4 | 15.213 | .004 |
| Presenting with PowerPoint 2010 or 2013 | 4 | 15.369 | .004 |
| Library media apps | 4 | 1.405 | .843 |
| Photo capture and editing | 4 | 8.236 | .083 |
| Video recording and editing | 4 | 12.263 | .001 |
| Using iBooks (dictionary, sticky notes, highlighter) | 4 | 2.666 | .615 |

Half of all multimedia applications had statistically significant differences between teacher age ranges. Photography, library media applications, and iBooks did not have significant differences among age ranges.

The data from teacher proficiency with multimedia tools was also examined by teacher experience level. Table 49 presents the mean sum of ranks from the posttest administered to teachers across various experience levels; while Table 50 summarizes the results from the Krusal-Wallis H test as it relates to teacher experience levels from teachers in their first 10 years of teaching, teachers in years 11 through 20, and teachers with 21 or more years of teaching experience.

Table 49

*Teacher Proficiency with Multimedia Tools Kruskal-Wallis H Test Mean Ranks by Teacher Experience Level*

| Survey Item | First 10 Years | Years 11-20 | Greater Than 21 Years |
|---|---|---|---|
| Presenting with Keynote | 130.41 | 130.22 | 102.76 |
| Presenting with PowerPoint 2010 or 2013 | 129.07 | 131.39 | 105.68 |
| Library media apps | 119.79 | 128.57 | 124.02 |
| Photo capture and editing | 129.24 | 128.97 | 108.36 |
| Video recording and editing | 129.80 | 131.77 | 101.51 |
| Using iBooks (dictionary, sticky notes, highlighter) | 123.54 | 123.25 | 123.62 |

Table 50

*Teacher Proficiency with Multimedia Tools Kruskal-Wallis H Test by Teacher Experience Level*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Presenting with Keynote | 2 | 7.894 | .019 |
| Presenting with PowerPoint 2010 or 2013 | 2 | 6.470 | .039 |
| Library media apps | 2 | .752 | .687 |
| Photo capture and editing | 2 | 4.524 | .104 |
| Video recording and editing | 2 | 8.812 | .012 |
| Using iBooks (dictionary, sticky notes, highlighter) | 2 | .001 | 1.000 |

Multimedia applications showed statistically significant differences in teacher experience level in three of the six areas. The presentations software programs of Apple Keynote and Microsoft PowerPoint showed differences across experience levels along with teacher proficiency in video editing.

The proficiency data from teacher multimedia application tools were also examined by type of school. Table 51 presents the mean sum of ranks from the posttest administered to teachers across various building levels; while Table 52 summarizes the results from the Krusal-Wallis H test as it relates to teachers in elementary, middle, and high schools.

Table 51

*Teacher Proficiency with Multimedia Applications Kruskal-Wallis H Test Mean Ranks by School Type*

| Survey Item | Elementary School | Middle School | High School |
|---|---|---|---|
| Presenting with Keynote | 127.13 | 136.40 | 102.66 |
| Presenting with PowerPoint 2010 or 2013 | 111.10 | 131.93 | 147.89 |
| Library media apps | 127.76 | 132.74 | 103.89 |
| Photo capture and editing | 122.51 | 131.48 | 119.91 |
| Video recording and editing | 126.85 | 126.48 | 110.87 |
| Using iBooks (dictionary, sticky notes, highlighter) | 123.24 | 124.79 | 121.07 |

Table 52

*Teacher Proficiency with Multimedia Applications Kruskal-Wallis H Test by School Type*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Presenting with Keynote | 2 | 7.840 | .020 |
| Presenting with PowerPoint 2010 or 2013 | 2 | 14.245 | .001 |
| Library media apps | 2 | 6.241 | .044 |
| Photo capture and editing | 2 | .850 | .654 |
| Video recording and editing | 2 | 2.576 | .276 |
| Using iBooks (dictionary, sticky notes, highlighter) | 2 | .083 | .959 |

Multimedia applications showed statistically significant differences in school type in three of the six areas. The presentations software programs of Apple Keynote and Microsoft PowerPoint showed differences across experience levels along with teacher proficiency in library media applications.

Connected classroom sought to increase teacher device proficiency and teacher instructional proficiency with mobile devices. Instructional proficiency was defined as the ability of teachers to utilize technology within four designated areas (basic device usage, communication and collaboration, productivity tools, and multimedia) with students in an instructional capacity. These survey questions shifted teacher perceptions of proficiency from self-use to their ability to facilitate student use. The first area of focus for instructional proficiency was teacher instructional basic device usage as it related to helping students become more fluent in how the devices could be used to support their learning. The technology proficiency survey contained three items relating to teacher proficiency in instructional basic device usage. Data from the second administration of the technology proficiency survey provided posttest results utilized in determining differences between groups of teachers based on age, years of experience, and school type. Table 53 presents the mean sum of ranks from the posttest administered to teachers across various building levels; while Table 54 summarizes instructional basic device usage data analyzed using the Kruskal-Wallis H test across the age ranges of teachers in their 20s, 30s, 40s, 50s, and 60s.

Table 53

*Instructional Basic Device Usage Kruskal-Wallis H Test Mean Ranks by Teacher Age Ranges*

| Survey Item | 20s | 30s | 40s | 50s | 60s |
|---|---|---|---|---|---|
| Conducting research using the internet and various library applications | 121.12 | 118.09 | 135.63 | 104.66 | 127.53 |
| Use of special device features like speak selection or guided access | 141.72 | 141.84 | 106.47 | 108.41 | 107.21 |
| Managing content with cloud storage | 138.94 | 132.67 | 114.71 | 105.8 | 125.88 |

Table 54

*Instructional Basic Device Usage Kruskal-Wallis H Test by Teacher Age Ranges*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Conducting research using the internet and various library applications | 4 | 7.247 | .123 |
| Use of special device features like speak selection or guided access | 4 | 16.089 | .003 |
| Managing content with cloud storage | 4 | 7.880 | .096 |

Conducting research using the internet and various library applications and cloud storage were the areas where no statistically significant differences existed among the different age groups tested. Special device features showed statistically significant differences, with the most marked differences existing between teachers in their 20s and 30s versus their older peers.

Teacher self-reported proficiency levels in basic device instructional usage were also examined for differences in teacher experience level. Teachers were divided into three groups with the first group containing teachers in the first 10 years of their career, teachers in years 11 through 20, and teachers with greater than 21 years of experience. Table 55 presents the mean sum of ranks from the posttest administered to teachers across various experience levels, while Table 56 summarizes instructional basic device usage data analyzed using the Kruskal-Wallis H test across the various experience levels.

Table 55

*Instructional Basic Device Usage Kruskal-Wallis H Test Mean Ranks by Teacher Experience Levels*

| Survey Item | First 10 Years | Years 11-20 | Greater Than 21 Years |
|---|---|---|---|
| Conducting research using the internet and various library applications | 116.28 | 134.16 | 117.75 |
| Use of special device features like speak selection or guided access | 129.20 | 117.12 | 109.91 |
| Managing content with cloud storage | 123.29 | 123.78 | 115.22 |

Table 56

*Instructional Basic Device Usage Kruskal-Wallis H Test by Teacher Experience Levels*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Conducting research using the internet and various library applications | 2 | 3.585 | .167 |
| Use of special device features like speak selection or guided access | 2 | 3.658 | .161 |
| Managing content with cloud storage | 2 | .725 | .696 |

No areas of instructional basic device usage showed statistically significant differences across teacher experience levels. The data were very inconsistent across experience levels with less experienced teachers reporting low proficiency in conducting internet research and higher levels of proficiency in special features and cloud storage.

Teacher self-reported proficiency levels in instructional basic device usage were also examined for differences in school type. Teachers were divided into three groups by the primary type of school in which they teach. Table 57 presents the mean sum of ranks from the posttest administered to teachers across various building levels, while Table 58 summarizes basic device instructional usage data analyzed using the Kruskal-Wallis H test across the various school types.

Table 57

*Instructional Basic Device Usage Kruskal-Wallis H Test Mean Ranks by School Type*

| Survey Item | Elementary School | Middle School | High School |
|---|---|---|---|
| Conducting research using the internet and various library applications | 111.44 | 127.60 | 144.56 |
| Use of special device features like speak selection or guided access | 132.51 | 120.90 | 91.88 |
| Managing content with cloud storage | 120.23 | 128.64 | 119.10 |

Table 58

*Instructional Basic Device Usage Kruskal-Wallis H Test by School Type*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Conducting research using the internet and various library applications | 2 | 10.597 | .005 |
| Use of special device features like speak selection or guided access | 2 | 15.416 | .000 |
| Managing content with cloud storage | 2 | .669 | .716 |

Cloud storage management did not produce statistically significant differences among school types. Teachers across all building types rated their proficiency with cloud storage moderately high with all mean rank sums falling within several points of each other.

The second area of focus for connected classroom was instructional communication and collaboration. The technology proficiency survey contained three items relating to instructional proficiency in communication and collaboration. Data from the second administration of the technology proficiency survey provided posttest results utilized in determining differences between groups of teachers based on age, years of experience, and school type. Table 59 presented the mean sum of ranks from the posttest administered to teachers across various building levels; while Table 60 summarized instructional communication and collaboration usage data analyzed using the Kruskal-Wallis H test across the age ranges of teachers in their 20s, 30s, 40s, 50s, and 60s.

Table 59

*Instructional Proficiency Communication and Collaboration Kruskal-Wallis H Test Mean Ranks by Teacher Age Ranges*

| Survey Item | 20s | 30s | 40s | 50s | 60s |
|---|---|---|---|---|---|
| Using online student response tools | 141.32 | 127.07 | 117.60 | 115.01 | 105.74 |
| Using online learning management tools for class discussion | 123.24 | 128.52 | 123.67 | 112.50 | 98.09 |

Table 60

*Instructional Proficiency with Communication and Collaboration Kruskal-Wallis H Test by Teacher Age Ranges*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Using online student response tools | 4 | 4.421 | .352 |
| Using online learning management tools for class discussion | 4 | 3.907 | .419 |

Using online learning management systems and learning management systems did not account for statistically significant results across teacher age ranges. These items did have the highest gains of the connected classroom professional learning program. Differences did exist for teachers in their 50s and 60s versus their younger peers, but these differences did not account for statistically significant results.

The data from teacher instructional proficiency with communication and collaboration was also examined by teacher experience level. Table 61 presents the mean sum of ranks from the posttest administered to teachers across various building levels; while Table 62 summarizes the results from the Krusal-Wallis H test as it relates to teacher experience levels from teachers in their first 10 years of teaching, teachers in years 11 through 20, and teachers with 21 or more years of teaching experience.

Table 61

*Instructional Proficiency Communication and Collaboration Kruskal-Wallis H Test Mean Ranks by Teacher Experience Level*

| Survey Item | First 10 Years | Years 11-20 | Greater Than 21 Years |
|---|---|---|---|
| Using online student response tools | 125.97 | 130.20 | 110.88 |
| Using online learning management tools for class discussion | 126.79 | 128.28 | 100.42 |

Table 62

*Instructional Proficiency Communication and Collaboration Kruskal-Wallis H Test by Teacher Experience Level*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
| --- | --- | --- | --- |
| Using online student response tools | 2 | 3.059 | .217 |
| Using online learning management tools for class discussion | 2 | 7.196 | .027 |

When examined for differences between teacher experience levels, no item in teacher communication and collaboration displayed statistically significant results. Teachers with greater than 21 years of experience rated themselves lower than teachers with less experience in these areas.

The data from teacher communication and collaboration was also examined by type of school. Table 63 presents the mean sum of ranks from the posttest administered to teachers across various building levels; while Table 64 summarizes the results from the Krusal-Wallis H test as it relates to teachers in elementary, middle, and high schools.

Table 63

*Instructional Proficiency Communication and Collaboration Kruskal-Wallis H Test Mean Ranks by School Type*

| Survey Item | Elementary School | Middle School | High School |
| --- | --- | --- | --- |
| Using online student response tools | 116.09 | 129.59 | 129.08 |
| Using online learning management tools for class discussion | 113.79 | 119.52 | 140.42 |

Table 64

*Instructional Proficiency Communication and Collaboration Kruskal-Wallis H Test by School Type*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Using online student response tools | 2 | 2.309 | .315 |
| Using online learning management tools for class discussion | 2 | 6.489 | .039 |

The online learning management tool area was the only item in communication and collaboration that showed statistically significant differences between school types. Following a similar pattern to teacher device proficiency, online learning management systems showed low instructional proficiency for elementary teachers.

Teacher instructional proficiency with productivity tools was the third focus area for the connected classroom professional learning program. The technology proficiency survey contained five items relating to teacher proficiency in productivity tools. Data from the second administration of the technology proficiency survey provided posttest results utilized in determining differences between groups of teachers based on age, years of experience, and school type. Table 65 presents the mean sum of ranks from the posttest administered to teachers across various building levels; while Table 66 summarizes instructional proficiency with productivity tools data analyzed using the Kruskal-Wallis H test across the age ranges of teachers in their 20s, 30s, 40s, 50s, and 60s.

Table 65

*Instructional Proficiency with Productivity Tools Kruskal-Wallis H Test Mean Ranks by Teacher Age Ranges*

| Survey Item | 20s | 30s | 40s | 50s | 60s |
|---|---|---|---|---|---|
| Word processing with Pages | 138.88 | 139.28 | 113.04 | 113.19 | 91.56 |
| Word processing with Word 2010 or 2013 | 124.46 | 134.12 | 119.82 | 109.19 | 114.89 |
| Spreadsheet design with Excel 2010 or 2013 | 148.64 | 129.73 | 118.41 | 103.10 | 122.35 |
| Spreadsheet design with Numbers on a mobile device | 145.32 | 129.82 | 111.03 | 114.65 | 111.91 |
| Note taking on a mobile device | 146.08 | 134.47 | 120.24 | 104.67 | 86.53 |

Table 66

*Instructional Proficiency with Productivity Tools Kruskal-Wallis H Test by Teacher Age Ranges*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Word processing with Pages | 4 | 12.618 | .013 |
| Word processing with Word 2010 or 2013 | 4 | 4.934 | .294 |
| Spreadsheet design with Excel 2010 or 2013 | 4 | 9.314 | .054 |
| Spreadsheet design with Numbers on a mobile device | 4 | 7.779 | .100 |
| Note taking on a mobile device | 4 | 14.095 | .007 |

Microsoft Word and Microsoft Excel were the only items in teacher instructional proficiency with productivity tools that did not indicate statistically significant results across teacher age ranges. These Microsoft products, while familiar to many teachers in the district, were not a major focus of professional development sessions.

The data from instructional proficiency with productivity tools were also examined by teacher experience level. Table 67 presents the mean sum of ranks from the posttest administered to teachers across various building levels; while Table 68 summarizes the results from the Krusal-Wallis H test as it relates to teacher experience levels from teachers in their first 10 years of teaching, teachers in years 11 through 20, and teachers with 21 or more years of teaching experience.

Table 67

*Instructional Proficiency with Productivity Tools Kruskal-Wallis H Test Mean Ranks by Teacher Experience Level*

| Survey Item | First 10 Years | Years 11-20 | Greater Than 21 Years |
|---|---|---|---|
| Word processing with Pages | 124.70 | 132.64 | 103.40 |
| Word processing with Word 2010 or 2013 | 123.42 | 126.48 | 113.62 |
| Spreadsheet design with Excel 2010 or 2013 | 132.77 | 110.47 | 115.72 |
| Spreadsheet design with Numbers on a mobile device | 127.33 | 117.24 | 113.30 |
| Note taking on a mobile device | 124.68 | 136.15 | 96.97 |

Table 68

*Instructional Proficiency with Productivity Tools Kruskal-Wallis H Test by Teacher Experience Level*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Word processing with Pages | 2 | 6.742 | .034 |
| Word processing with Word 2010 or 2013 | 2 | 1.409 | .494 |
| Spreadsheet design with Excel 2010 or 2013 | 2 | 5.685 | .058 |
| Spreadsheet design with Numbers on a mobile device | 2 | 2.195 | .334 |
| Note taking on a mobile device | 2 | 11.730 | .003 |

Apple's word-processing software, Pages, and note taking with a mobile device were the only items that displayed significant differences across teachers of differing experience levels. Teachers in the first 20 years of their career reported higher proficiency on most items compared to teachers in the latter part of their careers.

The data from teacher instructional proficiency with productivity tools was also examined by type of school. Table 69 presents the mean sum of ranks from the posttest administered to teachers across various building levels; while Table 70 summarizes the results from the Krusal-Wallis H test as it relates to teachers in elementary, middle, and high schools.

Table 69

*Instructional Proficiency with Productivity Tools Kruskal-Wallis H Test Mean Ranks by School Type*

| Survey Item | Elementary School | Middle School | High School |
|---|---|---|---|
| Word processing with Pages | 119.86 | 134.12 | 117.94 |
| Word processing with Word 2010 or 2013 | 114.64 | 114.77 | 146.48 |
| Spreadsheet design with Excel 2010 or 2013 | 114.80 | 119.95 | 141.98 |
| Spreadsheet design with Numbers on a mobile device | 117.20 | 127.28 | 125.97 |
| Note taking on a mobile device | 124.17 | 121.36 | 114.79 |

Table 70

*Instructional Proficiency with Productivity Tools Kruskal-Wallis H Test by School Type*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Word processing with Pages | 2 | 1.861 | .394 |
| Word processing with Word 2010 or 2013 | 2 | 10.661 | .005 |
| Spreadsheet design with Excel 2010 or 2013 | 2 | 6.817 | .033 |
| Spreadsheet design with Numbers on a mobile device | 2 | 1.264 | .532 |
| Note taking on a mobile device | 2 | .802 | .670 |

The Microsoft products of Word and Excel were the only areas that displayed statistically significant differences across the three types of schools. High school teachers reported instructional proficiency that was considerably higher than teachers in elementary and middle schools.

Teacher instructional proficiency with multimedia tools was the last focus area for the connected classroom professional learning program. The technology proficiency survey contained six items relating to teacher instructional proficiency in multimedia tools. Data from the second administration of the technology proficiency survey provided posttest results utilized in determining differences between groups of teachers based on age, years of experience, and school type. Table 71 presents the mean sum of ranks from the posttest administered to teachers across various age ranges; while Table 72 summarizes instructional proficiency data analyzed using the Kruskal-Wallis H test across the age ranges of teachers in their 20s, 30s, 40s, 50s, and 60s.

Table 71

*Instructional Proficiency with Multimedia Tools Kruskal-Wallis H Test Mean Ranks by Teacher Age Ranges*

| Survey Item | 20s | 30s | 40s | 50s | 60s |
|---|---|---|---|---|---|
| Presenting with Keynote | 155.40 | 135.82 | 109.56 | 109.82 | 87.00 |
| Presenting with PowerPoint 2010 or 2013 | 136.02 | 127.89 | 121.34 | 102.17 | 124.16 |
| Library media apps | 130.40 | 125.47 | 119.56 | 113.83 | 116.56 |
| Photo capture and editing | 137.82 | 124.63 | 120.50 | 111.06 | 119.79 |
| Video recording and editing | 144.44 | 126.03 | 121.41 | 106.31 | 100.09 |
| Using iBooks (dictionary, sticky notes, highlighter) | 132.52 | 124.83 | 120.96 | 113.52 | 117.12 |

Table 72

*Instructional Proficiency with Multimedia Tools Kruskal-Wallis H Test by Teacher Age Ranges*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Presenting with Keynote | 4 | 18.697 | .001 |
| Presenting with PowerPoint 2010 or 2013 | 4 | 6.406 | .171 |
| Library media apps | 4 | 1.491 | .828 |
| Photo capture and editing | 4 | 3.013 | .556 |
| Video recording and editing | 4 | 7.978 | .092 |
| Using iBooks (dictionary, sticky notes, highlighter) | 4 | 1.681 | .794 |

Only presenting with Apple's Keynote reported statistically significant differences between teacher age ranges. Teachers in their 20s and 30s rated their proficiency significantly higher than their peers in the 40s and 50s age range with teachers in their 60s reporting lower proficiency in most measures. Photography, video editing, PowerPoint, library media applications, and iBooks did not have significant differences among age ranges.

The data from instructional proficiency with multimedia tools was also examined by teacher experience level. Table 73 presents the mean sum of ranks from the posttest administered to teachers across various age ranges; while Table 74 summarizes the results from the Krusal-Wallis H test as it relates to teacher experience levels from teachers in their first 10 years of teaching, teachers in years 11 through 20, and teachers with 21 or more years of teaching experience.

Table 73

*Instructional Proficiency with Multimedia Tools Kruskal-Wallis H Test Mean Ranks by Teacher Experience Level*

| Survey Item | Elementary School | Middle School | High School |
|---|---|---|---|
| Presenting with Keynote | 127.13 | 136.40 | 102.66 |
| Presenting with PowerPoint 2010 or 2013 | 111.10 | 131.93 | 147.89 |
| Library media apps | 127.76 | 132.74 | 103.89 |
| Photo capture and editing | 122.51 | 131.48 | 119.91 |
| Video recording and editing | 126.85 | 126.48 | 110.87 |
| Using iBooks (dictionary, sticky notes, highlighter) | 123.24 | 124.79 | 121.07 |

Table 74

*Instructional Proficiency with Multimedia Tools Kruskal-Wallis H Test by Teacher Experience Level*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Presenting with Keynote | 2 | 8.285 | .016 |
| Presenting with PowerPoint 2010 or 2013 | 2 | 1.439 | .487 |
| Library media apps | 2 | .236 | .889 |
| Photo capture and editing | 2 | .098 | .889 |
| Video recording and editing | 2 | 1.64 | .490 |
| Using iBooks (dictionary, sticky notes, highlighter) | 2 | .173 | .917 |

Instructional proficiency with multimedia applications showed statistically significant differences in teacher experience in only one area. The presentations software program of Apple Keynote showed differences across teacher experience levels. Consistent with differences across age levels, Apple's Keynote showed the lowest proficiency ratings from teachers with greater than 21 years of experience.

The instructional proficiency data from multimedia application tools was also examined by type of school. Table 75 presents the mean sum of ranks from the posttest administered to teachers across various age ranges; while Table 76 summarizes the results from the Krusal-Wallis H test as it relates to teachers in elementary, middle, and high schools.

Table 75

*Instructional Proficiency with Multimedia Applications Kruskal-Wallis H Test Mean Ranks by School Type*

| Survey Item | First 10 Years | Years 11-20 | Greater Than 21 Years |
|---|---|---|---|
| Presenting with Keynote | 123.96 | 131.16 | 103.09 |
| Presenting with PowerPoint 2010 or 2013 | 109.63 | 116.80 | 152.94 |
| Library media apps | 124.10 | 127.38 | 108.16 |
| Photo capture and editing | 123.50 | 122.87 | 115.34 |
| Video recording and editing | 126.56 | 117.34 | 107.33 |
| Using iBooks (dictionary, sticky notes, highlighter) | 120.76 | 117.09 | 126.84 |

Table 76

*Instructional Proficiency with Multimedia Applications Kruskal-Wallis H Test by School Type*

| Survey Item | Degrees of Freedom | Test Statistic (H) | Significance Level (p) |
|---|---|---|---|
| Presenting with Keynote | 2 | 5.414 | .067 |
| Presenting with PowerPoint 2010 or 2013 | 2 | 18.128 | .000 |
| Library media apps | 2 | 2.764 | .251 |
| Photo capture and editing | 2 | .647 | .723 |
| Video recording and editing | 2 | 3.643 | .162 |
| Using iBooks (dictionary, sticky notes, highlighter) | 2 | .577 | .749 |

Instructional proficiency with multimedia applications showed statistically significant differences in school type in the area of Microsoft PowerPoint. High school teachers showed the greatest proficiency with PowerPoint, far outpacing their peers in middle and elementary schools. Photo editing and using iBooks showed nearly no differences across school types.

**Research Question 5: Supportive Conditions and Barriers to Implementation**

The fifth research question asked what teachers viewed as the conditions that supported their professional development and ability to utilize their mobile devices instructionally and what barriers hindered their professional learning and their ability to utilize their mobile devices in an instructional setting. To answer this question, the researcher developed a set of two focus-group questions (Appendix B). These focus-group questions were administered to five focus groups consisting of a total of 50 participants. The participants represented a random sampling of elementary teachers from three schools, teachers representing each team and special area teachers from a middle school, and teachers from each department in the district high school. Teacher responses were analyzed to generate general descriptive statements about each theme. Responses were transcribed and coded into theme statements according to Creswell's (2003) procedures for qualitative data review. Theme responses with a frequency of 0-6 instances were considered to have a low impact on connected classroom, responses with a frequency of 7-15 were deemed by the researcher to have a moderate impact, and responses with a frequency of 16 or greater were deemed to have a high impact on connected classroom. Frequency data from all 50 participants on teacher-reported supportive conditions are summarized in Table 77 which outlines the conditions of the connected classroom professional learning model that teachers found to be generally "supportive" to their learning and implementation of the technology.

Table 77

*Teacher Perceptions of Connected Classroom Supportive Conditions*

| Descriptive Statement | Frequency | % |
|---|---|---|
| Technology staff integrated professional learning into collaboration sessions | 4 | 8% |
| Training sessions offered to specific grade level/department | 4 | 8% |
| (LMS) increased work flow and accountability | 5 | 10% |
| One-on-one sessions with technology coaches | 5 | 10% |
| Special functions “cheat sheets” created by coaches | 5 | 10% |
| Airdrop/LMS facilitated student sharing of work | 6 | 12% |
| Student engagement with mobile device | 8 | 16% |
| Technology coach lessons for students | 8 | 16% |
| Student specific devices extended classroom resources to the home | 9 | 18% |
| Teacher creation sessions provided guidance for student product creation | 10 | 20% |
| Administration supported training | 11 | 22% |
| District-wide Tech Fest sessions provided ideas | 12 | 24% |
| Student specific devices taught student responsibility | 13 | 26% |
| Air server software facilitated sharing | 15 | 30% |
| Notability (Digital notebook application) provided multiple opportunities for student use | 15 | 30% |
| Short, school based mini-sessions aided growth | 16 | 32% |
| Follow up sessions with coaches provided context | 17 | 34% |

Teacher responses to the first focus-group question provided 18 descriptive statements that summarize the reported supportive conditions that teachers believed impacted their professional learning with connected classroom. Using the impact criteria stated above, two items were deemed to have a large impact on connected classroom. Short, school-based professional learning sessions was reported by 32% of focus-group teachers as being supportive of their learning and implementation. This finding was consistent with connected classroom surveys that reported teachers preferred site-based sessions during their working hours (K-12 Insight, 2015). Focus-group participants (34%) also reported that follow-up sessions with building technology coaches had a high impact on their professional learning through connected classroom.

Focus-group teachers were also asked what barriers hindered their professional learning and their ability to utilize their mobile devices in an instructional setting. Teacher responses were analyzed to generate general descriptive statements about each theme. Theme responses with a frequency of 0-6 instances were considered to have a low impact on connected classroom, responses with a frequency of 7-15 were deemed by the researcher to have a moderate impact, and responses with a frequency of 16 or greater were deemed to have a high impact on connected classroom. Frequency data from all 50 participants on teacher-reported supportive conditions are presented in Table 78.

Table 78

*Teacher Perceptions of Connected Classroom Barriers to Implementation*

| Descriptive Statement | Frequency | % |
|---|---|---|
| Outgrew professional development sessions quickly | 2 | 4% |
| Air Server software was unreliable | 2 | 4% |
| Professional learning took place outside of formal sessions | 3 | 6% |
| Lack of Wi-Fi for students at home | 3 | 6% |
| Speed with which Apple specialist conducted sessions | 3 | 6% |
| Organization of electronic material for assessment | 3 | 6% |
| Problems with student/teacher devices took instructional time | 4 | 8% |
| Teaching device responsibility | 4 | 8% |
| Training sessions were not tiered to ability level | 5 | 10% |
| Personal applications for elementary students were distracting | 5 | 10% |
| Development of technology back up plans | 6 | 12% |
| Many educational applications did not reflect best practices | 7 | 14% |
| Pushing apps/downloading updates took instructional time | 8 | 16% |
| Students not having devices charged/leaving device at home | 20 | 40% |

Teacher responses to the second focus-group question provided 14 descriptive statements that summarized the reported barriers or conditions that teachers believed hindered their professional learning with connected classroom. Using the impact criteria stated above, one item was deemed to have a large impact on connected classroom. Leaving devices at home or not having a charged device was listed as having a negative impact on connected classroom by 40% of focus-group teachers. However, it was noted that this barrier was not directly related to the professional development portion of connected classroom.

Focus-group data offered a glimpse into the thoughts of teachers after the first year of the connected classroom professional learning program. The focus-group data generally supported posttest data collected through the technology proficiency survey. The learning management system was mentioned by 10% of focus-group participants and was also one of the highest areas of gain for teachers, as noted in the posttest technology proficiency survey. Teachers reported in the technology proficiency survey that they preferred short, site-based sessions for their professional learning needs. This was supported with focus-group data with 32% of participants listing these types of sessions as a supportive condition to their implementation and professional learning.

# Chapter 5: Discussion

## Introduction

This chapter discusses the conclusions and implications of a logic model program evaluation analyzing the impact of a district's professional development program that accompanied a one-to-one connected classroom initiative. The purpose of this study was to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students.

A mixed-methods approach was used to examine the impact of the professional development program of connected classroom. Both quantitative and qualitative data were gathered from a district-administered survey that was developed by K-12 Insight (Appendix A). Survey questions gathered data on teachers' self-reported device proficiency and instructional proficiency in the areas of basic device usage, increasing student productivity on their devices, integrating multimedia, and facilitating student communication with their device. Quantitative data were examined in the preexperimental design model of one-group pretest/posttest design that is represented by $O_1$ X $O_2$ (Dawson, 1997). The qualitative portion of this study employed a descriptive research design. Focus-group questions (Appendix B) allowed teachers to describe their attitudes toward technology integration after their first year of professional development in the connected classroom program. These questions allowed the researcher to determine the impacts of the program across the entire district and provided a knowledge base for future programs that is rooted in research-based best practices for evaluation of professional development programs (Desimone, 2009; Lawless & Pellegrino, 2007; Smolin & Lawless, 2011).

Following the logic model of program evaluation, the identified needs arose from the district technology proficiency survey (K-12 Insight, 2015; Lawton et al., 2014). The need for professional development was identified to prepare teachers for a technology-rich learning environment for students. The connected classroom leaders developed a comprehensive professional development program as the identified output needed to address their professional development needs. This logic model of program evaluation identified the needs and outputs of connected classroom and evaluated the outcomes of the district's professional development initiative.

**Research Question 1 Discussion**

The first research question asked to what extent did the district's professional development program change teacher perceptions of their technology proficiency. The technology proficiency survey identified four areas of focus for the connected classroom professional learning program. These areas included basic device usage, communication and collaboration, productivity tools, and multimedia applications. Each focus area for connected classroom was two-fold in nature as it sought to both improve teachers' self-reported proficiency with their own mobile device usage across the identified areas as well as their instructional proficiency with students in each identified area. Research Question 1 only focused on teacher proficiency with their device.

The first focus area was basic device usage. Barrett-Greenly (2014) noted that teachers with basic device knowledge were better equipped to make technology-proficiency gains in professional development programs. In the area of basic device usage, the researcher from the technology proficiency survey identified three items. These items included conducting research using the internet, use of special device features on a mobile device, and managing content with cloud storage. Special features (p - .000) and cloud storage (p - .000) areas showed statistically significant gains for teachers in year 1 of the professional learning program. The gains enjoyed by connected classroom in these areas mimicked the gains of educators in studies by Barrett-Greenly and Efaw (2005). These studies identified the professional development needs of teachers and offered targeted interventions and professional learning needs for both basic and advanced technology needs (Barrett-Greenly, 2014; Efaw, 2005). Teachers rated their proficiency at a high level in the initial technology proficiency survey. The average Likert scale response for the pretest technology proficiency survey was 3.2. It was noted that the inability to show statistically significant gains in the area of internet research could have been attributed to the length of time teachers have spent in an internet connected environment. In an older review of educational technology, researchers noted that 99% of teachers reported access to the internet for research, and over 60% of those teachers utilized the internet during class time for research with students (Rowand, 2000). This base of support provided the context for initially higher levels of proficiency with internet research for connected classroom educators.

The next area of focus for district leaders concerned teachers' device proficiency with communication and collaboration. Two items on the technology proficiency survey represented the focus area of communication and collaboration. Online response tools and learning management systems were targeted by connected classroom professional development sessions. Initial results from the technology proficiency survey found that teachers did not rate their proficiency very high with online response tools or learning management systems with average Likert scores of 1.69 and 1.65, respectively. Both areas saw statistically significant gains with Z scores of -5.863 and -6.085 and significance levels of $p=.000$. The fact that teachers moved their proficiency levels so significantly in 1 year of professional development was promising because researchers have noted the importance of online student response tools in advancing teacher formative assessments and allowing all students the opportunity to engage in lessons (Arnesen et al., 2013; Latham & Hill, 2014). Moreover, learning management systems have generally offered educators the ability to streamline the management of instruction and have also provided a focal point of instruction for one-to-one educators of older elementary students through high school students (Nasser et al., 2011; Watson & Watson, 2007). Communication and collaboration gains for connected classroom showed similar gains to a study of preservice teachers that found educators rated their proficiency with technology integration after 1 year of classroom instruction (Coffman, 2015).

The third identified area of focus for connected classroom was teacher proficiency with productivity tools. Connected classroom leaders identified the word processing software packages of Microsoft Word and Apple Pages, spreadsheet management Microsoft Excel and Apple Numbers, and note taking on a mobile device as focal points for professional development sessions during the first year of the initiative. Not surprisingly, neither Microsoft Office products produced statistically significant results, as most teachers reported an initial higher level of proficiency with these products, and connected classroom technology coaches did not specifically target these areas. Starting with a much lower initial proficiency level, Apple's Pages and Numbers showed statistically significant results with Z scores of -4.361 and -3.566, respectively. This increase could have been due to the fact that these applications were relatively new to teachers as most received these devices several months before the professional development program for connected classroom began. Teachers and principals requested training on these new Apple products over their Microsoft counterparts. The increases in self-perceived proficiency with these productivity tools from the connected classroom teachers in the study closely resembled the findings of Jones's (2014) review of one-to-one initiatives. This review of one-to-one initiatives found that administrative support for teacher technology learning needs was a leading indicator of professional learning and implementation success (Jones, 2014).

The last focus area in teacher proficiency was the use of multimedia applications. Multimedia has long been a staple of educational technology (Prensky, 2009; Warschauer et al., 2004). Connected classroom educators reported statistically significant results for the majority of items on the technology proficiency survey concerning multimedia usage. These areas included Apple's Keynote and iBooks applications, library media applications, photo editing software, and video editing software. Teachers reported a high level of initial proficiency with the Microsoft PowerPoint but did report a small but not statistically significant gain in proficiency with the more commonly used PowerPoint software. It should be noted that Apple's Keynote was a major focus of many professional development sessions; and because of the similar nature of the programs, a transfer of learning effect could have occurred. Teachers reported higher gains with all other multimedia applications as well. Connected classroom, as a model of professional development geared toward instruction, focused heavily on multimedia applications because of its documented success with student achievement and educational applicability. A study of secondary biology students found statistically significant gains in student achievement with students enrolled in a course that blended traditional instruction with multimedia products (Gambari, Yaki, Gana, & Ughovwa, 2014). These results offered promise to the future of connected classroom teachers. As far back as the early 1980s and into the present, researchers have noted the importance of interactive multimedia and the potential to increase quality instructional time and engage students (Kulik et al., 1983; ZEMKE, 2001).

**Research Question 2 Discussion**

The second research question asked to what extent did the district's professional development program change teacher perceptions of their instructional proficiency with mobile devices. The subtle difference between personal proficiency and instructional proficiency with students was an important nuance to consider because research has shown that professional development was the single greatest factor affecting technology integration. If teachers are expected to truly integrate technology into instruction, and for students to ultimately integrate technology, one needs to ensure that teachers have been asked the extent to which they can use the device beyond personal use. Further, the professional development model a district should provide should include training that allows for transfer of skills to use in the classroom with students. Studies have shown that teachers have needed specific professional development to facilitate this transfer of technology integration; and teachers, on average, are receiving less than 9 hours of professional development in technology integration per year (Matherson et al., 2014; Sivin-Kachala & Bialo, 2000). The district's technology proficiency survey identified four areas of focus for the connected classroom professional learning program. These areas included basic device usage, communication and collaboration, productivity tools, and multimedia applications. Research Question 2 focused only on teacher instructional proficiency in using the device with students.

The first focus area was instructional proficiency with basic device usage. The technology proficiency survey identified three items in the basic device usage area. These items included internet research, special device features, and cloud storage. Unlike teacher proficiency, all areas of instructional proficiency in the area of basic device usage produced statistically significant results. Utilizing the internet to conduct research with students scored high on the initial technology proficiency survey but still managed to produce a significant gain. This was supported in focus-group data with 16% of participants stating that they felt their students' devices created more engagement with their content. The connected classroom model with basic device usage mirrored that of a model proposed by European researchers who found teachers preferred a professional development provided by peers and technology coaches and not by external professionals (Beauchamp, Burden, & Abbinett, 2015).

The second area of instructional proficiency was student communication and collaboration. Two items covered this area on the technology proficiency survey. Connected classroom leaders chose to focus on online student response tools and learning management systems. Students utilized their mobile devices outside of school as their primary mode of communication (Prensky, 2009; Warschauer et al., 2004; ZEMKE, 2001). Connected classroom aimed to capitalize on the trend of heavy mobile device usage by students and transform this time into extended instructional minutes. Instructional proficiency with student communication and collaboration provided statistically significant gains on both items. Teachers reported that online student response systems offered the ability to transform formative assessments and the ways in which teachers interacted with their students. Connected classroom teachers increased their ability to utilize student response systems much like teachers in a similar study of college-age students (Campbell & Monk, 2015). Campbell and Monk (2015) found that student response systems offered the ability to transform education, specifically student engagement, when the student response systems were used for formative assessments that informed classroom instruction. One unexpected occurrence in the connected classroom related to this area of the study was that the district invested large amounts of professional development time on helping teachers learn how to facilitate student learning using a learning management system. However, after only 1 year, the software developer scuttled the learning management system. This rendered the professional development series obsolete. However, district technology leaders began immediately to address this perceived problem by explaining to teachers that once they learned one learning management system, they could easily transfer that knowledge to a new learning management system. The elements of posting assignments within the system, developing discussion boards, the uploading of videos, and other instructional tools were the same even if the exact steps to complete those tasks in the new learning management software were slightly different. Transferring these skills has been shown effective in a previous study when the content and pedagogical basis were similar across technology products (Brenner, 2012).

The third focus area of instructional proficiency for connected classroom was the ability to utilize mobile devices for productivity with students. The technology proficiency survey highlighted five items concerning productivity. These items included Microsoft's Word and Excel, Apple's Pages and Numbers, and note taking software applications. Connected classroom participants achieved statistically significant results in all areas of instructional proficiency with productivity tools. These results mirrored a similar California study that found teachers with an intermediate baseline of skill could achieve proficiency with new forms of educational technology (Ivers, 2001). This study created a grant program structure for California K-12 schools that tied one-to-one technology initiative funding to professional development (Ivers, 2001). Iver's (2001) study showed that increasing teacher knowledge of instructional practices with technology increased student use of productivity tools in the classroom. The area of instructional productivity was especially promising with regard to the Apple branded products. The Apple applications of Pages and Numbers held relatively low pretest proficiency levels with average Likert scale scores of 1.72 and 1.51, respectively. Teachers reported average posttest proficiency levels of 2.24 and 1.76 on Pages and Numbers. While these averages were still low compared to their Microsoft counterparts, the result of connected classrooms' ability to grow teachers' self-reported proficiency in these areas was promising. One reason for this growth could be attributed to extra time spent with Apple products. This time investment was a best practice proposed by Mouza and Barrett-Greenly (2015) who found that teachers reported a need for more professional development with Apple products during a one-to-one iPad initiative due to the emerging technology base and its applicability to educational application.

The last area of focus for instructional proficiency was multimedia applications. The technology proficiency survey contained six items related to instructional proficiency with multimedia applications. These items included the presentation software packages of Microsoft PowerPoint, Apple Keynote, photo editing, video editing, library media software, and Apple iBooks. Multimedia has a long documented history of providing academic gains for students (Ercan, 2014; Kulik et al., 1983; Warschauer et al., 2004). All items, with the exception of Microsoft PowerPoint, showed statistically significant results after the first year of connected classrooms. This could have been attributed to the initially high level of instructional proficiency with PowerPoint as it had been a frequently used program by educators for an extended period of time. Coleman (2009) noted that PowerPoint has long been a staple in education and offers opportunities for students with disabilities to showcase their work in nontraditional ways. The Apple presentation software of Keynote saw a large average gain with an initial average score of 1.57 and a postmeasure average score of 2.29.

**Research Question 3 Discussion**

The third research question asked the areas in which teachers showed the largest gains in self-reported proficiency. The data were broken down by both basic technology proficiency and instructional proficiency in the areas of basic device usage, productivity, communication, and multimedia presentation. Data from the Wilcoxon Signed Rank test was utilized to determine effect size (r) and calculated by $r=Z/\sqrt{N}$ with N representing the total number of responses from both the pretest and posttest together. For the purposes of this study, an effect size (r) smaller than .1 was not statistically significant, an r greater than .1 was considered small, an r greater than .3 was considered medium, and an r greater than .5 was considered large.

The four areas of focus for connected classroom each consisted of two measures. The first measure asked how teachers rated their proficiency with each of the technologies that were focused on during the first year of connected classroom. The second measure asked how teachers rated their abilities to utilize the technologies instructionally with students.

Teacher proficiency with each of the four focus areas resulted in mostly null and small gains with Apple Keynote providing the only medium effect size (r=.375). Basic device usage produced an average effect size of r=.151. Communication and collaboration had the fewest number of items but enjoyed the greatest average effect size (r=.264). Productivity tools showed the lowest average effect size (r=1.49) and had the largest number of items with null effects. Multimedia, with the largest number of items, had an average effect size of r=.174 but had the largest single item gain with Apple Keynote. The Apple specific items of Keynote, special features, and cloud storage all enjoyed saw relatively larger gains compared to other items. Interestingly, the Apple spreadsheet management tool of Numbers did not produce a statistically significant effect size. In the context of connected classroom, Apple branded products received a large focus during professional learning sessions.

Instructional proficiency for basic device usage showed positive results for all items, unlike teacher basic device proficiency that offered mixed results. Basic device instructional proficiency had an average effect size of r=.204. Communication and collaboration had the lowest number of items but enjoyed the greatest average gains with an effect size of r=.286. These gains were a positive for connected classroom leaders because teachers reported higher gains with utilizing their devices for instructional purposes than their own proficiency. Unlike teacher proficiency for productivity tools, teachers reported small gains in all areas of instructional proficiency with productivity applications. The effect size for instructional proficiency with productivity tools was r=.191, which was small compared to the other areas of focus for connected classroom. Instructional proficiency with multimedia applications had the item with the single greatest gain on the technology proficiency survey. Just like teacher proficiency, Apple Keynote provided the only medium effect size (r=3.72) of all instructional proficiency items. Apple Keynote was an item with which most teachers and students became familiar after professional development sessions and its parallels with PowerPoint. Multimedia applications and teacher self-reported instructional proficiency offered an average effect size of r=2.36.

Effect sizes for this first year of connected classroom were generally small. This supported similar research on professional development programs that accompanied both one-to-one programs and nontechnology rich environments (Weaver, 2012). Weaver (2012) found that teachers who completed a technology-rich professional development program reported higher proficiency levels and readiness to implement a one-to-one program at a rate of over three times their peers without a similar professional development program. A longitudinal study of a sustained, technology integration professional learning plan found that teachers experienced similarly small gains during the first year of their program and showed greater gains as their knowledge base grew (Mouza & Barrett-Greenly, 2015). Mouza and Barrett-Greenly (2015) also offered the context of belief versus practice and how belief change over time can lead to change in practice.

**Research Question 4 Discussion**

The fourth research question asked if there were differences in the self-reported technology proficiency levels of teachers after the first year of the connected classroom professional development program relative to their age, years of experience, and type of school. The Kruskal-Wallis H test was utilized to examine differences across the categories listed above.

The first teacher proficiency focus area for connected classroom teachers was basic device usage. Statistically significant differences were found relative to teacher age in the areas of special device features and cloud storage with H scores of 29.034 and 10.817, respectively. A post hoc analysis of these results showed pairwise differences of teachers in the age range of 30s versus teachers in the age ranges of 40s, 50s, and 60s in the area of internet research, although no significant H statistic was reported for this area.

When the area of basic device usage was examined across teacher experience levels, only the area of special device features reported a significant H statistic (H=9.505). When examined by school type (elementary, middle, high), basic device usage showed statistically significant results in the areas of cloud storage and internet research. Pairwise analysis showed the greatest area of differences existing between elementary and secondary teachers in the area of internet research and high school teachers versus elementary and middle school teachers in the area of cloud storage. The area of special device features was the only area in basic device usage that offered consistent differences across all demographic categories.

Basic device usage was also examined from the standpoint of teacher proficiency with utilizing the devices instructionally with students. The primary goal of any one-to-one program is the meaningful integration of technology into the curriculum. Teacher age ranges only showed one area with statistically significant differences between groups of teachers. This area was the use of special device features with post hoc analysis showing that the most significant differences existed between teachers in the age groups of 30s and 40s. Interestingly, teachers in the 20s age group performed at a similar rate as teachers in the 60s age group. This can be attributed to the small amounts of growth recorded for both groups. No differences existed in the instructional basic device usage area when controlled for teacher experience level. When instructional proficiency with basic device usage was examined for differences across school type, the areas of internet research and special device features showed statistically significant differences with H scores of 10.597 and 15.416, respectively. Pairwise analysis showed elementary teachers scoring lower in the area of internet research and high school teachers scoring lower with special device features. No differences existed across school types for cloud storage.

This could be attributed to the fact that cloud storage is similar across the Apple platforms of iPads and MacBooks.

Teacher proficiency with communication and collaboration tools did not show statistically significant differences across teacher experience ranges. Learning management systems showed statistically significant differences across age ranges and school types. Post hoc testing showed that greatest differences existed between teachers at the elementary and high school levels.

Communication and collaboration is a uniquely student-centered area of instructional proficiency focus for connected classroom. Connected classroom leaders focused a large portion of their professional development time on the area of communication and collaboration. This focus of time and resources produced the largest gains of any area in connected classroom. This also produced teachers who did not show many differences across demographic areas. The only area with significant differences in instructional proficiency with communication and collaboration tools was learning management system with differences across school type and experience level. Pairwise analysis showed that teachers with greater than 21 years of experience and elementary teachers did not grow at a similar rate as their peers in the area of learning management systems. School type results could be misleading as the majority of elementary-level teachers reported lower scores in the area of learning management systems. Learning management systems were not typically utilized by the majority of elementary teachers as the student skill level required for the applications.

Productivity tool proficiency was the next area of focus for connected classroom. When examined for differences among teacher age ranges, all areas with the exception of Microsoft Word showed statistically significant differences. A post hoc analysis showed the greatest differences existed among teachers in the age ranges of 20s, 30s, and 40s versus their peers in the age ranges of 50s and 60s. Microsoft Word, which did not display statistically significant results, showed a similar pairwise difference between teachers in the age range of 60s versus their younger colleagues. This was not surprising as most teachers are familiar with Microsoft Word, according to the pretest technology proficiency survey. When teacher experience level was analyzed, only Apple Pages showed statistically significant differences. A post hoc pairwise analysis revealed teachers with 20 or more years of experience were less likely to rate themselves as proficient than their peers in their first and second decades of teaching. No statistical differences existed between the various school types on productivity tools.

Productivity tools instructional proficiency was also examined for differences across demographic areas. Apple Pages and note taking on a mobile device provided significant differences across teacher age ranges and experience level. When school type was examined for differences, the Microsoft products of Word and Excel were the only areas that showed significant differences. This is unique because post hoc analysis showed the major differences existed between teachers in middle and high schools. Secondary teachers have shown consistent results in most areas of focus for connected classroom.

Multimedia tools teacher proficiency showed differences across teacher age ranges in half of the items surveyed. Statistically significant differences were found in the areas of PowerPoint, Keynote, and video editing software. A similar pattern was also found to show significant differences when teacher experience levels were examined. Teachers with greater than 21 years of experience showed growth at a slower rate than their peers in the first 10 years of teaching experience. The same items of PowerPoint, Keynote, and video editing software were found to show statistically significant differences. A post hoc analysis of both teacher age ranges and experience levels showed the greatest differences between teachers in their 20s and 60s and teachers in their first decade of teaching and teachers with more than 20 years of experience. When school type was analyzed, significant differences were found in the areas of PowerPoint, Pages, and library media applications. The major differences were found between teachers at the elementary and middle school levels versus their high school peers. This could have been due to the fact that teachers and students in district elementary and middle schools received and were trained in the use of Apple iPads, while high school teachers received training on Apple MacBooks.

Multimedia instructional proficiency showed differences across age ranges, experience level, and school type in the area of Apple Keynote. Microsoft's PowerPoint was the only other area with statistically significant differences but only in the area of school type. Post hoc analysis showed that PowerPoint was rated high among high school teachers. It should be noted that high school students were the only students with access to PowerPoint on their mobile devices. Elementary and middle school students received Apple iPads with Keynote installed and high school students received an Apple MacBook with PowerPoint and the full Microsoft Office suite of software. This post hoc analysis held true for Apple Keynote with the most significant differences existing between teachers in elementary and high school and teachers in middle school and high school.

These results showed a lack of a consistent pattern of differences across different age ranges, experience levels, and school types. This lack of a pattern was consistent with research in the field of professional development that found no statistically significant differences across gender, age, and experience levels in various forms of teacher professional learning (Bayar, 2013; Schulze, 2014; Tas, 2012). However, several researchers have found that the most significant differences in teacher professional development have been manifested in teachers with high levels of experience with these educators not growing their skill base as much teachers in the earlier parts of their career (Boyd et al., 2011; Kraft & Papay, 2014).

**Research Question 5 Discussion**

The fifth research question asked what teachers viewed as the conditions that supported their professional development and ability to utilize their mobile devices instructionally and what barriers hindered their professional learning and their ability to utilize their mobile devices in an instructional setting. This question was asked in a series of focus groups in three of the district elementary schools, one middle school, and the high school. A total of 50 teachers participated in the focus groups.

The most reported supportive conditions for focus-group teachers were professional development sessions that were short in time and site-based (N=16) and follow-up sessions with technology coaches (N=17). This mirrored preprogram survey data that stated teachers preferred professional development sessions offered in their buildings during planning periods (K-12 Insight, 2015). This was also reported by teachers in a study of PLC development and teacher preference in professional development (Nadelson, Seifert, Hettinger, & Coats, 2013). Two items were also reported by 30% of focus-group teachers. These items were the software applications of AirServer and Notability. AirServer provided teachers the ability to broadcast the screen from their iPad onto an electronic whiteboard. Notability was a mobile device application that allowed users the ability to create digital notebooks and annotate documents. Many teachers utilized Notability for test preparation as well as assessment. It was noted that heavy emphasis was placed on both of these applications in the connected classroom professional development series. The other supportive conditions offered a variety of items that encompassed the activities of individual technology coaches, learning outcomes for students, and building leadership. This mirrored many of the published studies on technology professional development that supported the role of coaches, student-focused outcomes, and leadership in technology-rich environments (ISTE, 2015; Matzen & Edmunds, 2007; National Commission on Teaching, 1996; Pianta, 2011; Spillane et al., 2001; Stanhope & Corn, 2014; Tulbert, 2013).

The focus-group participants' comments regarding the supportive conditions provided thoughtful insight into the attitudes of teachers in the connected classroom professional development sessions. Several teachers noted that students seem more engaged with the curriculum with their mobile devices with one teacher stating, "it is like some students were more alive when we utilize the iPad for even the smallest of instructional tasks" (Focus Group, May 2015). Another teacher stated, "students enjoyed interacting with their iPads and that made my job more fun" (Focus Group, May 2015). With the ISTE theme of essential conditions and technology coaches playing an important role in the facilitation of one-to-one rollouts, many teachers agreed that their building coach provided a majority of the professional learning for connected classroom. One teacher stated,

> [Technology coach] took great care to differentiate our team's learning and made sure that we all moved forward at our own pace. She really modeled the technology with our students and that really made a big impact in showing me how to use the programs. (Focus Group, May 2015)

This sentiment was echoed by another teacher who said, “having [the technology coach] model lessons really helped me in understanding how to teach students how the technology should be used in the course of the lesson. It helps when I can separate myself from the process and watch” (Focus Group, May 2015).

Connected classroom barriers were often centered on items that did not impact the professional development portion of their program. These barriers included items of a technical nature such as lack of Wi-Fi (6%), problems with AirServer (4%), and the time it took to push or download applications to student devices (16%).

The most reported barrier to implementation was students not having their devices or their devices not being charged before class. It was noted that this barrier did not hinder teachers in their ability to grow in their professional development, but 40% (N=20) reported that it presented major challenges to their classroom routines. One teacher said, “when one student didn’t have an iPad I could usually just give them my iPad so they could still complete the assignment. If more than one student did not have their iPad I would sometimes change my lesson plans” (Focus Group, May 2015). These external factor barriers were also supported by research in studies by Weaver (2012) and Cuban (2001).

The most reported barrier to professional learning was developing backup plans for when technology was not accessible (16%). When discussing the need to develop backup plans, one teacher stated, “I feel like I need to develop two sets of lesson plans and that is very frustrating. Hopefully with time I will be able to adjust on the fly and the technology failures will become less stressful” (Focus Group, May 2015). Connected classroom professional development sessions also produced some barriers in the focus-group discussions. Focus-group participants (10%) stated that professional development sessions were not tiered or differentiated to teacher ability. This was closely related to 6% of the participants who stated the Apple embedded specialist moved too fast for teachers in their building. Conversely, 4% of participants stated that they outgrew the professional development sessions rather quickly, and another 6% stated they did the majority of their professional learning outside of the structured environment of connected classroom. On the subject of outside learning, one teacher said,

> I felt like some teachers on my grade level held us back in the sessions, there was so much I wanted to learn from [Apple embedded specialist] but his time was often spent covering background knowledge that I already had. (Focus Group, May 2015)

**Limitations**

The connected classroom initiative was the product of an entire school district in the upstate region of South Carolina. All teachers were required to complete an initial round of 10 professional development sessions and school-based follow-up sessions with an Apple specialist and technology coaches. These results could possibly be limited by the fidelity with which school-based sessions were conducted. Principals in each school directed coaches as to their school's identified needs, and no cohesive strategy was employed to ensure all district identified needs were addressed after the initial 10-hour round of professional development. This study also lacked a control group that did not receive the professional development program.

Another possible limitation was the type of data collected by the district. Self-reported proficiency data can be viewed as subjective, and data analysis may not have provided a clear picture of true results. Identified best practices in professional development call for an analysis of results and not satisfaction in the professional development activities (Desimone, 2009).

**Delimitations**

Connected classroom was a multifaceted program that encompassed deployment of thousands of Apple iPads and MacBook Air laptops to every student, the upgrading of server facilities to handle the additional data traffic, and the professional development of a sustainable professional development program targeted at increasing teacher competency in the identified areas of need. The scope of this program evaluation focused on teacher professional development and its relevance to the greater body of literature on one-to-one initiatives and technology integration professional development. With a focus on learning outcomes and not participant satisfaction, this program evaluation tested new ways in which researchers can evaluate professional development (Desimone, 2009).

**Implications for Future Study**

This program evaluation looked at the professional development portion of a one-to-one technology integration program in a South Carolina school district. The connected classroom initiative encompassed an investment in infrastructure, an investment in professional development, and a mindset change among the educators of an entire school district. The aims of this study were to examine one facet of a complex program.

Future studies on one-to-one implementations could seek to create an instrument to measure TPACK growth (Koehler et al., 2012). TPACK was a driving force behind connected classroom settings and the Apple embedded specialist's "train the trainer" model.

Microsoft's Anytime, Anywhere laptop initiative provided preprogram data that showed 74% of teachers reported using technology in the classroom for word processing and 58% for creating presentations. This data is nearly identical to preprogram data collected by connected classroom district leaders who found in 2013 that 80% of teachers used technology for word processing and 61% utilized technology for presentations. Many of the data points collected by connected classroom leaders did not exist in the mid-1990s for a true comparison. Future studies could follow teachers' utilization of technology for instructional purposes as a function of their level of technology proficiency levels or TPACK utilization (Koehler et al., 2012; Walker & Rockman, 1997).

**Logic Model Outcomes**

For the purposes of this study, a total of 32 items were measured utilizing a district-created technology proficiency survey. These 32 items included 16 items on teacher technology proficiency and 16 items relating to instructional proficiency. In terms of statistically significant gains, 12 of the 16 items relating to teacher proficiency showed gains. All 16 instructional proficiency items measured by the technology proficiency survey showed statistically significant gains. Instructional proficiency was the main goal of connected classroom leaders and all connected classroom professional development sessions and technology coaching sessions were geared toward this goal. The nexus of these results supports the previous work of researchers who found strong links between quality professional development and technology integration (Hanushek et al., 2005; Heck, 2007). The item with the biggest gains was Apple's presentation software of Keynote. Connected classroom professional development sessions provided a large amount of training on Keynote and other Apple products.

The qualitative portion of this program evaluation showcased many of the supportive conditions that teachers reported during the first year of their professional development program. Short, site-based sessions offered by in-house technology coaches were the highlights of the focus groups. This nearly mirrored the work of Yoon et al. (2007) who found technology professional development is best delivered in short sessions from peers and coaches and not in traditional workshop settings. The barriers most often mentioned by teachers were of a technical nature and not within the realm of the professional development portion of the program. This is of importance to district leaders planning a future one-to-one program. Considerable time and attention must be paid to all facets of any technology integration program to ensure fidelity of implementation.

The professional development portion of connected classroom was a largely successful program in terms of the stated objectives. This program evaluation highlighted the clear lines between the district inputs and outputs of professional development programs and the outcomes of teacher self-reported technology proficiency growth. This technology professional development program presented its own unique set of challenges and opportunities for teachers and district leaders. In part one of a four-part series, Harris (2008a) outlined many of the required components of a quality, research-based educational technology professional development program. The researcher highlighted nine conditions of high-quality technology professional development that have been derived from research. These nine conditions include conducted in the school setting, linked to school initiatives, concrete, planned and conducted by teachers, differentiated to teacher ability levels, addresses goals derived by teachers, hands on with reciprocal feedback encouraged, sustainable over longer periods of time, and provides for timely technical support (Harris, 2008a). The connected classroom initiative closely mirrored many of these nine conditions.

In terms of the logic model of program evaluation, the stated objects were met in

12 of the 16 short-term teacher proficiency goals and all 16 intermediate instructional proficiency goals. The inputs of strategic staffing with research-based technology coaching, emphasis on educational applicability through a train the trainer model with an Apple embedded specialist, and the creation of a comprehensive professional learning program led to the successful connected classroom outcomes of increased teacher proficiency (short-term goal) and increased instructional proficiency (long-term goal). Although statistically significant gains were noted in 12 of 16 areas of teacher proficiency and all 16 areas of instructional proficiency, the effect sizes were mostly small as evidenced in Research Question 3. These small effect sizes were consistent with similar studies of technology-focused professional development programs (Mouza & Barrett-Greenly, 2015). Prior research led connected classroom to invest in technology coaches for every school (Cifuentes et al., 2011; ISTE, 2015). This decision was supported by connected classroom focus-group participants with 5% of participants noting the importance of coaches, 16% noting that technology coaches effectively modeled lessons for teachers, 32% stating that short school-based coaching sessions aided their implementation, and 34% reporting that follow-up sessions with technology coaches provided the context needed to take full advantage of the professional learning program. A one-to-one professional learning program would best serve a school district when it is built upon similar inputs to connected classroom. Investments in technology infrastructure and technology staffing are required to maximize equipment usage while minimizing instructional downtime in the classroom. It was noted by 16% of focus-group participants that a significant barrier to implementation was time needed to push applications to devices. Another 6% of focus-group participants reported that development of technology backup plans was a major barrier to implementation due to

the loss of instructional time when problems occurred. Minimizing these barriers is paramount to a district in the process of developing a one-to-one program. Professional learning sessions in the context of a one-to-one program should provide the context necessary to develop contingency plans for when problems arise.

**Summary**

The purpose of this study was to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. The professional development program was designed around four areas of focus that were each assessed on teacher knowledge of the technology and their ability to utilize the technologies instructionally. The connected classroom initiative was planned to be a sustainable effort to provide ongoing and job-specific professional development to teachers as they make the full transition to a one-to-one environment and will be evaluated on an ongoing basis by district leaders. Research led connected classroom leaders to invest in infrastructure upgrades to support a professional learning program focused first on teacher proficiency and comfort with Apple devices, followed by a focus on increasing instructional proficiency in the classroom. Technology coaches were hired for every school and spent an entire year with an Apple embedded specialist focused on a train the trainer model that laid the foundation of a professional learning program that met the needs of connected classroom teachers. The strategic inputs of hiring technology coaches for every building and providing short site-based sessions with a large day-long professional learning program every year were paramount in connected classroom showing the small but statistically significant gains in the first year.

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# Appendix A

## Adapted Technology Proficiency Survey

**Adapted Technology Proficiency Survey**

Page 1: Demographic data

1. First Name
2. Last Name
3. School
4. Grade
5. Primary Subject Matter

Page 2: Current Technology Use in the Classroom

There are many factors that influence how you teach. The One-to-One initiative is designed to incorporate technology into teaching and learning. The next set of questions explores how you and your students use technology during the learning process.

6. How frequently do you incorporate some form of technology (Microsoft Office, Internet Research, etc.) into your instruction?
    a. Daily
    b. Once or twice per week
    c. Once or twice per month
    d. Once or twice per semester
    e. Once or twice per year

7. How often does a typical student in your class(es) use technology as a tool for learning?
    a. Daily
    b. Once or twice per week
    c. Once or twice per month
    d. Once or twice per semester
    e. Once or twice per year

8. Teachers will have access to a variety of technologies to facilitate students' use of their electronic device. Please rate your current skill level with the following technologies for use as a teacher tool.
   (Never Used the Technology, Novice, Intermediate, Highly Skilled)
    a. Word processing with Pages
    b. Word processing with Word 2010 or 2013
    c. Presenting with Keynote
    d. Presenting with PowerPoint 2010 or 2013
    e. Spreadsheet design and manipulation with Excel 2010 or 2013
    f. Spreadsheet design and manipulation with Note taking on a mobile device
    g. Research with Safari and various library media apps
    h. Note taking on a mobile device
    i. Library media apps
    j. Photo capture and editing
    k. Video recording and editing
    l. Use special features on device as a tool for learning like Speak selection and guided access

m. Managing content with Cloud storage
n. Using iBooks (the dictionary, highlighter and sticky notes)
o. Online student response tools
p. Using online learning management tools to have discussions and create assignments

9. How often do students engage in the following activities in your classroom? (Daily; Once or twice per week; Once or twice per month; Once or twice per semester; Once or twice per year)

    a. Communicate with experts, peers and others (via email or through discussion boards)
    b. Produce documents and publications with Word or Pages
    c. Produce presentations with Keynote or PowerPoint
    d. Take notes using a mobile device
    e. Conduct online research with Safari and various library apps
    f. Use drill and practice or tutorial software
    g. Use the Internet to collaborate with students in or beyond your school (~~Google Hangout~~; Skype; Facetime)
    h. Visually represent or investigate concepts (through concept mapping, graphing, reading charts, etc.)
    i. Use digital tools and peripheral devices (digital camera, Promethean board, probes, scanners, etc.) to enhance their schoolwork

10. During this school year, which of the following products do (or will) students in your classes use to demonstrate their learning? (Check all that apply)

    a. Word processing documents
    b. Presentations (PowerPoint or Keynote)
    c. Websites
    e. Models (modeling population trends in animal life, for example)
    f. Submissions to journals, newspapers or magazines (electronic or hard copy)
    g. Video conferences (Skype)
    h. Online assessments
    i. Online competitions

Page 3: Professional Learning
QUESTION MATRIX FOR Q10 and 11. If participant selects 'highly skilled' for Q11. Have participants answer Q12

11. Which best describes your skill level with each of the following technologies as it relates to have students use the tool to demonstrate learning? (Never Used the Technology, Novice, Intermediate, Highly Skilled)
    a. Word processing with Pages
    b. Word processing with Word 2010 or 2013

c. Presenting with Keynote
d. Presenting with PowerPoint 2010 or 2013
e. Spreadsheet design and manipulation with Excel 2010 or 2013
f. Spreadsheet design and manipulation with Note taking on a mobile device
g. Research with Safari and various library media apps
h. Note taking on a mobile device
i. Library media apps
j. Photo capture and editing
k. Video recording and editing
l. Use special features on device as a tool for learning like Speak selection and guided access
m. Managing content with Cloud storage
n. Using iBooks (the dictionary, highlighter and sticky notes)
o. Online student response tools
p. Using online learning management tools to have discussions and create assignments

12. Would you be willing to lead professional development sessions for others?
    a. Yes
    b. No

If participant answers yes, show comment 13 and question 14

13. Someone from the District Office may contact you about your interest in providing professional development. Thank you for your interest.

14. What products or topics would you be willing to share with others?

15. Clover School District administration is planning targeted professional development for all teachers to ensure successful One-to-One implementation. Therefore, all teachers will be required to participate in a minimum of X hours of professional development before Fall 2014. Please rank your top 2 choices.
    a. After school between 4pm and 6pm during Spring 2014 semester
    b. Half day summer sessions
    c. Virtual courses
    d. Short school-based sessions
    e. Video tutorials
    f. Print materials

Page 4: One-to-One Outcomes

16. Clover School District hopes to develop students who are armed with 21st century skills. Please rate the level of impact that you believe the one-to-one initiative will have on the following expected outcomes.

| | No Impact | Minor Impact | Moderate Impact | Major Impact | Not Sure |
|---|---|---|---|---|---|
| Student Outcomes | | | | | |
| Increasing student fluency with 21st century skills (creativity, collaboration, communication, etc.) | | | | | |
| Increasing student interest in their learning | | | | | |
| Increasing student achievement | | | | | |
| Increasing student use of technology in a digitally responsible way | | | | | |
| Improving student ability to critically analyze information | | | | | |
| Improving student ability to collaborate with others to solve real-world problems | | | | | |
| Teacher Outcomes | | | | | |
| Improving your ability to provide personalized instruction | | | | | |
| Increasing the number of collaborative activities in your classroom | | | | | |
| Increasing your technology use for instructional purposes | | | | | |
| Increasing your technology use for greater productivity | | | | | |
| Enhancing your ability to develop lessons that are relevant to students' lives | | | | | |

# Appendix B

## Focus Group Questions

**Connected Classroom Focus Group**

1. Reflecting back on our first year of Connected Classroom, discuss any conditions that lead to positive experiences during your professional learning sessions focused on technology integration and your ability to utilize your mobile devices (iPad/MacBook Air) instructionally.

2. Reflecting back on our first year of Connected Classroom, discuss any barriers that hindered your professional learning in the area of technology integration and your ability to utilize your mobile device (iPad/MacBook Air) instructionally.

Debriefing:

This research project will be used to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. It will specifically examine teacher self-reported proficiency, supportive conditions, and barriers to implementation of the connected classroom initiative. Thank you for your participation in this focus group. Do you have any questions?

# Appendix C

## Informed Consent Document

**Informed Consent Document**

For the Study: Connected Classroom: A Program Evaluation of the Professional Development Program of a One-To-One Educational Technology Initiative in South Carolina

RESEARCH PROCEDURES: This research project will be used to evaluate the impact of the first year of a multi-year, district-wide professional development program for teachers that accompanied a one-to-one Apple device rollout for all students. It will specifically examine teacher self-reported proficiency, supportive conditions, and barriers to implementation of the connected classroom initiative. If you agree to participate in this focus group you will be asked questions about your experiences during the professional development portion of connected classroom.

RISKS: There are no foreseeable risks for participating in this research.

BENEFITS: There are no direct benefits to you for participating in this study other than to further research in one-to-one technology initiatives and help the district improve connected classroom.

CONFIDENTIALITY: The data in this study will be confidential. Only the researchers will have access to the data collected. Your name will not be included on any of the focus group transcripts.

PARTICIPATION: Your participation is voluntary, and you may withdraw from this study at any time and for any reason.

CONTACT: This research is being conducted by the Clover School District and for a doctoral dissertation by Kelly J. Grant (kelly.grant@clover.k12.sc.us) at Gardner-Webb University. You may contact Kelly J. Grant, Assistant Principal of Griggs Road Elementary at 631-8200 or Dr. Sheila Quinn at Gardner-Webb University if you have questions or comments regarding your rights as a participant in this research.

This research has been reviewed according to Gardner-Webb University procedures governing your participation.

CONSENT

____I have read the Informed Consent Document and agree to participate in the study

____ I have read the Informed Consent Document and DO NOT agree to participate in the study

My signature below confirms the response checked above represents my wishes on participation in this study.

______________________________________________________________________

# Appendix D

## Focus Group Explanation Letter

**Connected Classroom Focus Group**

**Kelly J. Grant**
**Assistant Principal**
**Griggs Road Elementary**

**Who**: Selected teachers (you select and invite) from your respective buildings

1. Elementary – 1 teacher from each grade level and a special area teacher
2. Middle School – 1 teacher from each team and a special area teacher
3. High School – 1 teacher from each department

**What**: I will ask two questions about the positives and negatives from the first year of Connected Classroom. Responses to the questions will be recorded for data collection purposes but destroyed after transcripts are created. No personally identifiable information will be used in the dissertation.

**When**: After school for 30 minutes on one of the following days (May 11$^{th}$, 12$^{th}$, 13$^{th}$, 14$^{th}$, 18$^{th}$, 19$^{th}$, 20$^{th}$, 21$^{st}$) you can let me know the dates that work for your school.

**Where**: A conference room or empty classroom in the school. Once you confirm a date for me I will contact the principal to ask for a room.

**Why**: I am conducting a program evaluation of Connected Classroom for my doctoral dissertation. I need to conduct focus groups to collect qualitative data that will enhance the quantitative data collected by the technology proficiency survey.