TEACHER BEHAVIOR IN THE DIGITAL AGE: A CASE STUDY OF SECONDARY TEACHERS' PEDAGOGICAL TRANSFORMATION TO A ONE-TO-ONE ENVIRONMENT

by

Carrie M. Rowe

Bachelor of Science, Slippery Rock University, 1998

Master of Science, Robert Morris University, 2003

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This dissertation was presented

by

Carrie M. Rowe

It was defended on

March 25, 2014

and approved by

Dr. Charlene Trovato, Associate Professor, Administrative & Policy Studies

Dr. Cynthia Tananis, Associate Professor, Administrative & Policy Studies

Dr. Betty Sue Schaughency, Adjunct Faculty, Superintendent Emerita

Dissertation Advisor: Dr. Mary Margaret Kerr, Professor, Administrative & Policy Studies

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Carrie M. Rowe, Ed.D.

University of Pittsburgh, 2014

The current study examined changes in teacher behavior during the transformation to a 1:1 technology initiative on a secondary campus in the Mid-Atlantic region. This study assessed the frequency of instructional and non-instructional technology use over time. In addition, levels of instructional technology use were considered using Puentedura's (2005) SAMR model: substitution, augmentation, modification, and redefinition levels. The current study considered the demographic characteristics of the participants related to changes in use of instructional and non-instructional technology. The current study considered: 1) sex, 2) building level, 3) years of service, 4) participation in a previous technology initiative, 5) academic department, and 6) education level. A review of the literature suggested that several barriers to implementation of successful 1:1 technology initiatives exist (Lewis, 2003; Pelgrum 2001; BECTA, 2004; Levin & Wadmany, 2008; Pundak & Rozner, 2007). The literature indicates that failure to address the barriers to 1:1 technology initiatives may diminish the impact of the project; barriers include: 1) access, 2) time, 3) perception, and 4) professional development. Three measures were used for data collection at two points in time: 1) survey, 2) walkthrough observations, 3) observations. Data analyzed reflected changes in several demographic areas, wherein the specific combination of significant data points indicated that another barrier might exist.

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PREFACE

To my research advisor, Dr. Kerr, for helping me “to land the plane.”

To my coach, Dr. Szeles, for her supportive engagement.

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1.0 INTRODUCTION

The viewpoint that little has changed in the past 100 years in K-12 public education in the United States is clearly misguided; indeed, not much remains the same. While some of the staple mechanisms for instruction have persisted, many new manipulatives, technological peripherals, and instructional strategies have been significantly changed to meet the needs of the 21st century learner. Teacher instructional strategies have changed to incorporate higher order thinking skills, as the ubiquity of technology has rendered some fact memorization unnecessary. Constructivist strategies, wherein students are active participants in meaning and knowledge construction, such as project-based learning, are more prevalent. In only the past 10 years, major leaps have been made in the area of instructional technology, permitting students to practice writing skills through blogging, video-conference with experts around the world, download presentations for review, and collaborate on a scale never before experienced. What can be said is that so much has changed in education that very little would be recognizable to our contemporaries from only a few generations ago.

With such rapid changes in all aspects of K-12 public education in the United States, including the rapid development and diffusion of instructional technology tools marketed to K-12 public schools, consideration must be given to how the technology is used once it is received by teachers. The research seems to suggest that once technology tools are provided within the educational setting, learners, instructors, and parents will support the change toward a technologically enhanced educational program.

The BECTA (2007) study of more than 25,000 teachers seemed to support the idea that when presented with instructional technology, teachers would embrace the change. The results of the study suggested that teachers who had technology available in the classroom were using it with surprising frequency. When the data collected were analyzed, however, the previously lauded statistics of increase teacher use of technology were seen differently. While teachers, indeed, were using technology with greater frequency, the uses were often unrelated to direct student instruction, rather they were for clerical purposes, such as emailing parents and colleagues or entering student grades into a digital grade book. Researchers who analyzed similar data found that those teachers using technology for instructional purposes were doing so at a low-level; for example, by using presentational applications (such as PowerPoint or Keynote) to support traditional, direct teacher instruction or by teaching discrete technical skills in isolation in lieu of a focus on developing a more robust technological aptitude leading to the transference of technical skills (Tondeur, van Braak, & Valcke, 2007; Mouza, 2009). Based on the results of these studies, consideration was given to what barriers existed within the context of the school that limited a teacher's use of available instructional technology.

1.1 BARRIERS TO TECHNOLOGY INTEGRATION

Confounded by the ubiquity of technology in classrooms and its low-level or infrequent use, researchers began to study what obstacles existed to prevent teachers from utilizing what was generally viewed as an instructional enhancement (Fullan & Stiegelbauer, 1991; Fisher, 2006; & Harris, 2002). Among the barriers found were:

- **Accessibility** – Including over scheduled computer labs, lack of maintenance and updating of hardware and software, lack of technical support, and lack of personal access to technology for teachers. Accessibility is also limiting due to disproportionate state and local funding, leading to a lack of financial resources to purchase enough up-to-date technology.
- **Perspective** -- Teachers tended to passively resist technology integration when they perceived that using technology would increase their workload, not enhance it. Teachers also resisted technology when they perceived that their traditional instructional strategies were as effective as the new technology.
- **Time** -- Teachers suggested that the increased amount of time required to effectively integrate technology was a significant barrier to its use. Teachers perceived that they lacked time to plan technology related lessons, explore related websites, or practice the technology tasks that they desired to integrate. Standardized testing was also cited as a barrier related to time.
- **Professional growth**-- The lack of meaningful professional development training related to technology, that is differentiated to meet the diverse needs of individual teachers, was seen as another barrier. It was noted throughout the literature that professional development that simultaneously teaches technical skills and pedagogical skills would be effective in overcoming this barrier. Use of common planning time and providing teachers with a more capable peer as a mentor were also cited as ways to remove the this barrier to integration.

- **Learning Styles (LS) and Multiple Intelligences (MI)** – The seven learning styles and the nine intelligences present an alternative to the traditional logical and linguistic teaching and learning styles. Both theories, LS and MI, build on the premise that all learners approach learning tasks in different ways and benefit from information being disseminated in different ways. That said, if the aforementioned professional development is not presented in a way that makes the technology acquisition accessible to all types of learning styles and intelligences, then the manner of professional development can be as limiting as the failure to have effectual content and pedagogical trainings.

1.2 1:1 TECHNOLOGY: UNANSWERED QUESTIONS

While much research has been conducted regarding educational technology in the classroom, the idea of one-to-one correspondence of students to technology is still in its infancy; the one-to-one correspondence of students to technology is directly related to the barrier of accessibility noted in section 1.1. This term, often abbreviated as "1:1," is marked by each student having his/her own computerized device for school and home use (for use 24-hours a day, seven days a week). Research that has been conducted thus far on one-to-one technology initiatives has centered around three major questions:

- Does the proper use of 1:1 technology improve student learning in core subjects?
- What 1:1 technology for students is the best to improve student achievement?
- What is required to achieve a true return on investment (ROI)?

These questions are certainly worth exploring, as student achievement in a cost effective manner is the goal of any responsible school. While the aforementioned questions explore "what" happens with students, the current study explored "how" instructional strategies changed when a one-to-one correspondence was realized. The current study focused on how the teachers interacted with technology, rather than focusing on student achievement itself. Additionally, previous studies about one-to-one projects have focused on student responses to self-reflective surveys after the introduction of technology. This study used teacher self-reflective responses regarding their own use of technology in the classroom before and after the one-to-one correspondence with technology.

1.3 OVERVIEW OF THE CURRENT STUDY

This exploratory case study took place in a Mid-Atlantic public secondary school of 1,000 students and 70 faculty, comprised of grades 7-12, hereafter referred to as BCP.

Three measures of data, taken at two points in time approximately seven-months apart, were used to answer the primary research question: How have instructional strategies related to technology integration changed between two points in time? The three measures of data included:

- Archival data from teacher submission of a self-reflective Apple survey administered immediately prior to students receiving technology and again after seven months of concurrent teacher-student interaction with the technology.

- Archival data from observations (48 minutes) of teaching practices conducted by trained administrators, both prior to and after the introduction of student technology.
- Archival data from walkthrough observation (10 minutes) of teaching practices conducted by trained administrators, both prior to and after the introduction of student technology.

The survey data submitted by teachers in June 2013 and the observation and walkthroughs conducted by administration between January and June 2013 were treated as "Time 1" data. "Time 2" data used the same measures over the seven month period of instruction following the introduction of the one-to-one technology correspondence for students. The data from "Time 1" was compared to "Time 2" data in order to explore changes in instructional practices.

The current study considered all teachers serving grades 7-12. Inclusion in the study was predicated on having data for all three measures during both Time 1 and Time 2 (N=58). Of the 58 BCP teachers in this study, 42 were high school teachers (grades 9-12) and 16 were middle school teachers (grades 7-8). All core subject teachers (Math, Science, Social Studies, and English) were represented.

1.4 HOW THIS DOCUMENT IS ORGANIZED

The overall structure of this study takes the form of five chapters, including this introductory chapter. Chapter two reviews key terms and the literature relevant to this research. Chapter three outlines the methodology used to carry out the study. Chapter four presents the findings of the research, focusing on the themes that have been identified in analysis. Finally, Chapter five gives a brief summary and critique of the findings, and includes: discussion, analysis, implications for future research and conclusion.

2.0 THE LITERATURE

Inversely proportionate to the price and size of computerized devices has been their inclusion in the K-12 educational setting; that is, as the price and size have decreased, their use in schools has increased. Along with the increase in use has come a plethora of studies investigating the effects of a technologically enhanced curriculum. Studies have investigated teacher instructional technology from a variety of perspectives, most notably: 1) student achievement, 2) student engagement, and 3) student satisfaction. While some of the research has indicated a general acceptance of the need to use technology in the secondary classroom setting, proponents have been hard pressed to demonstrate its educational benefit. This literature review will describe several studies whose results indicated that increased use of technology, while increasing student engagement and satisfaction, did not increase student achievement. Additionally, this literature review will examine the possible reasons why student achievement remained stagnant in some areas after the introduction of technology, and only moderately increased in others.

Other researchers have chosen not to focus on the student perspectives noted above, but rather on teacher behavior toward technology. Researchers have described studies focusing on teacher behavior in terms of: 1) phases, 2) barriers to consistent use, and 3) the need for targeted professional development. A review of these study results may begin to untangle the curious lack of significant student achievement when technology is introduced.

Teacher behavior toward the inclusion of technology can also be understood through the lens of Roger's (2003) Diffusion of Innovations theory. Roger's theory, which extends to all technology and is not limited to the educational setting, considers: 1) What qualities make an innovation spread, 2) The importance of peer-peer conversations and peer networks, and 3) Understanding the needs of different user segments. This literature review will demonstrate how teacher behavior toward technology could be described by the Diffusion of Innovations theory's five user segments: 1) Laggards, 2) Late Majority, 3) Early Majority, 4) Early Adopters, and 5) Innovators. These user segments are described in detail in section 2.10.

Finally, technology use to date in the K-12 setting has historically been indicative of a handful of computers in the back of the classroom or the shared use of a school's computer lab. This literature review will consider how the introduction of the one-to-one correspondence to technology has begun to change teacher behavior. The term "one-to-one correspondence," often abbreviated as "1:1," indicates that each student has access to a computerized device for school and home use 24/7. Currently, the computerized devices most often used in 1:1 initiatives are netbooks, laptops, and tablets (such as iPads). This researcher posits that understanding this shift in paradigm is predicated upon an understanding of the teacher perspective of technology use, the student perspective of technology use, and an understanding of the Diffusion of Innovation theory.

This literature review is organized to orient the reader to the proposed study and begins with a section on definitions to facilitate the reader's understanding of the literature. The historical overview is discussed next and is followed by reviews of seminal studies that indicate a less than optimal correlation between student achievement and technology use, both in its antiquated sense, consisting of a handful of computers in the back of the classroom, and as it relates to use in a 1:1 setting. Barriers to successful integration of technology are discussed next and are followed by the connection to the Diffusion of Innovation theory. Finally, this section is followed by study alignment, research questions, measured variables, and gaps in the literature.

To conduct this review, scholarly guides, seminal publication content, and analysis records were reviewed. The online data source of search engines also delivered facts for the pursuit of the relevant literary works. Bibliographic and referral results were retrieved from appropriate headings found within the evaluation procedure. Previous studies were retrieved through EBSCOhost, ProAcademic Search Complete, PubMed, Sage, and Internet search engine Google for contribution of information, peer-reviewed journal articles, and books with keywords such as *technology, education, instructional practices, one-to-one correspondence of students to technology,* and *pedagogical beliefs of teachers*.

2.1 DEFINITIONS OF KEY TERMS

The following words and phrases will be used throughout the study. To facilitate the reader, they are defined here:

BCP: This is the fictitious name given to the Mid-Atlantic School where this study was conducted.

One-to-one correspondence/Initiative: This term is often abbreviated as “1:1” and is marked by each student having his/her own computerized device for school and home use 24/7.

ACOT Continuum – (Acronym for Apple© Classrooms of Tomorrow.) Demonstrates the phases through which teachers progress as they begin to incorporate technology until it becomes an integrated part of the instruction. Phases include: Entry, Adoption, Adaptation, Appropriation and Invention.

ACOT Continuum Entry Phase– Technology is rarely used, as the teacher perceives there is not enough time for its use. When technology is used, the teacher focuses on basic operations and trouble-shooting.

ACOT Continuum Adoption Phase– Technology is used infrequently. When technology is used, it often relegated to remediation of low-level drilling of facts through purchased single purpose software. Teachers in this phase will also begin to use technology for its word processing capabilities.

ACOT Continuum Adaptation Phase– Technology is used to supplement direct instruction up to 40% of instructional time. In this phase, the teachers' confidence in their technology related problem solving skills has increased enough to use databases and multiple computer aided instructional modules to increase comprehension and demonstrate student work. In this phase, teachers realize that students can accomplish more in a shorter period of time using instructional technology.

ACOT Continuum Appropriation Phase– In this phase, the teacher is confident in the use of technology for instruction and for student work. Technology begins to be used for collaborative purposes, team teaching, interdisciplinary projects, and to individualize instruction for groups of students.

ACOT Continuum Invention Phase– Technology use is in balance with instructional objectives; it is used when needed and balanced with direct instruction. Technology is used as a tool to promote a constructivist methodology, where students are active participants in making meaning of information.

SAMR Model – (Acronym for Substitution, Augmentation, Modification, and Redefinition.) The model defines a continuum, similar to the ACOT Technology Integration continuum, which allows the observer to assess technology related activities.

SAMR Model Substitution– Technology acts as a direct tool substitution, but there is no functional change. For example, a teacher may make a reading available to students on their iPads as a PDF. The students will still do the same task (read), except now they will use the technology. This is considered the lowest level of technology use.

SAMR Model Augmentation– Technology continues to act as a direct tool substitution, but there is a functional change. For example, a teacher who has students read a PDF on the iPad with the instructions to use the built-in dictionary when they encounter an unfamiliar word or the "speak" function to have the iPad read the passage to them.

SAMR Model Modification– Technology allows for task redesign. For example, a student may be instructed to use GoogleDocs to write a response to the reading and then virtually share the Doc with two collaborators. These collaborators can give the student feedback and ideas for improvement.

SAMR Model Redefinition– Technology allows for the creation of new tasks that were previously not possible without technology. For example, students take a virtual field trip using web conferencing technology. Students are able to interact with the local or global expert and share findings using a variety of student created media to demonstrate their understanding. Redefinition is considered the highest level of the SAMR model.

2.2 HISTORICAL OVERVIEW OF INSTRUCTIONAL TECHNOLOGY

This section will provide a historical perspective regarding the integration of instructional technology in the K-12 setting. Key to understanding the benefits and limitations of instructional technology use in today's educational setting is an understanding of the circuitous path that lead us to current technology practices in K-12 schools. This section will introduce the reader to the seminal studies related to instructional technology. Findings from the longitudinal Apple Classrooms of Tomorrow (ACOT) study, which began in 1985, will be explored. Findings from the longitudinal Anytime Anywhere Learning Project (AALP), sponsored by Microsoft and Toshiba, will be compared to those from the ACOT study. Similarities and differences between the studies and their findings will be discussed, further demonstrating the significance of their inclusion for the reader.

2.2.1 Apple Classrooms of Tomorrow (ACOT)

The Apple Classrooms of Tomorrow (ACOT) project began in 1985. The ACOT project was initiated as a cooperative venture between Apple and several universities throughout the nation in an attempt to discover the effect of computers on teaching and learning in K–12 classrooms. Recognizing that the effect of transforming traditional, computerless educational settings into advanced, collaborative and connected spaces had the potential to be revolutionary, ACOT had the foresight to gather longitudinal data to document the transformation. The analysis of four decades of data illustrated the changing realities of connected classrooms and the internal struggle experienced by teachers being asked to change methodological approaches. The ACOT data collection focused on analyzing what happens once instructors have continuous contact with technological innovation (ACOT, 1995).

Continuous contact with technological innovation would clearly necessitate large-scale changes to participating teachers' instructional methodologies. Despite having this advanced knowledge, most teachers participating in the ACOT program described extreme internal conflict about changing their instructional style and practice. The source of the internal conflict likely originated from experiencing decades of the traditional (computerless, unconnected) instructional methodologies as former learners and now as instructors. It is unsurprising, then, that in a profession where control of content and participants has been practiced and praised for decades, the notion of allowing students to use technology: 1) actively to explore ideas versus passively receiving them, 2) to promote an atmosphere of collaboration versus individualism, and 3) to use technology to solve real world problems versus prizing drilling for skill without benefit of technology would pose a cognitive dissonance for teachers.

The cognitive dissonance experienced by ACOT teachers did not evolve from the mere contact with the technology, but rather from the requirement to use consistently the technology in meaningful ways. Therefore, for the dissonance to be overcome, leading to true technological integration, ACOT experts had to provide cutting-edge technology-based professional development for the participants. After three decades, the ACOT researchers adopted a constructivist approach to learning and began encouraging instructors to utilize a more student-based instructional methodology, wherein students were partners in constructing meaning and making connections to content through the use of technology. Although the ACOT professional development sessions were meant to inspire immediate changes to instructional delivery and methodology, ACOT found that teachers were slow to modify their practices, and that visible changes in the classroom were gradual. Andrew (2007) surmised that the gradual changes to teacher instructional practices were likely less about passive resistance and more about the fact that K-12 environments remained largely subject-centered (as opposed to subject-integrated), and maintained an emphasis on high stakes test accountability.

Based on the data collected during the ACOT project, Apple articulated a continuum, that illustrated the phases through which teachers pass during the change from a traditional K-12 educational environment, to one in which technology was routinely integrated. The Phases of the ACOT Continuum are: Entry, Adoption, Adaptation, Appropriation, and Invention.

2.2.1.1 Entry Phase of ACOT

The Entry Phase is marked by heavy use of traditional, lecture-style, "student as passive receiver" instructional delivery. While technology is present in the classroom, teachers in the Entry phase often use technology resources only to support lecture based instruction, for static student presentations, and to promote quite seatwork. When Entry Phase teachers permit student use of technology, it is often done using the same step-by-step approach taken with most other content areas. Students are often asked to stay on the same screen as the instructor, and are only permitted to move ahead when they are instructed to do so. Entry Phase teachers do not account for differences in student technological aptitude, even if differentiated practices are prevalent in other aspects of their curriculum. Additionally, the best efforts of Entry Phase teachers are often hampered by otherwise small glitches in their instructional plan to use technology, as their knowledge and comfort level with attempts to problem solve in uncharted areas, particularly in the presence of the students, is limited.

Schools seeking to provide support for Entry Phase teachers to integrate technology on a regular basis should learn from the ACOT data. ACOT data indicates that supports for Entry Phase teachers should include Professional Development centered on basic operational skills acquisition and routine maintenance tasks. Basic operational skill acquisition for laptops, for example, might include powering on and off the machine, investigation of sleep mode, word processing functions, checking and responding to email, attaching files to email, and introducing static presentational software. Entry Phase teachers are most comfortable with instruction that is methodic and didactic. Entry Phase teachers are not ready for a constructivist approach, and will likely experience high levels of anxiety if information is required to be acquired in this manner.

Routine maintenance tasks may include charging computers, hard resets during times when the computer's functionality is severely impaired, screen and keyboard cleaning strategies, defragmentation of the hard drive, and clearing the cache. Mastering these basic instructional and maintenance skills will help build the confidence of Entry Phase teachers and make them more likely to attempt lessons that incorporate technology. This will also lessen the likelihood that Entry Phase teachers will use poorly functioning technology devices as an excuse to avoid their routine incorporation.

ACOT data also suggest that providing opportunities for teachers to share their integration experiences with other faculty members will enrich their experiences. Whether their experiences with technology integration were wholly or partially successful, there is much to be gained from reflection on practice. While teachers may initially be resistant to sharing in a professional learning community if it is not currently practiced in other areas of the school community, opportunities to showcase best practices will likely prove motivating to teachers who are struggling in similar ways.

Establishing a program that permits teachers to conduct peer observations during lessons where technological integration can be observed can also optimize support for Entry Phase teachers. Structured or non-structured conversations regarding planning, purpose, and learning outcomes between peers at different levels of the ACOT continuum, will incorporate an informal mentoring and professional development program whose dividends will often be realized more quickly than mentoring from non-resident experts and decontextualized professional development. As there is equal benefit to observing and to reflecting on practices with peers, it may also be advisable for administration to provide common planning time for Entry Phase teachers and those teachers functioning at a higher phase of the ACOT continuum. Consistent planning time among these teachers will provide Entry Phase teachers with a safety net as they make new attempts at technology integration.

2.2.1.2 Adoption Phase of ACOT

ACOT and other researchers concluded that in the Adoption Phase, teachers recognize the positive and significant relationship between integrating technology and student engagement (Damarin & Bohren, 1987, ACOT, 1995). While Adoption Phase teachers continue to rely on traditional instructional practices, such as using paper-pencil tests, physical textbooks, and chalkboards, their increased comfort level with technology gives way to more frequent integration. The Adoption Phase teacher will feel more comfortable permitting students to use computers as word processors, and will provide opportunities to remediate learning through pre-packaged learning software. Use of the Internet for content related searches and for acquisition of new resources to support or supplement physical copies is a hallmark of the Adoption Phase teacher.

Schools seeking to provide support for Adoption Phase teachers to integrate technology on a regular basis should learn from the ACOT data. ACOT data indicates that supports for Adoption Phase teachers should include additional professional development on themes such as common presentational and workflow tools. Training in the similarities between presentational applications with similar functionality, such as Microsoft's PowerPoint and Apple's Keynote, can begin to incorporate a more constructivist approach to teaching and learning. Adoption Phase teachers benefit from information that is partially presented through direct instruction and partially left to the teacher to intuit and find objective connections.

Schools can also provide support for Adoption Phase teachers through continued use of common planning and mentoring between peers at different phases of the ACOT continuum. This dialogue will continue to enrich and inform the teacher's practices in the lower phases, but also reinforce, through practice and teaching, the skills of the teacher higher on the ACOT continuum.

As Professional Learning Community participation becomes a more comfortable practice, Adoption Phase teachers can benefit from peer-to-peer engagement where feedback and ongoing learning experiences are collected and viewed through electronic formats. The use of blogs and wikis, which are non-static webpages, often offer non-threatening environments for the Adoption Phase teacher to interact with other members of the Professional Learning Community, and therefore make for an effective way to support teachers in this phase.

2.2.1.3 Adaptation Phase of ACOT

In the Adaptation Phase of the ACOT continuum, both teachers and students begin to realize shifts in perception of technology's role in the classroom and its ability to be used as a tool to provide differentiation for student needs through self pacing; that is, some students can spend more time remediating skills, while others can simultaneously accelerate to the next skill after mastery of the first. In the Adaptation Phase, teachers and students are no longer hampered by technology glitches, and begin to feel more comfortable problem solving when technology takes them into uncharted territory. Due to the increased confidence of the teacher and the increased opportunities for students to interact with technology, less time is spent on skill acquisition or content mastery. Therefore, Adaptation Phase teachers begin to see how the integration of technology can lead to additional time spent on learning at the highest levels of Bloom's Taxonomy of Cognition or Webb's Depth of Knowledge.

Schools seeking to provide support for Adaptation Phase teachers to integrate technology on a regular basis should learn from the ACOT data. ACOT data indicate that supports for Adaptation Phase teachers should include an introduction to an increased spectrum of technology resources. To this end, professional development created for Adaptation Phase teachers might include introductions to online databases (such as EBSCO and ERIC), use of interactive platforms for personalized learning (such as List Serves and threaded discussions), and dynamic work flow applications (such as GoogleDocs and DropBox).

Teachers at the Adaptation Phase of the ACOT continuum would also benefit from beginning to create wikis, blogs, threaded discussions, and other dynamic experiences, which they had previously only experienced as a resource. Teachers who begin to create and share dynamic resources, find continued benefit in peer observation, peer mentoring, and Professional Learning Community opportunities.

2.2.1.4 Appropriation Phase of ACOT

The Appropriation Phase of the ACOT continuum is marked by wide ranging changes. These changes are both tangible and intangible in nature. Intangibly, these changes are found in teachers' perceptions about technology and their behavior toward its inclusion. This will manifest in more thoughtful approaches to course objectives, with an emphasis on selecting from an array of technology tools that would benefit the specific task (previously, tasks may have been selected to correspond to one of the few applications with which they felt comfortable). In this phase, teachers will begin to use technology to incorporate higher order thinking skills, as defined by Bloom's Taxonomy of Cognition (1956) or Webb's Depth of Knowledge (2005) and learning will often be more open-ended and multidisciplinary.

These changes can be witnessed in the physical environment as well. A teacher in the Appropriation Phase will rearrange seating to make better use of space for collaborative activities and will rethink previous classroom management routines that would stifle spontaneous, on-task use of technology by students.

A hallmark of the Appropriation Phase is the introduction of differentiated assessment. Appropriation Phase teachers will introduce content using a direct teaching approach, but then give students the freedom to demonstrate mastery of the objectives in different ways. For example, an Appropriation Phase teacher may permit some students to demonstrate mastery by creating a video, others by adding to a course wiki, some through collaborative blogs with other students, and still others working individually to create avatar (computer based character or icon representing the users' physical or emotional characteristics) simulations to demonstrate their knowledge.

2.2.1.5 Invention Phase of ACOT

In the first three phases of the ACOT continuum (Entry, Adoption, and Adaptation), teachers struggled to find ways to use the technology with which they felt most comfortable to achieve existing instructional goals. When the teacher begins in the Appropriation phase, significant changes in perception and comfort with technology allow for significant changes to student learning activities. In the final phase of the ACOT continuum, aptly called the Invention Phase, teachers rarely use didactic or direct methods of instruction. Instead, they adopt a constructivist ideology toward student learning. The constructivist approach allows teachers to act as a guide or a coach, who guides students toward constructing their own meaning based on previous learning.

In a classroom where the teacher has graduated to the Invention Phase, students are given freedom over form, mode, and format to demonstrate their new understanding. Connections with previous learnings are prized and real-world project-based inquiries are the normal course of instruction. Assessments and checks for understanding often take the form of self-reflection, self-assessment, online surveys and checklists, and computer-assisted or face-to-face student collaboration sessions. In all aspects of this Invention Phase, teachers and students feel comfortable to express their deficiencies with technology or the content and seek the counsel of other teachers and students to help problem solve; in the Invention phase, teachers are able to view students as “experts” when warranted.

Invention Phase teachers ensure that technology is an ever present and transparent part of the daily student experience. As such, the hallmark of a teacher in this phase is the redefining of inquiry and exploration to such an extent that it would not have been possible without technology. Digital publishing, interaction with media and experts from around the globe, and, most importantly, student creation of technologically sophisticated constructs to exemplify their understanding, typify the student experience with an Invention Phase teacher.

2.2.1.6 Summary of ACOT

Teachers in K-12 settings often view the day in seven, forty-eight minute chunks and know that significant deviation from prescribed curricula and accepted teaching techniques, could result in lower standardized test scores for students in their care. Even if teachers do not ideologically believe in the one-size-fits-all standardized test as the sole determinant of student achievement, their perceptions and behavior are not always congruent. In this regard, teachers are seen as pragmatists, as they continue to use outdated methods of instructional delivery despite their perception that there are better approaches.

During the decades long ACOT research project, teachers were given professional development and hardware to determine what would happen if they had consistent contact with technology. The researchers found that teachers gradually began to shift their behaviors toward instructional technology from the Entry Phase to the Innovation phase, until they reached a place where their perceptions about the use of instructional technology and their behavior toward it in the classroom were aligned.

ACOT researchers noted the reflexive resistance of Entry Phase teachers and the anxiety they experienced as they began to use instructional technology, even at a low level, to substitute paper copies with digital versions of the same content. These teachers moved through the continuum gradually, as they began to replace their former methodologies with more constructivist and technology-based ones. The data seemed to emphasize that teachers were most apt to move through all stages of the continuum who: 1) felt supported by administration,

2) had daily schedules that permitted peer observation, 3) shared planning with teachers at higher levels on the continuum, and 4) experienced meaningful professional development. The researchers juxtaposed the description of the Entry Phase teacher with that of the Invention Phase teacher to demonstrate the continuum of technology integration over time. In stark contrast to the Entry Phase teacher, the Invention Phase teacher: 1) supports a constructivist teaching philosophy, 2) utilizes a democratic approach to the form and format of student learning tasks, 3) redefines learning tasks to include objectives that were previously impossible without technology, and 4) maintains a daily transparent use of technology.

2.2.2 Anytime Anywhere Learning Project (AALP)

The Anytime Anywhere Learning Project (AALP) began in 1996 as a joint venture between Microsoft and Toshiba. Similar to the ACOT project, the AALP targeted schools across the United States; in its first year, the AALP partnered with 52 schools, increasing to 800 schools only four years later. In this study, teachers and students were provided with 24/7 access to technology with a 1:1 correspondence (laptops), although most students in AALP classrooms did not have home Internet access.

The AALP researchers were equally diligent in procuring data throughout the project and data were collected for both quantitative and qualitative analysis. The AALP collected data through observations, focus groups, interviews, as well as student grades and test results. Similar to the ACOT study, AALP participating teachers were provided with professional development in using technology to help students meet curricular objectives. Perhaps learning from the ACOT study, which was 11 years underway at the inception of AALP, the AALP experts pushed a constructivist approach to teaching and learning; data collected regarding student and teacher outcomes seem to support the use of the constructivist approach.

2.2.2.1 AALP Teacher and Student Outcomes

Where ACOT and AALP diverge slightly relates to the focus of inquiry; while ACOT focused more on teacher behavior, AALP had a greater focus on student learning outcomes. To that end, data collected indicated that students generally:

- Took roles as more active learners, directing their own learning;
- Spent more time in collaborative projects and on homework;
- Produced writing at a higher quality and volume;
- Participated in more project-based education;
- Engaged in more critical thinking and problem solving
- Showed an ability to use technology in flexible ways and in ways associated with higher levels on Bloom's Taxonomy of Cognition.

Outcomes for participating AALP teachers, were similar to those observed with the students. AALP teachers were noted as mirroring the constructivist approach to teaching that was modeled in their professional development sessions. Additionally, in interviews and forums, the participating AALP teachers indicated that they felt more empowered in their classrooms due to the use of instructional technology (Rockman, 2000).

2.2.2.2 AALP Summary

In his three evaluation reports of the Anytime Anywhere Learning Project (1997, 1998, 2000), Rockman indicated that technological integration had positive student outcomes because students were: 1) involved in highly engaging and focused activities, 2) applied active learning strategies, 3) collaborated, 4) involved in project-based activities requiring critical thinking, and 5) regularly found, synthesized, and communicated information.

Unsurprisingly, Rockman's evaluation reports are confirmed by the research findings of subsequent studies regarding student and teacher outcomes related to technology integration. Research provides evidence that greater frequency of student engagement in collaborative, project-based activities have higher levels of motivation (Guthrie & Wigfield, 2000). Also supported by subsequent research was the assertion that student motivation is an important factor in: 1) improved student achievement in limited circumstances (Roderick & Engel, 2001; Haydel & Roeser, 2002; Gulek, 2003) 2) higher quality writing samples (Reeves, 2001; Goldberg, Russell & Cook, 2003) and 3) increased engagement with content (Gulek, 2003).

Rockman's findings related to teacher outcomes in the AALP have also been substantiated by previous and subsequent research studies. Subsequent studies have confirmed that teachers using a constructivist approach perceive a greater degree of student engagement (Marzano, 2003), thereby reducing discipline issues. Additionally, previous research supports Rockman's findings that teachers feel more empowered and spend less time lecturing when instructional technology is appropriately integrated (von Glaserfeld, 1995).

Studies presented throughout section 2.2 are arranged by author, date, study aim, and key findings in the table below.

Table 1.

Literature Review Studies and Findings in Section 2.2

Topic	Study Author (Date): Aims	Key Findings
Pedagogy	ACOT (1995): How would teachers respond to a 1:1 technology project?	Professional Development is integral to success. Pedagogical phase change occurs

		slowly.
	von Glaserfeld (1995): Constructivist approaches to teaching.	Teachers feel empowered and lecture less when technology is integrated.
Motivation	Guthrie and Wigfield (2000): What is the impact of project based pedagogical style on student motivation?	Collaborative, project based technology lessons beget higher levels of student motivation.
	Haydel and Roeser (2002): Students' motivational patterns and their perceptions of assessments.	There is a significant interaction between student achievement and student motivation.
	Roderick and Engel (2001): Motivational responses of low-achieving students to high-stakes testing.	There is a significant interaction between student achievement and student motivation.
	Goldberg, Russell, and Cook (2003): The effect of computers on student learning.	There is a significant interaction between higher quality writing samples and student motivation.
Student Engagement	Gulek (2003): Student achievement and high stakes testing.	There is a significant interaction between student achievement, increased engagement with content, and student motivation
	Marzano (2003): Classroom management strategies for teachers.	Teachers using a constructivist approach perceive a greater degree of student engagement
	Damarin and Bohren (1987): The evolution of the ACOT project.	Adoption phase teachers realize significance of instructional technology and student engagement.
Student Outcomes	Reeves (2001): Standards, assessments, and accountability.	There is a significant interaction between higher quality writing samples and student motivation.
	Rockman (2000): How would student learning outcomes change as a result of a 1:1 project?	Focus on student learning outcomes of AALP.

2.3 VARIATIONS IN TECHNOLOGY INTEGRATION

While some recent studies have matched the size of Apple's Classrooms of Tomorrow and Microsoft and Toshiba's Anytime Anywhere Learning initiatives (number of teacher and/or student participants), none has matched the longitudinal data set that they provided related to instructional technology integration in the K-12 setting. As noted in the preceding section, the ACOT and AALP studies were able to capture teacher behavior and teacher and student outcomes when access to technology was consistent, when professional development was targeted to model the constructivist instructional approach, and when teachers desired to participate. Conversely, this section explores how teachers use technology in contexts that do not offer the same supports as ACOT and AALP and the scope of the change required in these settings. Additionally, this section explores the limitations and barriers faced by teachers when technology integration is attempted in these less than ideal settings.

2.3.1 Increased Use of Technology at a Low Level

Without question, instructors have improved their individual and specialized uses of instructional technology (Smeets, 2005). Demonstrating the steady increase in the use of technology was the 2006 Teachers Talk Tech study (n=1000), wherein 79% of instructors self-reported using technology "to educate students," 88% to manage projects, and 86% for collaborative student projects. Also supporting Smeets' (2005) assertion that teachers are more frequently using technology is the 2007 Speak Up study (n=25,544), wherein 93% of the instructors reported using technology in order to connect with co-workers or students' parents.

While these reports of increased use of technology by K-12 teachers coincide with the advent of more powerful technological applications, the teacher's self-reported uses of the technology indicate that they are not taking advantage of these instructional possibilities; the possibilities that permit unprecedented global collaboration and differentiated instruction and assessment. Unfortunately, when the data that lauded increased use of technology by teachers were analyzed, it was revealed that computer usage was still generally at a "low-level." For example, by using presentational applications (such as PowerPoint or Keynote) to support traditional, direct teacher instruction or by teaching discrete technical skills in isolation in lieu of a focus on developing a more robust technological aptitude leading to the transference of technical skills (Tondeur, van Braak, & Valcke, 2007).

In the Speak Up (2007) nationwide study, teachers of grades 6-12 were asked to consider their main uses of technology to "assist student learning." The study revealed that 51% of the instructors used technology primarily: 1) to have students search for pre-specified content on the internet, 2) to type essays, and 3) to have students complete repetitious exercises to reinforce learning. This was confirmed at some level, by the large amount of learners in grades 6-12 taking the identical study, who revealed using technology at school: 1) to type projects (74%), 2) to gather information on the internet (72%), and 3) to check projects on the internet (58%).

Technology use simply to type essays or view an instructor's presentation, while not inappropriate, is wholly insufficient to meet the needs of 21st century students. Using classroom technology to reinforce lecture-based instruction is not the most effective method of integrating technology into classrooms (Schulta-Zander, Pfeifer, & Voss, 2008). While research pointing to instructional delivery changes from procedural or application based to a focus on technology for the enhancement of instruction, content, and differentiation with the classroom is encouraging, other research suggests that such changes are occurring more slowly than anticipated (Andrew, 2007). A 2007 study indicated that even instructors hailed as having a student-centered constructivist methodology were labeled by researchers as not using technology in a highly effective, impressive, or engaging manner (Tondeur, van Braak, & Valcke).

A 2009 study of nearly 10,000 K-12 classrooms across the country also illustrates that classroom computers were rarely used or were used to support simple, low cognitive level learning tasks, such as routine exercise or word processing (Glazer, Hannafin, Polly, & Rich, 2009); these uses are consistent with an Entry Phase teacher on the ACOT technology integration continuum. Analysis of data from the same study also illustrated that despite increased access to technology, the most prevalent instructional practices remained the lecture-based, didactic, teacher as expert approaches, while instructional practices that would lend themselves to the integration of technology, such as constructivist methodology, project-based challenges, and student centered approaches, were much less frequently reported. Participant self-reported responses from over 90,000 instructors produced similar results, showing that instructional technology was most often used for low-level tasks in teacher-centered surroundings. Thus, it is not surprising to see that computer use has not lead to improved student achievement.

There is an obvious gap between the quantity of technology currently available in schools and the teachers' low-level, infrequent, or non-existent use for academic endeavors. In a study by the National Center for Educational Statistics, fewer than 50% of the 3,000 K-12 educators interviewed indicated that they routinely used instructional technology during the period of instruction. The same respondents also indicated increased contact for management & organizational issues such as grading and attendance (Mouza, 2009). In the same way, others have discovered that instructors more often use technological innovation for non-instructional projects, such as interacting with colleagues and parents via email or finding relevant digital resources for lesson design. This has led to a critique concerning the cost-benefit ratio related to technology in the K-12 setting.

Studies presented in section 2.3.1 are arranged by author, date, study aim, and key findings in the table below.

Table 2.

Literature Review Studies and Findings in Section 2.3.1

Topic	Study Author (Date): Aims	Key Findings
Pedagogy	Andrew (2007): Teachers' actual instructional methods compared to the constructivist ideal.	Pedagogical changes occur slowly.
	Tondeur, van Braak, and Valcke (2007): Curricula and the use of ICT in education.	Increased teacher frequency of technology use remains at low levels.
	Schulta-Zander, Pfeifer, and Voss (2008): Observation measures for attitudes and competencies for technology.	Technology use to reinforce lecture-based material is insufficient.
Professional Development	Glazer, Hannafin, Polly and Rich (2009): Factors influencing technology integration and professional development.	Classroom computer use was infrequent and low level, support only.
	Mouza (2009): Teacher learning in technology integration.	Increased technology contact begets increased non-instructional technology use.
	Smeets (2005): Does ICT contribute to powerful learning?	Teachers have improved their use of technology.

2.3.2 Scope of the Change Required to Increase Rigor on the SAMR Model

This section takes into account the key findings of the Speak Up (2007) and Teachers Talk Tech (2006) studies discussed in the previous section. Data from those studies suggested that teachers who had consistent access to technology were not creating lessons indicative of rigorous learning experiences for students, such as those at SAMR's Modification or Redefinition levels. This section explores the key areas identified in research that could lead to increased use of technology for lessons that promote critical thinking and rigorous application of knowledge in less than ideal settings (such as those described in the ACOT study). Once instructors are asked to use educational technology to accomplish learning in the K-12 setting, a certain level of change is necessary along any or all of the succeeding scopes: 1) values, behavior, or educational principles; 2) technological literacy; 3) background of educational techniques or approaches; and 4) fresh or changed educational sources, technological innovation, or components (Fullan & Stiegelbauer, 1991).

2.3.2.1 Change in Values, Behavior, or Educational Principles

While considering technology as an advancement, Fisher (2006) stopped short of endorsing technological advancement as a broker of change; he suggested that teachers must take responsibility for this role. Harris (2002) posited that "using technological advancement as a 'Trojan horse' for academic change has been successful in only a handful of K-12 settings." This researcher attempted to determine what differences existed between those instructors who embraced educational technology and those who reflexively resisted it. Additionally, the researcher considered what differences may exist between an instructor's espoused support of technology and their actual low level or infrequent use.

Educators usually depend on traditional instructional strategies and 'reflexively resist' curricular and academic modernization (Mueller, Wood, Willoughby, Ross, & Specht, 2008). Although instructors might believe that technological advancement allows them to complete professional and/or personal projects more effectively, they are generally doubtful about integrating similar sources into the academic setting for a wide range of reasons, such as the lack of professional development (Lawless & Pellegrino, 2007), low self-efficacy (Mueller et al., 2008), and perception of current instructional techniques (Somekh, 2008). Additionally, the context or culture in which instructors work frequently restricts personal initiative (Tondeur, van Braak, & Valcke, 2007; Voogt, 2008).

Studies presented in sections 2.3.2 and 2.3.2.1 are arranged by author, date, study aim, and key findings in the table below.

Table 3.

Literature Review Studies and Findings in Sections 2.3.2 and 2.3.2.1

Topic	Study Author (Date): Aims	Key Findings
Educational Change	Fisher (2006): What is education transformation?	Access, Perspective, Time, and Professional Development.
	Fullan and Stiegelbrauer (1991): What is the new meaning of educational change?	Access, Perspective, Time, and Professional Development.
	Harris (2002): Innovative pedagogical practices using ICT.	Access, Perspective, Time, and Professional Development.
Teacher Perception	Lawless and Pellegrino (2007): Pursuing better questions and	Lack of professional development leads to lack of technology

	answers for professional development & technology.	integration.
	Mueller, Wood, Willoughby, Ross and Specht (2008): Discriminating variables between teachers who use and do not use technology.	Teachers 'reflexively resist' curricular and academic modernization.
	Somekh (2008): Factors affecting teachers' pedagogical adoption of ICT.	Technology integration fails due to teacher perception.
Curriculum and Integration	Tondeur, van Braak, and Valcke (2007): Curricula and the use of ICT in education.	Increased teacher frequency of technology use remains at low levels.
	Voogt (2008): ICT and the curriculum process.	Context and culture restrict personal initiative.

2.3.2.2 Change in Technological Literacy

The more technologically literate the instructor is, the better chance the students have for academic success (Hofer & Swan, 2009). Whether used during classroom lessons or for studying, the use of technology in teaching was recognized by instructors as eventually leading to improved engagement, abilities, study habits, and academic accomplishment (Chen, 2008). Instructors arrive at this improved view of educational technology gradually, by building on previous experiences and through increased interaction with educational technologies, connected classrooms, and encounters with others who use said technologies to redefine their instructional practices.

The lack of meaningful professional development training related to technology integration is cited throughout the literature as a barrier to integration (Pelgrum 2001, Beggs 2000, Sicilia, 2005, BECTA, 2004). This barrier is not easily overcome due to its complex nature in that time for training must be established for both pedagogical and technological skill acquisition. Meaningful professional development that is differentiated to meet the needs of individual teachers that simultaneously teaches technical and pedagogical skills is absolutely essential to eventual integration. Research indicates that K-12 teachers often report that they have attended professional development focused on skills acquisition and also report that they still do not integrate technology; this may be due, in part to the lack of simultaneous pedagogical and skill acquisition approach. While not currently in practice in most teacher education programs, training in either or both of these areas prior to certification by the teacher's respective institution of higher education would be beneficial (BECTA, 2004; Gomes, 2005).

Meaningful professional development does not always need to occur in a large group setting wherein one expert is facilitating the learning of multiple learners. In a 2010 study of 379 K-12 teachers, researchers concluded that the use of peer mentors was closely related to professional growth resulting in more consistent technology integration. Data from the same study revealed that mentored instructors were more confident with technological innovation and more consistently engaged student-centered usages of technological innovation than non-mentored instructors (Lowther, 2008). Zhao and Bryant (2006) similarly discovered that instructors who did not get in-classroom assistance were less probable to apply student-centered educational methods with technological innovation.

Research indicates that mentored instructors are more successful at problem-solving technology issues with less expert assistance, have a clearer perspective regarding the benefits of using technological innovation for instruction, and have more obvious objectives for using technology in their instruction. These habits of mind may be why mentored instructors more consistently use technological innovation for educational reasons than non-mentored instructors.

Supplying instructors with the mentoring, pedagogical, and technical skills necessary to handle effectively the barriers to integration are key steps to successful implementation.

The values and behaviors of instructors have an impact on the incorporation of technology in the K-12 setting (Pundak & Rozner, 2007). Full-scale implementation of technology requires much professional growth and often spans many years before the values and behavior of instructors are significantly modified. In order for these significant changes to instructors' values and behavior to be sustained, Levin & Wadmany (2008) posit that the incorporation of technology in the K-12 setting must be accompanied by ongoing and targeted professional development and increased pedagogical understanding. Li's (2007) research focused, in part, on teacher resistance due to the perception that computer-based instruction may eventually supplant the traditional face-to-face educational setting. However, Chen (2008) dismisses the idea that teachers will no longer be necessary if technology is increasingly used and instead posits that when technology is used in a "high level" way, as a consequence of rich professional development, that computers will improve engagement and retention in the face-to-face environment.

Studies presented in sections 2.3.2.2 are arranged by author, date, study aim, and key findings in the table below.

Table 4.

Literature Review Studies and Findings in Section 2.3.2.2

Topic	Study Author (Date): Aims	Key Findings
Teacher Perception of Technology	Chen (2008): Beliefs and practice in technology integration.	Teachers may believe in positive outcomes of technology, but not engage with it. Technology will not replace teachers, it will enhance the face-

		to-face environment.
	Pundak and Rozner (2007): Active learning methods.	Teacher values have an impact on technology integration.
	Li (2007): Student and teacher view of technology.	Teachers resist technology for fear of being replaced. Teachers and students form opposite opinions of technology's efficacy.
Barriers to Integration	Gomes (2005): Integration of ICT in Science teaching.	Universities need to update curriculum to include technology.
	Hofer and Swan (2009): Technological Pedagogical content knowledge.	Academic success is correlated with teacher technology literacy. Academic success is improved through technology integration.
	Lowther (2008): Technology integration and barriers.	Use of technology coaches is integral to successful practices.
	Pelgrum (2001): Obstacles to integrating technology.	Lack of technical support is a barrier.
	Levin and Wadmany (2008): Teacher views of factors affecting ICT integration.	Teachers willing to use technology cite multiple barriers.
	Sicilia (2005): Challenges and benefits of constructivism in a technology supported environment.	Common planning time is a barrier to successful integration. Teachers perceive technology adds to their workload.
	Zhao and Bryant (2006): Teacher technology training and the effect on integration.	Use of technology coaches is integral to successful practices.
	BECTA (2007): Would teachers embrace technological change?	Access, common planning time, and inadequate software are barriers to success. Introduction of technology must be paired with changes in learning goals, curricula, and teaching strategies.

2.3.2.3 Changes in Pedagogical Approach

Hofer & Swan's (2009) findings that academic success is improved through the use of technology is supported by myriad other research projects. Of interest is research suggesting that learning with technology can foster improved student understanding by engaging students in higher-order thinking, self-regulated learning, and collaborative or cooperative learning (Jonassen, Howland, Moore, & Marra, 2003; Lowyck & Elen, 2004). Of course, these outcomes may also be achieved by using other constructivist methodologies.

In a mixed methodology research study, Li (2007) examined the opinions of instructors and learners in a Canadian institute about the use of technology for studying. His research suggested that instructors and learners formed opposing opinions about the efficacy of using technological innovation for studying. Li (2007) attributed this finding to the differences in objective between the instructors and the students. That is, the objective of the instructors was to "survive" the technology requirements and associated difficulties. Conversely, the learners' focus was on choice and the effectiveness of the modality, as well as user engagement.

Learners in Li's (2007) study used instructional technology to study at home and indicated that it was not only effective, but also stimulating. Learners also indicated that the use of multimedia designs, interactive models, and collaborative technology tools would prepare them for a broader learning community that was becoming progressively more specialized. Li (2007) aptly concluded that student objectives were more likely to be achieved when issues of instructional strategies, including the technology integration, were left to the instructor.

Studies presented in section 2.3.2.3 are arranged by author, date, study aim, and key findings in the table below.

Table 5.

Literature Review Studies and Findings in Section 2.3.2.3

Authors (Date)	Aim of Study	Key Findings
Teacher Perception	Hofer and Swan (2009): Technological Pedagogical content knowledge.	Academic success is correlated with teacher technology literacy. Academic success is improved through technology integration.
	Li (2007): Student and teacher view of technology.	Teachers resist technology for fear of being replaced. Teachers and students form opposite opinions of technology's efficacy.
Student Outcomes	Jonassen, Howland, Moore and Marra (2003): Evaluating constructivist learning.	Improved student understanding through technology occurs with higher order thinking, self-regulated learning.
	Lowyck and Elen (2004): Linking ICT, knowledge domains, and learning support for the design of learning environments	Improved student understanding through technology occurs with higher order thinking, self-regulated learning.

2.3.2.4 Changes in Accessibility

In K-12 settings that are not experiencing a 1:1 initiative, teachers are often left to decide how to use the two computers effectively that are anchored in the back of their room. Teachers who do not routinely have access to technology may also lack the ability to solve seemingly routine maintenance issues related to the available technology. Lewis (2003) and Pelgrum (2001) found that K-12 educators perceive the lack of technical support as their number one barrier to integration. Accessibility issues may also be associated with factors such as poor organization of resources (need to request use of a computer lab in advance), poor quality of hardware (often monies are found for acquisition, but not for maintenance and updates), inadequate software, or lack of personal access for teachers (BECTA, 2004).

Accessibility issues can also be understood from the perspective of time. Sicilia (2005) identified the increased amount of time required to integrate effectively technology was a significant barrier to its use. Respondents to Sicilia's study perceived that they lacked time to plan technology related lessons, explore related websites, or practice the technology tasks that they desired to integrate. Lack of common planning time and lack of time to schedule whole-group instruction in computer labs were also frequently cited as barriers throughout the literature (BECTA, 2004; Beggs, 2000; Schoepp, 2005; Sicilia, 2005).

Studies presented in section 2.3.2.4 are arranged by author, date, study aim, and key findings in the table below.

Table 6.

Literature Review Studies and Findings in Section 2.3.2.4

Authors (Date)	Aim of Study	Key Findings
Barriers to Integration	BECTA (2007): Would teachers embrace technological change?	Increase frequency of use was non-instructional in orientation. Universities need to change their curriculum to include technology. Access is a barrier to success. Common planning time is a barrier to successful integration. Inadequate software is a barrier. Introduction of technology must be paired with changes in learning goals, curricula, and teaching strategies.
	Beggs (2000): Influences and barriers to technology adoption.	Lack of common planning time is a barrier to technology integration.

Lewis (2003): How can teaching and learning be enhanced through ICT?	Lack of technical support is a barrier to technology integration.
Pelgrum (2001): Obstacles to integrating technology.	Lack of technical support is a barrier.
Schoepp (2005): Barriers to technology integration.	Common planning time is a barrier to successful integration.
Sicilia (2005): Challenges and benefits of constructivism in a technology supported environment.	Common planning time is a barrier to successful integration. Teachers perceive technology adds to their workload.

Summary

Among the barriers to full technology incorporation noted by teachers in Chen's (2008) research were issues of access, competing deadlines, curricula requirements, and the demands of high-stakes testing. Even among instructors who purported to believe in the advantages of the frequent use of technology, the demands of standardized testing were often cited as a barrier to regular engagement with technology (Lim & Chai, 2008).

The incorporation of technology depends on several factors, including instructor values and behaviors, as well as participation in related professional development. Even when presented with willing teachers and rich professional development opportunities, other barriers to full incorporation were often present, including issues of access, time constraints, and available support (Levin & Wadmany, 2008). Lim & Chai (2008) succinctly summarized the barriers to technology integration in less than optimal settings as sociocultural aspects of the K-12 setting.

Studies presented in this summary section are arranged by author, date, study aim, and key findings in the table below.

Table 7.

Literature Review Studies and Findings in the Summary Section

Authors (Date)	Aim of Study	Key Findings
Teacher Perceptions	Chen (2008): Beliefs and practice in technology integration.	Teachers may believe in positive outcomes of technology, but not engage with it. Technology will not replace teachers, it will enhance the face-to-face environment.
	Levin and Wadmany (2008): Teacher views of factors affecting ICT integration.	Teachers willing to use technology cite multiple barriers.
	Lim and Chai (2008): Teacher pedagogical beliefs regarding technology integration.	Standardized testing is perceived as a barrier to technology integration. Barriers are sociocultural aspects of K-12 setting.

2.4 TRADITIONAL VS. CONTEMPORARY (ONLINE) LEARNING

Each of the preceding studies including ACOT, AALP, Speak Up, and Teacher's Talk Tech, presumed a face-to-face setting, where the teacher and the students were physically present in the same location for learning that could be enhanced with technology. This section explores the studies that focus on otherwise equal educational opportunities, where one setting is completely online and the other setting is face-to-face with limited contact with technology. Additionally, researchers of studies represented in this section concerned themselves with issues of student achievement and student satisfaction. Specifically, were student achievement results significantly better in the otherwise equal online course or in the traditional course; and were students generally more satisfied with the learning experience in the online setting or in the traditional setting?

Hansen and Williams (2008) performed research evaluating cross-cultural mindset by creating two otherwise equal versions of the course and offering one online and the other in the traditional format. The 101 participants, ranging in age from 18 to 21, were from a primarily white, southern institution. Archival information was utilized for the 56 learners in the traditional instruction category. Forty-eight learners were in the contemporary instruction category. A span of several years existed between the traditional and contemporary sessions although the researchers did not indicate the actual period of time between the two studies (Hansen & Williams, 2008). Both study sessions required the participants to purchase four to five books and take three examinations during the course of the term. The traditional category utilized only textbooks, while the contemporary category used one textbook, three paperback books, visits by the instructor to a participants' homes, a guided experiment involving role playing, the creation and editing of videos, and other interactions with technology (Hansen & Williams, 2008). The learners in the conventional category were taught through direct instruction by teachers who used a didactic approach, featuring instructor lectures and student note-taking centered on assigned readings.

While Hansen and Williams' (2008) first assessment indicated no difference between the contemporary and traditional groups, differences were observed between the two groups on the second and third examinations. According to the research, the contemporary group performed better on examination two and the traditional group performed better on examination three. While this finding initially proved interesting, timeline variations might account for the change in exam readiness. For example, the contemporary group was required to demonstrate their knowledge in myriad ways, including submitting a participant created video presentation immediately prior to examination three (which was not a requirement for the traditional group). Therefore, it is possible that the variation in exam scores, which seemed to indicate that the instructional strategies used with the traditional group begot better exam results, could be the product of the contemporary group's split attention on both the exam and the project.

A majority of the traditional group's participants mentioned that they did not purchase all of the reading material nor did they complete all of the assignments. As such, it was indicated that less class time was devoted to collaborative discussion and more time was spent on lecture. The same cannot be said of the participants in the contemporary group, whose learners, while indicating a heavier workload, also indicated that they collaborated frequently about course projects, regularly communicated with each other about course readings, completed the majority of the assignments, and purchased all required materials. Accounting for learner differences, including willingness to purchase course materials and participate fully in all requested assignments is nearly impossible. These differences, however, may have played a large role in the outcomes of the study.

The results of the analysis did not confirm the hypothesis of the researchers, wherein it was conjectured that the contemporary group would outperform the traditional group. The contemporary group was recognized as being generally more involved and excited about the course content, yet the exams did not indicate that they made more connections to the material than the traditional category. The analysis resulted in numerous unanswered questions that might be resolved through future analyses. One important aspect of future analyses may be to determine why the contemporary group was more involved and to learn what factors made the contemporary method of learning more attractive to the learners. Additionally, researchers might consider whether changes to the mode or format of assessments are warranted for those who learn the information in a contemporary context.

Studies to validate the effectiveness of contemporary, technology-based strategies, such as the Hansen & Williams (2008) study, often involve a two-fold approach: 1) Student satisfaction, and 2) Student achievement. The literature on student achievement indicates mixed results. A study of 19 graduate courses focused on student achievement was conducted by Rovai and Barnum (2003). The researchers of this study concluded that the variability between and amongst courses utilizing a contemporary instructional delivery method made it difficult to generalize the effectiveness of the integration of technology. Studies related to student satisfaction of contemporary, technology-based courses have also shown mixed results. A meta-analysis, summarizing the findings of 24-studies focused on student satisfaction in traditional courses as compared to student satisfaction in courses having the same content but where technology was integrated, was undertaken by Allen, Bourhis, Burrell, and Mabry (2002). The conclusion reached after analyzing the data from the 24-studies indicated that there is no statistical difference in student satisfaction between equivalent courses taught with traditional or contemporary methodologies.

A study conducted by Purcel & Stertz (2005), also compared contemporary methodologies, referred to as Web Based Instruction (WBI), and traditional approaches. As in studies previously discussed, Pucel & Stertz also used the indicators of student satisfaction and student achievement to evaluate the effectiveness of instructional strategies in otherwise equivalent courses. The participants in this study were all Minnesota teachers that were certified in a non-traditional manner; that is, these teachers were content specialists who later decided to become teachers and, therefore, were required to enroll in courses focused on methodology and philosophy, instead of content.

The certifying university for these teachers, the University of Minnesota, offered two of the required courses, a Philosophy of Education course and an Instructional Methodology course, in both the WBI and the traditional environments with corresponding instructional methodologies. Two Ph.D. instructors, who had previously taught the courses in the traditional format and who were interested in WBI, collaborated to create the technology-based version of the course. Unlike Hansen & William's (2008) study, researchers for this study ensured that the traditional and WBI courses had the same projects, goals, and rating requirements. The researchers enlisted the help of two doctorate candidates who had knowledge of the course content and in creating web-based instruction.

The traditional programs took place during summer and fall of the same academic year. The two web-based programs were offered during spring and the following summer. For all the programs, student satisfaction surveys and grades were collected at the end of the term. Pucel and Stertz (2005) noted that very few students completed the student satisfaction surveys.

The outcomes of the Purcel and Stertz' (2005) research revealed that students perceived that they invested the same or more time in the WBI version of the course than students enrolled in the traditional versions. The students also perceived that the WBI courses were less difficult than the traditional versions. Interestingly, this would seem to indicate that students perceived that they needed to spend more time on coursework that they perceived to be less challenging, than if it were completed using a traditional instructional approach.

The Instructional Methodology course revealed the largest difference in student satisfaction. In this study, student satisfaction was measured using 6 evaluation descriptors: 1)

Instructor's overall teaching ability, 2) Instructor's knowledge of the content, 3) How much students' perceived they learned, 4) The overall quality of the materials, 5) Helpfulness of the feedback about student performance, and 6) The degree to which the evaluation procedures measured their learning. Students were asked to consider these evaluation descriptors on a 7-point scale where 1 indicated poor and 7 indicated exceptional. The student satisfaction survey data indicated that there were no significant differences between the WBI and traditional methodologies (Pucel & Stertz, 2005) in this course. The only evaluation descriptor that indicated level of significance corresponded with how much the students perceived they learned during the course; students in the WBI version of the Instructional Methodology course perceived that they learned more than the those learners in the traditional version of the equivalent course.

When Purcel and Stertz (2005) considered student accomplishment, the data revealed mixed results. While student scores tended to be lower in the WBI Philosophy course than its traditional equivalent, student performance in the WBI Instructional Methodology course was comparatively better than the course's traditional equivalent. The researchers indicate that while there were some differences between the two versions of otherwise equivalent courses, the differences were not large. Therefore, if this study's results are generalizable, courses using WBI and traditional methodologies can be viewed equally effective.

Purcel and Stertz's (2005) study attempted to control for issues that would allow the results to be generalizable to a larger audience. As such, the researchers were systematic in their attempt to offer as comparative as possible a learning experience for their analysis. The research may have been enhanced if the same instructor had been responsible for the WIB and traditional versions of both courses, as the teachers' instructional approaches could have affected the learners' responses to the survey's evaluation descriptors.

2.5 LIMITATIONS OF CURRENT RESEARCH TO ANSWER STAKEHOLDER QUESTIONS

One-to-one (1:1) initiatives have significant variations throughout the K-12 educational setting. In its most simplistic definition, a 1:1 initiative is marked by each student having his/her own computerized device. Some examples of 1:1 devices used in the K-12 setting are laptops, tablets, and netbooks; less frequently, smart phones and iTouches are used for such initiatives.

The research conducted by Penuel (2006) and Zucker & Light (2009) is effective in providing a common description of 1:1 initiatives in a way that incorporates the variations and complexities of form, function, and limitations encompassed in these K-12 initiatives. One-to-one initiatives in K-12 settings:

- Utilize a wireless platform and wireless-ready devices
- Utilize devices that are accessible to the Internet via a local network
- Have devices equipped with applications to support instructional delivery, work flow, and productivity needs, and
- Demonstrate a high degree of compatibility to previously available interactive devices such as whiteboards, data collection probes and LCD projectors, as well as new digital and Web 2.0 tools.

As the ubiquity of 1:1 technology initiatives increases, the need for additional research into the benefits of such initiatives, as measured by student academic achievement, student academic growth, student satisfaction, and changes to teacher instructional strategies is warranted. To date, research into the effects of 1:1 technology initiatives has been centered around three major areas: Business and Community Partnerships, Funding and Budgeting, and Instruction and Professional Development.

2.5.1 Business and Community Partnerships Concerns

Prior to schools initiating 1:1 projects, communication with the business industry and community partners is often undertaken to compare the skill set of graduating students with the changing demands of industry. While discussions with these stakeholders can be reaffirming and enlightening, they also serve to rally a broad based support for the initiative. Research suggests that these groups often focus on questions such as:

- Does the proper use of 1:1 technology improve student learning in core subjects?
- What 1:1 technology for students is the best to improve student achievement?
- What is required to achieve a true return on investment (ROI)?

2.5.2 Funding and Budgeting Concerns

While in the past, funds were plentiful for education in general, many of the previous sources of additional revenue needed to create and sustain a 1:1 technology initiative dried up with the recession that began in the United States in 2008. Florida, Maine, Michigan, North Carolina, South Dakota, and Texas are examples of states that utilized large amounts of Federal funds to implement 1:1 projects (Holcomb, 2009; Argueta, et al., 2011). Similarly, Pennsylvania utilized millions of dollars to level the technological playing field amongst its 500 school districts through competitive grants to districts through the “Classrooms for the Future” initiative. Research suggests that funding and budgeting concerns often focus on questions such as:

- Is the 1:1 initiative more effective and efficient than the use of textbooks and other materials?
- What process will work best to fund the 1:1 initiative?
- What are the training and deployment costs for an effective 1:1 initiative?

2.5.3 Instruction and Professional Development Concerns

While acquisition costs and deployment strategies are valid concerns, of paramount importance is how the devices will be used in the classroom setting. Although appropriate training and professional development related to proper technology integration is often overlooked, lack of appropriate teacher readiness (perception and training) is the one issue that can make a 1:1 technology initiative die a slow death. For this reason, stakeholders preparing for a 1:1 initiative often ask questions such as:

- What are the best research-based practices to implement and sustain technology related professional development?
- What instructional technology tools are districts using that are currently engaged in a 1:1 initiative?
- How do we integrate effective use of technology with best practices for maximizing student achievement?

2.5.4 Summary of Stakeholder Limitations

Educators are wise to seek the counsel of business and community stakeholders to determine their expectations for the outcomes of a 1:1 initiative. Additionally, it would seem that the questions being asked of the literature, as noted above, are on point. Unfortunately, research into most aspects of technology, including 1:1 initiatives, changes so quickly that finding research that is recent enough to matter in the planning process is challenging. Other factors contributing to the limitations of current studies into 1:1 technology initiatives include: differences in device functionality, lack of uniform access to updates and support, differences in desired outcomes as a product of the initiative, and teacher readiness as a product of professional development or interest.

2.6 TECHNOLOGY'S INFLUENCE ON INSTRUCTIONAL PRACTICES

The omnipresent nature of technology is evident in many aspects of our lives. This section will explore the ubiquity of technology. While the preceding section outlined the barriers to full integration of technology despite increases in accessibility, this section will consider the perceived benefits of instructional technology in the K-12 setting.

Technology is omnipresent. Consider how the industries of banking, commerce, and travel have altered our interactions. Automatic Teller Machines (ATMs) replace face-to-face service at a bank. Online banking automates our ability to pay bills and manage other aspects of our finances remotely. Online shopping makes the world market accessible from home. Global Positioning Systems (GPS) enables us to map desired travels and increase our accountability.

Likewise, computers are more easily accessible in K-12 classrooms across the U.S. than ever before. Some estimates indicate that the ratio of students to technology throughout the education system in the United States is one computer for every four students. Unfortunately, the integration of technology into the instructional practices of K-12 teachers has not kept pace with the increase in access. Additionally, research has not indicated that with improved access has come a corresponding improvement in student accomplishment (Belland, 2009). For this reason, before a relationship between access and achievement can be assessed, inquiry into the frequency of use and nature of instructional strategies related to technology in K-12 classrooms must be reviewed; that is, do these outcomes indicate that technological innovation use does not have a positive effect on student achievement, or could the lack of evidence of improved achievement be related to *how* the technology is being deployed in the classroom?

In reaction to the need for improvements in the use of instructional technology, a section of the Federal No Child Left Behind (NCLB) Act of 2001 mandated state governments to provide assistance in: 1) applying confirmed strategies for developing technological innovation into curricula and instruction; 2) creating high quality professional development activities to accomplish such integration; and 3) examining the circumstances under which technological innovation is effective in improving student achievement and instructor performance (NEA, 2008). Additionally, issues related to the perceived benefits of instructional technology need to be well articulated.

2.6.1 Perceived Effects of Technology

If the barriers and limitations for teachers are to be overcome, one of the key factors will be the ability to articulate accurately and clearly the perceived benefits of technology use. There are four consistent themes regarding instructor behavior and beliefs about effects of technology that warrant consideration: 1) student engagement, 2) time efficiency, 3) innovative ways of introducing lessons, and 4) fresh learning encounters.

2.6.1.1 Student engagement

Research and evaluation studies report that technology initiatives increase students' engagement with academic work, which is an important finding given the large dropout rates in many secondary schools (Penuel, 2006). These studies indicate that engagement was enhanced when technological innovation was incorporated into any aspect of a lesson. No differences were noted throughout the literature that would indicate differences in this heightened engagement based on the learners' educational ability, economic position, race, or native language; all studies reviewed indicated that educational technology enhanced learner engagement and caused increased student involvement with the content than the previous environment, featuring a lack of technology.

2.6.1.2 Time Efficiency

Once instructors are comfortable using technology, its use shortens the amount of time necessary to spend on a given student learning task than introducing the same lesson without benefit of technology (Bauer & Kenton, 2005). A bi-product of the increased efficiency noted in Bauer and Kenton's (2005) study was that teachers perceived that they had more time to dedicate toward other educational setting responsibilities. Additionally, the extra time gave the instructors the option to either cover more material or increase the depth of its review.

2.6.1.3 Innovative Lesson Design

The introduction of technology was considered a perfect way to enhance lessons through content and visually stimulating media. Zucker (2008) studied the innovative lessons at a public charter high school in Colorado, which was involved in a 1:1 technology initiative. The school served a disproportionate amount of low-income students, but was also lauded for having 30% of its students take and pass the Advanced Placement exam for Physics; national average for students taking and passing the AP Physics exam in a single high school is 3%. The research at this high school showed a multitude of ways that the faculty was integrating innovative lesson strategies into the daily student experience. Students were exposed to interactive electronic textbooks, computer-based physics simulations, probes for collecting laboratory data, and other digital tools. The research seems to indicate that the school's increase in student achievement was not due to the innovative instructional practices alone, but rather was part of a coordinated, systematic approach that aligned educational goals, instructional materials, student assignments, teacher practices, and assessment techniques.

One way to look at the unusually positive outcomes of the Colorado school's 1:1 technology initiative is through the lens of Christensen's (2013) Disruptive Innovation theory. This theory posits that there are two ways in which the introduction of innovation can be classified: 1) Disruptive or 2) Sustaining. Using sustaining innovations, schools (organizations) maintain their path toward their goals. Disruptive innovations, however, create new definitions of what constitutes good teaching (products, services) and appeal to groups of individuals who were previously non-consumers though user-friendly and cost-effective means. The coordinated and systematic approach that this Colorado school is credited with using, seems to embody both the sustaining innovation of traditional practices and the disruptive innovation of the 1:1 technology initiative making theses fresh learning encounters possible.

2.6.1.4 Fresh Learning Encounters

Of course, the effects of effective computer integration may have indirect educational benefits as well. A 2007 study of the third year of a 1:1 initiative in Texas demonstrates this. This multimillion dollar, 4-year longitudinal study, including twenty 1:1 experimental schools and twenty schools not engaged in a 1:1 initiative found positive impacts of: increased technology use and proficiency, increased interest among teachers in student-centered instruction, reduced student disciplinary actions, and greater teacher collaboration. Interestingly, however, the researchers did not find significant impacts to standardized test scores in Language Arts and only a weak impact in mathematics (Law, Pelgrum, & Plomp, 2008). This would seem to strengthen the assertion that the availability of computers alone has little to no impact on student academic achievement, but that increases in technology availability must be used in concert with innovative instructional approaches coupled with technology in order to realize changes in performance.

2.6.2 Summary

In order for teachers to make changes to their instructional strategies, the positive effects of technology integration must be clearly articulated. Simply providing teachers with more technology is not in and of itself enough to create the change to student achievement that is often sought as a goal of 1:1 initiatives. Moreover, the mere addition of technology is insufficient to change instructional practices. At a minimum, learning goals, curricula, teaching strategies, and assessments must change as well (BECTA, 2007; Cuban, 2001; Zucker, 2008).

Research has found that teachers often do not use computers because the benefits of doing so have not been articulated in professional development sessions; these sessions must begin to incorporate both pedagogical and technology related skill building. In these sessions, instructional technology specialists (ITS) must begin to provide teachers with a clear vision of how computers are to be used, what digital resources are available, and a continuum of training. Additionally, ITS professional development leaders can ensure that the technical support required by teachers in all phases of the ACOT technology integration continuum, for computers, networks, printers, software, and other components is available. The finding of a 2008 pedagogical study is simple, yet powerful in its application: teachers' competence in using technology is related to the amount of professional development in which they have been engaged, and is associated with more effective use of technology for instruction (Law, Pelgrum, & Plomp).

2.7 THE DIFFUSION OF INNOVATIONS THEORY

The Diffusion of Innovations theory was created and revised by Rogers (2003). This theory seeks to explain how innovations are adopted in a population. Rogers defines an innovation as an idea, behavior, or object that is perceived as new by its audience. This section will explore the

Diffusion of Innovations theory and its applicability to instructional technology adoption by teachers. This section will first consider the three insights into the process of social change that this theory suggests: 1) The qualities that make an innovation spread; 2) The importance of peer-peer conversations and peer networks; 3) Understanding the needs of different user segments. User segments are identified in the theory as: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards. Descriptions of the user segments will be explored. Finally consideration of the interconnectedness of this theory with the instructional technology adoption patterns described in the ACOT, AALP, Speak Up, and Teachers Talk Tech studies will be identified.

2.7.1 What Qualities Make an Innovation Spread

The Theory of Diffusion of Innovations posits that adoption of an innovation within a population is not predicated upon persuading groups of people to change their minds. This theory begins with the assumption that people, within their user segments, will remain static. Therefore, it is the innovation itself that needs to be reinvented or needs to evolve to better fit the needs of the users.

The theory posits five reasons why some innovations succeed and other fail. The first reason is termed relative advantage. Simply put, relative advantage is a term that indicates the degree to which user segments perceive the new innovation as better than its predecessor in terms of price, convenience, satisfaction, prestige, or simplicity of use. If a population perceives a high relative advantage to using the innovation, then its adoption will be more rapid. According to the theory, the second reason that some innovations catch on quickly while others fail is the perception of continuity with the user's existing practices and values. An innovation that is inconsistent with a user's values or past experiences will not be adopted as rapidly. Third is the simplicity of use. For obvious reasons, users are not interested and will not readily adopt innovations that are more difficult to understand, to use, or ones that require the adopter to develop new skills. The theory also posits that an innovation that is able to be tried on a limited basis by the user who is considering it is more likely to be adopted by the population more quickly. Finally, adopters of innovation like to witness observable results. When the uncertainty regarding an innovation is decreased through limited trials or observable results, adoption by a population will occur rapidly. These five characteristics account for as much as 87% of the variation in adoption of innovation (Rogers, 2003).

2.7.2 Peer-peer Conversations and Peer Networks

According to the Theory of Diffusion of Innovations, as mentioned in the previous section, adoption of innovation deals with the management of uncertainty and risk. For this reason, peer-peer conversations and peer networks are believed to be integral to an innovation's rapid adoption. While impersonal marketing methods like advertising and media stories spread *information* about innovations, conversations, it is posited, spread *adoption*. In a risk adverse culture, user segments generally trust people they know and people who have successfully adopted the innovation. Naturally, potential adopters of the innovation are seeking credible reassurances that the innovation is worth their time, effort, and limited finances; the exceptions to this rule are the user segment labeled "early adopters," (described in detail in the succeeding section) who are the first user groups to latch-on to an innovation, seeing more reward than risk and perceiving change as positive.

Therefore, it is the peer-peer conversations and the early adopters' social networks that will unlock the potential of the innovation for the majority audiences, thereby allowing the need to adopt the innovation to spread.

2.7.3 Needs of Different User Segments

The Diffusion of Innovations theory posits that a population can be categorized into five user segments: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, 5) laggards. These user segments are thought to be stagnant, meaning that, for a given innovation, a person will stay classified in a single user segment. However, a person may be in different user segments regarding other innovations based on their perception of its simplicity, congruence with their norms, and their perception of its usefulness to their situation. For example, a person who rarely watches television programming would likely be in the laggard user segment, while the same person, who loves to use Apps on a phone, might be an early adopter of the newest iPhone or Android. Understanding how each user segment perceives and behaves toward innovation is key to having an innovation rapidly adopted by a population.

2.7.3.1 Innovators

Innovators are a very small group of imaginative individuals, only 2.5% of the population, who spend excessive amounts of time inventing, reinventing, or bringing about the evolution of an innovation. These people are helpful to have around when the early adopters begin to use the innovation so that minor changes and updates can be made. In this way, the early adopters are not complaining, but rather are helping to make the innovation better. In recent times, an example would be the frequency with which Apps on iPhones and iPads are updated based on user (often early adopter) feedback.

2.7.3.2 Early Adopters

Early adopters, representing 13.5% of the population, are the first group to adopt an innovation. They self-identify as trend setters and enjoy finding innovations that benefit their professional or personal lives. Often innovations are markedly more expensive prior to the innovation spreading to the majority groups. Therefore, it is presumed that early adopters generally have more discretionary income that permits such purchases. Working with companies to improve product use is important to an early adopter, who typically enjoys talking to his or her peers about how he or she influenced the latest edition of an innovation and how it is cheaper, more advantageous, and easier than the innovation it supplanted. It is precisely these peer-peer conversations and the social networking that begin to affect the diffusion of the innovation.

2.7.3.3 Early Majority

If an innovation makes it to the early majority user segment, representing 34% of the population, it is likely that a lot of the minor problems that reduced efficiency have been removed. This is important because this user segment is described as pragmatic – seeking more efficient ways to do the same thing, low cost innovations or those with a quick return on investment. This user group wants to be able to take the innovation out of the box and begin to use it through intuitive means. Appealing phrases for this user segment would be: plug and play and user-friendly.

2.7.3.4 Late Majority

As a user group, the late majority is on the conservative side of pragmatism and is risk-averse. The opinions of this user segment, representing 34% of the population, are largely shaped by the laggards. Practically speaking, they would prefer not to have innovation change anything. On the other hand, they are described as being concerned with how others perceive them. Therefore, if they can see the benefits and begin to believe they are among the last to adopt the innovation, they will adopt due to peer pressure.

2.7.3.5 Laggards

The final group is the laggards, representing the last 16% of adopters. As their name suggests, they lag behind all other groups in innovation adoption. This is the most risk averse group and will hold out until the end. A laggard may ask himself, "Why does every student need an iPad if I could just project the lesson on my overhead projector?" Laggards are also a group that will argue against innovation and, perhaps, perceive it as a badge of honor that they are the 'only' one who isn't using the innovation. Nowadays, one might consider someone without a cell phone to be a laggard, as the relevancy, the price, the convenience, and the ease of use have been established. Laggards might only decide to get cell phones because they are no longer able to find payphones on road trips.

2.7.4 Summary

The Diffusion of Innovations theory provides researchers with another lens from which to view the integration of technology in the K-12 setting. While the SAMR model provides a mechanism to categorize how the teachers behave when they have technology available, the Diffusion of Innovations theory may answer the critical question of *why* they act as they do. It is, perhaps, easier to reach teachers who have shunned the use of instructional technology if the principal, instructional coach, or peer can identify them as a late majority adopter who is, by nature, pragmatic, risk averse, and must be provided with a strong rationale as to the need for and use of the innovation in question.

3.0 RESEARCH METHOD

A one to one correspondence with technology, often abbreviated as "1:1," is marked by each student having his/her own computerized device for school and home use. While the type of device may vary between laptops and tablet options, it must be portable and available to students and teachers 24-hours a day, seven days a week.

This chapter provided a detailed discussion of the methods that were used to conduct the proposed research study. The study aims and research questions are described first. Next, the theoretical framework is articulated, followed by the research design. This is followed by a description of the setting of the studied 1:1 initiative and multiple descriptions of the teacher participants. To obtain a more complete picture of the setting and participants, this research has included a brief description of a previous technology initiative that occurred within the school. This information was selected for inclusion as it was believed that the former initiative played a role in shaping the readiness for the 1:1 initiative related to technical skill development and pedagogical integration. Next, the three measures of data used to analyze teacher instructional strategies on two occasions are reviewed in detail. This section also details data collection methods, data analysis methods, and ethical assurances.

3.1 STUDY AIMS AND RESEARCH QUESTIONS

The purpose of this study was to explore teacher instructional strategies at two points in time: 1) When only teachers have a computerized device (iPad), and 2) When students have a 1:1 correspondence with technology. The two points in time are seven months apart: June 2013 and January 2014. The study took place in a Mid-Atlantic public secondary school of 1,000 students and 70 faculty, comprised of grades 7-12, hereafter referred to as BCP. Archival data from teacher submission of a self-reflective Apple survey administered immediately prior to students receiving technology and again after seven months of teacher-student interaction with the technology was used as one data source. Additionally, observations and walkthroughs of teachers, conducted by trained administrators both prior to and after the introduction of student technology were used as data sources.

Because the focus of this study was on examining the instructional practices of BCP teachers, pre-existing data were necessary to identify changes over time. The data measures submitted in June 2013 were treated as "Time 1" data, while assessment data after the introduction of the one-to-one correspondence were considered as "Time 2" data, January 2014. The data from "Time 1" was compared to "Time 2" data in order to explore differences in instructional practices.

The following research question was addressed to achieve the purpose of this study: How have instructional strategies related to technology integration changed between two points in time?

3.2 THEORETICAL FRAMEWORK

Researchers have generally held that the integration of technology into the instructional practices of teachers happens in phases, with the greatest educational benefit occurring from higher-level technology activities. In order to assess lessons that incorporate technology, administrators required a standardized method through which technology lessons could be categorized; the SAMR model provided such a lens. SAMR in an acronym for Substitution, Augmentation, Modification, and Redefinition. The SAMR model provided a blueprint that administrators and teachers used to assess the technology use in a classroom. The SAMR model defines a continuum, similar to the ACOT Technology Integration continuum created by Apple, that allows the observer to stratify the technology related activities based on what the learner is doing. A side-by-side table (Table 8) illustrating the alignment of the SAMR model and the ACOT continuum can be found in this section. A brief explanation of each level of the continuum is described below:

Substitution – Technology acts as a direct tool substitution, but there is no functional change. For example, a teacher may make a reading available to students on their iPads as a PDF. The student will still do the same task (read), except now they will use the technology. This is considered the lowest level of technology use.

Augmentation – Technology continues to act as a direct tool substitution, but there is a functional change. For example, a teacher who has students read a PDF on the iPad with the instructions to use the built in dictionary when they encounter an unfamiliar word or the "speak" function to have the iPad read the passage to them.

Modification – Technology allow for task redesign. For example, a student may be instructed to use GoogleDocs to write a response to the reading and then virtually share the

Doc with two collaborators. These collaborators can give the student feedback and ideas for improvement.

Redefinition – Technology allows for the creation of new tasks that were previously not possible without technology. For example, students take a virtual field trip using web conferencing technology. Students are able to interact with the local or global expert and share findings using a variety of student created media to demonstrate their understanding. Redefinition is considered the highest level of the SAMR model.

For the scoring of the Apple survey, the observation reports, and the walkthrough reports, narrative responses indicating technology use were analyzed for their alignment to one of the SAMR levels. Numeric values were assigned as follows: Substitution = 1, Augmentation = 2, Modification = 3, and Redefinition = 4. If no technology use were noted in an observation or walkthrough narrative, then a score of zero (0) was assigned.

Table 8.

SAMR vs ACOT

Levels	SAMR	ACOT
1	Substitution	Entry
2	Augmentation	Adoption
3	Modification	Adaptation
4	Redefinition	Appropriation
5		Invention

3.3 RESEARCH DESIGN

A quantitative exploratory case study was conducted to assess differences in teacher instructional practices at two points in time. According to Merriam (1998), a case study research design is often used when enquiry focuses on:

- Process rather than outcomes,
- Context rather than specific variables, and
- Discovery rather than confirmation.

Appropriately, then, the exploratory case study design was selected in order to gain additional insight into the changes in instructional practices in this specific context, rather than causal implications. Exploration of meaning within the context of the current study will be used to improve practice.

The case study design is also selected when the focus of an enquiry of an "instance" fits into the category of a(n): Individual, program, institution, group, event, or concept (Merriam, 1988). In the case of the current study, the instance of enquiry was conceptualized as a program, wherein all students were issued a computerized device (iPad) for school and personal use; such a program is often referred to as a 1:1 initiative.

This researcher also sought to capitalize on the strength of the case study research design. The major strength of the case study is the design protocol in which the researcher seeks to triangulate one or more of the following areas: data, investigators, theories, or methodologies (Feagin, Orum & Sjoberg, 1991; Denzin, 1984). In the current study, data source triangulation is realized through considering the similarity of data outcomes in different contexts. The different contexts or measures used include archival data, self-reflective surveys, and observations of participants. Protocols not relevant to this case study design are:

- Theory triangulation – when interpretations of data are made by researchers with different philosophical approaches.
- Methodological triangulation – when more than one approach is used to interpret study outcomes.

Triangulation, through any of the aforementioned protocols, increases the reliability of the data and, consequently, the interpretations made based on the data collected.

Reliability, according to Yin (1994), should also be considered during the data collection process. To that end, Yin suggested two data collection principles for consideration. First, Yin suggests that the researcher create a case study database. In the current study, data gathered were stored in a password-protected computer to ensure that only the researcher had access. There was no identifying information of the schools or teachers utilized in this study. Instead, numerical codes, with embedded contextual meaning, were assigned to collected data to ensure the confidentiality of participants. Contextual meaning of participant identifiers indicated teachers' sex, length of teaching career, subject taught, and high school or middle school teaching status. Data collected, processed, and analyzed will be destroyed three years after the completion of this study.

The second prong of Yin's approach to increased reliability suggests that the researcher articulate a clear chain of evidence. To this end, this researcher provided a written affidavit of an external observer who can attest to the data's authenticity. Additionally, this researcher provided a case study report that cites where the actual evidence contained in the database will be located (during the three years immediately following the completion of the study).

3.3.1 Researcher Role

The researcher was an employee of BCP and a member of the administrative team throughout the planning and implementation stages of the 1:1 initiative. According to Merriam (1988), a case study in education is one that "presents a detailed account of the phenomenon under study." As the researcher was both a participant and an observer, her recollections of experiences and conversations, as well as access to pertinent internal documents throughout the planning and implementation stages, should provide a rich description of context specific discoveries and findings. The researcher also performed tasks related to observations and gathering pertinent documents (data measures) for all aspects of the study. LeCompte (1993) reminds researchers that moving between active and passive participation is permissible and often necessary.

3.4 SETTING

BCP is a suburban secondary school located in Mid-Atlantic region of the United States serving 1,100 students in grades 7-12. BCP is situated along a river, approximately 1 hour from the nearest metropolitan area and half-hour from the closest airport. BCP serves four local municipalities. BCP was ranked by a top rated business magazine as the best school district in its county and in the top 10% of schools in the region. BCP student SAT scores exceed state and national averages. Additionally, BCP boasts a 98% 4-year cohort graduation rate with 80% of its graduates attending a 2 or 4-year institution of higher education.

3.4.1 Previous Technology Initiatives at BCP

In June 2008, BCP administration began implementation of a three-year state funded technology grant. Per grant requirements, the only teachers permitted to participate were High School "core subject" teachers. In selecting only Math, Science, English, and Social Studies teachers, many teachers in other disciplines more adept and more willing to participate in a technology grant, were excluded. Selected by district administration for participation were six Science, five Language Arts, five Social Studies, and two Math teachers. Of the eighteen teachers selected for participation, nine teachers were identified as multi-grade instructors, four as 9th grade only, two as 11th grade only, and three as 12th grade only; nearly 800 students had contact with the devices purchased through this state grant.

On behalf of BCP participating teachers, state grant funds were used to purchase hardware and software and to update the infrastructure needed to support the new devices. Where formerly there had been only one interactive whiteboard in the entire school, the initiative added 20 more. Every teacher participant (N=18) also received an LCD projector, which more than doubled the total number available in the school. Doubled or nearly doubled were the number of multi-media speakers, student laptops, and wireless ports, which increased the accessibility of technology and positively affected connectivity. Where previously only one mobile laptop cart had been available, with the purchase of 35 new student laptop computers split over two mobile carts, access was increased two fold.

3.5 PARTICIPANTS

Unlike the previous technology initiative, which provided computerized devices and professional development for only 18 teachers, the 1:1 technology initiative discussed in the current study considered all teachers serving grades 7-12. Teachers who had archival data for all three measures, during both Time 1 and Time 2, were included (N=58). Table 2 below illustrates the demographic information of the participants.

Table 9.

Demographic Information of Participants

	Total Sample (N=58)
Gender n(%)	
Male	22 (37.9%)
Female	36 (62.1%)
Age (Mean±SD, range)	41.19±11.71, 24-68
Department n(%)	
Math	8 (13.8%)
English	10 (17.2%)
History	9 (15.5%)
Science	9 (15.5%)
Music/Art	5 (8.6%)
Foreign Language	4 (6.9%)
Physical Education	3 (5.2%)
Undesignated*	10 (17.2%)
Years of Teaching n(%)	
1-5 years	10 (17.2%)
6-10 years	20 (34.5%)
11-15 years	10 (17.2%)
16- 20 years	8 (13.8%)
21+ years	10 (17.2%)
Educational Level n(%)	
Bachelors	19 (32.8%)
Masters/Doctorate	39 (67.2%)

**Undesignated teachers would include Special Education, Family and Consumer Science, Business, and Industrial Arts.*

It is important to note that of the 58 teacher participants considered for this exploratory study, 18 participated in the school's previous technology initiative described in section 3.4.1; this section also disaggregates the participants of the previous technology initiative by department.

3.5.1 Participants Include Part-Time Technology Coaches

Believing that professional development would play a pivotal role in successfully integrating technology into teacher instructional practice, two Instructional Technology Specialists (ITS) were selected. These ITS coaches were selected from the existing faculty at BCP to lead professional development sessions and to provide pedagogical and skill based support to teachers during implementation. Both ITS coaches received a half-time teaching load and spent the other half of their day planning, coaching, and problem-solving technology related issues with teachers.

One ITS coach had previously held the role of ITS coach during BCP's previous technology initiative. During that time, she received a plethora of professional development to help bolster her already strong content knowledge. She attended an Instructional Technology Integration Coaches Boot Camp, a 1:1 Computing Conference, The Pennsylvania Educational Technology Expo and Conference (PETE&C), participated in a preparatory 30-hour online course entitled, "Teaching in the 21st century: The Need for Change," and a 40-hour online course entitled, "Teach Thinking with Technology."

The other ITS coach is seen as a technology leader and pioneer amongst his peers. He attended previous technology conferences, including a regional education conference sponsored by Google. His master's degree in Instructional Leadership presented a unique advantage to engage teachers in a quasi-administrative role – both as teacher-coach and teacher-leader. This ITS coach has facilitated a multitude of professional development sessions dealing with instructional technology including: GoogleDrive, Moodle (an open source information management system similar to BlackBoard), iOS and iCloud, Skype for virtual fieldtrips, managing files, file sharing options, workflow options, whiteboard Apps, creating a custom search engine, and iTunes University.

3.5.2 Participant Teachers Receive iPad

Teachers at BCP received 2nd Generation 16 GB iPads in June 2012. Teachers also received a Bluetooth keyboard, protective case, and an adapter to connect the iPad to an LCD projector. These iPads were used throughout the 2012-2013 school year and professional development and support for pedagogical and skill based knowledge were provided by administration and ITS coaches.

3.5.3 Participant Teachers Receive Professional Development

The following voluntary professional development sessions were facilitated during the 2012-2013 school year, encompassing more than 170 potential hours of skill-based and pedagogical training:

- iPad 101
- iBooks Author App
- Build a Blended Course

- iPad Refresher
- DropBox and GoogleDocs Apps
- Show-Me, Educreation, & ScreenChomp Apps
- App Fest 1: 10 Educational Apps
- App Fest 2: 10 (different) Educational Apps
- iPad 102: Educational Apps
- iPad 103: iTunesU intro, eBooks, & Social Media
- iPad 104: iTunesU Build a Course
- iPad 105: Professional Learning Community

3.5.4 Students at BCP Receive iPad for 1:1 Initiative

Students at BCP began receiving 16GB iPad minis in June 2013. Due to the complexity of giving iPads to over 1,000 students, the roll out process was spread between June and August. Each month, four sessions were held to present students with their iPad. In June, students entering their junior or senior years, along with any student taking an Advanced Placement course, were offered the opportunity to receive their iPads. In July, students entering their freshmen and sophomores years, were offered the opportunity to receive their iPads. In August, students entering their seventh or eighth grade years, were offered the opportunity to receive their iPads. All students receiving an iPad between the months of June through August were required to attend one informational session featuring information about BCP's 1:1 initiative, the school's Acceptable Use Policy (Appendix A), and to receive information about required Apps to download prior to the start of school in late August 2013 (Appendix B).

3.6 MEASURES

Three measures of data were compared to determine differences in teacher instructional practices. These measures were assessed when only the teacher had technology (Time 1) and again after the students and teachers both had a one-to-one correspondence with technology for seven months. Measures used included:

Measure 1: Differences in teacher instructional practices as measured through the self-reflective Apple survey.

Measure 2: Differences in teacher instructional practices as measured through teacher observation, as conducted by trained administrators.

Measure 3: Differences in teacher instructional practices as measured through teacher walkthroughs, as conducted by trained administrators.

These measures and the manner in which each is scored is described in greater detail in the succeeding three subsections.

3.6.1 Measure 1: Apple Self-Reflective Survey

The Apple self-reflective survey was expected to take 20-minutes to complete and consisted of 47 questions. The survey was split into three sections (Appendix C).

Section one requested basic demographic information including: 1) grade level, 2) subject taught, 3) students' primary learning technology device, 4) who provides the student device, 5) if the school is involved in a 1:1 initiative at the time of the survey, and 6) if the students were permitted to take their devices home.

The second section consisted of self-reflective multiple-choice questions regarding the role that technology played in helping students to achieve learning objectives. Thirty common ways that teachers use technology to help students achieve instructional goals were assessed on a four point Likert scale; available responses range from "no role" to "a crucial role."

The third section consisted of multiple choice questions regarding the teacher's own professional (or non-instructional) use of technology. Again, the same four point Likert scale was employed to determine the role that four technology devices and seven work activities played in the teacher's workday. Responses to the questions were synthesized to reveal an overall picture of the school's technology use by teachers. Individual teacher responses were scored using the SAMR model, described in section 3.2.

3.6.2 Measure 2: Observation Reports

All observations of participating teachers were completed by principals or assistant principals trained in the last three years to utilize the Department of Education's Teacher Evaluation System, hereafter referred to as the Framework for Teaching (Appendix D). The Framework for Teaching is based on the work of Charlotte Danielson, former public school teacher and author of several books on the subject of teacher observation. The Framework for Teaching outlines the focus of administrative observations, which lead to teacher evaluation. The Framework for Teaching requires an assessment in each of four domains:

- Domain 1: Planning and Preparation
- Domain 2: Classroom Environment
- Domain 3: Instruction

- Domain 4: Professional Responsibilities

These domains are sorted into two categories: 1.) Off-stage domains, and 2.) On-stage domains.

First, the off-stage domains are domains 1 and 4. They are referred to as off-stage domains because criteria other than what is observed during the administrative visit to the classroom can be used. Issues of professionalism such as punctuality and adherence to school policies cannot usually be assessed to any great degree during an observation. Instead, these off-stage domains require the administrator to consider other sources of evidence.

The second category into which the domains are sorted is referred to as the on-stage domains. Domains 2 and 3 are referred to as on-stage because issues of instructional practice and classroom environment are easily observed during an administrative observation.

While past practice has left administrators to determine for themselves what specific practices should be considered with each domain, the new Framework for Teaching further delineates the on-stage and off-stage domains by including sub-sections, referred to as components. The components cue the administrator to issues of import within each domain. The use of components has led to greater standardization for administrators using the Framework for Teaching. The domains and corresponding components are illustrated in Figure 1.

Figure 1. Framework for Teaching

Domain 1 – Planning and Preparation	Domain 2 – Classroom Environment
A. Content knowledge and pedagogy B. Knowledge of students C. Instructional outcomes	A. Environment of respect and rapport B. Culture for learning C. Classroom procedures

D. Knowledge of resources E. Coherent Instruction F. Student Assessments	D. Student behavior E. Physical space
Domain 3 – Instruction A. Communication with students B. Q/A techniques C. Student engagement D. Assessment of instruction E. Flexibility and responsiveness	Domain 4 – Professional Responsibilities A. Reflection on teaching B. Accuracy of records C. Communication with families D. Participation in professional community E. Professional development F. Professionalism

These 22 components are operationalized within the scoring rubric and a summative evaluation of the teacher's performance is made for each component. These component evaluations are then synthesized into a single rating for each domain.

The single rating for each domain can be considered: 1) Failing, 2) Needs Improvement, 3) Proficient, or 4) Distinguished. Each of the four rating categories is assigned a value on a four-point scale, as illustrated in Figure 2.

Figure 2. Rating Scale Value for Teacher Evaluation

Category	**Value**
Failing	0
Needs Improvement	1
Proficient	2

Distinguished	3

Finally, to operationalize the collection of data related to domains and components during an administrative observation, administrators and teachers adhered to the following five-step protocol when an observation using the Framework for Teaching occurred: 1) The administrator and teacher had a pre-observation conference, 2) The administrator observed lesson and gathered evidence, 3) The administrator and the teacher completed the rubric separately, 4) The administrator and the teacher met for a post-observation conference and compared rubric scores; only those items where the administrator and the teacher had differences of opinion were required to be discussed, 5) The administrator's report, with any changes based on teacher input, was signed by both parties and filed at central office. For the purposes of the current study, each narrative was reviewed for content related to technology use and was scored using the SAMR model, described in section 3.2.

It may be important to note that all administrators who provided observation data had previously received 12-hours of training provided by the Department of Education through a local agency. Training pertained to the development of the new observation model, descriptive note-taking, and using observable behavior in observation reports in lieu of opinion statements. During the two-day training, administrators engaged in guided simulations for practice. A post-test ensured that all participants acquired the necessary content.

3.6.3 Measure 3: Walkthrough Reports

Walkthroughs can be viewed as a shorter and less formal version of the observation protocol noted above. Walkthroughs are generally between 5 and 15 minutes and provide the administrator with a snapshot of the teacher's practices and classroom environment. Administrators take descriptive notes about the interactions between and amongst students, the types of activities observed, the use of technology, the absence or presence of student exemplars, and other environmental features (See Appendix E). Said descriptive notes are required to be objective and fact-based.

After taking notes related to instructional practices, technology integration, and classroom environment, the administrator articulated these observations on a writable PDF. The walkthrough form requires a narrative response for each of the following headings: 1) Evidence of satisfactory teaching, 2) Levels of Cognitive Learning (Bloom's Taxonomy of Cognition), 3) Best Practices, and 4) Reflections, noted as, "Think About."

At BCP, the narrative responses comprising the walkthrough report (Appendix E) were completed by building or central office administrators. Titles of those with permission to complete a walkthrough report were: Principal, Assistant Principal, Director of Pupil Services, Assistant Superintendent, and Superintendent. Walkthrough reports were shared with the observed teacher and kept on file at central office. While it is generally acknowledged that a single 15-minute walkthrough will not give a complete picture of the teacher, it is believed that a series of these snapshots will provide the administrators with a photomosaic of the teacher's practices. For the purposes of the current study, each narrative was reviewed for content related to technology use and was scored using the SAMR model, as described in section 3.2. The walkthrough practice employed by BCP administration was informed by the work of Charlotte Danielson, however the form used was locally developed and contains no copyrighted or proprietary information.

3.7 DATA COLLECTION

For the purpose of this study, measures employed at the time when only the teachers had technology were considered “Time 1” data. These measures included the self-reflective Apple survey and observation and walkthrough reports submitted by trained administrators. Measures employed when both teachers and students had technology were considered “Time 2” data. Statistical analyses were conducted for each of the measures to explore any changes in instructional strategies recorded between “Time 1” and “Time 2.” The data required to explore changes was obtained from the archival records of BCP.

Archival records required for “Time 1” data collection included three measures. First, participant teachers’ answers to a technology self-reflective survey were collected. The second and third measures obtained from archival records included administrative reports from observations and walkthroughs. “Time 1” survey data were collected in June 2013. “Time 1” observation and walkthrough reports were collected between September 2012 and June 2013.

Archival records required for “Time 2” data collection included the same three measures: 1) Answers to the same technology self-reflective survey, 2) Administrative reports from observations, and 3) Administrative reports from walkthroughs. “Time 2” survey data were collected in January 2014. “Time 2” observation and walkthrough reports were collected between September 2013 and January 2014.

3.8 DATA ANALYSIS

For purposes of the data analysis, the dataset involved all submitted assessments provided by administrators at BCP. Descriptive statistics (mean, standard deviation, minimum and maximum) and frequency tables were used to describe the interval-level and binary variables, respectively. Additionally, skewness and kurtosis statistics were computed for interval-level variables, in order to determine whether they follow a normal distribution.

To address the overall research question posed in this study, it was necessary to analyze data related to teacher instructional practices submitted at two points seven months apart.

To address Measure 1, independent samples *t*-tests were conducted to compare the Apple Survey scores for Time 1 and Time 2. The significance level was set at .05. This test determined whether there were significant differences in the measure of the Apple Survey between Time 1 and Time 2. Data for all measures were normally distributed and, therefore, did not require additional tests to conclude significance.

Measures 2 and 3 were addressed in the same way as Measure 1, using observation reports and walkthrough reports. They also were tested through independent samples *t* tests and were normally distributed.

Subjectivity in scoring narrative responses for walkthroughs and observations was plausible; that is to say, the scoring of narrative responses was not completely objective, rather scoring opened a space for rater interpretation. Therefore, an inter-rater reliability test was used to assess the degree to which this researcher and another rater's interpretations matched. The second rater was a certified teacher and current Director of Technology of a Mid-Atlantic school district. He was selected due to his education and administration background, in addition to his expert knowledge of the SAMR scale. The second rater has taught a multitude of online courses related to technology skill acquisition in general, as well as specific courses related to the SAMR scale. To demonstrate inter-rater reliability, the second rater was given 22 de-identified observations and walkthroughs to read and score using the SAMR scale. This researcher and the second rater agreed on all scores save one, giving a reliability of 95%.

To address the research question posed in this study, it was necessary to analyze the results of the three measures. This study could provide insight into the changes in teacher instructional practices based on the correspondence to technology.

3.9 SUMMARY

Chapter three discussed the research aims, theoretical framework, research design, setting, participants, measures, data collection techniques, and data analysis methodology used in the current study.

Archival data of assessments at BCP were used in this study. Although secondary data were used, IRB review was necessary to proceed with the analysis because the study involves responses of teachers in the assessments. Protecting participant confidentiality and anonymity was ensured throughout the course of this research.

In the succeeding section, Chapter four, the results and findings for the statistical analysis conducted in this study are presented. This includes an overview of the data collection techniques as well as a description of the sample. The description of the sample includes a presentation of summary statistics of study variables. The results of the analysis also were presented to answer the research question and provide insight into teacher instructional practices and technology correspondence.

4.0 DATA PRESENTATION AND ANALYIS

The results of the data analysis are presented in this chapter. The presentation of the data begins with a description of the demographic information collected from those who participated in this study. This is followed by analyses of relational significance. First, analyses of relational significance were assessed between survey mean scores of instructional and non-instructional questions and demographic information. Then, analyses of relational significance were assessed between demographic information and frequency of use of each level of the SAMR scale of both walkthrough and observation measures.

4.1 DEMOGRAPHICS

All teachers of grades 7 – 12 at BCP School District were initially considered for participation. There was only one participation requirement: A participant teacher must have data for all three measures during time one and time two. This would naturally exclude teachers who were newly hired and therefore not present during the 2012-13 school year. Additionally, this criterion excluded teachers who were not observed, which may have occurred due to: 1.) leave status, 2.) resignation, 3.) retirement, or 4.) non-teaching status (no students assigned to teacher). Of the 70 total teachers at BCP, 58 met the above stated criterion and were therefore selected for participation.

During the years studied, the 1:1 technology initiative in the district extended only to secondary campus teachers: 28% middle school and 72% high school.

Additionally, teachers from all departments were represented: Math (8, 13%), English (10, 17%), History (9, 16%), Science (9, 16%), Art/Music (5, 9%), Foreign Language (4, 7%), Physical Education/Health (3, 5%), and other (10, 17%). Teachers were placed in the other category if the number of teachers in their subject area was sufficiently small as to not qualify for department status, including: Special Education, Family & Consumer Science, and Industrial Arts. To enhance data reliability, academic departments were collapsed into the following categories: Math/Science (17, 29%), English/History (19, 33%), Elective [including Foreign Language, Music, Art, and PE] (12, 21%), and Other (10, 17%).

Other demographics of interest in the current study were sex, years of experience in teaching, and education level. Of the 58 participant teachers, 62% were female and 38% were male. Years of experience in education, grouped into intervals of five years, were also collected.

Table 10.

Years of Teaching by Category

Years of Experience	Frequency	Percent
1-5 years	10	17.2
6-10 years	20	34.5
11-15 years	10	17.2
16-20 years	8	13.8
21 or more years	10	17.2
Total	58	100

Of additional interest was the highest level of education achieved by each participant teacher; of the 58 participant teachers, one-third (33%) had only obtained a Bachelor's degree, while two-thirds (67%) had earned a Master's degree. Only one participant teacher had earned a Doctorate and is represented in the collapsed category designation of Masters/Doctorate.

While participant sex and building categories may seem skewed, it may be important to recognize that the number of teachers in the total population of the middle school is less than that of the high school and that female teachers within the district outnumber male teachers; percentages are proportionate to the total population of their respective categories. It may also be important to note that two-thirds of the population having an advanced degree is not unusual, given the requirements to maintain teacher certification in this Mid-Atlantic state. In this Mid-Atlantic state, a teacher's initial certification is referred to as an Instructional Level I certificate. This initial certification is valid for up to six years of service (not calendar years). Thereafter, it must be converted to an Instructional Level II certificate, which is good for 99 years provided continuing education credits are earned as stipulated by state law. In order to convert to the Instructional Level II certificate, a teacher must meet the following requirements: 1) Earn 24 post-baccalaureate credits (six credits must be in the teacher's certification area), 2) Have six satisfactory bi-annual evaluations, and 3) Complete a Department of Education approved induction program. Given the requirement to earn 24 credits to convert to an Instructional Level II certificate within 6 years, most teachers decide to earn said credits toward completion of an advanced degree. Therefore, the fact that two-thirds of the participant teacher population within this district has a Master's degree is unremarkable.

This researcher also collected data regarding which participant teachers in the current study were also participants of the district's previous technology initiative. This researcher sought to explore the relationship between previous technology integration experiences and technology usage as measured by the survey, walkthroughs, and observations. Given that the literature indicated that an optimal technology environment would ensure devices that are well maintained and a two-pronged focus to professional development related to the device (then a MacBook Pro) as well as pedagogical coaching, it seemed reasonable to presume that these teachers (18, 31%) would perform differently than their peers (40, 69%), perhaps having a higher mean score on some or all measures.

4.2 SURVEY DATA

The survey used during time one and time two was identical in form and format. One section consisted of self-reflective multiple-choice questions regarding the role that technology played in helping students to achieve learning objectives. These thirty common uses of instructional technology were assessed on a four point Likert scale indicating the role that each category played in the teacher's instructional delivery: 1) no role, 2) minor role, 3) significant role, and 4) crucial role. The second section of the survey asked the participants to respond to questions related to their non-instructional use of technology. Namely, participants selected the response on the same Likert scale used in the first section to clarify the role of four technology devices and seven technology related activities.

4.2.1 Survey: Instructional Uses of Technology

Survey questions in this section related to instructional uses of technology. All teacher participants (N=58) responded to the common uses of instructional technology questions (N=30). The relationship between mean scores (30-120) and six demographic indicators were tested for statistical significance.

4.2.2 Survey: Non-Instructional Use of Technology

Survey questions in this section related to the non-instructional uses of technology. All teacher participants were asked to reflect on their use of four technology devices and seven work activities that are non-instructional in nature. Answers to these questions permitted this researcher to review differences between the teachers' self-reported use of technology in instructional and non-instructional related activities. Mean scores for this section were between 11 and 44.

4.3 DEMOGRAPHIC SIGNIFICANCE IN THE SURVEY

This researcher collected several demographic indicators about each participant teacher, as outlined in the previous section. In the following subsections, these demographic aspects will be compared to survey mean scores for time one and time two for both instructional and non-instructional components of the survey. Determining the statistical significance of mean scores and paired demographics is integral to understanding which areas impact changes in teacher use of technology. This section is organized to demonstrate mean scores and their statistical significance as disaggregated by: 1) sex, 2) participation in the district's previous technology initiative, 3) building level, 4) years in teaching, 5) years of teaching, 6) department affiliation, and 7) education level.

4.3.1 Survey Results Disaggregated by Sex

Table 11 illustrates the group statistics for participant teachers, disaggregated by sex, related to answers for Time 1 and Time 2 on both parts of the survey: 1) instructional and 2) non-instructional.

Table 11.

Survey Results Disaggregated by Sex

Section, Time	Sex	n	M	SD
Instructional,T1	Male	22	38.09	6.08
	Female	36	36.75	5.43
NonInstructional,T1	Male	22	19.73	4.80
	Female	36	20.86	4.86
Instructional,T2	Male	22	40.68	6.47
	Female	36	39.64	7.29
NonInstructional,T2	Male	22	22.36	5.29
	Female	36	23.44	5.15

The significance of males having a higher mean score during time 1 and time 2 for both instructional and non-instructional activities was assessed using independent samples tests.

Table 12.

T-test for Sex

Section, Time	Sig.	t	Sig(2-tailed)	MD
Instructional,T1	.42	.87	.39	1.34
NonInstructional,T1	.99	-.87	.39	-1.13
Instructional, T2	.84	.55	.58	1.04
NonInstructional,T2	.82	-.77	.45	-1.08

Levene's Test for Equality of Variances was then applied; the variability between the conditions is not significantly different. The results of the two tailed tests for Equality of Means, reveal values that are also greater than .05. Therefore, it can be said that during time one and time two for instructional questions, there was no significant effect of sex, $t(56) = .39$, $p > .05$ and $t(56) = .58$, $p > .05$ respectively. Neither was there a significant effect of sex during time one and time two for non-instructional questions, $t(56) = .39$, $p > .05$ and $t(56) = .45$, $p > .05$ respectively.

4.3.2 Survey Results Disaggregated by Participation in Previous Technology Initiative

Table 13 illustrates the group statistics for participant teachers, disaggregated by participation in the previous technology initiative, related to answers for Time 1 and Time 2 on both parts of the survey: 1) instructional and 2) non-instructional.

Table 13.

Survey Results Disaggregated by Participation in Previous Technology Initiative

Section, Time	Participation	n	M	SD
Instructional,T1	No	40	36.90	5.66
	Yes	18	38.06	5.77
NonInstructional,T1	No	40	19.70	4.78
	Yes	18	22.06	4.66
Instructional,T2	No	40	39.55	6.14
	Yes	18	41.11	8.59
NonInstructional,T2	No	40	22.25	4.87
	Yes	18	24.78	5.58

The significance of participants of the previous technology initiative having a higher mean score during time 1 and time 2 for both instructional and non-instructional activities was assessed using independent samples tests.

Table 14.

T-test for Participation in Previous Technology Initiative

Section, Time	Sig.	t	Sig(2-tailed)	MD
Instructional,T1	.54	-0.72	.48	-1.16
NonInstructional,T1	.48	-1.75	.09	-2.36
Instructional, T2	.51	-0.79	.43	-1.56
NonInstructional,T2	.68	-1.75	.09	-2.52

Levene's Test for Equality of Variances was then applied; the variability between the conditions is not significantly different. The results of the two tailed T-tests for Equality of Means, reveal values that are also greater than .05. Therefore, it can be said that during time one and time two for instructional questions, there was no significant effect for participation in the previous technology initiative, $t(56) = .48$, $p > .05$ and $t(56) = .43$, $p > .05$ respectively. Neither was there a significant effect for participation in the previous technology initiative during time one and two for non-instructional questions, $t(56) = .09$, $p > .05$ and $t(56) = .09$, $p > .05$ respectively.

4.3.3 Survey Results Disaggregated by Building Level

Table 15 illustrates the group statistics for participant teachers, disaggregated by the building level in which each teacher works, related to answers for time one and time two on both parts of the survey: 1) instructional and 2) non-instructional.

Table 15.

Survey Results Disaggregated by Building Level

Section, Time	Building	n	M	SD
Instructional,T1	Middle Sch.	16	39.94	5.69
	High Sch.	42	36.62	5.60
NonInstructional,T1	Middle Sch.	16	21.00	5.34
	High Sch.	42	20.21	4.67
Instructional,T2	Middle Sch.	16	42.25	7.89
	High Sch.	42	39.19	6.46
NonInstructional,T2	Middle Sch.	16	23.25	5.54
	High Sch.	42	22.95	5.11

The significance of Middle School teacher participants having a higher mean score during time one and time two for both instructional and non-instructional activities was assessed using independent samples tests.

Table 16.

T-test for Building Level

Section, Time	Sig.	t	Sig(2-tailed)	MD
Instructional,T1	.47	1.40	.17	2.32
NonInstructional,T1	.56	0.55	.58	0.79
Instructional, T2	.511	1.52	.14	3.06
NonInstructional,T2	.675	0.19	.85	0.30

Levene's Test for Equality of Variances was then applied; the variability between the conditions is not significantly different. The results of the two tailed tests for Equality of Means, reveal values that are also greater than .05. Therefore, it can be said that during time one and time two for instructional questions, there was no significant effect for building level, $t(56) = .17$, $p > .05$ and $t(56) = .14$, $p > .05$ respectively. Neither was there a significant effect for building level during time one and two for non-instructional questions, $t(56) = .58$, $p > .05$ and $t(56) = .85$, $p > .05$ respectively.

4.3.4 Survey Results Disaggregated by Years of Teaching

Some may suggest that the longer a teacher has been in education, the better they know the art and the science of their work. If this were true, then teachers with more years of experience might have more time and willingness to dedicate to learning the functional and pedagogical benefits of technological devices. It would be reasonable to expect that these teachers would be using technology more often and in increasingly more transformative ways than their counterparts with less experience. On the other hand, some may propose that the longer a teacher is in education, the more his craft becomes stale and the less willing he becomes to deviate from traditional practices. These teachers would seem to have little incentive to try new and innovative pedagogical strategies related to technology, let alone take the time to learn the complex functionality of a new device. It would stand to reason that these teachers would be using technology at the lowest level, if at all, in a mere effort to comply with perceived administrative demands. Meanwhile, their colleagues with less experience would appear more adept with the new technology. Disaggregating the data by years of experience permitted this researcher to determine if more years of experience correlated with greater or more frequent uses of technology in instructional and non-instructional situations.

Table 17.

Survey Results Disaggregated by Building Level

Section, Time	Years of Experience	n	M	SD
Instructional,T1	1-5	10	37.40	7.46
	6-10	20	37.70	6.84
	11-15	10	36.90	3.87
	16-20	8	37.75	4.20
	21 or more	10	36.20	4.26
	Total	58	37.26	5.67
NonInstructional,T1	1-5	10	28.30	4.14
	6-10	20	30.90	4.76
	11-15	10	21.40	5.02
	16-20	8	22.63	3.66
	21 or more	10	18.90	5.80
	Total	58	20.43	4.83
Instructional,T2	1-5	10	42.00	8.43
	6-10	20	40.90	6.97
	11-15	10	38.00	3.56
	16-20	8	39.00	4.75
	21 or more	10	39.20	9.47
	Total	58	40.03	6.95
NonInstructional,T2	1-5	10	21.50	3.14
	6-10	20	23.80	4.62
	11-15	10	24.10	6.57
	16-20	8	24.00	4.00
	21 or more	10	21.20	7.07
	Total	58	23.03	5.18

Mean scores related to instructional technology use did increase in each 5-year incremental category for years of service. Interestingly, while mean scores related to non-instructional technology use also increase from time one to time two, they also increase in a bell shape: lower mean scores are reported from teachers having 1-5 years of experience. This number steadily climbs to those having 11-15 years of experience, falling slightly for those who have 11-16 years of experience and 21+ years of experience respectively. To determine whether the increases between time one and time two for instructional and non-instructional mean scores are significant, however, this researcher used an ANOVA test. First a Test of Homogeneity of Variances using the Levene Statistic was conducted and revealed that the homogeneity of variances assumption was not violated.

During time one for instructional technology questions, there was no significant main effect, $F(4, 53) = .13$, $p = .67$. During time two for instructional technology questions there was no significant main effect, $F(4, 53) = .56$, $p = .70$. During time one for questions related to non-instructional technology, there was no significant effect, $F(4, 53) = 1.33$, $p = .27$. During time two for non-instructional technology questions, there was no significant main effect, $F(4, 53) = .81$, $p = .53$. Therefore, it can be said that there is no significant difference between or among years of experience categories during time 1 and time 2 related to instructional or non-instructional survey items.

4.3.5 Survey Results Disaggregated by Department Affiliation

Just as some individuals in the entire population accept new innovations at different rates than others (Rogers, 2005), this research considered the possibility that different academic departments on the secondary campus may adopt instructional and non-instructional technologies at different rates than other academic departments. Would the four so-called "core" departments, Math, Science, English, and History, find more uses for technology in their classrooms than Physical Education or Industrial Arts teachers? Or would academic departments that lend themselves more naturally to "hands-on" applications find the technology initiative more practical? To help determine answers to these questions, this researcher looked for statistically significant interactions between the eight academic departments displayed in Table 9. Mean scores on the instructional and non-instructional aspects of the survey were compared. The mean scores are displayed in Table 18.

Table 18.

Survey Results Disaggregated by Department

Section, Time	Department	n	M	SD
Instructional,T1	Math	8	37.75	9.05
	English	10	37.00	4.71
	History	9	37.89	6.05
	Science	9	38.11	3.69
	Foreign Lang.	4	40.00	6.83
	Music/Art	5	35.80	2.28
	Phys. Educ.	3	32.67	3.06
	Other	10	36.80	6.30
	Total	58	37.26	5.67
NonInstructional,T1	Math	8	20.63	5.42
	English	10	20.70	4.03
	History	9	20.22	4.97
	Science	9	21.00	5.61
	Foreign Lang.	4	24.00	7.16
	Music/Art	5	20.40	5.55
	Phys. Educ.	3	16.33	1.15
	Other	10	19.50	3.84
	Total	58	20.43	4.83
Instructional,T2	Math	8	41.88	8.75
	English	10	40.50	3.47
	History	9	39.56	7.09
	Science	9	42.56	8.68
	Foreign Lang.	4	43.25	8.45
	Music/Art	5	37.40	3.23
	Phys. Educ.	3	32.67	3.06
	Other	10	38.50	7.14
	Total	58	40.03	6.95
NonInstructional,T2	Math	8	22.86	4.70
	English	10	24.20	3.61
	History	9	21.89	4.40
	Science	9	24.78	7.01
	Foreign Lang.	4	27.50	7.85
	Music/Art	5	23.60	4.67
	Phys. Educ.	3	17.00	1.00
	Other	10	21.20	4.32
	Total	58	23.03	5.18

While the mean scores of departments show an increase between time one and time two, this researcher needed to determine whether the increase was significant, to warrant additional analyses. To that end, this researcher used an ANOVA test. First a Test of Homogeneity of Variances using the Levene Statistic was conducted and revealed that the homogeneity of variances assumption was not violated.

During time one for instructional technology questions, there was no significant main effect, $F(7, 50) = .50$, $p = .83$. During time two for instructional technology questions there was no significant main effect, $F(7, 50) = .67$, $p = .69$. During time one for questions related to non-instructional technology, there was no significant effect, $F(7, 50) = 1.04$, $p = .41$. During time two for non-instructional technology questions, there was no significant main effect, $F(7, 50) = .81$, $p = .16$. Therefore, it can be said that there is no significant difference between or among academic departments during time 1 and time 2 related to instructional or non-instructional survey items.

4.3.6 Survey Results Disaggregated by Education Level

A similar supposition can be used with education levels of participant teachers as with years of service. One could suppose that new innovations would be more likely to be used by teachers who have been newly trained in the state's teacher preparation system. These teachers recently entering the workforce with, presumably, Bachelor's level education, then, would be most adept in engaging with innovative technological practices such as a 1:1 technology initiative. On the other hand, one might posit that teachers just entering the workforce would be so overwhelmed with the daily routines surrounding their profession that trying new innovations would be likely to happen by teachers with more years of experience, (i.e. higher educational levels). To help determine answers to these questions, this researcher looked for statistically significant interactions between teachers with a Bachelor level education and those with Masters or Doctorates during time one and time two. Mean scores on the instructional and non-instructional aspects of the survey were compared. The mean scores are displayed in table 19.

Table 19.

Survey Results Disaggregated Education Level

Section, Time	Building	n	M	SD
Instructional,T1	Bachelor	19	36.00	5.82
	Master/Doc	39	37.87	5.57
		58	37.26	5.67
NonInstructional,T1	Bachelor	16	18.05	4.01
	Master/Doc	42	21.59	4.81
		58	20.43	4.83
Instructional,T2	Bachelor	16	38.26	5.74
	Master/Doc	42	40.90	7.38
		58	40.03	6.95
NonInstructional,T2	Bachelor	16	20.53	3.44
	Master/Doc	42	24.26	5.48
		58	23.03	5.18

Mean scores for participant teachers at the Master/Doctoral level exceed those of participants at the Bachelor level during time one and time two, and in both instructional and non-instructional aspects of the survey. This researcher needed to determine whether the increase was significant, to warrant additional analyses. To that end, this researcher used an ANOVA test. First a Test of Homogeneity of Variances using the Levene Statistic was conducted and revealed that the homogeneity of variances assumption was not violated.

During time one for instructional technology questions, there was no significant main effect, $F(1, 56) = 1.40$, $p = .24$. During time two for instructional technology questions there was no significant main effect, $F(1, 56) = 1.86$, $p = .18$. During time one for questions related to non-instructional technology, there was a significant effect, $F(1, 56) = 7.66$, $p = .008$. During time two for non-instructional technology questions, there was a significant main effect, $F(1, 56) = 7.35$, $p = .009$. Additional study regarding the interaction between education level and mean score over time is, therefore, warranted. Figure 1 illustrates the relationship of the change in the survey scale between time one and time two by education level.

Figure 3. Non-Instructional Survey Results by Education Level

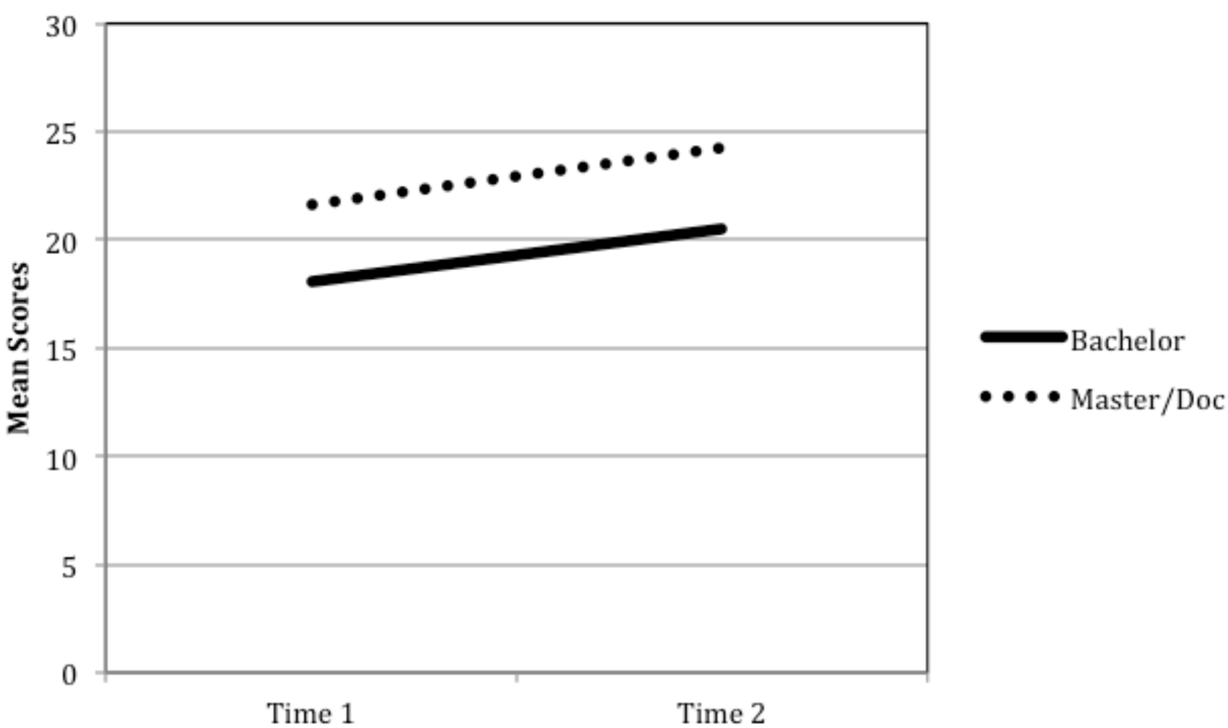

Figure 1 shows that there is a significant difference in non-instructional technology by time; there was more use of non-instructional technology during time two than time one (time effect). Additionally, Figure 1 illustrates that Master/Doctoral level teachers use non-instructional technology significantly more than Bachelor level teachers (group effect). Finally, the data demonstrate that the increase between time one and time two is the same, meaning that there is no interaction effect; if there were an interaction effect, the lines for Bachelor and Master level teachers would intersect.

4.3.7 Summary of Significance of the Survey Results

Survey results were reviewed for relational significance with six demographic indicators: 1) sex, 2) participation in previous technology initiative, 3) building level, 4) years of teaching, 5) academic department, and 6) education level. Changes between mean scores on the instructional and non-instructional questions on the survey were noted with each of the six demographic indicators. However, only a participant teachers' education level was significant. There were two areas of significance noted. First, both Bachelor and Master level teachers experienced a proportionate increase in their non-instructional technology use between time one and time two (time effect). Secondly, teachers with higher educational levels used non-instructional technology more frequently than their Bachelor level peers (group effect).

4.4 DEMOGRAPHIC SIGNIFICANCE OF THE WALKTHROUGHS

In this section, the researcher reported the results of data collected though the walkthrough measure in time one and time two with six demographic indicators. Determining the statistical significance of the frequency of instructional technology use by each demographic is integral to understanding what impacts change in teacher use of technology. This section is organized to demonstrate frequency of use of instructional technology at each level of the SAMR model disaggregated by: 1) sex, 2) participation in the district's previous technology initiative, 3) building level, 4) years in teaching, 5) department affiliation, and 6) education level.

A full discussion of the SAMR model is addressed in Chapter 3 and is integral to understanding the importance of the results in the following Observation and Walkthrough sections.

4.4.1 Walkthrough Results at SAMR levels Disaggregated by Sex

The SAMR theory, that all instructional technology use can be categorized on a scale of substitution, augmentation, modification, or redefinition, was used to score walkthrough data. Technology observed was first categorized and then scored as follows: 1) substitution = 1, 2) augmentation = 2, 3) modification = 3), and 4) redefinition = 4. If no technology were used in a given observation, then zero points were recorded.

This researcher first considered the significance of sex in the frequency of use of instructional technology at the substitution level. There were 22 male and 36 female teacher walkthroughs conducted during time one and time two. During time one, 17 (77%) male participants were noted as having zero instances of instructional technology use at the substitution level. Five (23%) male teachers were noted as having one instance of instructional technology use at the substitution level. There were no male teachers that were noted as having two or more instances of using instructional technology at the substitution level. Twenty-seven (75%) female participants were observed as having zero instances of instructional technology use at the substitution level. Three (8%) female teachers used technology at the substitution level during an observation. Finally, 6 (17%) female teachers used instructional technology at the substitution level.

This researcher use Chi Squared tests to determine the statistical significance of female teachers' higher use of instructional technology at the substitution level than their male counterparts. Pearson Chi-Square test could not be used as 67% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables was significant, $p=0.48, p < .05$.

Next, this researcher considered the results of the crosstab between sex and instances of observing the instructional technology use at the substitution level during walkthroughs at time two. Of the 22 males that were observed in the walkthrough format during time two, 4 (18%) male teachers were noted as having zero instances of using instructional technology at the substitution level. Nine (40%) males were noted as having used technology once, while nine other male teachers were observed using instructional technology two or more times. Of the 36 females that were observed in the walkthrough format during time two, 19 (53%) female teachers were noted as having zero instances of using instructional technology at the substitution level. Eight (22%) female teachers were noted as having used technology once, while nine (25%) other female teachers were observed using instructional technology two or more times. In time two, it is evident that instances of instructional technology use by male teachers at the substitution level were far more frequent than that of their female counterparts. The statistical significance of this finding was tested using Chi-Square tests.

During time two, the Pearson Chi-Square test was used to determine if the higher use of instructional technology at the substitution level by male teachers constituted a statistically significant finding. The relation between these variables was significant, X^2 (2, N = 58) = .032, $p < .05$.

4.4.2 Walkthrough Results Disaggregated by Participation in Previous Technology Initiative

Next, the significance of previous participation in a technology initiative and the frequency of instructional technology use at the augmentation level of time one was considered. Of the 40 teachers who did not participate in the previous technology initiative, 27 (68%) teachers did not use augmentation during the walkthrough, 5 (12.5%) teachers used augmentation once, and 8 (20%) used augmentation two or more times. Of the 18 teachers that were participants in the previous technology initiative, 10 (56%) did not use augmentation during the walkthrough, 7 (39%) used augmentation once, and 1 (6%) used augmentation two or more times. While a smaller percentage of previous participants of the technology initiative were recorded as not using augmentation at all, non-participants of the previous technology initiative far outpaced the participants in using augmentation two or more times.

To test the significance of this finding, a Chi Square test was used. Peason's Chi-Square test could not be used as 33% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables during time one was significant, $p = 0.05$, $p < .05$.

In time two, the significance of previous participation in a technology initiative and the frequency of instructional technology use at the augmentation level was again considered. Of the 40 teachers who did not participate in the previous technology initiative, 15 (38%) teachers did not use augmentation during the walkthrough, 15 (38%) teachers used augmentation once, and 10 (25%) used augmentation two or more times. Of the 18 teachers that were participants in the previous technology initiative, 4 (22%) did not use augmentation during the walkthrough, 4 (22%) used augmentation once, and 10 (55%) used augmentation two or more times. Again those with participation in the previous technology initiative had a higher frequency of using augmentation two or more times, with fewer teachers reported as not using augmentation at all during the walkthrough.

To test the significance of the significance of this finding, a Chi Square test was used. This researcher used the Pearson's Chi-Square, which indicated that the relation between these variables during time two was not significant, X^2 (2, N = 58) = .077, $p > .05$.

4.4.3 Walkthrough Results Disaggregated by Building Level

The significance of building level and the frequency of instructional technology use at the augmentation level of time one was considered. Of the 16 teachers at the Middle School level, 4 (25%) teachers did not use augmentation during the walkthrough, 6 (38%) teachers used augmentation once, and 6 (38%) used augmentation two or more times. Of the 42 teachers at the High School level, 33 (79%) did not use augmentation during the walkthrough, 6 (14%) used augmentation once, and 3 (7%) used augmentation two or more times. The frequency of use of augmentation once or two or more times at the Middle School level is higher than that of their High School level counterparts. Additionally, a lower percentage of Middle School teachers (25%) were reported as having no instances of using augmentation than teachers at the High School level (78%).

To test the significance of this finding, a Chi Square test was used. Pearson Chi-Square test could not be used as 33% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables during time one was significant, $p = 0.01$, $p < .05$.

This researcher then reviewed the data to determine if there were a similar finding during time two. Of the 16 teachers at the Middle School level, 4 (25%) teachers did not use augmentation during the walkthrough, 4 (25%) teachers used augmentation once, and 8 (50%) used augmentation two or more times. Of the 42 teachers at the High School level, 15 (36%) did not use augmentation during the walkthrough, 15 (36%) used augmentation once, and 12 (29%) used augmentation two or more times. The frequency of use of augmentation once or two or more times at the High School level is higher than that of their Middle School level counterparts.

To test the significance of this finding, a Chi-Square test was used. This researcher used the Pearson's Chi-Square, which indicated that the relation between these variables during time two was not significant, X^2 (2, N = 58) = .077, $p > .05$.

4.4.4 Walkthrough Results Disaggregated by Department

Next, the walkthrough data were reviewed by looking at trends between academic departments. There are seven academic departments at BCP High School and one additional group of teachers comprising an undesignated or other category. For the purposes of this data review, the departments were collapsed into two categories: 1) Math/Science (17) and 2) other (41).

4.4.4.1 Substitution

Of the 17 teachers in the Math/Science category, 9 (53%) teachers did not use substitution during the walkthrough, 3 (18%) teachers used substitution once, and 5 (29%) used substitution two or more times. Of the 41 teachers in the other category, 35 (85%) did not use substitution during the walkthrough, 5 (12%) used substitution once, and 1 (2%) used substitution two or more times. The percentage of use of substitution once or two or more times within the Math/Science category (47%) is higher than that of those represented in the other category (14%). Additionally, a lower percentage of Math/Science teachers (53%) were reported as having no instances of using substitution than teachers in the other category (76%).

To test the significance of this finding, a Chi Square test was used. Pearson Chi-Square test could not be used as 50% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables during time one was significant, $p = 0.01$, $p < .05$.

This researcher then reviewed the data to determine if there were a similar finding during time two. Of the 17 teachers in the Math/Science category, 7 (41%) teachers did not use substitution during the walkthrough, 6 (35%) teachers used substitution once, and 4 (24%) used substitution two or more times. Of the 41 teachers in the other category, 16 (39%) did not use substitution during the walkthrough, 11 (27%) used substitution once, and 14 (34%) used substitution two or more times. The percentage of use of substitution once or two or more times within the other category (61%) is slightly higher than that of those represented in the Math/Science category (59%). Additionally, a slightly lower percentage of Math/Science teachers (41%) were reported as having no instances of using substitution than teachers in the other category (39%).

To test the significance of the significance of this finding, a Chi Square test was used. This researcher used the Pearson Chi-Square, which indicated that the relation between these variables during time two was not significant, X^2 (2, N = 58) = .69, $p > .05$.

4.4.4.2 Augmentation

Of the 17 teachers in the Math/Science category, 6 (35%) teachers did not use augmentation during the walkthrough, 8 (47%) teachers used augmentation once, and 3 (18%) used augmentation two or more times. Of the 41 teachers in the other category, 31 (76%) did not use augmentation during the walkthrough, 4 (10%) used augmentation once, and 6 (15%) used augmentation two or more times. The percentage of use of augmentation once or two or more times within the Math/Science category (65%) is higher than that of those represented in the other category (25%). Additionally, a lower percentage of Math/Science teachers (35%) were reported as having no instances of using augmentation than teachers in the other category (75.6%).

To test the significance of this finding, a Chi Square test was used. Pearson Chi-Square test could not be used as 33% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables during time one was significant, $p = 0.01$, $p < .05$.

This researcher then reviewed the data to determine if there were a similar finding during time two. Of the 17 teachers in the Math/Science Department, 4 (24%) teachers did not use augmentation during the walkthrough, 6 (35%) teachers used augmentation once, and 7 (41%) used augmentation two or more times. Of the 41 teachers at the High School level, 15 (37%) did not use augmentation during the walkthrough, 13 (32%) used augmentation once, and 13 (32%) used augmentation two or more times. The percentage of use of augmentation once or two or more times within the Math/Science category (76%) is higher than that of those represented in the other category (62%); although the difference is not as large as during time one. Additionally, a lower percentage of Math/Science teachers (24%) were reported as having no instances of using augmentation than teachers in the other category (37%).

To test the significance of the significance of this finding, a Chi Square test was used. This researcher used the Pearson's Chi-Square, which indicated that the relation between these variables during time two was not significant, $X^2(2, N = 58) = .61$, $p > .05$.

4.4.4.3 Modification

Of the 17 teachers in the Math/Science category, 14 (82%) teachers did not use modification during the walkthrough, 2 (12%) teachers used modification once, and 1 (6%) used modification two or more times. Of the 41 teachers in the other category, 41 (100%) did not use modification during the walkthrough. The percentage of use of modification once or two or more times within the Math/Science category (18%) is higher than that of those represented in the other category (0%). Additionally, a lower percentage of Math/Science teachers (82%) were reported as having no instances of using modification than teachers in the other category (100%).

To test the significance of this finding, a Chi Square test was used. Pearson Chi-Square test could not be used as 67% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables during time one was significant, $p = 0.02$, $p < .05$.

This researcher then reviewed the data to determine if there were a similar finding during time two. Of the 17 teachers in the Math/Science Department, 13 (77%) teachers did not use modification during the walkthrough, 4 (24%) teachers used modification once, while zero instances of modification were recorded at the two or more times interval. Of the 41 teachers in the other category, 32 (78%) did not use modification during the walkthrough, 6 (15%) used modification once, and 3 (7%) used modification two or more times. The percentage of use of modification once or two or more times within the Math/Science category (24%) is less than that of those represented in the other category (22%); although the difference is not as large as during time one. Additionally, a lower percentage of Math/Science teachers (76%) was reported as having no instances of using augmentation than teachers in the other category (78%).

To test the significance of this finding, a Chi Square test was used. Pearson Chi-Square test could not be used as 50% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables during time two was not significant, $p = 0.48$, $p > .05$.

4.5 DEMOGRAPHIC SIGNIFICANCE OF THE OBSERVATIONS

In this section, the researcher reported the results of data collected through the observation measure in time one and time two with six demographic indicators. Determining the statistical significance of the frequency of instructional technology use by each demographic is integral to understanding what impacts change in teacher use of technology. This section is organized to demonstrate frequency of use of instructional technology at each level of the SAMR model disaggregated by: 1) sex, 2) participation in the district's previous technology initiative, 3) building level, 4) years in teaching, 5) department affiliation, and 6) education level.

4.5.1 Observation Results Disaggregated by Building Level

The observation data were reviewed by looking at trends between building levels. There are two building levels on BCP's secondary campus: 1) middle school and 2) high school. There are 16 and 42 teachers in each building, respectively.

4.5.1.1 Augmentation

The significance of building level and the frequency of instructional technology use at the augmentation level of time one for observations was considered. Of the 16 teachers at the Middle School level, 4 (25%) teachers did not use augmentation during the walkthrough, 4 (25%) teachers used augmentation once, and 8 (50%) used augmentation two or more times. Of the 42 teachers at the High School level, 27 (64%) did not use augmentation during the walkthrough, 9 (21%) used augmentation once, and 6 (14%) used augmentation two or more times. The frequency of use of augmentation once or two or more times at the Middle School (75%) level is higher than that of their High School (46%) level counterparts. Additionally, a lower percentage of Middle School teachers (25%) were reported as having no instances of using augmentation than teachers at the High School level (64%).

To test the significance of this finding, a Chi Square test was used. Pearson Chi-Square test could not be used as 33% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables during time one was significant, $p = 0.01, p < .05$.

This researcher then reviewed the data to determine if there were a similar finding during time two. Of the 16 teachers at the Middle School level, 6 (38%) teachers did not use augmentation during the walkthrough, 5 (31%) teachers used augmentation once, and 5 (31%) used augmentation two or more times. Of the 42 teachers at the High School level, 13 (31%) did not use augmentation during the walkthrough, 16 (38%) used augmentation once, and 13 (31%) used augmentation two or more times. The frequency of use of augmentation once or two or more times during time two at the High School level (69%) is slightly higher than that of their Middle School level (62%) counterparts.

To test the significance of this finding, a Chi Square test was used. This researcher used the Pearson's Chi-Square, which indicated that the relation between these variables during time two was not significant, X^2 (2, N = 58) = .086, p > .05.

4.5.2 Observation Results Disaggregated by Participation in Previous Technology Initiative

Next, the significance of previous participation in a technology initiative and the frequency of instructional technology use at the modification level of time one was considered. All 40 (100%) teachers who did not participate in the previous technology initiative did not use instructional technology at the modification level during time one. Of the 18 teachers that were participants in the previous technology initiative, 17 (94%) did not use modification during the walkthrough, while 1 (6%) teacher used modification two or more times.

To test the significance of this finding, a Chi Square test was used. Pearson Chi-Square test could not be used as 50% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables during time one was not significant, $p = 0.31$, p > .05.

In time two, the significance of previous participation in a technology initiative and the frequency of instructional technology use at the modification level were again considered. Of the 40 teachers who did not participate in the previous technology initiative, 21 (53%) teachers did not use modification during the walkthrough, 11 (28%) teachers used modification once, and 8 (20%) used modification two or more times. Of the 18 teachers that were participants in the previous technology initiative, 15 (83%) did not use modification during the walkthrough, 13

(16%) used modification once, and no teachers used modification two or more times. Interestingly, those with participation in the previous technology initiative had a lower frequency of using modification once or two or more times, with fewer teachers reported as not using modification at all during the walkthrough.

To test the significance of this finding, a Chi Square test was used. Pearson Chi-Square test could not be used as 33% of the cells had an expected count of less than 5, thereby making the results unreliable. Therefore, this researcher used the Fisher's Exact Test, which indicated that the relation between these variables during time two was significant, $p = 0.04$, $p > .05$.

4.6 SUMMARY OF SIGNIFICANT FINDINGS

Chapter four reviewed findings from the three measures used in the current study: 1) survey, 2) walkthrough, and 3.) observation. This researcher sought to determine if changes to teacher instructional practices occurred between the two times. In order to organize the results, this researcher reported the findings by measure and the six demographic indicators: 1) sex, 2) participation in the district's previous technology initiative, 3) building level, 4) years of teaching, 5) department affiliation, and 6) education level. As an immense number of possibilities exist when pairing demographic indicators with the SAMR scale, only findings wherein either of the times (one or two) resulted in a significant relationship were reported. All other permutations of the data that are not reported herein should be considered not statistically significant.

4.6.1 Summary of Survey Results

There was a significant effect during time one between mean score on non-instructional survey questions and education level, $F(1, 56) = 7.66$, $p = .008$. There was a significant effect during time two between mean score on non-instructional survey questions and education level, $F(1, 56) = 7.35$, $p = .009$. In other words, teachers with a Master's or Doctoral degree are more likely to use technology for non-instructional purposes (collaboration with colleagues, emails to parents, searching for new lesson components on websites, etc.) than are their Bachelor's level counterparts.

4.6.2 Summary of Walkthrough Results

There was a significant effect between gender and higher frequency use of instructional technology at the substitution during time one, $p=0.48$, $p < .05$. There was also a significant effect between gender and higher frequency use of instructional technology at the substitution during time two, X^2 (2, N = 58) = .032, $p < .05$. There was a significant effect between academic department and higher frequency use of instructional technology at the substitution level during time one, $p = 0.01$, $p < .05$. Lastly, there was a significant effect between academic department and higher frequency use of instructional technology at the augmentation level during time two, $p = 0.01$, $p < .05$. In other words, during time one (i.e. when no students had iPads), female teachers were more likely to use existing instructional technology than male teachers. This trend reverses during time two (when students also have iPads) with male teachers using more instructional technology. Additionally, the significant effect at time one and time two is indicative of Math and Science teachers out performing all other academic departments with the use of instructional technology. That said, a female Math or Science teacher, according to these walkthrough results, would be most likely to use instructional technology during time one, with male Math and Science teachers taking the lead in time two.

4.6.3 Summary of Observation Results

There was a significant effect between building level and higher frequency use of instructional technology at the augmentation level during time one, $p = 0.01$, $p < .05$. There was a significant effect between participation in the previous technology initiative and higher frequency use of instructional technology at the modification level during time two, $p = 0.04$, $p > .05$. This indicates that during time one, Middle School teachers used instructional technology with greater frequency at the augmentation level than High School teachers. Interesting, the second finding indicates that teachers who were not participants of the district's previous technology initiative were more apt to use technology at the augmentation level than those who received the specialized training and equipment several years prior.

5.0 DISCUSSION

The purpose of this chapter is to discuss and interpret the findings and make recommendations for future research. This chapter is segmented into four sections that include the discussion, interpretation of findings, suggestions for further research, and conclusions.

5.1 DISCUSSION

The current study sought to explore teacher behavior toward instructional technology use over time. In essence, this researcher sought to consider any changes in teacher instructional strategy that occurred once the transformative power of technology was introduced into the teacher and student populations, approximately one-year apart. Myriad research studies presented in the literature review have considered the limitations of 1:1 technology initiatives. What makes the current study particularly relevant is how the impact of these limitations was reduced within the studied population. Said identified limitations are: 1) access, 2) time, 3) perception, and 4) professional development.

5.1.1 Discussion of Limitations of Access

In the literature, access is often described in terms of allocating available financial resources to purchase technology and peripheral devices (routers, keyboards, printers, etc.), in terms of the maintenance and routine upgrading of purchased technology, and in terms of the ubiquity of technology (who has use of computers and how many students or teachers must share). In the current study, the issue of access was decidedly clear. The administrative team, with authorization from the Board of Education, purchased one personalized computing device (iPad) for every teacher and student. In the first year of the 1:1 technology initiative on BCP's secondary campus, all teachers in grades 7 - 12 received a new 2nd Generation 16 GB iPad, Bluetooth keyboard, and protective case. Additionally, the school's Internet capacity and supporting structures were enhanced. This is similar to the ACOT (1995) and AALP (1997) 1:1 initiatives wherein new computers were offered to teachers and students. At the time of those seminal studies, however, access to the Internet both at school, and most certainly at home, was marginal at best.

5.1.2 Discussion of Limitation of Time

In the literature, time is often described in terms of teachers being afforded time to plan lessons that are enhanced by the use of instructional technology. Of additional concern is often having time to collaborate with pedagogical or functionality experts, who can guide the teachers' inquiry and facilitate meaningful exploration related to the use of the instructional technology device. Again, the issue of time in the current study was decidedly clear. The administration reassigned two teachers that were seen by their peers as both pedagogical and functionality experts. These two teachers were reassigned to the role of technology integration coaches and given leave to work with teachers to conceptualize, design, and develop engaging lessons that foster inquiry and feature instructional technology. The coaches' specific educational backgrounds and expertise are articulated in detail in Chapter 3.

5.1.3 Discussion of Limitation of Perception

Perception is a many-nuanced concept. The literature mostly relates issues of perception to whether teachers believe the introduction of instructional technology will add to their work load or enhance what they already do; whether the educational benefit of instructional technology warrants the expense or if traditional (less expensive) methods are just as effective; whether instructional technology is here to stay or just another educational fad. BCP secondary campus teachers' overwhelmingly participated in optional professional development sessions (described in Chapter 3). High attendance at professional development sessions coupled with the district's previous participation in a technology initiative, lead this researcher to conclude that teacher perception of technology leaned toward lesson enhancement, a sense that instructional technology is part of the district's norm, and that its possible effectiveness warranted the extra effort.

5.1.4 Discussion of Limitation of Professional Development

Finally, literature regarding barriers to success of 1:1 initiatives highlights the need for extensive and continual professional development. Research into the topic of professional development needs related to instructional technology during a 1:1 planning indicate that a two pronged approach is necessary: 1) device functionality and, 2) pedagogical changes. Again, BCP's secondary campus was a prime location for this research due to the extensive professional development series that was offered to teachers. With over 150 hours of courses, individualization of content, form, and format for beginner and expert users were facilitated.

5.1.5 Discussion Summary

If success in a 1:1 technology initiative is at least partially related to the amount of meaningful instructional technology used by teachers, then thoughtful considerations should be given to these barriers prior to commencing a 1:1 technology initiative. Due to the reduced effect that these barriers would have on the results of the current study, this researcher believed that BCP's secondary campus would be an ideal research setting. Once the barriers were addressed, how would teacher behavior toward instructional technology change?

5.2 INTERPRETATION OF FINDINGS

The focus of this exploratory study was based on one overarching research question.

Is there a change in teachers' behavior toward instructional technology at two times (wherein time one only teachers had iPads and in time two each student also had an iPad)?

The data from BCP revealed several significant interactions between the use of instructional technology and education level, academic department, gender, building level, and previous participation in a technology initiative.

First, the survey indicated that education level had a significant effect on non-instructional technology use. Specifically, the research indicated that when Masters level teachers possessed technology that was reliable and whose functionalities were understood, that they would use the technology for non-instructional purposes more than their Bachelor level peers. This finding is similar to BECTA's 2007 study of 25,000 teachers that showed that consistent, reliable access to computers resulted in increased use of said technology. While initially lauded as a positive shift, the analysis of the data revealed that the increased use of computers was largely in the non-instructional realm. Results from the current study support BECTA's 2007 finding and add the possibility that education level may also be significant.

Curiously, although mean scores were higher for Masters level teachers on questions related to instructional technology, the finding was not significant during time one or time two. That is to say, there is no significant relationship between a teacher's education level and the frequency with which they use technology for instructional purposes based on the data collected. The data also revealed that education level and years of service are not correlative. As such, one can assume that some teachers with many years of teaching experience have not earned their Masters degree, but rather have only earned the 24 post-baccalaureate credits required to remain certified. It can also be assumed that some teachers who have recently entered the profession are doing so with a Masters degree. Therefore, the lack of significant interaction between education level and instructional technology use should not be used as a means to obfuscate the need for policy changes regarding certification coursework in higher education settings. Indeed, this researcher would argue that the lack of a significant finding related to years of service, particularly those teachers in the one to five year category, who have just emerged from an intensive certification program, is indicative of a flawed curriculum. The need for certifying institutions to update curriculum related to instructional technology has never been greater.

Data analysis from the walkthrough measure indicated two areas of significance. First, there was a significant effect between academic department and instructional technology use. The data revealed that, during time one and time two, Math and Science teachers on BCP's secondary campus were more likely to use instructional technology than members of all other departments combined. There are numerous possibilities to explain this; however, one likely explanation is that one of the current technology integration coaches, who was also the technology coach during the former technology initiative, functions as the department chair for Science. Having additional contact with the technology integration coach may have played a role in that department's decidedly higher frequency of technology use.

Of additional interest in the walkthrough measure was the statistical significance between gender and frequency of instructional technology use. Confounding the significance of this finding is that female teachers were observed using instructional technology more frequently than male teachers during time one, while the opposite was true during time two. No previous studies were included in the literature review wherein a significant interaction between gender and instructional technology use was observed. Nothing in the data collected for the current study nor the literature reviewed qualifies this researcher to offer supposition as to the relevance of this finding.

Data analysis from the observation measure indicated that there was a significant effect between building level and teacher instructional use of technology. The data revealed that Middle School level teachers were more likely than High School teachers to use instructional technology during time one. Interestingly, during time two, when students also had technology, there was a significant interaction between High School teachers and increased use of instructional technology. The Middle School teachers in the current study have, as a group, used instructional technology longer than High School teachers. Middle School teachers at BCP were required to maintain a classroom website as early as 1999, while the High School teachers were not required to do so until 2012. Additionally, the Middle School teachers used to showcase instructional technology lessons during faculty meetings, in lieu of a more traditional information dissemination style meeting. While this focus on technology ended in 2010 with the departure of the principal, the groundwork that emphasized the importance of instructional technology had already been laid. Additionally, one of the technology integration coaches was also the coach of the previous technology initiative and a Middle School teacher. The effect that this teacher's leadership skills, content knowledge, and enthusiasm for instructional technology exhibited cannot be overlooked; her qualifications are detailed in Chapter 3.

The final area of statistical significance related to teacher participation in the previous technology initiative. During time one, there was not a significant interaction. However, during time two, the teachers who were not participants of the previous technology initiative used technology with greater frequency than those who had participated. This researcher found this finding surprising, as participation in the previous technology initiative had afforded those teachers with exclusive professional development, laptop computers (MacBook Pro), LCD projectors, and interactive whiteboards. One possible reason for this seemingly perplexing interaction was the non-voluntary nature of the previous technology initiative. That is to say, teachers who participated in the previous initiative did not do so out of interest in instructional technology. Rather teachers were selected by the narrow terms of the grant, which specified that only teachers in core content areas (i.e. Math, Science, English, and History) could participate. Therefore, teachers of elective courses, such as the other current technology integration coach, were not permitted to receive the exclusive training or new computer equipment during the previous technology initiative. On the other hand, there were teachers selected for participation who had no desire to be a part of the previous technology initiative. These unwilling participants may not have been as motivated to learn and apply the pedagogical skills taught during the former technology initiative. Therefore, the participation criteria of the former technology initiative may have played a role in the unusual result. Had elective teachers with a desire to participate and apply the instructional technology professional development been permitted to do so, the outcome may have been reversed.

5.3 SUGGESTIONS FOR FUTURE RESEARCH

The following recommendations for further study are based upon the discussion and interpretation of the data collected in this study:

- This study could be conducted at the same location in one year. This study was limited to one and a half school years. If additional time were allowed to pass before data were reassessed, teachers may have progressed further on the SAMR scale. The ACOT study (1995) and the AALP study (1997), along with Roger's Diffusion of Innovation theory (2003), indicate that it takes time for technological innovation to be accepted (i.e. used) by a population.

- This study could be conducted with other suburban schools within the state that are beginning a 1:1 project with iPads. This study was limited to a single secondary campus in the Mid-Atlantic region. Other geographic regions within the same state would certainly add new data to the current study.
- This study could be conducted using the current measures with the addition of attitudinal survey questions. These questions could be written to determine the extent to which each teacher desires to use instructional technology. A teacher who doesn't wish to change his or her pedagogical style to include technological innovation and who also scores low in instructional technology use, would clarify the current study's previous technology initiative finding.
- This study could be conducted using survey questions that better encompass the technology use patterns of the studied population; including open-ended questions that permit the participant to include narrative responses related to their use of instructional technology that is not explicitly asked. The current study was limited to existing survey information, and therefore, all survey findings are based on only the survey questions asked.
- This study could be conducted using a scale other than SAMR to score narrative results. The Technology Acceptance Model (TAM) scale would be an example of an existing scale that may add an additional layer to the interpretations presented herein. There are

several variations of the TAM scale, however at least one encompasses the "voluntariness of use" issue presented by the participation in previous technology initiative finding.

5.4 CONCLUSIONS

Schools with a 1:1 technology initiative are no longer bound by the confines of the classroom. Rather they can access the world in the blink of an eye. If your Economics course is studying trade agreements, why not contact the world's foremost expert in Malaysia? Science discussions about nanotechnology need not be done in the abstract. Rather, through partnerships with universities and research labs around the country, students can observe and, in some cases, control the very experiments that are influencing the current course of technological development. Indeed the computing power brought forth by today's personal computing devices, when matched with high-speed Internet service, offers the world's resources to every "connected" classroom. Clearly, technology can have a very powerful influence on education. However, in terms of instructional technology use by teachers, what *can be* and *what is* a reality are often two very different concepts.

The current study's findings affirm the need to consider thoughtfully the barriers to successful implementation of 1:1 technology initiatives. However, even when the barriers are reduced or removed, the current study shows that teacher behavior toward instructional technology is more of an evolution than a revolution. The Apple Classrooms of Tomorrow study asserted, and this study confirms, that the use of instructional technology occurs gradually despite new devices, extensive professional development, and coaching. Movement through the

ACOT continuum, from substitution level activities to redefinition activities, does not happen in a single school year.

What then, spurs the change toward instructional technology use if not the reduction in or removal of barriers? This researcher found a single thread running through all significant data points that may answer this question. The answer may lie in who is in charge, who is issuing the call to revolution, who is rallying the troops to break with a tradition that previously brought excellence? A single individual appears in the data related to each significant finding of this study. That person is the technology integration coach. This person perceives that technology can make a difference, that using instructional technology can engage and motivate students, and that it is more than a passing fad. She demonstrates this belief by and through her own innovative teaching style, her willingness to take instructional risks, and her ability to lead others. This coach is a female (sex), has a Masters degree (education level), is the Science department chair (academic department), teaches in the middle school (building level), and was the coach for the previous technology initiative. This thread running through all significant points may indicate that the key to moving from evolution to revolution does not lie in reduction of barriers alone, but also in leadership.

The existence of single individual in each significant data point is not, in and of itself, noteworthy. Rather the significance is extrapolated from the composite of traits that the individual presents, which leads this researcher to underscore the significance of the coach. If the coach's leadership is of such vital importance, one wonders in what roles this coach must serve. In order to realize the full potential of the coach and to set the stage for a successful 1:1 technology initiative, this researcher posits that the coach must be prepared to engage the faculty as a(n): 1) resource provider, 2) data coach, 3) mentor, 4) school leader, and 5) catalyst for change.

As a resource provider, the coach should be expected to choose applications, tools, and provide essential information to support classroom instruction. The coach should be prepared to provide internet links to discipline specific web-sites, introduce scholarly articles relevant for specific lessons and web 2.0 tools, and share best practices seen in the school or during trainings in order to help teachers in the 1:1 initiative to engage with the technology. Acting in the capacity of a resource provider will also give the coach a plausible reason to enter other teachers' classrooms, which could be viewed as threatening to teachers unaccustomed to adults entering their classroom for non-evaluative purposes. To enable the coach to function in the capacity of resource provider, school districts would be wise to enroll the coach in an instructional technology integration conference. This mid-Atlantic region has held several such conferences to help the coach become immersed in discussions of curriculum integration, instructional strategies, and coaching strategies.

The role of data coach should provide an opportunity for the teachers in the 1:1 initiative and the coach to review school and course specific data and to reflect on their practices in a supportive setting. In this capacity, the coach should be in charge of all data collection and logistics associated with the 1:1 initiative. Data collections should take place twice (pre and post surveys) during each school year, ensuring that teacher and student perceptions related to the implementation of technology and related effects (student engagement and motivation) are captured. As a means of enabling the coach to function effectively in this role, the coach should be encouraged to consult with industry leaders (Apple, Microsoft) and university survey research experts to ensure that survey tools will provide useful data to improve the quality of the 1:1 educational experience.

As a mentor, the coach should provide guidance, structure and encouragement during instructional delivery and in co-planning and co-teaching settings. In this role, the coach should seek to create an environment of self-reflection, self-evaluation, and collaboration in support of a constructivist approach. School districts seeking to integrate technology might also consider adopting a peer observation framework, whereby teachers become invited guests of the coach and colleagues during showcase lessons. Peer observations could be conducted during the visiting teacher's preparation period, however school district administration would be wise to further bridge the barrier of time by supplying a substitute for the visiting teacher when requested. Having an established professional learning community (PLC), including peer observations and collegial feedback, the coach will likely experience less resistance to her presence in the classroom and to her pedagogical and instructional critiques.

As a teacher on new assignment, the coach will be in a unique position, not an administrator and yet something more than a peer. The coach must become a school leader and a catalyst for change, helping to align classroom, school, and district goals in a non-evaluative way and helping to change school culture. As one mechanism for achieving this feat, the coach should be invited to participate during a segment of monthly administrative team meetings. The coach will be able to inform all administrators about meetings, conferences, and workshops facilitated or attended, as well as instances of co-teaching or co-planning with participating teachers. This portion of administrative meetings can also be used to brainstorm solutions to technology related obstacles to the successful implementation of the 1:1 initiative. The coach may be asked to provide information specific to:

- Cross-department classroom visits
- Establishment of a digital PLC
- Management of lesson study groups
- Examination of student work and assessment
- Co-planning of lessons which meaningfully integrate technology, and
- Design and implementation of professional development opportunities.

Finally, as a catalyst for change, the coach should also be prepared: 1) to facilitate conversations with faculty related to technology integration, 2) to lobby administration for time and resources, and 3) to encourage and motivate teachers to reflect on their technological practices. In modeling effective learning practices and reflection of practice, the coach will help teachers to retain, transfer, and apply their new technology related skills. Through the coach's proactive support and modeling, teacher technological aptitude, perceptions toward technology integration, and teacher pedagogical behavior will begin the transformation process.

Permitting the coach to don the mantle of resource provider, data coach, mentor, school leader, and catalyst for change, places participating teachers at the intersection of evolution and revolution.

APPENDIX A

BCP ACCEPTABLE USE POLICY

BCP Acceptable Use Policy for Technology

The BCP District recognizes technology is an essential instructional tool to help all students develop into critical thinkers who use data, innovation, and creativity in order to become skilled problem solvers and learners in the 21st century. Technology skills are a necessity for our students for lifelong learning, in the workplace, and in the global community. However, access is a privilege, not a right, and carries with it responsibilities for all involved. Misuse means any violation of this agreement or any other use that is not included in the agreement but has the effect of harming people, infrastructure, or hardware.

For the protection of students, filtering of content, monitoring of the network, and protection of information will be conducted in accordance with Act 197 (Mid Atlantic House Bill 2262), The Children's Internet Protection Act. Despite every effort for supervision and filtering, all users and their parents/guardians are advised that access to the Internet may include the potential for access to inappropriate materials for school-aged students. Every user must take responsibility for his or her use of the network and avoid these sites.

Hardware and Software: Includes, but not limited to, all computers, laptops, iPads, printers, and all programs installed on said devices.

- Hardware and software shall not be destroyed, modified, or abused in any way. Intentionally altering the files and/or the hardware on district computers will be viewed as vandalism. Each student will be held responsible for the intentional altering of a device that occurs while said device is in their possession.
- The user shall be responsible for damages to the District's equipment, systems, and software resulting from deliberate or willful acts. Students, parents, or guardians will be charged for willful damage to hardware.
- All district iPads are covered under AppleCare. However, in an instance that AppleCare will not cover damages to the iPad, the student, parents, or guardians will be charged the cost of repair or the cost of replacement.
- All district required apps take precedence over personal apps. Personal apps must/will be deleted if storage limits are exceeded.

Internet and Intranet: The BCP District utilizes a local area network, a wireless network and provides access to the internet for academic purposes.

- District iPads will be content filtered at all times, removal of the profile that governs this is not permitted.
- The internet, network, and computer technology may not be used for illegal activity; transmitting or willfully receiving offensive materials; hate mail; discriminating remarks; or to willfully obtain or send obscene, pornographic, sexist, racist, anarchist, violent or bomb making material. If for any reason such material is received, the material is to be deleted immediately. Saving, forwarding, or printing of said material is strictly prohibited.
- Users shall not intentionally seek information, obtain copies of, or modify data, or passwords belonging to other users or misrepresent other users on the network. Users may not give their password to anyone. Users may not send or receive a message with someone else's name on it.
- Any unauthorized attempt to access the BCP District's servers, mainframe, routers, networking equipment, internet filters, or operating systems either from on campus or off campus will be considered an attempt at "hacking" and is prohibited.
- Network accounts are to be used only by the authorized owner of the account for an authorized purpose. Attempts to log on to the Internet, network or workstation under an assumed identification will result in cancellation of the user's privileges. Any user identified as a security risk, or having a history of problems with other computer systems may be denied access to the Internet or other technological services.
- The BCP District reserves the right to log Internet use and monitor computer activity by remote access while still respecting the privacy of user accounts.
- The BCP District may terminate the availability of Internet, network, or computer technologies accessibility at its sole discretion.

IPADS

- BCP District assumes no responsibility for configuration, installation of software, or support of personal devices.
- BCP District assumes no responsibility for lost, damaged or stolen devices. Students use their personal devices at their own risk.
- BCP District assumes no responsibility for content viewed or accessed by students who "tether" their personal device and use their cellular data network
- Student devices with camera and video capability can be used only for educational use when authorized by the building principal, district administration, or designated professional staff member for the purposes of participation in educational activities. The Board prohibits all other photography, audio recording, and/or video recording, via electronic devices by students during the instructional day in district buildings, on district property, and when engaged in a school-sponsored activity. The Board prohibits students from taking, storing, disseminating, transferring, viewing, possessing or sharing obscene, pornographic, lewd, or otherwise illegal images or photographs, whether by electronic data transfer or other means, including, but not limited to, texting and e-mailing. Because such violations may constitute a crime under local, state and/or federal law, the district shall report such conduct to local, state and/or federal law enforcement agencies.

Web 2.0 Tools

- Use of blogs, wikis, educationally-based social networking sites, collaboration sites, and other similar web 2.0 entities (including the BCP district website and Moodle) are tools for learning, and as such will be constrained by the requirements and rules of classroom teachers.
- Use of google apps, including e-mail access, are available through the school's domain to ALL students and teachers inside and outside the building but this is still considered a classroom space and must be treated as such.
- COPPA regulations require children under 13 to obtain permission to use certain interactive websites (due to exposure to advertising and creation of accounts). Signing this document will serve as parental permission to use these sites under the guidance of a classroom teacher.
- Users are forbidden to access imessage, chat rooms, blogs, or similar sites without the express permission and guidance of a teacher or administrator.
- The use of anonymous proxies is a form of impersonation and is strictly forbidden.
- The use of devices for game playing is prohibited unless approved and monitored within in a course or during a faculty supervised activity.

Digital Etiquette

The BCP District will educate all students about appropriate online behavior, including interacting with other individuals on social networking websites and in chat rooms and cyber bullying awareness and response.

There can be serious repercussions with the inappropriate use of social and digital media that can affect your future. All users must abide by rules of network etiquette, which include the following:

1. Users may not swear, use vulgarities, harass, or use any other inappropriate language. Abusive language will not be tolerated.
    a. Do not write anything ANYWHERE you would not want your parents to read or to be read out loud in a court of law.
    b. Even though you delete a message, it is backed up on a server somewhere.
    c. Speech that is inappropriate for class is not appropriate for use online.
    d. What you say and do online should be reflective of who you are.
    e. You are representatives of the school when you are online in class.
2. Use of the network to create or transmit material likely to be offensive or objectionable to recipients is prohibited.
    a. Even though you may be in a "private" space nothing online is really private.
3. Users are NOT permitted to reveal their personal address or phone number or those of other students and colleagues.
    a. Respect others' privacy and your own.
    b. Don't give out personal information about yourself or someone else.
    c. Instant messages, away messages, and profiles can be copied and pasted.
4. All communication should be clearly identifiable as to who created it.
    a. Do not send anonymous messages
    b. Do not send messages claiming to have been written by someone else.
    c. Having a copy of something doesn't mean you have the right to copy or distribute.
5. Respect the ideas of others and if you disagree be constructive, not critical or rude.
6. Users are expected to adhere to copyright laws.
    a. Fraudulent or illegal copying, communication, taking or modification of material is prohibited and will be referred to the appropriate authorities.
    b. The illegal use of copyrighted software, files, pictures, music or other electronic information is is a violation of federal law and therefore strictly prohibited.
    c. Students may not use plagiarized information to complete assignments. All Internet sources must be cited.
7. Cyber Bullying will NOT be tolerated.

Limitations of Liability: In no event shall the BCP District be liable for any damages, whether direct, indirect, special, or consequential, arising out of the use of the Internet. Use of information obtained via the Internet is at the user's own risk.

Failure to follow the procedures listed above will result in suspension or loss of the right to access the Internet, to use BCP District's technology, and the user may be subject to other disciplinary or legal actions.

BCP District Technology Authorization Form

Student:

I have read, understand, accept, and will abide by the rules and procedures, which govern my use of the Internet and the computer technology at the BCP District. I understand that the Internet account is designed for educational purposes only. I understand that failure to follow the procedures listed above may result in suspension or loss of the right to access the Internet and/or use the BCP District's technology and may result in other disciplinary or legal actions as noted above. I will not hold my teacher, other district personnel, or the BCP District responsible for or legally liable for materials distributed or acquired from the Internet or network. I also agree to report any misuse of Internet or network to a teacher or administrator.

Date: ___________________________ Grade: ________________ Homeroom: ____________

Printed Name of Student: _____________________________

Signature of Student: ____

Parent/Guardian:

I have read this contract and understand the Internet/Network account is designed for educational purposes only. I understand that the BCP District will do everything it can to adhere to the Children's Internet Protection Act (Act 197-Mid-Atlantic House Bill 2262) and filter questionable material. I also understand that teachers, district personnel, and the BCP District are not responsible or legally liable for materials distributed to or acquired from the network. I also agree to report any misuse of information to the school administration. I accept full responsibility for my student's use of the Internet/Network in the school setting on an independent basis and as outlined in the Internet/ Network and Computer Technology procedures and when the student accesses these services when not in school. I hereby give my permission to issue an account for my student and certify that the information contained on this form is correct.

Printed Name of Parent/Guardian: _______________________________________

Date Accepted and Agreed: ____

Signature of Parent/Guardian: ____

BCP District
Consent and release to photograph/videotape a student

To publicize the achievements of our students and the great work they do, we occasionally publish our students' names, photographs, or achievements in our school publications or release the information to the local newspapers. We also will post the information on the school district's web site.

We understand that you may not want to have your child's name, photo, and/or achievements published so please complete the form at the bottom of this letter.

....

I, ______________________________the parent/guardian of _____________________________

Print Parent/Guardian Name — Student Name

in grade _____ a student at _______________________________on behalf of my child.

Attending School

☐ Do Consent ☐ Do Not Consent to the photographing/videotaping of my child while he/she in involved in any school programs and/or activities while enrolled at BCP District*. Your authorization will enable us to use specially prepared materials to increase public awareness and promote continuation and improvement of education programs through the use of mass media, displays, brochures, websites, etc.

I hereby release and hold harmless the BCP District and its authorized representatives from any and all actions, claims, damages, costs, or expenses, including attorney's fees, brought by the pupil and/or parent or guardian which relate to or arise out of any use of these recordings as specified above.

It is understood that the school district will not duplicate photograph(s)/videotape(s) for the use or benefit of any individual student or parent. **It is also understood that failure to return this permission form to the school will constitute parent/ guardian consent for the purposes described above.**

My signature shows that I have read and understand the release and I agree to accept its provisions.

______________________________ ________________

Parent/Guardian Signature — Date

*Not to include Public Events

APPENDIX B

BCP REQUIRED APPS FOR IPAD

BCP Required Apps for 2013-14

Qrafter	Socrative	Showbie
iTunes U	Drop Box	Google Drive
Follett Reader	Qrafter	Destiny Quest

APPENDIX C

BCP SURVEY OF TECHNOLOGY USE

Technology Survey

Overview and Demographic Info

This survey will take approximately 5-minutes to complete. There are 4 demographic questions. Then, there are 30 questions about how students use technology in your classes and 11 questions about how you use technology in a variety of professional settings. All questions are multiple choice (except for your name).

Your answers will NOT be used for year-end evaluation purposes. Answers will aide in creating technology-based professional development for your needs.

You will recognize the questions from June of last year.

***1. What is your last name?**

***2. What is your first name?**

***3. In what building do you primarily work?**

- Middle School
- High School

***4. In which Department do you primarily work?**

- 01 Math
- 02 English
- 03 Social Studies / History
- 04 Science
- 05 Foreign Language
- 06 Music / Art
- 07 Physical Education
- 08 Other, not listed above

***5. What is the highest level of education you have attained (completed)?**

- Bachelor's degree
- Master's degree
- Doctoral degree

Student Use of Technology

On this page, you will answer 30 questions about what role technology plays for students in your courses. Each question is answered using the same Likert scale:
00 No role
01 A minor role
02 A significant role
03 A crucial role

***6. In my teaching, student use of blogs or wikis to publish and share original work with an audience plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***7. In my teaching, student use of aggregation tools or RSS feed readers to access and integrate multiple information sources plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***8. In my teaching, student use of Twitter or other social networking tools to gather information or knowledge from beyond the confines of their community plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***9. In my teaching, student use of audio or video conferencing tools to communicate with otherwise inaccessible people plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***10. In my teaching, student use of augmented reality tools to map information or narratives onto the physical world plays...**
(Augmented reality is when artificial information about the environment and its objects are overlaid on the real world. Apps such as: Across Air, Google Goggles, Google Earth, Google Sky map, Car Finder, Yelp, Lookator, etc.)

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***11. In my teaching, student use of databases to collect and organize information plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***12. In my teaching, student use of clicker apps to respond to in-class quizzes or surveys plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***13. In my teaching, student use of spreadsheets or statistical packages to analyze data and discover patterns plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***14. In my teaching, student use of spreadsheets to create “what if” scenarios as part of student development and exploration of models plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***15. In my teaching, student use of eBook authoring apps to create textbook-type resources for other students plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***16. In my teaching, student use of presentation apps plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***17. In my teaching, student use of e-textbooks to expand the reading experience with embedded media and interactive tools plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***18. In my teaching, student use of location-aware search apps to provide students with information that is geographically contextualized plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***19. In my teaching, student use of symbolic math apps to explore mathematical or scientific concepts plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***20. In my teaching, student use of graphing apps to generate multiple visualizations of data sets plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***21. In my teaching, student use of simulation tools to model physical or social phenomena plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***22. In my teaching, student use of programming languages to create software that responds to student interests plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***23. In my teaching, student use of mapping and Geographical Information Systems (GIS) tools to explore layers of historical or scientific information in geographic context...**
(GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.)

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***24. In my teaching, student use of GPS tools to geotag data, images, or other media as they are collected in the physical world plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***25. In my teaching, student use of timeline apps to develop student understanding of the structure of historical events plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***26. In my teaching, student use of data collection software to interface with built-in sensors or external probes plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***27. In my teaching, student use of concept mapping apps to visualize and discover complex patterns in concepts or processes plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***28. In my teaching, student use of comics authoring tools to create fiction or non-fiction narratives plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***29. In my teaching, student use of video editors to develop student-driven narratives plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***30. In my teaching, student use of photo editors to alter photos to better convey meaning plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***31. In my teaching, student use of music tools to explore expressive performance and original composition plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***32. In my teaching, student use of paint apps to create original work, either in standalone form or as part of a larger narrative plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***33. In my teaching, student use of educational games to model and study social or physical phenomena plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***34. In my teaching, student use of educational games to practice math or language skills, plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***35. In my teaching, student use of game creation tools to produce games that deepen student understanding of a topic, plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

Your Work Use of Technology

This section contains 11 questions about your use of technology to complete your daily work. This can be work when students are present, work that you do in preparation for classes, or the myriad other tasks that you perform that are related to your work. Each questions will be answered using the same Likert scale:
00 No role
01 A minor role
02 A significant role
03 A crucial role

***36. In my work, a handheld device (iPhone iPod touch, etc) plays:**

- ○ 00 No role
- ○ 01 A minor role
- ○ 02 A significant role
- ○ 03 A crucial role

***37. In my work, a tablet (iPad) plays...**

- ○ 00 No role
- ○ 01 A minor role
- ○ 02 A significant role
- ○ 03 A crucial role

***38. In my work, a notebook computer (laptop, Mac book, etc) plays...**

- ○ 00 No role
- ○ 01 A minor role
- ○ 02 A significant role
- ○ 03 A crucial role

***39. In my work, a Desktop computer (iMac, Dell, etc.) plays...**

- ○ 00 No role
- ○ 01 A minor role
- ○ 02 A significant role
- ○ 03 A crucial role

***40. In my work, serving on committees to help shape how technology is used in teaching and learning plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***41. In my work, working in formal or informal teams with other educators at my school to develop and improve technology-based teaching practices plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***42. In my work, participating in online social networks to enhance and share my knowledge of teaching practices plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***43. In my work, accessing online resources created by other educators to acquire knowledge or materials for use in my classroom plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***44. In my work, contributing learning knowledge or materials in one or more online formats plays...**

- 00 No role
- 01 A minor role
- 02 A significant role
- 03 A crucial role

***45. In my work, creating educational resources for my students as part of a “flipped classroom” approach plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

***46. In my work, using technology to communicate and collaborate with parents in developing their children’s education plays...**

- ◯ 00 No role
- ◯ 01 A minor role
- ◯ 02 A significant role
- ◯ 03 A crucial role

APPENDIX D

FRAMEWORK FOR TEACHING RUBRIC

RUBRIC ASSESSMENT
Date________________ Teacher Self-Assessment ☐ Evaluator Assessment ☐ Formal Observation ☐ Individual Growth Project ☐ Intensive Support Plan ☐ Summative ☐

Domain 1: Planning and Preparation

Effective teachers plan and prepare for lessons using their extensive knowledge of the content area, the core/managed curriculum and their students, including students' prior experience with this content and their possible misconceptions. Instructional outcomes are clearly related to the major concepts of the content area and are consistent with the curriculum design. These outcomes are clear to students and classroom visitors (including parents). Learning activities require all students to think, problem-solve, inquire, defend conjectures and opinions and be accountable to the learning community. Effective teachers work to engage all students in lessons and use formative assessment to scaffold and provide differentiated instruction. Measures of student learning align with the curriculum and core concepts in the discipline, and students can demonstrate their understanding in more than one way.

Component	Failing	Needs Improvement	Proficient	Distinguished
1a: Demonstrating knowledge of content and pedagogy	Teacher's plans and practice demonstrate evidence of little to no knowledge of the important concepts in the discipline, prerequisite relationships between them, or of the instructional practices specific to that discipline and alignment to PA Academic Standards.	Teacher's plans and practice demonstrate evidence of knowledge of the important concepts in the discipline, prerequisite relations between them and of the instructional practices specific to that discipline and their alignment to PA Academic Standards.	Teacher's plans and practice demonstrate evidence of the application of the important concepts in the discipline, prerequisite relationships between them and of the instructional practices specific to that discipline and their alignment to PA Academic Standards.	Teacher's plans and practice demonstrate evidence of extensive knowledge and application of the important concepts and structure of the discipline. Teacher actively builds on knowledge of prerequisites and misconceptions when designing instruction and designs strategies for causes of student misunderstanding. Teacher shows strong evidence of building alignment with PA Academic Standards and differentiates for student progress in planning.
1b: Demonstrating knowledge of students	Teacher's plans contain little to no evidence of knowledge of students' backgrounds, cultures, skills, language proficiency, interests, and special needs, and has done nothing to seek such understanding.	Teacher shows awareness of the importance of understanding students' backgrounds, cultures, skills, language proficiency, interests, and special needs, and has added to that knowledge for the class as a whole.	Evidence that the teacher actively seeks knowledge of students' backgrounds, cultures, skills, language proficiency, interests, and special needs, and seeks to incorporate that knowledge into the planning for specific groups of students.	Teacher actively seeks knowledge of Students' backgrounds, cultures, skills, language proficiency, interests, and special needs from a variety of sources, and uses this knowledge regularly in planning for the benefit of individual students.

1c: Setting instructional outcomes	Instructional outcomes are unsuitable for students, represent trivial or low-level learning, do not relate to PA Academic Standards or are stated only as activities. They do not permit viable methods of assessment.	Instructional outcomes are of moderate rigor and are suitable for some students, but consist of a combination of unrelated activities and goals, some of which permit viable methods of assessment. They reflect more than one type of learning, but teacher makes no attempt at coordination or integration.	Instructional outcomes are stated as goals reflecting high-level learning and curriculum standards. They are suitable for most students in the class, are appropriate for different types of learning, and are capable of assessment. The outcomes reflect opportunities for coordination.	Instructional outcomes are stated as goals that can be assessed, reflecting rigorous learning and PA Academic Standards. They represent different types of content, offer opportunities for both coordination and integration, and take account of the needs of individual students and different styles of learning.
1d: Demonstrating knowledge of resources	Teacher demonstrates little to no familiarity with resources to enhance personal knowledge, to use in teaching, or for students who need them. Teacher does not seek such knowledge.	Teacher shows evidence of some familiarity with resources available through the school or district to enhance personal knowledge, to use in teaching, or for students who need them. Teacher does not actively seek to extend such knowledge.	Teacher is fully aware of resources available through the school or district to enhance own knowledge and develops and maintains a database or list of resources, and uses them in teaching, or to meet individual student needs.	Teacher seeks out resources in and beyond the school or district in professional organizations, on the Internet, and in the community to enhance own knowledge, and uses them in teaching, and to meet individual student needs.
1e: Designing coherent instruction	The series of learning experiences are poorly aligned with the instructional outcomes and do not represent a coherent structure. They are suitable for only some students.	The series of learning experiences shows evidence of partial alignment with instructional outcomes, some of which may engage students in significant learning. The lesson or unit has a recognizable structure and reflects partial knowledge of students and resources.	Teacher coordinates and aligns knowledge of content, of students and of resources to design a series of learning experiences aligned to instructional outcomes and suitable to groups of students. The lesson or unit has a clear structure and is likely to engage students in significant learning.	Teacher coordinates and aligns knowledge of content, of students and of resources to design a series of learning experiences aligned to instructional outcomes, differentiated where appropriate to make them suitable to all students and likely to engage them in significant learning. The lesson or unit's structure is clear and includes different pathways according to student needs.
1f: Designing student assessment	Teacher's plan for assessing student learning contains no clear criteria or standards, is poorly aligned with the instructional outcomes, or is inappropriate for many students. There is no evidence that assessment results influence planning.	Teacher's plan for student assessment is partially aligned with the standards and instructional outcomes, contains no clear criteria, and is inappropriate for at least some students. Teacher shows some evidence of intent to use assessment results to plan for future instruction for the class as a whole.	Teacher's plan for student assessment is aligned with the standards and instructional outcomes, uses clear criteria, and is appropriate to the needs of students. Teacher shows specific evidence of intent to use assessment results to plan for future instruction for groups of students.	Teacher's plan for student assessment is fully aligned with the standards and instructional outcomes, uses clear criteria that show evidence of student contribution to their development. Assessment methodologies may have been adapted for individuals, and the teacher shows clear evidence of intent to use assessment results to plan future instruction for individual students.

Domain 2: Classroom Environment

Teacher Self-Assessment ☐ **Evaluator Assessment** ☐

Effective teachers organize their classrooms so that all students can learn. They maximize instructional time and foster respectful interactions among and between teachers and students with sensitivity to students' cultures, race and levels of development. Students themselves make a substantive contribution to the effective functioning of the class through self-management of their own learning and maintaining a consistent focus on rigorous learning for all students by supporting the learning of others. Processes and tools for students' independent learning are visible/available to students (charts, rubrics, etc.). Artifacts that demonstrate student growth over time are displayed/available.

Component	Failing	Needs Improvement	Proficient	Distinguished
2a: Creating an environment of respect and rapport	Classroom interactions, both between the teacher and students and among students, are negative, inappropriate, or insensitive to students" cultural backgrounds, and are characterized by sarcasm, put-downs, or conflict. Standards of behavior are not clear or visible in the classroom.	Classroom interactions, both between the teacher and students and among students, are generally appropriate and free from conflict but may be characterized by occasional displays of insensitivity or lack of responsiveness to cultural or developmental differences among students. Minimal evidence of clear standards of behavior being visible in the classroom.	Classroom interactions, between teacher and students and among students are polite and respectful, reflecting general warmth and caring, and are appropriate to the cultural and developmental differences among groups of students. Standards of behavior are clear and visible and there is evidence that standards are consistently maintained.	Classroom interactions among the teacher and individual students are highly respectful, reflecting genuine warmth and caring and sensitivity to students" cultures and levels of development. Students themselves ensure high levels of civility among members of the class. Evidence that the teacher places a high priority on appropriate and respectful behavior and interaction and behavioral standards are clear and consistent.
2b: Establishing a culture for learning	The classroom environment conveys a negative culture for learning, characterized by low teacher commitment to the subject, low expectations for student achievement, and little or no student pride in work.	Teacher's attempt to create a culture for learning are partially successful, with little teacher commitment to the subject in evidence, modest expectations for student achievement, and little student pride in work. Evidence that both teacher and students appear to be only "going through the motions."	The classroom culture is characterized by high expectations for most students, genuine commitment to the subject by both teacher and students, with students demonstrating visible pride in their work.	Evidence of high levels of student energy and teacher passion for the subject that create a culture for learning in which everyone shares a belief in the importance of the subject. All students hold themselves to high standards of performance, for example by initiating improvements to their work.

2c: Managing classroom procedures	Much instructional time is lost due to inefficient classroom routines and procedures for transitions, handling of supplies, and performance of non-instructional duties.	Some instructional time is lost due to only partially effective classroom routines and procedures, for transitions, handling of supplies, and performance of non-instructional duties.	Little instructional time is lost due to classroom routines and procedures for transitions, handling of supplies, and performance of non-instructional duties. Class period runs smoothly and efficiently.	Students contribute to the seamless operation of classroom routines and procedures for transitions, handling of supplies, and performance of non-instructional duties. Evidence of a community that takes pride in their classroom operation.
2d: Managing student behavior	No evidence that standards of conduct have been established, and little or no teacher monitoring of student behavior. Response to student misbehavior is inconsistent, repressive, or disrespectful of student dignity.	Evidence that the teacher has made an effort to establish standards of conduct for students. The teacher tries, with uneven results, to monitor student behavior and respond to student misbehavior.	Evidence that standards of conduct are clear to students, and that the teacher monitors student behavior against those standards. Teacher response to student misbehavior is consistent, appropriate and respects the students" dignity.	Standards of conduct are clear, with evidence of student participation in setting and maintaining them. The teacher's monitoring of student behavior is subtle and preventive, and the teacher's response to student misbehavior is sensitive to individual student needs. Students take an active role in monitoring the standards of behavior.
2e: Organizing physical space	The physical environment is unsafe, or some students do not have access to learning. There is poor alignment between the physical arrangement and the lesson activities.	The classroom is safe, and essential learning is accessible to most students. Teacher's use of physical resources, including computer technology, is moderately effective. Teacher may attempt to modify the physical arrangement to suit learning activities, with partial success.	The classroom is safe, and learning is accessible to all students. The teacher ensures that the physical arrangement is appropriate to the learning activities. Teacher makes effective use of physical resources, including computer technology.	The classroom is safe, and the physical environment ensures the learning of all students, including those with special needs. Opportunities are available to all learning styles. Students contribute to the use or adaptation of the physical environment to advance learning. Technology is used skillfully, as appropriate to the lesson.

Domain 3: Instruction

Teacher Self-Assessment ☐ **Evaluator Assessment** ☐

All students are highly engaged in learning and make significant contribution to the success of the class through participation in equitable discussions, active involvement in their learning and the learning of others. Students and teachers work in ways that demonstrate their belief that rigorous instruction and hard work will result in greater academic achievement. Teacher feedback is specific to learning goals and rubrics and offers concrete ideas for improvement. As a result, students understand their progress in learning the content and can explain the goals and what they need to do in order to improve. Academic progress is articulated and celebrated in the learning community and with families. Effective teachers recognize their responsibility for student learning in all circumstances and demonstrate significant student growth over time towards individual achievement goals, including academic, behavioral, and/or social objectives.

Component	Failing	Needs Improvement	Proficient	Distinguished
3a: Communicating with students	Expectations for learning, directions and procedures, and explanations of content are unclear or confusing to students. Teacher's use of language contains errors or is inappropriate to students" cultures or levels of development.	Expectations for learning, directions and procedures, and explanations of content are clarified after initial confusion; teacher's use of language is correct but may not be completely appropriate to students" cultures or levels of development.	Expectations for learning, directions and procedures, and explanations of content are clear to students. Communications are appropriate to students" cultures and levels of development.	Expectations for learning, directions and procedures, and explanations of content are clear to students. Teacher's oral and written communication is clear and expressive, appropriate to students" cultures and levels of development, and anticipates possible student misconceptions.
3b: Using questioning and discussion techniques	Teacher's questions are low-level or inappropriate, eliciting limited student participation, and recitation rather than discussion.	Some of the teacher's questions elicit a thoughtful response, but most are low-level, posed in rapid succession. Teacher's attempts to engage all students in the discussion are only partially successful.	Most of the teacher's questions elicit a thoughtful response, and the teacher allows sufficient time for students to answer. The students are engaged and participate in the discussion, with the teacher stepping aside when appropriate.	Questions reflect high expectations and are culturally and developmentally appropriate. Students formulate many of the high-level questions and ensure that all voices are heard.

3c: Engaging students in learning	Activities and assignments, materials, and groupings of students are inappropriate and ineffective to the instructional outcomes, or students' cultures or levels of understanding, resulting in little intellectual engagement. The lesson has no structure or is poorly paced.	Activities and assignments, materials, and groupings of students are partially appropriate and effective for the instructional outcomes, or students' cultures or levels of understanding, resulting in moderate intellectual engagement. The lesson has a recognizable structure but is not fully developed or maintained.	Activities and assignments, materials, and groupings of students are fully appropriate and effective for the instructional outcomes, and students' cultures and levels of understanding. All students are engaged in work of a high level of rigor. The lesson's structure is coherent, with appropriate pacing.	Students are highly intellectually engaged throughout the lesson in significant learning and make relevant and substantive contributions to the activities, student groupings, and materials. The lesson is adapted to the needs of individuals, and the structure and pacing allow for student reflection and closure.
3d: Using assessment in instruction	Assessment is not used in instruction, either through students' awareness of the assessment criteria, monitoring of progress by teacher or students, or through feedback to students.	Assessment is occasionally used in instruction through some monitoring of progress of learning by teacher and/or students. Feedback to students is uneven, and students are aware of only some of the assessment criteria used to evaluate their work.	Assessment is regularly used in instruction through self-assessment by students, monitoring of progress of learning by teacher and/or students, and through high quality feedback to students. Students are fully aware of the assessment criteria used to evaluate their work.	Assessment is used in a sophisticated manner in instruction through student involvement in establishing the assessment criteria, self-assessment by students and monitoring of progress by both students and teachers, and high quality feedback to students from a variety of sources.
3e: Demonstrating flexibility and responsiveness	Teacher adheres to the instruction plan, even when a change would improve the lesson or students" lack of interest. Teacher brushes aside student questions; when students experience difficulty, the teacher blames the students or their home environment. Teacher lacks a repertoire of strategies to allow for adaptation of the lesson.	Teacher attempts to modify the lesson when needed and to respond to student questions, with moderate success. Teacher accepts responsibility for student success, but has only a limited repertoire of strategies to draw upon.	Teacher promotes the successful learning of all students, making adjustments as needed to instruction plans and accommodating student questions, needs and interests. Teacher maintains a broad repertoire of strategies and uses them quickly and effectively.	Teacher seizes an opportunity to enhance learning, building on a spontaneous event or expression of student interests. Teacher ensures the success of all students, using an extensive repertoire of instructional strategies and shows evidence of actively seeking new strategies.

Domain 4: Professional Responsibilities

Teacher Self-Assessment ☐ **Evaluator Assessment** ☐

Effective teachers have high ethical standards and a deep sense of professionalism. They utilize integrated systems for using student learning data, record keeping and communicating with families clearly, timely and with cultural sensitivity. They assume leadership roles in both school and district projects, and engage in a wide-range of professional development activities. Reflection on their own practice results in ideas for improvement that are shared across the community and improve the practice of all. These are teachers who are committed to fostering a community of effortful learning that reflects the highest standards for teaching and student learning in ways that are respectful and responsive to the needs and backgrounds of all learners.				
Component	**Failing**	**Needs Improvement**	**Proficient**	**Distinguished**
4a: Reflecting on teacher and student learning	Teacher's reflection does not accurately assess the lesson's effectiveness, the degree to which outcomes were met and/or has no suggestions for how a lesson could be improved.	Teacher's reflection is a sometimes accurate impression of a lesson's effectiveness, the degree to which outcomes were met and/or makes general suggestions about how a lesson could be improved.	Teacher's reflection accurately assesses the lesson's effectiveness and the degree to which outcomes were met and cites evidence to support the judgment. Teacher makes specific suggestions for lesson improvement.	Teacher's reflection accurately and effectively assesses the lesson's effectiveness and the degree to which outcomes were met, cites specific examples; offers specific alternative actions drawing on an extensive repertoire of skills.
4b: System for managing students' data	Teacher's information management system for student completion of assignments, student progress in learning and non-instructional activities is either absent, incomplete or in disarray.	Teacher's information management system for student completion of assignments, progress in learning and non-instructional activities is ineffective or rudimentary, not maintained and/or requires frequent monitoring for accuracy.	Teacher's information management system for student completion of assignments, student progress in learning and non-instructional activities is fully effective.	Teacher's information management system for student completion of assignments, progress in learning and non-instructional activities is fully effective and is used frequently to guide planning. Students contribute to the maintenance and/or interpretation of the information.

4c:Communicating with families	Teacher provides little/no culturally-appropriate information to families about the instructional program, student progress or responses to family concerns. Families are not engaged in the instructional program.	Teacher provides minimal and/or occasionally insensitive communication and response to family concerns. Partially successful attempts are made to engage families in the instructional program with no attention to adaptations for cultural issues.	Teacher provides frequent, culturally-appropriate information to families about the instructional program, student progress, and responses to family concerns. Frequent, successful efforts to engage families in the instructional program are the result of flexible communication.	Teacher provides frequent, culturally-appropriate information to families with student input; successful efforts are made to engage families in the instructional program to enhance student learning.
4d: Participating in a professional community	Professional relationships with colleagues are negative or self-serving; teacher avoids participation in a culture of inquiry and/or avoids becoming involved in school events and/or school and district projects.	Professional relationships are cordial and fulfill required school/district duties. The teacher will sometimes become involved in a culture of inquiry, school events and/or school/district projects when asked.	Professional relationships are characterized by mutual support and cooperation; include voluntary active participation and substantial contributions to a culture of professional inquiry, school events and school/district projects.	Professional relationships are characterized by mutual support, cooperation and initiative in assuming leadership in promoting a culture of inquiry and making substantial contributions to school/district projects.
4e: Growing and developing professionally	Teacher engages in no professional development activities and/or resists feedback on teaching performance and/or makes no effort to share knowledge with others or to assume professional responsibilities.	Teacher engages in professional activities to a limited extent and/or accepts feedback on performance with reluctance and no evidence of change and/or finds limited ways to contribute to the profession.	Teacher engages in seeking out professional development opportunities, welcomes feedback on performances, and adapts suggestions for change and participates actively in assisting other educators.	Teacher engages in seeking out opportunities for leadership roles in professional development and makes a systematic effort to conduct action research, seeks out feedback and initiates important activities to contribute to the profession.
4f: Showing professionalism	Teacher's professional interactions are characterized by questionable integrity, lack of awareness of student needs, and/or decisions that are self-serving, and/or do not comply with school/district regulations.	Teacher's interactions are characterized by honest, genuine but inconsistent attempts to serve students, decision-making based on limited data, and/or minimal compliance with school/district regulations.	Teacher's interactions are characterized by honesty, integrity, confidentiality and assurance that all students are fairly served, participation in team or departmental decision-making, and/or full compliance with regulations.	Teacher displays the highest standards of honesty, integrity, confidentiality; assumption of leadership role with colleagues, in serving students, challenges negative attitudes and practices, and promotes full compliance with regulations.

APPENDIX E

BCP WALKTHROUGH FORM

Teacher: **Course:**
Observer: **Date:**

Look-fors

- Teacher discourse (questions, discussions, dialogue) approaches levels of analysis, synthesis, and/or evaluation.
- Activities and classwork require students to apply knowledge.
- In relation to Bloom's Taxonomy, teaching strategies are consistent with the goals of the lesson.
- Students demonstrate an awareness of higher-level expectations.
- New learning relates to previous knowledge or understanding.
- Students demonstrate an ability to provide alternative solutions to assigned problems.
- The educational process emanates enthusiasm toward learning.

*While it is understood that not all of these "look-fors" will be observed during a given lesson, it is expected that the teacher continually strives to achieve higher-level cognitive skills and challenges students to achieve their personal best.

Evidence of satisfactory teaching:

Levels of cognitive learning:

Best Practices:

Think about:

APPENDIX F

IRB NOTIFICATION

University of Pittsburgh
Institutional Review Board

3500 Fifth Avenue
Pittsburgh, PA 15213
(412) 383-1480
(412) 383-1508 (fax)
http://www.irb.pitt.edu

Memorandum

To: Carrie Rowe

From: Sue Beers, PhD, Vice Chair

Date: 1/17/2014

IRB#: PRO14010269

Subject: Teacher Behavior in the Digital Age: A Case Study of Secondary Teachers' Pedagogical Transformation to a 1-to-1 Environment

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The above-referenced project has been reviewed by the Institutional Review Board. Based on the information provided, this project meets all the necessary criteria for an exemption, and is hereby designated as "exempt" under section
45 CFR 46.101(b)(1).

Please note the following information:

- If any modifications are made to this project, use the "**Send Comments to IRB Staff**" process from the project workspace to request a review to ensure it continues to meet the exempt category.
- Upon completion of your project, be sure to finalize the project by submitting a "**Study Completed**" report from the project workspace.

Please be advised that your research study may be audited periodically by the University of Pittsburgh Research Conduct and Compliance Office.

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