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ONE-TO-ONE IPAD TECHNOLOGY IN THE MIDDLE SCHOOL MATHEMATICS
AND SCIENCE CLASSROOMS

DISSERTATION

A dissertation submitted in partial fulfillment
of the requirements for the degree Doctor of Philosophy in the
College of Education
at the University of Kentucky

By
Sharon Grace Creech Bixler
Lexington, Kentucky

Director: Dr. Molly Fisher, Associate Professor of Mathematics Education
Lexington, Kentucky
2016

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ABSTRACT OF DISSERTATION

ONE-TO-ONE IPAD TECHNOLOGY IN THE MIDDLE SCHOOL MATHEMATICS AND SCIENCE CLASSROOMS

Science, technology, engineering, and mathematics (STEM) education has become an emphasized component of PreK-12 education in the United States. The US is struggling to produce enough science, mathematics, and technology experts to meet its national and global needs, and the mean scores of science and mathematics students are not meeting the expected levels desired by our leaders (Hossain & Robinson, 2011). In an effort to improve achievement scores in mathematics and science, school districts must consider many components that can contribute to the development of a classroom where students are engaged and growing academically. Computer technology (CT) for student use is a popular avenue for school districts to pursue in their goal to attain higher achievement.

The purpose of this study is to examine the use of iPads in a one-to-one setting, where every student has his own device 24/7, to determine the effects, if any, on academic achievement in the areas of mathematics and science. This comparison study used hierarchical linear modeling (HLM) to examine three middle schools in a private school district. Two of the schools have implemented a one-to-one iPad program with their sixth through eighth grades and the third school uses computers on limited occasions in the classroom and in a computer lab setting. The questions addressed were what effect, if any, do the implementation of a one-to-one iPad program and a teacher's perception of his use of constructivist teaching strategies have on student academic achievement in the mathematics and science middle school classrooms.

The research showed that although the program helped promote the use of constructivist activities through the use of technology, the one-to-one iPad initiative had no effect on academic achievement in the middle school mathematics and science classrooms.

KEYWORDS: One-to-one, iPad, middle school, mathematics, science

Sharon Grace Creech Bixler

July 11, 2016

ONE-TO-ONE IPAD TECHNOLOGY IN THE MIDDLE SCHOOL MATHEMATICS
AND SCIENCE CLASSROOMS

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DEDICATION

This is dedicated to my husband, Dwayne, and my children, Todd, Grace, Rachel, and Claire who always believed Mom could accomplish a doctoral degree.

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CHAPTER I: INTRODUCTION

Rationale of the Study

Science, technology, engineering, and mathematics (STEM) education has become an emphasized component of PreK-12 education in the United States. The US is struggling to produce enough science, mathematics, and technology experts to meet its national and global needs, and the mean scores of science and mathematics students are not meeting the expected levels desired by our leaders (Hossain & Robinson, 2011). According to Cavanagh (2008), the Program for International Student Assessment (PISA, 2006) stated 15-year-old US students ranked 24th on the mathematics test and 17th on the science test compared to 29 other industrialized countries (as cited in Hossain & Robinson, 2011, p.2). The US's once acquired leadership status in mathematics and science education has fallen behind many other countries. Ramirez (2008) stated "The fact that some less developed countries now perform better in math and science achievement than the US is seen by many US educators, business leaders and politicians as a crisis" (as cited in Hossain & Robinson, 2011, p.2).

In an effort to improve achievement scores in mathematics and science, school districts must consider many components that can contribute to the development of a classroom where students are engaged and growing academically. Computer technology (CT) for student use is a popular avenue for school districts to pursue in their goal to attain higher achievement. CT has become a much studied research topic in the last few decades as school districts commit to spending their precious resources of time and money for technology integration in the classroom. Determining the best plan of implementation falls on all education partners including administrators and teachers.

They must take many issues into consideration such as affordability, infrastructure, and best practices when deciding what technologies should be incorporated into the classroom.

The U.S. Department of Education, the National Council of Teachers of Mathematics (NCTM), the National Science Teachers Association (NSTA), and the International Society of Technology in Education (ISTE) have supported computer technology integration in the PreK-12 classroom as a means to create a more successful mathematics and science curriculum for US students. The U.S. Department of Education (2010) contributed to this charge by stating in its National Education Technology Plan “technology is the core of virtually every aspect of our daily lives and work, and we must leverage it to provide engaging and powerful learning experiences and content, as well as resources and assessments that measure student achievement in more complete, authentic, and meaningful ways” (p. ix).

National Council of Teachers of Mathematics

Mathematics, Science, and Technology leadership organizations are promoting the use of modern technologies to enhance instruction. The NCTM (2011) released an organizational position stating we must provide regular access to technology in order to develop sense making, reasoning, problem solving, and communication in our students. Teachers who can effectively use technology to help students with their understanding, to increase their interest in the subject, and to raise mathematics proficiency will be successful in providing greater access to mathematics for every student. The Common Core State Standards for Mathematics (CCSSM, 2010) also encourages the use of technology in its fifth standard for mathematical practice: use appropriate tools

strategically. It states mathematically proficient students will use available tools including calculators, spreadsheets, statistical packages, and dynamic geometry software to solve mathematical problems. Mathematics proficiency opens the door for a number of career choices in the STEM fields empowering our students for their future.

National Science Teachers Association

The NSTA, through its Next Generation Science Standards (NGSS, 2013), also encourages the use of technology for the role it plays in the learning of science by recognizing that new technologies have given our scientists new capabilities for studying the natural world. The advances in technology have also provided more precise ways to record, manage, and analyze data as students conduct investigations during the learning process. The NGSS framework states, “engineering and technology provide opportunities for students to deepen their understanding of science by applying their developing scientific knowledge to the solution of practical problems... By integrating technology and engineering into the science curriculum, teachers can empower their students to use what they learn in their everyday lives” (NGSS, Appendix A, p.5).

International Society of Technology in Education

ISTE (2013) developed the widely recognized standards for learning, teaching, and leading with technology. Through sets of standards designed for students, teachers, administrators, coaches, and computer science educators, ISTE has provided schools with a set of best practices for technology use designed to improve higher-order thinking skills, prepare students for the global job market, design student-centered, project-based and online learning environments, guide schools in creating digital places of learning, and inspire models for students to encourage working, collaborating and decision making.

With the support of the national groups and an abundance of technology appearing in schools, it is imperative teachers learn effective ways to incorporate technology into their classrooms to increase academic achievement. The National Education Technology Plan (US Department of Education, 2010) calls for teachers to use technology to create engaging and empowering learning experiences for their students that are designed to meet the individual needs and the prior knowledge of the learner. This type of learning environment is based on the theoretical framework of constructivism.

Theoretical Framework

Narayan, Rodriquez, Araujo, Saqlaih, & Moss (2013) stated constructivism is based on the theory that people learn by actively constructing knowledge through their experiences. The learning process cannot be a passive transmission of facts. Instead, the learner must be actively participating in the process. According to Narayan et al. (2013), Jerome Bruner explained three key principles of constructivism: readiness of the learner to participate in the experiences needed for learning, spiral organization of curriculum to allow learners to grasp knowledge, and generation in which the learner goes beyond information to apply the knowledge. Others that contributed to the theory were John Dewey who held learning depended on action and experience, and Lev Vygotsky who stressed social learning comes before cognitive development. Overall, the constructivists believe learning must be an active process and social interactions play a key component in that process (Brown, Collins, & Duguid, 1989; Jonassen, 1991; Ertmer & Newby, 1993; Narayan et al., 2013).

The challenge for teachers is to take the recommendations of the national organizations and the available technology and use them to provide students with a constructivist-learning environment that encourages participation both individually and collaboratively, addresses prior knowledge of the student, allows for the creation of activities that continuously spiral back to past learning, and provides opportunities to apply learning to real life scenarios.

Statement of the Problem

Mobile devices, such as the iPad and other tablet-based devices, are the latest technology schools are looking toward for assistance in the teaching of the CCSSM and NGSS standards. There has been a substantial amount of research on computer technology in the areas of mathematics and science showing the benefits of its implementation in the classroom (Bayraktar, 2002; Li & Ma, 2010). However, according to Fisher, Lucas, and Galstyan (2013), “There is very little research involving the direct observation of the usage of iPads in the classroom” (p.166). Most of the iPad-focused research involves analyzing students’ and teachers’ perceptions of the benefits of iPads rather than measuring its effects on academic achievement. In order for school systems to justify the expense of incorporating mobile devices, such as the iPad, into their instruction, research needs to be conducted to determine the effect, if any, on students’ learning.

Purpose of the Study

The purpose of this study is to examine the use of iPads in a one-to-one setting, where every student has his own device 24/7, to determine the effects, if any, on academic achievement in the areas of mathematics and science. This research project

examined three middle schools in a private school district. Two of the schools have implemented a one-to-one iPad program with their sixth through eighth grades and the third school uses computers in the classroom and in a computer lab setting on periodic occasions. Parents and schools have invested large amounts of money not only on the devices themselves but also on the schools' infrastructures to ensure adequate wireless Internet capabilities are in place to support multiple devices. The limitation of this study is that it is designed to provide an analysis of academic achievement for one specific private school district, thus the results are limited. However, its results may be used as a starting point for other districts grappling with determining the benefits of one-to-one iPad programs.

By determining the effects of the iPad program, the district will be able to see some of the results of the time and fiscal resources that have been dedicated to the program. Through the use of hierarchical linear modeling (HLM), the research examined the Measure of Academic Progress (MAP) scores obtained over two years from two schools that participated in a one-to-one iPad program and one school that uses alternate forms of technology in instruction. A survey addressing the perceived use of constructivist strategies was administered to analyze if a teacher's perception of his use of constructivist strategies affects results. This study addressed the following research questions:

1. What effect, if any, does implementation of a one-to-one iPad program have on student academic achievement in the mathematics and science middle school classrooms?

2. What effect, if any, does a teacher's perception of his or her use of a constructivist teaching style have on student academic achievement in the mathematics and science middle school classrooms? What effect, if any, do the teachers' characteristics have on the students who made the most gains in achievement?

CHAPTER II: LITERATURE REVIEW

The review of the literature for the use of iPads in the classroom centered on the following topics:

- Constructivism
- Constructivism in the classroom
- Use of technology in a constructivist learning environment
- Constructivist-oriented Technological Pedagogical Content Knowledge
- History of computer technology in the mathematics and science classroom
- Computer technology in the mathematics classroom
- Computer technology in the science classroom
- Mobile devices in the mathematics and science classroom
- iPads in a one-to-one environment
- Laptops in a one-to-one environment
- Gender differences in the mathematics and science classroom

Constructivism

Ertmer and Newby (1993) stated constructivism sees knowledge as something an individual creates from his experiences. This theory does not believe knowledge can be mapped onto the learner. Instead a student will create his own meaning of the content rather than it being given to him. Whereas behaviorists and cognitivists believe in an objective reality, constructivists believe reality is relative to the experiences learners have had and how they have chosen to interpret them. The learner and the environment play a part in the construction of knowledge through their interactions with each other, and knowledge is constantly evolving as the learner experiences more of the world. Due to this, memory is always being constructed. With constructivism, the focus is on encouraging students to not use memorized facts but to use prior knowledge to create new understandings of a situation.

The transfer of knowledge, according to Ertmer and Newby (1993), in constructivism, is due to students completing authentic tasks. Learning must take place in

a real world setting where students can relate prior knowledge to the task at hand. The acquisition of knowledge is best through ill-structured domains where students are provided with a problem that may have multiple answers or no one right answer. This type of learning is of the more advanced stage. Jonassen (1991) stated introductory knowledge is a better fit for behaviorism and cognitivism, while constructivism can be used for the more complex problems. Strategies most appropriate for a constructivist-learning environment are providing tasks mirroring real world situations, modeling and coaching throughout the process, collaborative learning, discussions, debates, and reflection during and after the task. Constructivist teachers will emphasize the context in which the learning occurs, encourage learners to actively use their prior knowledge, present information in multiple ways, and support using problem-solving skills. By analyzing different ways of representing a problem, they can design experiences that are authentic and relevant to the learner's world.

Brown (1998) summarized what types of classroom activities would reflect constructivism into three broad components: curriculum practices, instructional practices, and assessment practices. She based these practices on Jonassen's (1994) eight principles designed to guide instructional design to meet the constructivist theory.

1. Provide multiple representations of reality;
2. Represent the natural complexity of the real world;
3. Focus on knowledge construction, not reproduction;
4. Present authentic tasks (contextualizing rather than abstracting instruction);
5. Provide real-world, case-based learning environments, rather than pre-determined instructional sequences;
6. Foster reflective practice;
7. Enable context-and content dependent knowledge construction;
8. Support collaborative construction of knowledge through social negotiation (p.35).

Within curriculum practices, Brown (1998) discussed the uses of applied learning designs, interdisciplinary integration, field-related experiences, and school-community linkages. Applied learning designs involve students using mathematics to solve real world problems. This may involve students conducting research, analyzing information and using relevant tools to construct an answer. Interdisciplinary integration allows for a problem-centered approach where multiple content area teachers create a project encouraging students to see how different knowledge from areas such as mathematics and science are interrelated and can be used together to solve a common problem. Field-related experiences provide students the opportunities to be on sight of a work place and see first hand the application of content learned in school. School-community linkages are designed to provide students a chance to apply their classroom skills to solve problems in the social community.

Within instructional practices, Brown (1998) discussed experiential learning, problem-based learning, student-directed learning, and mentoring. Experiential learning places students into groups where they work collaboratively to solve a real world problem by negotiating solutions and ultimately justifying the chosen solution. One value of this strategy is students learn to consider multiple perspectives while designing answers to the problem. Problem-based learning's focus is on solving problems that have real world significance. These problems are ill structured which means there is no one right answer. Student-directed learning is designed to be a small-group experience in which students participate in critical thinking and teamwork to solve problems. Its benefits are it aids in meeting the needs of diverse learners and bolsters self-esteem as group members are able to share their individual knowledge of past experiences.

Mentoring, the last instructional practice, allows students to actively assist others in their learning process by drawing on their prior knowledge of the content.

Within assessment practices, Brown (1998) discussed journal writing, the scoring rubric, portfolios, and observation checklists. Journal writing is a form of self-assessment designed to allow students to reflect on their learning and how they may use their knowledge in new ways. The scoring rubric is a tool designed to provide clear performance expectations of an assignment at the beginning of a lesson and then by using fixed scales, students are able to evaluate what areas they have mastered and what areas need more work. Portfolios are tools used to assess the students over time. By allowing students to choose their pieces to be included, a strong focus is placed on reflection of learning from the student's perspective. Finally, observation checklists provide students a way to track which skills they have learned and to what extent they have mastered them. Following that, the students are engaged in the planning of how to improve on their learning.

Effects of the Constructivist Approach

Ayaz and Sekeric (2015) conducted a meta-analysis to determine what effects a constructivist learning approach had on students' academic achievement. They reviewed a total of 53 studies conducted between 2003 and 2014 in Turkey that used the constructivist learning approach as the experimental group and the traditional teaching approach as the control. The studies covered all educational levels, elementary through college.

By definition, a traditional approach is teacher-oriented with instruction focused more on lecture, whole group lessons, and mastery of facts and skills. The teacher solves

problems for the class and students' differences are only addressed if there is a problem. Typically, a single assessment for all students is used at the end of instructional units (Ornstein, Lasley, & Mindes, 2005). In contrast, a constructivist approach is student-oriented with activities designed to encourage active learning. Assessments are different from one single test at the end of a unit. Instead they can be formatted as project work, portfolios, self-assessments, and performance evaluations (Ayaz and Sekerci, 2015).

Two of the common teaching tactics that were identified as constructivist in the studies Ayaz's and Sekerci's (2015) analyzed were the use of the 5E-learning model and problem-based learning. The 5E-learning model is a constructivist-based model for science instruction. It follows the five steps of engagement, exploration, explanation, elaboration, and evaluation when creating lessons. During engagement, activities are designed to encourage interest in the topic to be learned. Exploration activities are then designed to allow students to carry out investigations of the topic and begin to form understanding of the topic. The third step of explanation provides teachers the time to help students process their findings and may involve some direct instruction of the topic. Elaboration is intended to provide an opportunity for concept application of the topic. The final stage is evaluation, which can be completed using numerous types of assessments (Bass, Contant, and Carin, 2009). Ayaz and Sekerci (2015) found the use of the 5E had a 1.303 positive effect size on student achievement.

The use of problem-based learning is defined as a lesson that starts with a problem being shared with the students. An example may be to pose the question of how to dispose of garbage with the least amount of negative impact on the environment. This problem is ill structured, meaning it will not have only one solution. Students work to

create a solution, assess their work, and possibly refine their solution or generate another solution (Ornstein et al., 2005). With this method, Ayaz and Sekerci (2015) found an effect size of 1.415 on student achievement.

Overall, Ayaz and Sekerci (2015) found using a constructivist learning approach had a very strong effect size (1.156) on students' academic achievement, with 50 of the 53 studies showing positive effects and 3 showing negative effects. The effect sizes were found highest with high school and college level, and were effective in different class sizes.

Constructivism in a 6th Grade Mathematics Classroom

Varying individual studies have been completed on the comparisons of constructivist and traditional learning environments. Kim (2005) researched mathematics achievement of sixth graders taught by the differing learning styles. Seventy-six students were divided into two groups. During forty hours of instruction over nine weeks, the experimental group was taught by the constructivist approach using the activities of inviting of ideas, exploring, proposing, explanation and solution, and taking action. The control group followed a traditional approach of introduction to concepts, development, and review. Kim found, given the pre-test/post-test design of the study, students in the constructivist group made an 11.05 point gain on the post-test whereas the traditional group had a 5.08 point decline in scores. Kim concluded there was a significant difference in the two groups with the constructivist-teaching group outperforming the traditional group in mathematics academic achievement.

Constructivism in a 5th Grade Science Classroom

Wu and Tsai (2005) studied fifth grade students, over a semester, to determine if

science academic achievement differed according to teaching style. Sixty-nine students were divided into two groups: 35 students in a constructivist style science class and 34 students in a traditional class. Analyzing the data, they found the constructivist-oriented instruction group had better learning outcomes, showed better metacognitive capacity in interviews, showed more integrated cognitive structures, and stored ideas in a higher level mode of information processing resulting in higher total overall scores in every area. “Constructivist-oriented science instruction could facilitate the connections between new conceptions and pre-existing knowledge within learners’ cognitive structures and promote the usage of higher order information processing modes” (p.833). In the end, students in the constructivist group had better learning outcomes when compared to the traditional group.

Constructivist Learning Environments

Constructivist theory stresses classrooms should be student-centered as opposed to teacher-centered (Kelsey, 2007; Young & Maxwell, 2007). From Constructivism has come the instructional design of constructivist-learning environments (CLE). A CLE can be defined as “a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities” (Wilson, 1996, p.5). Jonassen, Peck, & Wilson, (1999) add these environments provide students with the opportunities to “explore, experiment, construct, converse, and reflect on what they are doing so that they learn from their experiences” (as cited in Wang, Teo, & Woo, 2009, p.81). This leads to a more student-centered and collaborative learning environment. Participating in this environment allows

students to deepen their understanding of content through the use of resources and sharing of knowledge (Kong, 2011).

Technology can aid in the construction of a CLE by providing current information not available in textbooks giving an authenticity to the lessons. The use of online resources can facilitate “the learner’s journey of discovery and acquisition of new knowledge. Communication resources such as discussion boards enable learners to participate in collaborative learning with other students and with educators” (Sultan, Woods, & Koo, 2011, p.151). Fosnot (1996) stated students acquire knowledge by physically constructing it through active learning. Providing technology-based CLE’s allows students to participate in varying activities and engage in meaningful conversations with others (Jonassen & Rohrer-Murphy, 1999).

Teaching in a digital classroom allows teachers to promote the tenets of constructivism. The use of mobile devices are removing the constraints of time and space from the learning process and instead providing opportunities for students to communicate, collaborate in and out of the classroom, and access information freely (Wong 2012). In the constructivist classroom, assessments can range from self-report measures, classroom observations, and varying analyses of student performance data. One-to-one technology can afford teachers the opportunities to incorporate many different forms of assessments (Sultan et al., 2011).

Hoffman (2010) stated that as we shift to a student-centered learning environment, we are providing opportunities for students to learn 21st century skills of inquiry, critical thinking, communication and collaboration. Technology can assist in this shift. However, it is essential schools are using technology to its fullest potential.

Teachers' Perceptions of C-TPACK

With a shift to more technology-infused CLE's, it is important teachers know how to successfully integrate the devices into instruction. As stated before, a constructivist classroom has shown to be effective in increasing achievement (Ayez & Sekerci, 2015; Kim, 2005, and Wu & Tsai, 2005). However, teachers must feel comfortable with and prepared to use the technology in order to create a successful technology-infused learning environment for their students. Koh, Chai, and Tsai (2014) conducted a study to determine teachers' perceptions of their constructivist-oriented technological pedagogical content knowledge (C-TPACK). C-TPACK refers to a teachers' knowledge of using technology with appropriate teaching methods for their content area to implement constructivist instruction.

Koh's et al. (2014) research study included 354 teachers, 54% at the elementary level and the rest at the secondary or junior college level. The average teaching experience was 8.83 years and the average age was 34.93 years. The questions addressed were:

1. What are Singapore practicing teachers' constructivist-oriented TPACK perceptions?
 2. How do teacher demographics (age, gender, teaching experience, and teaching level) and TPACK constructs (C-TK, C-PK, CK, C-PCK, TCK, and C-TPK) predict practicing teachers' constructivist-oriented TPACK (C-TPACK)?
- (p.187)

In order to create the survey, Koh, et.al., examined Jonassen, Howland, Marra, and Crismond's (2008) principles that relate to an information and communications

technology (ICT)- supported constructivist learning environment. The five principles included students actively manipulating objects and observing results, reflecting and articulating their personal understandings of their observations, engaging in authentic tasks based on real world problems, intentionally setting goals for learning and planning problem-solving processes, and collaborating to problem-solve within their classroom community. Technology can serve as a tool to support these principles to encourage our students to be engagers and facilitators of thinking.

Koh et al. (2014) used these five dimensions and the seven-construct TPACK framework developed by Mishra and Koehler (2006) to assist in the creation of their teacher survey. The seven constructs included the following:

- Technological knowledge (TK) – knowledge of technology tools
- Pedagogical knowledge (PK) - knowledge of teaching methods
- Content knowledge (CK) – knowledge of subject matter
- Technological pedagogical knowledge (TPK) - knowledge of using technology to implement teaching methods
- Technological content knowledge (TCK) – knowledge of subject matter presentation with technology
- Pedagogical content knowledge (PCK) – knowledge of teaching methods with respect to subject matter content
- Technological pedagogical content knowledge (TPACK) - knowledge of using technology to implement constructivist-teaching methods for different types of subject matter content

The researchers then added the constructivist-oriented component to the seven constructs to create C-TK, C-PK, C-CK, C-TPK, C-TCK, C-PCK, and C-TPACK to address the responses of the survey.

Koh's et al. (2014) survey collected teachers' reported abilities of incorporating technology into a constructivist-learning environment. It was designed on a Likert scale where 1- strongly disagree, 2 – disagree, 3- slightly disagree, 4 – neither agree nor

disagree, 5 – slightly agree, 6 – agree, 7 – strongly agree. They found teachers rated themselves as highly confident of their content knowledge (CK) with a mean of 5.84, their ability to provide constructivist instruction (C-PK) with a mean of 5.56, and their ability to provide constructivist instruction specific to their content area (C-PCK) with a mean of 5.43. However, when the survey added technology into the equation, the confidence level dropped. Teachers rated their ability to use technology tools to create a constructivist instruction (C-TK) with a mean of 5.17, their use of technology to teach their content area (TCK) with a mean of 5.20, their use of technology in their teaching to create constructivist instruction (C-TPK) with a mean of 5.20, and their knowledge of technology to create constructivist instruction in their content area (C-TPACK) with a mean of 4.86. The teachers' surveys showed they were confident in implementing constructivist-oriented instruction but revealed their struggles were in the areas of ICT-driven constructivist-oriented instruction.

After reviewing the responses to the survey in regards to their confidence in the seven constructs, Koh et al. (2014) then turned to analyzing the results by teacher characteristics. They found a small negative correlation between age with TPACK constructs and teaching experience with TPACK constructs. They also found males rated themselves higher (small effect size) in constructs that had technology as a component. In addition, primary teachers rated themselves lower (small effect size) in the construct of C-TPACK than secondary and junior college teachers.

Some possible explanations of Koh's et al. (2014) finding are that more experienced teachers, who had a lower perceived C-TPACK, are more influenced by the exam driven school system that has traditionally been focused on the dissemination of

knowledge and facts rather than a constructivist approach. Also, primary teachers, who perceived themselves as lower than other participants in C-TPACK, may be at a disadvantage solely due to the fact they teach multiple subjects at the elementary level. Secondary and junior college teachers typically focus on only one content area and thus may be more confident with C-TPACK.

Koh et al. (2014) concluded that this study could give insight into how school districts could provide professional development to assist teachers with technology implementation in the classroom. First, professional development needs to go beyond teaching constructivist instruction in general to more specific training of how to address ICT in a constructivist context. Greenhow, Dexter, and Hughes (2008) stated teachers focus their technology integration on how to represent content. However, Windschitl (2002) stressed teachers must learn how to instead focus on facilitating student learning through authentic problem-based tasks and creating opportunities for classroom discourse. Teachers need to have a strong C-TPACK in order to create a technology-infused constructivist-learning environment.

Constructivism and Technology in the Classroom

Overbay, Patterson, Vasu, and Grable (2010) found teachers who leaned toward a constructivist approach in the classroom and thought the technology could be used as a tool in a student-centered environment were more likely to report using technology. “With the rapidly changing landscape of the K-12 classroom, asking questions about the relationship between constructivist practice and the use of classroom technologies seems more important than ever” (p.104). As a result, teachers that adhere to the constructivist theory would use technology to engage students and to encourage them to find meaning

in the material versus memorization of facts. The tools would be used for knowledge construction rather than drill and practice focused on skills.

Overbay et al. (2010) researched the IMPACT model of technology integration, designed to promote student-centered learning, being used in North Carolina schools. This model was designed to provide teachers and media and technology personnel the opportunity to collaborate as they developed a student-centered environment focused on 21st century learning. The project examined the relationship between teachers' level of constructivism and their reported use of technology in the classroom. One of the research questions was "What was the relationship among individual-level variables (e.g. sex, years of experience, and subject taught) and technology use, and do they interact significantly with level of constructivism in predicting technology use" (p.106)? Overbay et al. used The Activities of Instruction (AOI) survey to measure the amount of constructivist practices that were occurring in the North Carolina schools. This survey was developed to consider constructivist practices when describing classroom activities of teachers at different grade levels.

Overbay et al. (2010) found teachers' reported level of constructivist practice had a significant positive association with their level of reported technology use. After studying the other variables, they found the best predictor of teachers' reported technology use was the level of constructivism. They interpreted this to state, "teachers who use constructivist activities are also willing to incorporate technology into routine student-centered activities" (p.116). As school districts strive to find the most effective ways to implement technology, training teachers on how to create a constructivist-

learning environment may result in classrooms that are actively incorporating technology into lessons.

History of Computer Technology in the Mathematics and Science Classroom

Mobile devices, specifically the iPad and other tablet-style devices, are the most recent in a long line of technology tools made available for classroom implementation over the past decades. Computer technology (CT) and computer assisted instruction (CAI) have been a part of the learning environment for quite some time and is only growing. By 2001, US public schools housed more than ten million computers and 87% of classrooms offered Internet access (Hernandez-Ramos, 2005, as cited in Holden, Ozok, & Rada, 2008). Now, years later, the issue is no longer access to technology but how can we use it to promote student learning and achievement (Holden et al., 2008). Is mobile technology a viable option for increasing learning and achievement? Past studies on computer technology seem to support answering that question positively (Bayraktar, 2002; Li & Ma, 2010).

The use of computer technology in education has been researched for the last few decades, and numerous studies and meta-analyses have been completed on the effects of CAI and CT use on achievement in the mathematics and science classrooms (Bayraktar, 2002; Li & Ma, 2010). One way to analyze the use of technology over the past decades and its effect on learning is by looking at the meta-analyses conducted on the research of computer technology. A meta-analysis allows the researcher to statistically analyze several separate research projects' findings. This provides a more collective picture of technology use and its impact on mathematics and science achievement. Studying different meta-analyses enables us to look at the ways technology was being used in the

classroom by the types of studies that were being conducted during that time period and if the uses were significantly impacting learning in the classroom.

Computer Technology in the Mathematics Classroom

Li and Ma (2010) conducted a meta-analysis of the effects of computer technology on K-12 students' mathematics learning. The research encompassed 46 studies involving 36,793 learners. This meta-analysis included studies providing research findings on the numerous implementations of computer technology now being used in the classroom. Li and Ma focused on three research questions.

1. Does mathematics learning with computer technology (CT) impact mathematics achievement of K-12 students, compared to mathematics learning without CT? If so, to what extent?
2. What study features moderate the effects of CT on K-12 students' mathematics achievement?
3. What are the optimal conditions for effective mathematics learning with CT in terms of K-12 students' mathematics achievement (p.220)?

The term CT for this study referred to computer technology software. The criteria for inclusion were the studies were conducted with students in regular K-12 classrooms, the CT was used for instructional purposes, and the outcome was mathematics achievement. Also, the chosen studies were published during 1990-2006, used an experimental or quasi-experimental design, and provided enough quantitative data to be able to compute an effect size. If a study provided more than one effect size, the one primary to the research was used. If they all shared similar features then an average of the effects sizes was used.

The research gleaned from the 46 primary studies showed an overall small, positive effect (0.28) of CT on mathematics achievement. Of the 85 effect sizes found, only seven showed a negative effect on mathematics achievement. Li and Ma (2010) sorted the technology use into four types- tutorial, communication media, exploratory environment, and tools. The findings showed the types of technology use had no effect on mathematics achievement of students. However, the meta-analysis found large effects with certain teaching styles. When analyzing the data, they categorized the studies into two pedagogical approaches- traditional and constructivist teaching. To make the classification, they defined a traditional style as one that is teacher-centered with whole-class instruction whereas a constructivist style is student-centered with discovery-based and problem-based learning, and situated cognition based on constructivism. They found there was a large effect with CT use in a constructivist environment rather than a traditional one (1.00). “When used in settings where teachers practiced constructivist approach to teaching, technology had much stronger effects on mathematics achievement than settings where teachers practiced a traditional approach to teaching” (p.228).

In conclusion, Li and Ma (2010) found CT had positive effects on mathematics achievement when analyzing 46 different studies. In addition, they found one of the largest positive effects (1.00) came when teachers used a constructivist approach, by adding techniques such as inquiry-based and problem-based instruction when implementing technology in the classroom.

Computer-Assisted Instruction in the Science Classroom

Bayraktar (2002) conducted a meta-analysis on the effectiveness of computer-assisted instruction (CAI) on student achievement in the secondary and college science

classroom by comparing CAI instruction with traditional instruction. Computer-assisted instruction is the use of computers in the classrooms to aid in the teaching and learning process. The purpose of the analysis was to determine the overall effectiveness of CAI in physics, chemistry, biology, general science, and physical sciences. In order to be included in the analysis, the studies needed to be an experimental or quasi-experimental design that compared achievement of science students in a CAI classroom with those taught through traditional methods. Studies were eliminated if they had no comparison group, did not report effect sizes or if not enough information was included so effect sizes could be calculated.

After including 42 studies that produced 108 effect sizes, Bayraktar (2002) first examined the overall effects of CAI on achievement in science. Of the 108 effect sizes, seventy of the effects were positive for the CAI group being more effective, 38 were negative meaning the traditional instruction was found more effective, and one study showed no difference. Of the 70 CAI positive effects, forty-two exhibited small effects and 28 exhibited moderate to large effects. The mean of the 108 effect sizes was 0.27, a small positive effect for achievement in CAI as compared to traditional instruction. This mean indicated the typical student in the CAI treatment group moved from the 50th percentile to the 62nd percentile.

Bayraktar (2002) next analyzed the different CAI implementations and found the most effective use of CAI was simulations and the second most effective was tutorial. Using CAI for drill and practice in the science class actually had a negative effect on achievement. Other implementations that were found more effective were software developed by the experimenter/teacher rather than commercial software and using the

computers as a supplement to instruction rather than a replacement for regular instruction. There was no difference in effect size when examining the school level, and CAI was most effective when the duration of use was four weeks or less. Overall, Bayraktar (2002) determined the best implementations for CAI were to use it as a supplement to traditional instruction.

Mobile Devices

The issue that now arises is to determine if the success of computer technology on raising achievement has translated to success of mobile devices. Within the classroom, there has been a move in the past few years from computer technology to mobile devices, including iPads and Android tablets. According to Kiger, Herro, and Prunty (2012), as these devices become more prevalent, schools are using them to improve student engagement, collaboration, communication among peers and teachers, and to move learning past the walls of the classrooms. For instance, students are using them on field trips to enhance learning outside of the school building. These devices are a cheaper option to computers and provide teachers a viable way to enhance learning. However, this movement should be approached with caution. Melhuish & Falloon (2010) warn the device should not become the focus in this situation. Instead, “our focus must remain on the way mobile learning can be integrated into effective, evidence-driven, innovative practices, so that the learner is empowered and enriched by the learning experience” (p.13). The researchers go on to state five benefits mobile devices can bring to the classroom. Portability of the device allows students the ability to learn beyond the school desk. The devices are affordable allowing for a larger number of users. They also allow for situated learning opportunities that promote collaboration with others enhanced by the

use of cloud-based computing. The ease of connectivity allows participants to interact with others. Finally, the mobile devices offer the ability to individualize a learner's experience.

Melhuish and Falloon (2010) specifically speak of the mobile device, the iPad, and its potential uses in the classroom. When revisiting the five benefits, the iPad is not only portable but has many of the functions of a computer without the costs of a computer that has the same computing power. The iPad's functionality also allows for a constructivist-learning environment as it promotes collaboration and can provide authentic tasks for students to explore. Its connectivity feature allows students to communicate synchronously or asynchronously in online learning communities. Finally, teachers are able to use the multiple functions, such as the plethora of apps; to create individualized learning opportunities for students.

The search for apps to use in the classroom can be overwhelming to teachers. According to Larkin (2014), although there are many apps available, teachers must determine which are of high quality and will promote understanding of the content rather than essentially being flash cards in a digital format. The information given in the app store is often not enough to make those decisions resulting in frustration of teachers with locating appropriate technological tools for instruction. In the area of science, the iPad apps can provide an experience students cannot receive from traditional resources. For instance, in the area of life science, there are many apps that allow students to examine the brain and cells by rotating and zooming in on key components to create a better understanding of the workings of the human body than still pictures in a textbook can provide (TCEA, 2016). Beyond apps, there are other technological resources for teachers

to use in the classroom with the iPads. Hohenwarter and Preiner (2007) discussed Geogebra, a dynamic geometry software, which allows students to view concepts through two representations, graphically and algebraically, to help develop a deeper understanding of the mathematics being studied. This program is available for use on the iPad giving students a virtual way to explore mathematics.

As the push for mobile devices continues, schools must ensure the use of the iPad is based on sound research-based practices. However, limited research is available to show the effects of this mobile device on student achievement. The following address some of the studies involving the iPads in educational settings.

iPad Use in a University Setting- Mathematics Classroom

As mentioned earlier, Fisher et al. (2013) noticed a deficiency in research that addressed the usage of iPads in the classroom. As a result of this, the researchers completed a project in a university setting by studying the use of the iPads versus laptops in a business calculus classroom. They based their research on Vygotsky who “recognizes that the process of learning is inherently social and our interaction with others is central to our development as a learner” (p.167). They also relied on activity theory when collecting data by focusing on collaborative learning rather than individual learning. They looked at how the iPads were being used as students interacted in groups. Data was collected through observations, focus groups, and surveys. Through coding of the observations, they found there were three tiers of how the technology was used: multi-use, multi-view, and single-use. Multi-use involved multiple students using one device to complete activities. Multi-view involved one student sharing his work on the iPad with other students. In the case of single-use, the students discussed their work on

the iPad but did not show the evidence to others. Through the surveys and focus groups, Fisher et.al. determined how students were using the technology during the instructional unit.

Fisher et al., (2013) found through the observations that students with iPads incorporated them in almost all interactions with other students whereas the laptops were only brought into this type of learning environment approximately half the time. The iPad group was more willing to share screens and look at each other's devices during the learning. Another difference found was 7.5% of the time the laptop group was off task compared to 0.8% of the iPad group. The openness of the iPad screen and the inability to have multiple windows open may have contributed to this result. The surveys showed students felt the iPad was more conducive to showing work and justifying their actions to groups and the class. Survey responses showed 82% of the iPad group used the technology to show information to classmates versus only 47% of the laptop group. Also, 53% of iPad group took advantage of the device for reading materials but only 16% of the laptop group used it for this reason.

Fisher et al., (2013) found iPads could be used not only for calculations but also for collaboration among students. It enabled the participants to explain their reasoning behind how they solved a problem and to share and defend their work to their peers. The Common Core State Standards (CCSSI, 2010) for mathematical practice states students will “construct viable arguments and critique the reasoning of others” (p. 298). They found students benefited from sharing their knowledge by being the teacher for others. This helped to strengthen their understanding of the mathematical content. The iPads

served “as a public center of communication in which multiple students can view, discuss, and interact with the device simultaneously” (Fisher et al., 2013, p.176).

As more emphasis is placed on creating constructivist-oriented learning environments that encourage rich discussions among participants, this study was beneficial because it is one of the first to focus on how iPads can be used to enhance collaboration and communication in the classroom beyond the abilities of a laptop. This new technology revealed the many benefits to incorporating it into a student-centered learning environment at the college level. More research will need to be completed to find if its benefits transfer to the K-12 level of education.

iPad Use in the Fifth Grade- Mathematics Classroom

Castelluccio (2010) found teachers are beginning to use the iPads to engage, introduce, practice, and reinforce learning concepts. Castelluccio stated, “The iPad has specialized applications in which multiple sense (e.g., auditory, visual, and tactile) are incorporated; the use of multiple sensory inputs has been shown to reinforce student learning and to achieve a variety of mathematics objectives” (as cited in Carr, 2012, p.270). To add to the scholarly research, Carr (2012) completed a study with fifth-graders researching if iPads affected mathematics achievement when used for game-based learning.

Carr’s (2012) quasi-experimental study was conducted with two 5th grade classes in which the experimental group used the iPads as one-to-one computing devices daily during mathematics class for nine weeks. A pretest/posttest was used to analyze if the iPads had a positive effect on student achievement. Using ANOVA to analyze the data, the experimental group saw a 6.74% increase in pretest to posttest scores whereas the

control group saw a 6.67% increase. This difference was not large enough to be deemed significant.

Carr's (2012) findings showed iPads did not have a significant influence on students' mathematics achievement. When listing limitations, she stated students in the study had limited access of the iPads, which may have played a role in the findings. Carr's research highlighted some of the issues of technology availability and the possible impact it has on instruction. Suggestions for future research were to conduct studies where the students have 24-hour access to the technology, increase in the intervention duration, using a larger sample size, and collecting qualitative data. Carr stated the verdict for one-to-one devices has been mixed thus far. As more implementation occurs, more studies are needed to determine the benefits of iPad use in the mathematics classroom.

iPod Touch Use in the Third Grade- Mathematics Classroom

With limited research on iPad use to examine, one study that can provide a glimpse into its usefulness is Kiger's et al., (2012) research with third grade mathematics achievement using the iPod Touch technology. Although the iPod Touch has limited capabilities compared to the iPad, it has similar technological features. This nine-week project used iPods to promote a mobile learning intervention (MLI) to practice multiplication skills through multiple available math apps. The following research questions were addressed.

1. Does participation in the MLI explain a significant amount of variation on a post-intervention multiplication test controlling for several covariates

including prior student achievement? If so, what is the influence of the intervention relative to the control variables?

2. Does participation in the MLI explain a significant amount of variation on the most difficult post-intervention multiplication items controlling for several covariates, including prior student achievement? If so, what is the influence of the intervention relative to the control variables? (p. 64)

Kiger's et al. (2012) study was conducted in four classrooms in which two practiced math facts by using flash cards each day and the other two practiced using math apps downloaded onto iPod Touches. The findings showed the MLI students outperformed the other students on the multiplication posttest with the effect size being a significant 0.22 indicating a small effect. "MLI participation was the most influential 'explainer' of test performance excepting the pretest" (p. 75).

The Kiger et al. (2012) study in contrast to Carr (2012) showed a positive effect on student's mathematic achievement. With multiple studies finding conflicting results, this reinforces the need for more research of its use in the classroom.

iPad Use in the High School- Science Classroom

Physics courses enable students to apply the mathematics they have learned in meaningful ways. Students use analytical skills to solve word problems that can represent real world situations and begin to understand the background of many of the technological advances we use today. Success in physics can help open the doors to many STEM careers for our students. The question in the next study was whether iPads could facilitate that success. Through a project called iPad Enhanced Active Learning (iPEAL), Van Dusen & Otero (2012) set out to determine the effects iPads would have on students'

interactions with and relationships to physics. The study was conducted with five high school physics classes consisting of approximately 140 junior and senior level students. The project provided a classroom set of iPads and activities designed to supplement the traditional physics assignments. For example, the students used the iPads to create screencasts of how to solve problems from the textbook.

Van Dusen and Otero (2012) based their research on the idea that if a learner is actively engaged in something personally meaningful, then learning is more likely to occur. The study was focused on providing a positive experience in physics class by incorporating the iPads into instruction. Through the use of field notes, artifacts, video recordings, student surveys, and student interviews, the researchers found the iPads had an effect on four specific areas. First, by using iPads for data collection, analysis, and collaboration, the students were able to construct their own learning based on evidence they collected rather than knowledge from the teacher or book. Secondly, the iPads created excitement for learning and students began to come to work on physics projects outside of class time. Thirdly, the iPads increased student agency as students used the screencasts to take more responsibility for their own learning. Finally, students experienced an impact on their social status of being a member of this learning community as others verbalized a desire to be part of their learning community.

Van Dusen and Otero (2012) concluded the iPads created an environment that promoted a positive relationship between students and physics. This could set up a situation where the students would continue to enroll in future physics courses.

iPad Use in a One-to-one Environment

As schools move to more technology-infused environments, one of the biggest

technological changes in education today is the implementation of one-to-one programs. These programs can be loosely explained as every student having their own device such as a laptop, iPad, or another tablet device to be used at home and school; however, the school largely defines the organization of that implementation. Penuel (2006) stated the policies vary among institutions. Some may have all students buy the same device, while others may have devices student rent or lease for the school year. Others may have students check them in and out each school day but not take them out of the school building. Another option is to follow a bring your own device (BYOD) policy where students may choose the best option for them. However, in each case, there are three common characteristics: students each have a device, Internet is provided through wireless access, and the devices are used for academic tasks such as completing homework and assessments and for presentations. Overall, “ubiquitous, 24/7 access to computers makes it possible for students to access a wider array of resources to support their learning, to communicate with peers and their teachers, to become fluent in their use of the technological tools of the 21st century workplace” (p.332).

One-to-one Tablet Initiative Private Middle School Program

Oliver and Corn (2008) completed a study to measure differences in students’ technology use and skills after a one-to-one tablet initiative with middle-school students. In this research project, participants were students in the sixth through eighth grade at a private middle school in the US who completed a survey before and after participating in a one-to-one program for a year. The survey asked questions about how satisfied they were with technology use at their school, their technology experiences in the classroom, how it was used in the different content areas, and their technology skills. A control

group also completed the surveys, as well. The researchers completed observations of the classrooms to collect data on how the technology was being implemented.

Oliver and Corn (2008) found students in the one-to-one group were more satisfied with the technology use at their school, more time was spent in class using technology, and significantly more frequent use of technology in the mathematics and science classes. Observations showed more project-based learning, teachers acting as coaches, and student-centered projects assigned. However, teacher-centered instruction was still the most common approach to teaching in the classroom. Even with one-to-one technology, teachers were still not using them to create learner-centered environments that would encourage collaborative learning.

One-to-one iPad Initiative PreK-4th Grade Program

One-to-one technology integration is appearing not only at the secondary and university level, but also in our elementary schools. Milman, Carlson-Bancroft, & Boogart (2012) analyzed the implementation of a one-to-one iPad program at a PreK-4th grade school. They researched how teachers and students were using the iPads for teaching and learning, specifically how they were being used for differentiation and how they were used across content areas.

Milman's et.al. (2012) mixed methods study collected data by completing 68 observations for a total of 50 hours, and by collecting surveys. Although the study is in the preliminary stages, they have found the use of iPads have netted the following results. Student engagement has been very high and helped with attention issues of the students. Even after months of use, students were still excited to participate in lessons that incorporated the iPads. Also, the observations showed teachers taking a facilitative

approach to teaching when the iPads were in use. Students showed a collaborative spirit as they assisted each other with activities. Finally, all teachers were able to use the iPads to differentiate instruction in their classrooms. Overall, the iPads were being successfully incorporated into instruction to provide for an engaging, personalized learning experience.

One-to-one iPad Initiative Private Middle/High School Program

Heinrich (2012) at the Longfield Academy in Kent, England conducted research of the students at the school who were participants in a one-to-one iPad initiative. The school has approximately 960 students in year 7 to year 13 and 76% of the students have iPads. The school's goal of the one-to-one program was to provide students with engaging lessons, the ability to use technology in every lesson, and for the technology to improve learning. The academy's research done prior to the one-to-one implementation showed iPads were a significant tool to support learning (Learning Exchange, 2011), students preferred it to a laptop and it aided learning (Glicksman, 2011), the device was beneficial for note taking (Vrtis, 2010), and encouraged group collaboration (Garcia & Friedman, 2011). Heinrich pointed out most of the research available was based on class sets of the devices rather than a one-to-one setting. Their study strived to determine the implications of all students having their own device. Surveys were collected from students, teachers, and parents to determine the success of the program.

Heinrich (2012) first found the implementation of the iPads into instruction to be abundant. 84% of students reported iPad use in one to ten lessons per week with 27% of those stating use in 6 to 10 lessons per week, and 12% reporting iPad use in the majority of lessons. Teachers corroborated those numbers by 80% reporting use in 1 to 10 lessons,

38% in 6 to 10 lessons, and 17% using the technology in the majority of their lessons. It was found the majority of the lessons were in English, math, and science and determined offering these devices in a one-to-one environment played a significant role in how much the devices were being used.

Heinrich (2012) identified three main implementations of the iPad: researching topics online, using mind-mapping tools, and creating presentations. The devices were also used for traditional activities such as word processing and watching videos. Collaboration was also an aspect used frequently with 42% of students and 52% of teachers reporting the use of collaboration. When students were asked what were the benefits of using an iPad compared to the pre-iPad classroom, some of the responses were easy internet access, making movies, educational games, mind mapping, apps for learning, communication with teachers, creating and delivering presentations, and annotation of texts. Heinrich reported, “There is a clear message that students regard the iPad as a tool that enables them to work more efficiently and thus, by extrapolation, more productively” (p.23). When teachers were asked how the iPads had changed their setting, they stated the personal benefits were the ability to create podcasts, easier lesson planning and sharing of resources. The classroom benefits were creating engaging lessons for students, immediate research capabilities, ease of differentiating instruction and immediate feedback for students of learning.

Overall, Heinrich (2012) found 90% of students reported being happy with the use of iPads for learning and 77% of teachers were happy to regularly use them. Both participant groups felt they could work more effectively with the iPads and their level of collaboration had improved. In the end, it was reported the devices had a significant and

very positive impact on learning and teaching, and there was an expectation the impact would be noticeable in future achievement.

One-to-one Laptop Initiative Middle School Setting

With the lack of studies completed addressing the effect of one-to-one iPad's on academic achievement in the middle school mathematics and science classroom, Dunleavy's and Heinecke's (2007) study can be used to shed some light on the benefits of a one-to-one program. They conducted research in a middle school that used Apple iBooks laptops as their mobile devices. The urban school in the study had 972 students in grades six through eight, a percentage poverty of 59.67 and a percentage minority of 87.20. As the students entered sixth grade, approximately one third of the students were randomly assigned to the one-to-one program. The students were allowed to use the devices in every class and take them home during the week. However, devices were required to be left at school on the weekends.

Dunleavy and Heinecke (2007), by using a pretest-posttest control-group design, analyzed the effects of the laptop implementation on eighth graders who had used the technology for two years. The students' fifth grade pre-existing mathematics and science achievement scores on the state standardized test were used as the covariate to equate the treatment and control groups. Using ANCOVA, the researchers used the scores on the eighth grade standardized test to determine any effects as a result of the intervention of the one-to-one program. The participants in their study consisted of 54 students in the treatment group and 113 students in the control group.

Dunleavy and Heineche (2007) had three main findings from the analysis. First, after accounting for differences using the pretest scores, the laptop initiative was found to

have a small, significant, positive effect (0.24) on the science posttest scores. Secondly, this effect was found to be more significant for males (0.55) than females (0.04). Finally, in regards to mathematics, the laptop treatment had no significant impact on achievement.

In discussion, Dunleavy and Heineche (2007) brought up some interesting questions to be addressed in future studies. With a significant effect on students' science achievement found, why does that not carry over to mathematics? Was the technology implemented differently in science class or were there possibly more technological resources available for science content? Why was the positive effect in science found to be larger in males than females? Although this study helped to shed light on whether one-to-one programs have a place in education, it also leaves a need for more research in this area.

Gender

Gender differences in the middle school classroom have been researched for many years. Hyde and Linn (2006) conducted a review of meta-analyses to determine gender similarities in multiple areas including mathematics and science. For mathematics, they examined 100 studies and found there was no significant difference, overall, in performance of girls and boy. There were a few subcategories though with significant results. For one, girls outperformed boys on computation in elementary school and middle school (-0.20), but there was no difference when examining understanding of deeper mathematical concepts and complex problem solving. However, there was a small significant result (0.29) for boys outperforming girls in complex problem solving. Hyde and Linn (2006) stated the similarities in mathematics achievement are mirrored by the

fact that, in 2001, women earned 48% of the bachelor's degrees in mathematics in the United States.

To determine gender differences in science, Hyde and Linn (2006) examined the National Assessment of Educational Progress (NAEP) that provides information of approximately 100,000 students at the fourth, eighth, and twelfth grades in the US. They found boys performed significantly better than girls at the fourth grade level with a small effect of 0.12 and again at the twelfth grade (0.11); however, the researchers pointed out that increasingly large sample sizes make it easier to detect increasingly small differences. They stressed the point that these were both small effects found in rather large populations and posed, "The NAEP data provide better evidence for gender similarities in science achievement than they do for gender differences" (p.600). The National Center of Education Statistics (NCES, 2016) stated the small effect has not significantly changed. In 2005, fourth grade boys scored a little less than four points higher than girls, in 2009 the difference was four points and in 2011 it was five points.

The 2011 Trends in International Mathematics and Science Study (TIMSS) report showed some results in conflict with Hyde's and Linn's (2006) meta-analysis. In the area of mathematics, at the 4th grade level, US boys significantly outperformed girls by 9 points. However, by 8th grade, there was no significant difference in scores between boys and girls in the US. When analyzing science scores, at the 4th grade, boys outperformed girls by 10 points and there was still a significant difference at the 8th grade, with boys scoring 11 points higher than girls.

To bring a different perspective than standardized test scores to gender differences, Voyer and Voyer (2014) conducted a meta-analysis to determine if there was

a gender difference in teacher-assigned school marks. From 369 samples, they collected 502 effect sizes from studies conducted at the elementary, middle, high school, and university level. They found that girls scored significantly higher than boys with an effect size of 0.07 in mathematics and an effect size of 0.15 in science. Overall, they concluded when using school marks to determine academic achievement, girls perform significantly higher than boys.

Summary

Throughout the last decades, technology has flourished in our schools and more emphasis has been placed on creating student-centered environments that follow the tenets of Constructivism. The research questions focus on whether using iPads in a one-to-one middle school setting has a positive effect on mathematics and science academic achievement and whether a teacher's perceived use of constructivist strategies contributes to that achievement.

A constructivist style of teaching was shown to be effective at the 5th and 6th grade levels. Wu and Tsai (2005) showed in a 5th grade science class setting, the constructivist group had better learning outcomes than the traditional group. Kim (2005) showed through the 6th grade mathematics study that the constructivist group outperformed the traditional group. In both instances, academic achievement was significantly higher for those students learning in a constructivist setting. Ayaz and Sekerci (2015) mirrored these individual studies with a meta-analysis that showed strong effect sizes for using a constructivist approach in the classroom, with the strongest effects found at the high school and college level.

Through the use of meta-analyses, Bayraktar (2002) found CAI was significantly more effective than traditional instruction when analyzing 42 studies of high school and college level science classes. Li and Ma (2010) discovered the same results in the area of mathematics and not only did CT have a positive effect on mathematics achievement but it also had larger effects when paired with a constructivist-learning environment.

With the previous studies showing positive effects of a constructivist learning environment and the use of computer technology on mathematics and science academic achievement, research is now needed to see if that effect translates to the use of iPads in a one-to-one setting. Research has shown the use of iPods positively effected mathematics achievement when used in the classroom (Kiger et al., 2012); however, there have not been many studies completed on the iPads effects, especially in a one-to-one setting. The research of one-to-one iPads have focused mostly on analyzing students' and teachers' perceptions of the technology and how the iPads are being implemented with little research conducted on actual achievement scores (Oliver and Corn, 2008; Milman et al., 2012; Heinrich, 2014). Research on one-to-one settings with laptops has shown this type of implementation is effective in raising science achievement (Dunleavy and Heineche, 2007).

A key component to a one-to-one initiative, though, is our teachers' abilities to create effective technology-infused classrooms. Koh et al. (2014) showed not all teachers have the strong C-TPACK necessary to successfully implement technology into a constructivist-learning environment, especially those who have been teaching for a long period of time and those teaching at the elementary level.

This study examined if there were any gender differences that occurred in achievement in the classrooms. Hyde and Linn (2006) found there were no overall differences with mathematics and small significant effects of boys outperforming girls in science. NCES (2016) showed the small difference has continued but not significantly changed up to 2011. The 2011 TIMMS report showed no significant difference in 8th grade boys and girls in mathematics but there was a significant difference in science with boys outperforming girls. Voyer and Voyer (2014) added that when analyzing school marks rather than standardized tests, girls scored significantly higher than boys.

The research is designed to analyze the MAP test scores of middle school students who have participated in a one-to-one iPad initiative in their school. By looking at the iPad initiative, gender, and the perceived use of constructivist teaching strategies in the classroom, it is the intention that this study will contribute to the research available addressing the effects, if any; a one-to-one iPad environment has on mathematics and science achievement.

CHAPTER III: METHODOLOGY

The purpose of this study is to examine the effects, if any, of a one-to-one iPad initiative on student achievement in the middle school mathematics and science classrooms. The research will seek to investigate the following questions:

1. What effect, if any, does implementation of a one-to-one iPad program have on student achievement in the mathematics and science middle school classrooms?
2. What effect, if any, does a teacher's perception of his or her use of a constructivist teaching style have on student academic achievement in the mathematics and science middle school classrooms? What effect, if any, do the teachers' characteristics have on the students who made the most gains in achievement?

Research Design

The comparison study examined three schools and their technology use in the middle school mathematics and science classrooms over participants' 6th and 7th grade years. By collecting data at multiple time points over a two-year period, the project examined if a one-to-one iPad program significantly affected students' growth in mathematics and science academic achievement. A comparison study analyzes an event that has already occurred by determining if an independent variable affected an outcome (Brewer & Kubn, 2010). This type of survey method does not allow for randomization of participants and was preferable for the study since random assignment of participants by the researcher was not possible.

Achievement test scores in mathematics and science were collected from all students. These scores measured academic achievement over the two-year period at up to six time points for each student. Participants were drawn from three schools. Two of the schools had implemented a one-to-one program where all middle school students had their own iPads for school and home use. The third school used computers on a limited basis in the classroom and in a computer lab at the school. The participants, both students and teachers, at the two one-to-one iPad schools were invited to complete surveys to determine the frequency, ease, and type of use of the iPads during instruction. The participants, both students and teachers, at the third school completed a survey addressing frequency, ease, and type of computer technology used at their school. A survey was administered to the teachers to determine teachers' perceptions of the use of constructivist teaching strategies during instruction. This survey was used to provide data for the second question of the project as to whether teachers' perceptions of their use of constructivist teaching strategies affected students' achievement scores.

For this project, the data was analyzed using a two-level hierarchical linear model (HLM) with a hierarchical structure of data with repeated measures nested within students. Raudenbush and Bryk (2002) explained that when using repeated measures, data is collected at different times and then nested within study participants (as cited in Woltman, Feldstain, MacKay, and Rocchi, 2012, p.52). SPSS, a statistical package for the social sciences, was used to prepare the data for the HLM software and to analyze the residual files to determine the top twenty-five students in regards to initial statuses and growth.

Population

The study examined the current 8th grade students at three private middle schools. The researcher of this study was one of the mathematics teachers that participated in the study. The research site was a private school district located in the Southeast portion of the US. The three PreK-8 schools are all of similar size, ranging from approximately 400 to 530 students per school. Two of the schools have used iPads as a one-to-one device for at least the last two years. The third school periodically used computers in the classroom and in a computer laboratory setting but has not implemented a one-to-one program with any type of technological device.

A total of 112 students served as the participants of the study that examined data from the 2013-2014 and 2014-2015 school years. If a student was not at the school for both years, he was removed from the study. Ten of the thirteen teachers (77%) of mathematics and science at the middle school level, one being the researcher, completed the survey addressing their perceptions of how frequently they use constructivist-teaching strategies in their classroom. The teachers and the students were invited to complete a survey identifying the frequency of use and the ways the iPads or other technology were implemented in instruction. Ten of the teachers (77%) chose to complete the survey as well as eighty-six (77%) of the students.

The students at the two iPad schools were part of a one-to-one initiative in which every student began using an iPad at the beginning of 6th grade at school as well as at home. The two iPad schools had 29 students at one school and 50 students at another, for a total of 79 participants who used iPads in a one-to-one setting. The third school that did

not use iPads had a total of 33 student participants. This was a convenience sampling since the students participating were chosen due to their school attendance choice.

In mathematics, the students covered the sixth and seventh grade Common Core State Standards for Mathematics (CCSSM, 2010) as well as various algebraic topics. None of the students were taking Geometry during the sixth or seventh grade years. In science, the students followed the Next Generation Science Standards (NGSS, 2013) by covering physical and life sciences in the sixth and seventh grades.

Instrumentation and Reliability/Validity

NWEA MAP Test

There were three types of instrumentation used in the research project. First, test scores from the Measure of Academic Progress (MAP), a computer adaptive test, developed by the Northwest Evaluation Association (NWEA), were used to measure students' growth by points on the RIT scale. The RIT scale score is based on the Rasch Unit scale that is an equal interval vertical scale. The MAP, through the use of computer-based adaptive assessment technology, measures individual student achievement, calculates student growth, and compares students' growth to other students (NWEA, 2013). Thorndike and Thorndike-Christ (2010) explained a computer-based adaptive test uses item response theory (IRT) as its basis, which "assumes the existence of a relatively unified underlying trait that determines an individual's ability to succeed with some particular type of cognitive task" (p.108). The trait can then be represented on a linear scale where people are placed in ordered sequence. Adaptive testing uses questions from a bank where each question has been assigned a difficulty level. It then adjusts the difficulty level of the test tasks to the student's ability. The test starts by giving a test

question labeled at a 50% difficulty for the grade group and then raises or lowers the difficulty based on the student's response.

The study examined the mathematics and science MAP scores for the 2013-2014 and 2014-2015 school years of students who completed 6th and 7th grade during that time period. The MAP assessment is designed to measure students' achievement at multiple points during the school year. The testing window for the MAP to be administered is in the fall, winter, and spring giving up to six achievement scores for each student in each of the areas of mathematics and science over a two-year period.

NWEA MAP Test Reliability and Validity

The NWEA (2004) used a combination of the test-retest and type of parallel forms to address reliability over time by analyzing Pearson correlations. Both types were administered over a seven to twelve month time span. Most coefficients were in the mid .80's to the low .90's with only two tests falling slightly below the acceptable .80 level. To determine the internal consistency of test items, the NWEA used the test characteristics; test information and RIT scale score, to calculate the marginal reliability coefficient. This resulted in consistency almost equal to coefficient alpha.

The NWEA (2004) addressed content validity by choosing test items that matched the content standards of the school district or state. It also took care to choose items that had a uniform distribution of difficulties. Two tests were given to students approximately two to three weeks apart and a Pearson correlation coefficient was used to determine the strength of correlation between the two tests with mid .80's considered a strong relationship.

Teacher Constructivist Strategies Survey

Secondly, a teacher survey was administered that measured teaching styles. After not finding an appropriate survey, Henry (2003) created one designed to measure the use of constructivist and traditional teaching strategies. She used the survey to measure the correlation between constructivist teaching strategies and academic performance in the middle school. Henry found constructivist-teaching strategies did not have a significant effect on students' academic performance on the Florida Accountability scale. However, there was a positive correlation between the use of constructivist-teaching strategies and class size meaning the larger the class size the more frequent use of constructivist teaching strategies. Also, there was a negative correlation between constructivist teaching strategies and the number of behavior referrals per year indicating that the more constructivist teaching strategies were implemented in the classroom the less behavior referrals were submitted.

The Henry (2003) survey was administered to teacher participants in the present study to determine teachers' reported perceived use of constructivist teaching strategies in the classroom. The survey addressed three main topics- classroom management, teaching activities, and assessments. The questions identified with either constructivist or traditional teaching styles and asked participants to answer based on the Likert scale of 5 = Always, 4 = Frequently, 3 = Sometimes, 2 = Rarely, 1 = Never. The assignment of questions was as follows: 13 items addressing classroom management styles, 29 items addressing teaching activities, and 15 items addressing assessment strategies (See Appendix A).

Teacher Constructivist Strategies Survey Reliability and Validity

Henry (2003) created the survey by using “teacher forums, instructional strategy textbooks, the CRISS Manual (Santa, Havens, & Maycumber, 1998), the SHINES Manuel (Finger, 1999), the National Board Professional Teaching Standards (NBPTS, 2002) and reference books including Bruce Marlowe and Marilyn Page’s *Creating and Sustaining a Constructivist Classroom* (Marlowe & Page, 1998)” (p.34). Henry addressed content validity by having a focus group of sixteen middle school teachers categorize individually and collectively each survey item as either constructive or traditional. Following that, five experts in the field of instructional strategies approved of the survey items and agreed the items were grouped in the correct categories of classroom management, teaching and learning activities, and assessment. A correlation analysis between scales was conducted to address construct validity. The analysis showed a positive correlation between traditional teaching style items and a negative correlation between traditional and constructivist styles, as well as constructivist items showing a positive correlation with other constructivist items.

Henry (2003) addressed reliability by using Cronbach’s Alpha to determine each item’s association with other items. After deleting some items that detracted from internal consistency, all remaining items resulted in reliability estimates greater than or equal to an alpha of .60.

Teacher and Student Surveys of Technology Use

Thirdly, the researcher created a survey that addressed the frequency of use, ease of use, and type of use of the technology, and their opinions of whether the use was beneficial to learning. The students were asked how often they used the technology in

mathematics and science classes (daily, two to three times a week, once a week, one to three times a month, or rarely), how easy was it to use (very easy, somewhat easy, difficult, very difficult), and did they feel the technology helped them learn in mathematics and science classes (definitely helpful, helpful sometimes, helpful on rare occasions, not helpful at all). They were also asked what were the two most common ways the technology was used in the mathematics and science classrooms (See Appendix B).

The teachers were asked how often they used the technology in their mathematics or science class for instructional purposes (daily, two to three times a week, once a week, one to three times a month, or rarely), how often the students used the technology in their classes (daily, two to three times a week, once a week, one to three times a month, or rarely), how easy was it to use (very easy, somewhat easy, difficult, very difficult), and did they feel the technology helped the students learn in mathematics and science classes (definitely helpful, helpful sometimes, helpful on rare occasions, not helpful at all). They were also asked what were the two most common ways the technology was used in their classrooms, how many years of experience they had and their current teaching certification and rank (Appendix C). In the state of Kentucky, teachers are considered Rank III with a bachelor's degree and teaching certificate, a Rank II with a master's degree, and a Rank I with 30 approved graduate or equivalent continuing education hours past a masters.

Research Design Reliability and Validity

There are validity and reliability issues when using HLM and a comparison design. With a comparison design, groups are not randomly assigned, meaning there can

be differences in how the students are allocated. Also, the characteristics of the setting may pose a threat. In this study, the settings are all small, private, suburban schools; thus generalizations to other school settings may not be appropriate (Creswell, 2009). When using HLM, there are steps to take when addressing validity. Group mean centering was not used since the groups do not differ dramatically. Another issue with validity is the small amount of participants involved in the study. To reach adequate power, HLM requires a large sample size (Woltman et al., 2012). To address assumptions in HLM, descriptive statistics were observed to identify any values that may be a potential problem. Level 1 residuals were checked for normal distribution (Anderson, 2012). With a population including 112 students and 10 teachers, validity is compromised. As a result, inferences drawn for this school district may not translate well to larger populations.

Analysis

HLM allows for the analysis of repeated measures to be nested within the students. Following are the level one and level two variables used to analyze the MAP achievement test score data.

Level 1 Variables

The MAP scores provided up to six measures of mathematics achievement and six measures of science achievement for each student that served as the continuous outcome variables for the study. In HLM, outcome variables are always at the first level of the hierarchy. Students were not eliminated if they did not have six scores since HLM allows for missing data at the first level (Woltman et al., 2012). MAP scores were entered using grand mean centering since MAP scores do not have a true zero point.

Level 2 Variables

The study was originally designed to use the student characteristics of attending or not attending one of the iPad schools, gender, and socioeconomic status (SES) as the level-two predictor variables. Socioeconomic status was determined by identifying those students who qualified for the national free or reduced lunch program. After identifying these students, there were only 6% of the participants who fell into this category so SES was removed from the list of student characteristics. The remaining predictor variables of iPad use and gender were treated as dichotomous variables.

Table 3.1

Variables for Hierarchical Levels

Hierarchical Level	Hierarchical Level Description	Variables
Level-2	Student Level	iPad use in a one-to-one setting Gender
Level-1	Repeated measures	MAP scores in mathematics and science over the students' 6 th and 7 th grade yrs.

HLM was then used to determine if there was growth over time in mathematics and science academic achievement among students and whether student characteristics could predict academic growth. The level- 1 model (shown below) analyzed whether students varied significantly in their initial status and growth across six time points in mathematics and science achievement. The model for this portion of the analysis was as follows:

$$Y_{it} = \pi_{0i} + \pi_{1i}*(TIME_{it}) + e_{it}$$

Within this model:

Y_{it} = outcome (MAP scores)

t = time

i = individual students

π_{0i} = is the intercept, representing initial status

$\pi_{1i}*(TIME_{it})$ = slope, in respect to time

e_{it} = the random effect of student i with time t

After analyzing the level-1 model, the predictors of gender and iPad usage were introduced to determine their ability to predict growth in students' mathematics achievement. The model for this portion of the analysis was:

$$Y_{it} = \beta_{00} + \beta_{01}*SEX_i + \beta_{02}*IPAD_USE_i + \beta_{10}*TIME_{it} + r_{0i} + r_{1i}*TIME_{it} + e_{it}$$

With this model: β_{01} , β_{02} , and β_{10} serve as slopes for sex, iPad use, and time respectively along with β_{00} serving as the intercept and the error terms listed for the model.

A full model was not created for science since the null model showed students did not vary significantly in their growth in the science classroom.

Further Analysis

Upon completion of the HLM analysis, the survey responses of the teachers' perceptions of constructivist strategies and the student and teacher surveys addressing uses of the technology were examined using descriptive statistics to gather a broader picture of the learning environments that HLM could not provide. Following, the top 25 students with the highest initial status and the top 25 students who showed the highest growth in points on the RIT scale in both mathematics and science were identified using the residual files created from the HLM software. Those students were then identified by

iPad use, gender, and teachers to examine how those characteristics were represented in the sample.

CHAPTER IV: ANALYSIS

The analysis for this study was conducted in four parts using the data from 112 students and 10 teachers from three different schools, two of which were part of a one-to-one iPad initiative (Table 4.1). First an HLM analysis was conducted to determine if iPad use had any effect on growth in points on the RIT scale for academic achievement in the area of mathematics over students' 6th and 7th grade years. Secondly, the same HLM analysis was conducted for students' growth in points in the area of science. Next, the teacher constructivist teaching strategies survey and student and teacher use of technology surveys were examined using descriptive statistics. Finally, the HLM residual files were used to identify the top twenty-five students who had the largest growth in points in either mathematics or science. The students were then identified by the characteristics of iPad use, gender, teacher and inclusion in the top twenty-five students with highest initial status. The goal of this portion of the analysis was to determine if there were specific characteristics evident in the students with the largest growth in academic achievement.

Table 4.1

Descriptive Statistics of Student and Teacher Participants

	<i>Frequency</i>	<i>%</i>
School Participants		
School A (iPad)	29	25.9
School B (iPad)	50	44.6
School C (Non-iPad)	33	29.5
Total iPad Users	79	70.5
Total non-iPad Users	33	29.5
Student Gender		
Female	52	46.4
Male	60	53.6

Table 4.1 continued

Teacher Participants		
School A (iPad)	5	50.0
School B (iPad)	2	20.0
School C (Non-iPad)	3	30.0
Total iPad Users	7	70.0
Total non-iPad Users	3	30.0
Teacher Gender		
Female	9	90.0
Male	1	10.0

Mathematics Achievement

The first data set included 112 students with up to six mathematics achievement scores over the 2013-2014 and 2014-2015 school years. Scores were analyzed, first, to determine if students varied significantly in their initial statuses and growth in points. After using grand mean centering for the MAP test scores in mathematics, the level-1 model created by HLM was $MATH_{it} = \pi_{0i} + \pi_{1i}*(TIME_{it}) + e_{it}$.

The null model (Table 4.2) showed students varied significantly in their initial statuses and their point growth across the six time points. There was a positive (0.32), although not strong, correlation between initial status and point growth indicating higher achieving students grew at a faster rate than the lower achieving students. The average initial status, being the fall score of the student's sixth grade year, for the population was 227.49 with an average 3.18 point growth from one time point to the next.

Table 4.2

Results of Null Model of Mathematics Achievement

Table 4.2 continued

Fixed Effect	Coefficient	SE	t-ratio	<i>p</i> -value
Intercept (Initial MAP score) β_{00}	227.49	1.03	221.05	<0.001
For TIME slope, π_1 Intercept 2, β_{10}	3.18	0.12	27.03	<0.001
Random Effect	Variance	<i>d.f.</i>	Chi-square	<i>p</i> -value
Intercept 1, r_0	110.46	111	1439.49	<0.001
Time slope, r_1 level-1, e	0.57 17.40	111	174.01	<0.001

After showing there was significant growth, the predictor variables of iPad use in a one-to-one setting and gender were introduced into the analysis with results shown in table 4.3. Both iPad use and gender were dichotomously coded. The full analysis showed gender and iPad use were not significant in predicting growth. After deleting predictors with the highest *p*-value, it was found all predictors remained insignificant when determining if they were capable of predicting the growth for students. The only significance was iPad use in relation to initial status. Those students who used the iPad had an average initial status of 5.21 points lower than those who did not use iPads. In regards to the first question of the study, it was found that iPad use in a one-to-one setting did not affect students' mathematics achievement for this study.

Table 4.3

Results of Full Model of Mathematics Achievement

Fixed Effect	Coefficient	SE	t-ratio	<i>p</i> -value
Intercept, β_{00}	232.04	2.23	104.14	<0.001

Table 4.3 continued

(Initial MAP score)				
Sex, β_0	-1.59	2.01	-0.79	0.429
iPad Use, β_{02}	-5.40	2.25	-2.40	0.018
For TIME slope, π_1				
Intercept 2, β_{10}	3.23	0.25	12.86	<0.001
Sex, β_{11}	-0.02	0.24	-0.10	0.925
iPad Use, β_{12}	-0.06	0.25	-0.22	0.825
Random Effect	Variance	d.f.	Chi-Square	p-value
Intercept 1, r_0	106.24	109	1367.38	<0.001
TIME slope, r_1 level-1, e	0.60	109	173.95	<0.001

Science Achievement

The second data set included the same 112 students with up to six science achievement scores over the 2013-2014 and 2014-2015 school years. Scores were analyzed, first, to determine if students varied significantly in their initial statuses and growth in points. After, using grand mean centering for the MAP test scores in science, and dichotomously coding gender and iPad use, the HLM analysis was first run without the predictors to analyze the null model, explained in the methodology.

The null model (Table 4.4) showed students varied significantly in their initial statuses but not in their growth across the time points measuring science achievement. There was a weak, negative correlation (-0.29) between initial status and growth indicating the gap between the high and low achieving students was narrowing. The average initial status was 213.27 with an average growth in points from one time point to the next of 1.42 points.

Table 4.4

Results of Null Model of Science Achievement

Fixed Effect	Coefficient	SE	t-ratio	p-value
Intercept (Initial MAP score) β_{00}	213.27	0.78	272.22	<0.001
For TIME slope, π_1 Intercept 2, β_{10}	1.42	0.12	11.74	<0.001
Random Effect	Variance	d.f.	Chi-square	p-value
Intercept 1, r_0	54.17	111	509.19	<0.001
Time slope, r_1	0.07	111	115.52	0.365
level-1, e	22.68			

After determining growth was not significant for science achievement, a full model analysis introducing iPad use and gender was not conducted. As a result of there being no variance among students, iPad use was not a factor in students' growth in the middle school science classroom.

Teacher Survey of Perceived Use of Constructivist Strategies

The Henry (2003) survey was administered to the teachers to find their reported perceived use of constructivist strategies in the classroom. Ten of the thirteen teachers participated in the survey (77%). Table 4.5 below shows the descriptives and constructivist scores of the ten teachers who completed the constructivist strategies survey. To determine the constructivist score, the mean was calculated using the responses to the questions addressing constructivist approaches to teaching. This analysis was similar to the study conducted by Henry comparing the frequency of constructivist strategies effect on academic performance, student social behavior, and relationship to class size as well as Koh' et al. (2014) study which analyzed the teachers' perceptions of

constructivist-oriented TPACK in relation to teachers' age, gender, teaching experience, and teaching level. Although the study does not have enough teachers to provide a strong analysis, some interesting things emerged that would warrant another study with a larger sample size.

A few things to note, the three teachers with the most experience had the lowest perceived use of constructivist teaching strategies. Also, in regards to education, three of the top four teachers had received a Rank I teaching certificate. In the state of Kentucky, a Rank III signifies the teacher has a bachelors degree and a teaching certificate, a Rank II signifies the teacher has completed a masters in education, a Rank I signifies the teacher has completed 30 hours of approved graduate work or equivalent continuing education past the masters. A final interesting note is four of the top five constructivist strategy scores belonged to science teachers. The implications of these findings will be discussed in the following chapter.

Table 4.5

Descriptive Statistics for Constructivist Strategies Survey

	Subject Taught	Yrs. Experience	Education	iPad school	Constructivist Score
Teacher A	Science	6	Rank II	no	3.58
Teacher B	Science	15	Rank I	yes	3.52
Teacher C	Math	9	Rank I	yes	3.45
Teacher D	Science	14	Rank I	yes	3.35
Teacher E	Science	11	Rank II	yes	3.32
Teacher F	Math	9	Rank II	yes	3.29
Teacher G	Math	3	Rank III	no	3.19
Teacher H	Math	34	Rank II	no	3.16
Teacher I	Math	20	Rank II	yes	2.90
Teacher J	Science	27	Rank I	yes	2.58

When broken down into the three categories of classroom management, teaching activities, and assessment, the weakest category for perceived use of constructivist teaching strategies falls in the area of assessment (Table 4.6). This included not only the type of assessment given but also the freedom given to students to choose their own form of assessment.

Table 4.6

Breakdown of the Total Score of Constructivist Teaching Strategies

	Management	Teaching activities	Assessment
Teacher A	3.71	3.59	3.43
Teacher B	3.71	3.47	3.43
Teacher C	3.57	3.53	3.14
Teacher D	3.43	3.53	2.86
Teacher E	3.86	3.47	2.43
Teacher F	3.43	3.18	3.43
Teacher G	3.57	3.18	2.86
Teacher H	3.14	3.24	3.00
Teacher I	3.14	3.00	2.43
Teacher J	3.00	2.59	2.14

Overall, the teachers at the iPad schools had a mean perceived use of 3.20 with the non-iPad teachers reporting a mean perceived use of 3.31. A non-parametric U test was performed to determine if there was a significant difference between the teachers in the one-to-one iPad schools and those at the other school. It was found there was not a significant difference (U=10, p=0.91). The survey also had questions addressing traditional teaching strategies. Every teacher had a higher reported perceived score of traditional teaching strategies than their constructivist strategy score.

Teacher Survey of Technology Use

The teachers also filled out a survey addressing the frequency of use for

themselves and their students, how helpful they thought the technology was in assisting learning, and the ease of use of the technology. Table 4.8 addresses the responses of the teachers at the one-to-one iPad schools and Table 4.9 addresses the teacher responses from the non-iPad school. The mathematics teachers' and science teachers' data have been combined for this section into iPad users or non-iPad users to ensure anonymity of responses. With this survey, ten of the thirteen teachers (77%) participated.

Teachers were asked to report their technology use and that of their students as daily, two to three times a week, once a week, one to three times a month, or rarely. At the iPad schools, 100% reported students used the iPads either daily or two to three times a week. In contrast, 100% of the teachers at the non-iPad school reported students used a computer rarely. When using the iPads or computers for instruction, 100% of teachers at the iPad schools reported using iPads or computers either daily or two to three times a week. At the non-iPad school, 66% reported using a computer rarely and 33% reported using it once a week for instruction.

When reporting how teachers used the iPads or computers for instruction, there was no clear use that was mentioned more than others. The uses included to create tutorial videos, access edmodo website to share resources and communicate with students, search for appropriate apps, track behavior, and use Socrative, a formative assessment tool. The non-iPad teachers reported using computers to monitor students on Khan Academy, administer MAP tests, show YouTube videos, and search for instructional ideas. When reporting how the students were using the technology, iPad teachers reported the students used the iPads for ixl, edmodo for communication and resources, creating presentations, accessing online textbook, exploring animated models,

taking notes, and using Socrative. The non-iPad teachers reported the students used computers for ixl, Khan Academy, and science research.

Along with their frequency, teachers also reported their opinions on whether using technology helped students learn in class. Teachers chose from the options of definitely helpful, helpful sometimes, helpful on rare occasions, or not helpful at all. Teachers also reported the ease of use by choosing very easy to use, somewhat easy, difficult, or very difficult. With helpfulness, 100% of iPad teachers reported the technology as definitely helpful and 100% of non-iPad teachers reported it as either definitely helpful or sometimes helpful. 100% of iPad teachers reported the iPads as very easy or somewhat easy. 66% of the non-iPad teachers reported the technology as somewhat easy and 33% as difficult to use.

Table 4.7

iPad Teachers' Reported Frequency of Use, Helpfulness, and Ease of Use

	Frequency	%
iPad use by students		
Daily	2	28.6
2 -3 times a week	5	71.4
Once a week	0	0.0
1-3 times a month	0	0.0
Rarely	0	0.0
iPad or Computer use by teachers (for instruction)		
Daily	5	71.4
2-3 times a week	2	28.6
Once a week	0	0.0
1-3 times a month	0	0.0
Rarely	0	0.0
Helpfulness		
Definitely helpful	7	100.0
Helpful sometimes	0	0.0
Helpful on rare occasions	0	0.0
Not helpful at all	0	0.0
Ease of Use		

Table 4.7 continued

Very easy	5	71.4
Somewhat easy	2	28.6
Difficult	0	0.0
Very difficult	0	0.0

Table 4.8

Non-iPad Teachers' Reported Frequency of Use, Helpfulness, and Ease of Use

	Frequency	%
Computer use by students		
Daily	0	0.0
2 -3 times a week	0	0.0
Once a week	0	0.0
1-3 times a month	0	0.0
Rarely	3	100.0
Computer use by teachers (for instruction)		
Daily	0	0.0
2-3 times a week	0	0.0
Once a week	1	33.3
1-3 times a month	0	0.0
Rarely	2	66.7
Helpfulness		
Definitely helpful	1	33.3
Helpful sometimes	1	33.3
Helpful on rare occasions	1	33.3
Not helpful at all	0	0.0
Ease of Use of Technology		
Very easy	0	0.0
Somewhat easy	2	66.7
Difficult	1	33.3
Very difficult	0	0.0

Student Survey of iPad Use

The students completed a survey addressing how frequently they used the iPads in their mathematics and science classes, whether the iPad technology was helpful in their learning process, and how easy it was to use the iPad (Table 4.10). The iPad schools had 62 students (78%) participate in the survey. With frequency, students reported a strong

use of the technology. The students were given the choices of daily, two to three times a week, once a week, one to three times a month, or rarely. In mathematics, 89% of the students responded they used the iPads either daily or two to three times a week. In science, 87% of the students responded they used the iPads either daily or two to three times a week.

Table 4.9

iPad Students' Reported Frequency of Use of iPads

	Frequency	%
Math Frequency- iPads		
Daily	45	72.6
2-3 times a week	10	16.1
Once a week	3	4.8
1-3 times a month	0	0.0
Rarely	4	6.5
Science Frequency- iPads		
Daily	25	40.3
2-3 times a week	29	46.8
Once a week	6	9.7
1-3 times a month	1	1.6
Rarely	1	1.6

Students reported they were using them for a variety of reasons (Table 4.11).

However, the most common uses in mathematics were for accessing their online textbook, completing problems on ixl, a tutorial based mathematics website, and using the iPad's calculator. The most common uses in science were to access their online textbooks, accessing edmodo, an online classroom designed for teachers and students to communicate about assignments, administer and complete assessments, and share documents, and searching the Internet for information.

Table 4.10

iPad Students' Most Commonly Reported Types of Use of iPads

	Frequency	%
Mathematics Classroom		
Online Textbooks	27	43.5
ixl Program	27	43.5
Calculators	17	27.4
edmodo Classroom	14	22.6
Online Assessments	13	21.0
Science Classroom		
Online Textbooks	30	48.4
edmodo Classroom	17	27.4
Web Access for Information	14	22.6
Animations/Interactive Models	11	17.7

Along with their frequency, students also reported their opinions on whether using the iPads helped them learn in class (Table 4.12). Students chose from the options of definitely helpful, helpful sometimes, helpful on rare occasions, or not helpful at all. In mathematics, 94% of the students felt the technology was definitely or sometimes helpful in their learning. In science, 90% of the students reported they felt technology was definitely or sometimes helpful with assisting them in the learning process.

With the iPads, the students reported the ease of use by choosing very easy to use, somewhat easy, difficult, or very difficult. With this topic, 100% of the students reported the iPads were either very easy or somewhat easy to use.

Table 4.11

iPad Students' Reported Helpfulness and Ease of Use of iPads

	Frequency	%
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Helpfulness- Math Class

Table 4.11 continued

Definitely helpful	38	61.3
Helpful sometimes	20	32.3
Helpful on rare occasions	3	4.8
Not helpful at all	1	1.6
Helpfulness- Science Class		
Definitely helpful	38	61.3
Helpful sometimes	18	29.0
Helpful on rare occasions	6	9.7
Not helpful at all	0	0.0
Ease of Use of iPads		
Very easy	48	77.4
Somewhat easy	14	22.6
Difficult	0	0.0
Very difficult	0	0.0

Student Survey of Computer Use (Non-iPad School)

The non-iPad school had 24 students (73%) participate in the survey. The students at the non-iPad school completed a survey addressing computer technology use in the mathematics and science classrooms. With frequency of use, students reported a low use of computer technology (Table 4.13). The students were given the choices of daily, two to three times a week, once a week, one to three times a month, or rarely. In mathematics, none of the students reported daily use and only 8% of the students responded they used computer technology two to three times a week, in contrast to the iPad users' 89%. In science, 0% of the students responded they used computer technology either daily or two to three times a week, in contrast to the iPads users' 87%.

Table 4.12

Non-iPad Students' Reported Frequency of Use of Computers

	Frequency	%
<hr/>		
Math Frequency- computers		

Table 4.12 continued

Daily	0	0.0
2-3 times a week	2	8.3
Once a week	2	8.3
1-3 times a month	8	33.3
Rarely	12	50.0
Science Frequency- computers		
Daily	0	0.0
2-3 times a week	0	0.0
Once a week	0	0.0
1-3 times a month	10	41.7
Rarely	14	58.3

Students were using the computers for a variety of reasons (Table 4.14).

However, the most common uses in mathematics were accessing Khan Academy, a tutorial based website, and accessing other math related websites. The most common uses in science were using computers for research, most often specifically science fair research, and watching science-related content videos.

Table 4.13

Non-iPad Students' Most Commonly Reported Types of Use of Computers

	Frequency	%
Mathematics Classroom		
Khan Academy	12	50.0
Math-related Websites	6	25.0
Science Classroom		
Research	11	45.8
Content Videos	4	16.7

Along with their frequency, students also reported on whether using a computer helped them learn in class (Table 4.15). Students chose from the options of definitely helpful, helpful sometimes, helpful on rare occasions, or not helpful at all. In

mathematics, 84% of the students felt the technology was definitely or sometimes helpful in their learning. In science, 75% of the students reported they felt the computer was definitely or sometimes helpful with assisting them in the learning process. Surprisingly, although these students were not using technology with the same frequency as the iPad schools, they still felt it was a beneficial tool in the learning process of mathematics and science when they had the opportunity to utilize it.

With technology, the students reported the ease of use by choosing very easy to use, somewhat easy, difficult, or very difficult. With this topic, 100% of the students reported the technology they used was either very easy or somewhat easy to use.

Table 4.14

Non-iPad Students' Reported Helpfulness and Ease of Use of Computer

	<i>Frequency</i>	<i>%</i>
Helpfulness- Math Class		
Definitely helpful	4	16.7
Helpful sometimes	16	66.7
Helpful on rare occasions	3	12.5
Not helpful at all	1	4.2
Helpfulness- Science Class		
Definitely helpful	6	25.0
Helpful sometimes	12	50.0
Helpful on rare occasions	4	16.7
Not helpful at all	1	4.2
Ease of Use of Computer		
Very easy	14	58.3
Somewhat easy	10	41.7
Difficult	0	0.0
Very difficult	0	0.0

Top 25 Students- Mathematics

For the next analysis, using the residual files created in SPSS by HLM, the software identified the students with the top 25 initial statuses, being the first MAP score

from the fall of their 6th grade year, and the top 25 with highest growth in points in mathematics. These students were then identified by their gender, whether they were attended one of the iPad schools and who their teachers were during their 6th and 7th grade years. Table 4.16 shows the descriptive statistics of these top 25 students for each category. The students with the top 25 initial statuses had a representation of 11 females (44.0%) and 14 males (56.0%), which was fairly consistent with the total population of 52 females (46.4%) females and 60 males (53.6%) males. However, the representation of students with iPads did not reflect the total population. Although the total participants were 70.5% iPad users, in the top 25 students of initial status, there were only 48% iPad users.

When comparing those numbers to the students who had the largest growth, the following was found. There were 9 females (36%) and 16 males (64%) who placed in the top 25 students with highest growth. This showed slightly fewer females than the population. However, in regards to the proportion of iPad users, there were 16 iPad users (64%) represented in the largest growth top 25, a more representative percentage of the total population.

Table 4.15

Results of Top 25 Students in Initial Status and Growth – Mathematics

Frequency	Initial Status	%	Growth	%
Technology Use				
iPad User	12	48.0	16	64.0
non-iPad User	13	52.0	9	36.0
Gender				
Female	11	44.0	9	36.0
Male	14	56.0	16	64.0

The HLM analysis showed there was a correlation, although not strong, between initial status and growth, meaning students with higher initial status should grow faster than others. However, in this study, there were 11 students who did not place in the top 25 in initial status but were in the top 25 for highest growth.

When examining if the teachers may have been a contributing factor, it was found no teacher showed up more than any others in the students who made it to the top 25 when comparing percentage of students taught to percentage of students placing in the top 25. With some students having different teachers for 6th and 7th grades, it was not feasible to determine specific teacher contributions. However, when analyzing as a school, School A had 5 students not in the initial group make the top 25 in highest growth, then School B followed with 4 and School C with 2 (Table 4.17). When examining teachers' perceived constructivist strategies collectively, School A had a mean perceived score of 3.37, which was the highest combined reported score of the math teachers at each school.

Table 4.16

11 Students in Top 25 in Growth but Not Initial Status

	Frequency	%	Mean Constructivist Strategies Score
School A (iPad)	5	45.5	3.37
School B (iPad)	4	36.4	2.90
School C (non-iPad)	2	18.2	3.18

Top 25 Students- Science

For the next analysis, using the residual files created in SPSS by HLM, the software identified the students with the top 25 initial statuses and the top 25 in growth in

science. These students were then identified by their gender, whether they were iPad users and who their teachers were during their 6th and 7th grade years. Table 4.18 shows the descriptive statistics of these top 25 students for each category. The students with the top 25 initial statuses had a representation of 7 females (28%) and 18 males (72%), which was not consistent with the total population of 52 females (46.4%) females and 60 males (53.6%) males. However, the representation of students with iPads did reflect the total population. The total participants were 70.5% iPad users and in the top 25 students there were 72% iPad users.

When comparing those numbers to the students who had the largest growth, the following was found. There were 12 females (48%) and 13 males (52%) who placed in the top 25 students in relation to growth, a more representative sample of the population. In regards to the proportion of iPad users, there were 17 iPad users (68%) and 8 non-iPad users (32%) represented in the largest growth top 25. The HLM analysis showed there was a negative correlation, although not strong, between initial status and growth, meaning the gap between higher and lower achieving students was narrowing. This is corroborated by the fact that none of the students who ranked in the top 25 in initial status were in the top 25 for highest growth. These descriptive statistics bring about the need for more research to determine if the iPads are helping to narrow that gap.

Table 4.17

Results of Top 25 Students in Initial Status and Growth – Science

Frequency	Initial Status	%	Growth	%
Technology Use				
iPad User	18	72	17	68
non-iPad User	7	28	8	32

Table 4.17 continued

Gender				
Female	7	28	12	48
Male	18	72	13	52

When analyzing if the teachers may have been a contributing factor, it was found no teacher showed up more than any others in the students who made it to the top 25. However, one of the iPad schools went from having a total of 6 students in the initial status top 25 to having 10 students in the top 25 for highest growth (Table 4.19). In this case, the teachers had a mean score of 3.14, which was the lowest mean score for perceived use of constructivist teaching strategies reported by the science teachers at any school.

Table 4.18

25 Students in Top 25 in Growth but Not Initial Status

	Frequency	%	Mean Constructivist Strategies Score
School A (iPad)	10	40.0	3.14
School B (iPad)	7	28.0	3.35
School C (non-iPad)	8	32.0	3.58

CHAPTER V: DISCUSSION

This project explored the effects of a one-to-one iPad initiative on the academic achievement of middle school students in mathematics and science. Using hierarchical linear modeling, the study determined whether the variables of iPad use in a one-to-one setting and gender could predict students' growth in academic achievement in mathematics and science. Descriptive statistics were used to examine teacher responses of a survey addressing perceptions of use of constructivist strategies in the classroom. Descriptive statistics were also used to examine student and teacher responses of a survey addressing frequency, types, and ease of use of technology. Finally, residual files from the HLM analysis were used to determine the top 25 students with the highest initial status and the top 25 students with highest growth in academic achievement in mathematics and science and then descriptive statistics were used to discuss those students, including whether they were part of a one-to-one iPad setting, gender, and teacher.

This chapter will expound upon the findings of the analysis completed in Chapter IV for both mathematics and science. Limitations are also included as well as suggestions for further research needed of the topic that would assist those parties interested in implementing a one-to-one initiative in their school district.

Mathematics and Science Achievement

The mathematics and science MAP scores of the 112 students were analyzed to determine if the use of iPads in a one-to-one setting or gender had an effect on students' growth in academic achievement over their 6th and 7th grade years in mathematics and science. Kiger's et al. (2012) research has shown positive effects of using iPods in an

elementary mathematics classroom on mathematics achievement when implemented over a 9-week period; however, in this research, iPads were shown to have no significant effect on mathematics achievement scores. This matches the research of Carr (2012) who found using iPads daily in a 5th grade mathematics classroom for 9 weeks had no impact, and Dunleavy and Heineche (2007) who found no significant effect of using laptops in a one-to-one middle school setting over a two year period on mathematics achievement. When using HLM to explore the science MAP scores, no variation among students' growth was found so the intervention of iPads could not be analyzed. However, research has shown laptops in a one-to-one setting over a two-year period were significant in increasing science achievement among middle school students (Dunleavy & Heineche, 2007). With conflicting findings, more research needs to be completed to determine what situations produce a significant impact on achievement.

Gender was not a significant predictor of academic achievement in the area of mathematics or science for this study. Hyde and Linn (2006) found no significant overall difference in boys' and girls' academic achievement in mathematics. For science, they found a small positive effect for boys, which has not changed over the past few years. However, they stressed the fact that with large sample sizes, such as in their study, increasingly small differences are detected and pointed out that the small effects lead to evidence of gender similarities instead of differences.

Benefits of the One-to-one Classroom and iPads

Although the use of iPads in this study was not shown to positively effect academic achievement in mathematics and science, there are other benefits to using technology in a one-to-one setting. Penuel (2006) stressed the importance of students

being able to access technology 24/7 and with that ability comes an array of resources, communication opportunities, and fluency with technological tools. This study found students reported frequent use of the iPads, which was made possible by the implementation of the one-to-one initiative. Both teachers and students reported they felt the technology was helpful to students in their mathematics and science learning. This was apparent in the reports of iPad use by the teachers and the students as they utilized the devices multiple times a week in class. Overall, both teachers and students at the one-to-one schools felt the experience of being part of the iPad initiative had created a positive impact on the learning opportunities for the students. Oliver and Corn (2008) also found with their middle school one-to-one tablet initiative a high satisfaction rate among students in regards to the technology use at their school and significantly more frequent use of the technology in mathematics and science classes. Observations showed more project-based learning, teachers acting as coaches, and student-centered projects assigned.

Within this study, ixl, a mathematics website, provided teachers the opportunity to differentiate instruction by assigning students modules specific to their individualized needs. The online learning program offers “unlimited algorithmically generated questions, real-time analytical reports, and dynamic scoring to encourage mastery” (www.ixl.com, 2016). Teachers are able to pick from hundreds of topics aligned with the Common Core Standards for Mathematics that best fit an individual’s learning needs. Students are then able to self-monitor learning through the feedback and report options ixl provides. Milman et al. (2012) found in their study a one-to-one iPad initiative increased engagement of students and promoted an individualized learning experience at

the elementary level. They found the increased engagement helped with attention issues, and teachers were taking on the role of facilitators and using the devices to differentiate their instruction in the classroom.

Students in this study also reported frequent use of the iPads to access edmodo, an online classroom website, designed to allow communication with teachers and peers, collaboration opportunities, assessment options and a digital platform for sharing resources. The educational website uses a social network format designed to be appropriate for the classroom. Students can share ideas with peers or teachers and receive feedback on their work through teacher-monitored posts. They are able to collaborate on group assignments outside of the classroom through the website as well as turn in assignments to allow for a more paperless learning environment. Heinrich's (2012) study of a middle school one-to-one iPad initiative found students and teachers felt the program was positively impacting the learning and teaching in the school through its abilities to be used for communication among peers and teachers, to work more efficiently, create and deliver presentations, and share resources. When considering the device itself, iPads have been shown to increase collaboration and communication at the university level (Fisher et al., 2013). Fisher discovered the devices were able to change the classroom workspace into one that promoted the sharing of ideas as students were incorporating their iPads into almost all interactions with other students. Van Dusen and Otero (2012) also found iPads in the high school science classroom promoted collaboration and engagement. The iPads were used to assist students in their construction of knowledge, created excitement for learning that went beyond the class time, and promoted responsibility for their own learning.

However, using the devices frequently may not be enough to produce results in academic achievement. Research has shown computer technology is more effective when used in a constructivist classroom (Li & Ma, 2010) and the constructivist approach to learning has been shown to be an effective way of teaching (Ayaz & Sekeric, 2015; Kim, 2005; & Wu & Tsai, 2005). Ayaz's and Sekeric's (2015) meta-analysis was able to pinpoint some of the tactics used to create an effective constructivist-learning environment such as the use of the 5-E learning model in science and problem-based learning. This information allows school systems a glimpse into what is working as they develop ways to use technology to create an effective classroom. The first step toward that is to ensure teachers understand how and feel comfortable with their abilities to use technology to create a constructivist-oriented classroom.

Teacher Survey of Constructivist Teaching Strategies

The teachers completed a survey, by Henry (2003) addressing their perceived use of constructivist teaching strategies in the classroom. Although this study does not have enough teacher participants to provide a strong examination, some interesting information emerged that would warrant another study with a larger sample size. Koh et al. (2014) found in their study the teachers with the most teaching experience had a perceived lower score for constructivist-oriented technological pedagogical content knowledge (C-TPACK). In this study, the three teachers with the most experience had the lowest perceived use of constructivist teaching strategies. This may be due to these teachers beginning their careers in schools that had a more traditional focus to them. As new research-based methods are taught at our universities, more experienced teachers

may have a harder time adapting to the new methods and resist changing the format they have always used.

The study also found, in regards to amount of education, three of the top four teachers who reported the highest perceived use of constructivist teaching strategies had received the most formal education by reaching a Rank I certification (completed 30 hours past their masters degree). With more education, teachers have the opportunity to learn more current research based practices to incorporate into their classrooms.

Another finding was science teachers had four of the top five scores of perceived use of constructivist teaching strategies. Dunleavy and Heineche (2007) found the laptop initiative resulted in significant results for science but not for mathematics. They posed the question of whether science lends itself more readily to the implementation of technology than mathematics and whether it is easier to implement constructivist-teaching strategies in science due to the nature of its content. In this study, implementations of the iPad were similar with online textbooks and use of the edmodo classroom appearing on both lists of common uses in mathematics and science. However, some uses in science that were not on the mathematics list were accessing the web for information, which enabled students to view the most current content in the area of science, and the use of interactive models to promote understanding of concepts. When analyzing teachers C-TPACK, it's important school administrators ensure teachers understand and feel comfortable implementing constructivist strategies that have been proven effective in their content areas. As teachers are developing their constructivist strategies, professional development that focuses on how to implement technology into

specific content areas rather than broad applications of technology may enhance the training for teachers participating in one-to-one initiatives.

Henry (2003) broke the constructivist strategies questions into three categories- classroom management, teaching activities, and assessment. The lowest perceived scores for the teachers in this study were in the area of assessment. Koh et al. (2014) posed more experienced teachers might have a lower perceived C-TPACK as a result of spending more time in an exam driven school system. The fact teachers in this study rated themselves lowest in the area of using constructivist strategies for assessment may possibly be as a result of the system to which Koh et al. was referring in their study. As seen in the surveys of iPad use, the only reports of using them for assessments were in the area of mathematics, and it was only 13 of the 62 students that reported this type of use. More professional development in the area of utilizing iPads to administer constructivist forms of assessment would be beneficial to this specific school district. Sultan et al. (2011) pointed out one-to-one technology allows teachers opportunities to incorporate many different forms of assessment. Teachers need to be shown ways technology can promote more individualized assessments that incorporate a more constructivist approach.

A final point of interest with the teacher survey is every teacher reported a higher mean score of perceived use of traditional strategies than of constructivist strategies. This shows that although there are constructivist-oriented activities occurring in the classroom, traditional methods are still prevalent- another reason to provide more professional development for teachers to help raise their C-TPACK.

iPad Users Frequency of Use, Helpfulness, and Ease of Use

One component of creating a successful one-to-one iPad initiative is ensuring they are actually being used in the classroom. Research has shown there is significantly more frequent use of technology in mathematics and science when a one-to-one program has been implemented (Oliver & Corn, 2008). Providing students and teachers with iPad technology does not guarantee it is being used during instruction. However, this study has shown they are using the devices. When asked about frequency of use, 89% of students reported they used the iPad either daily or at least two to three times a week in math class and 87% of students reported the same for science. Teachers were in agreement as 100% of both the mathematics and science teachers reported students used the devices either daily or at least two to three times a week.

Possible reasons the frequency use is high in this study is the ease of using the technology. 100% of the students and the teachers reported it as being either very easy or somewhat easy. The students also reported they felt the iPads were helpful in their learning; with 93% of the students reporting the devices were definitely helpful or sometimes helpful in mathematics and 90% the same for science, the students are seeing the benefits of using technology in school. All teachers, both mathematics and science, rated the iPads as definitely helpful to learning. This is an important statistic because if teachers do not feel the technology has merit they are not going to revise instruction to incorporate the devices into their lessons. Overbay et al. (2010) found teachers who reported a high level of constructivist practice also reported a high level of technology use. This is encouraging for this study since teachers in this school district have embraced the frequent use of iPads during instruction.

Non-iPad Users Frequency of Use, Helpfulness, and Ease of Use

The frequency of use with non-iPad users differed dramatically from the one-to-one schools. In mathematics, no students at the non-iPad school reported daily use of technology and only 8% reported using it two to three times a week. In science, no students reported daily use or two to three times a week for their use of technology. The three teachers agreed with all reporting technology was rarely used in their classes. Surprisingly, though, the students' reports of helpfulness were positive. For instance, 83% of students felt the computers they used in mathematics class was either definitely helpful or sometimes helpful to them, and 75% of students felt it was definitely or sometimes helpful in science class. Also, 100% of the students stated the technology was very easy or somewhat easy to use.

The teachers at the non-iPad school had differing opinions of the computer technology. All three teachers chose differently for helpfulness- one choosing definitely, one choosing sometimes, and the last choosing helpful only on rare occasions. With ease of use, two teachers stated the technology was somewhat easy and one stated it was difficult to use. The teacher who stated it was difficult to use and only used it on rare occasions had one of the lowest perceived scores for implementing constructivist-teaching strategies in the classroom. However, the teacher felt it was definitely helpful for student learning when used. This emphasizes the need for appropriate professional development not only with how to use technology but also suggestions for more constructivist strategies to increase teachers' C-TPACK. This would be beneficial not just for teachers in the one-to-one schools but also the school that, although limited, does have access to some technology to be used during instruction.

Since the students felt the technology was helpful, this brings up the question of even if it were not a one-to-one school, would students bring their own devices if allowed. This is an option for schools that may have the infrastructure in place for wireless Internet capabilities but not a solid plan for a specific device. The opportunity to use technology in the classroom, even if they are not all the same devices, can have an impact on students' engagement, ability to access current content of the subject area, and encourage communication and collaboration.

Types of iPad Uses

With computer technology integration in mathematics, Li and Ma (2010) found in their meta-analysis the technology could be sorted into four types- tutorial, communication media, exploratory environment, and tools. However, their findings showed the type of technology use was not significant when analyzing the effects on mathematics achievement of students, but more importantly, it was significantly more beneficial in classrooms where the constructivist approach to learning was being practiced.

The question arises to whether the iPads in this study were being used to enhance a constructivist-learning environment. In mathematics, students reported multiple ways they used the iPads in class. However, the three most commonly reported uses were to access online textbooks, complete practice programs on a tutorial-based website, ixl, or use them as calculators. With online textbooks, an interactive component is present that is not available with traditional texts. For instance, the use of current data for real life application problems incorporated into lessons can promote authentic tasks for students. Calculators on an iPad can provide graphing options not available on standard calculators

enabling students to explore concepts virtually. The website, ixl, offers practice in a multitude of topics in mathematics. An interactive component is provided that is not available when practicing problems on a worksheet. If a student misses a problem, he is provided with an instant solution and explanation of how to solve it correctly, allowing the opportunity to self-assess learning. It also has a tracking component where students can see the progress they've made and earn badges which can be an engaging way to motivate learning. This website is similar to Brown's (1998) assessment practice of observation checklists. She stated this type of use promotes a constructivist approach as it helps students track their learning and engage in planning how to improve their learning of the mathematical content.

In the area of science, Bayraktar (2002) found the most effective use of CAI was through simulations and the second most effective was tutorial. Neither one of these two formats were listed in the top three ways the schools were using the iPads. However, the most common options have the ability to provide students with a learning experience they could not have without the iPads.

In science, the three most common uses were accessing an online textbook, using an edmodo classroom, and accessing the web for information. As with math, the interactive textbooks can provide the most current information available. Online textbooks have interactive models for virtual exploration of science content. This is a huge benefit when our understanding of the world is changing daily. An edmodo classroom allows for communication between teacher and student or between students. It can offer peers a way to collaborate inside and outside of the classroom, an important part of the constructivist-learning environment. It also offers multiple assessment options-

both formative and summative. Accessing the web for information is something students have been doing at home and in computer labs at school for some time. Penuel (2006) stated “24/7 access to computers makes it possible for students to access a wider array of resources to support learning, to communicate with peers and their teacher, to become fluent in their use of the technological tools of the 21st century workplace (p.332)”. The one-to-one environment allows for easier access to that information aiding in the creation of a more efficient classroom.

Overall, each of the uses of the iPads in the mathematics and science classes could promote a constructivist-learning environment for the students. Through their use, students were able to learn using the most current information for the subject areas and had the ability to collaborate with peers and self assess their learning process in and out of the classroom.

Types of Computer Uses (Non-iPad School)

With the non-iPad school, although students reported a lack of technology use, they still reported some common uses in the classroom. For mathematics, the most common use was the website, Khan Academy, and the second use was math-related websites. Khan Academy is a tutorial website that allows students to practice math problems, receive immediate feedback on their answer along with explanations of how to solve the problems, and links to tutorial videos if a student needs extra assistance. The websites were reported as different sites that allowed for the practice of math problems. In science, the most common use reported was conducting research using the Internet on science-related topics. The second was to watch science-specific content videos about

topics they were learning. Both of these uses provided students with more current information than textbooks can provide.

Although this school environment was not using technology often, the choices of how they were using it added to their learning experience. The students reported they felt the use of technology aided in their learning in the mathematics and science classroom.

Top 25 Students in Mathematics

HLM residual files were created to identify the top 25 students in initial status and the top 25 students in highest growth in the mathematics classroom. The percent of males and females in the top 25 of both lists was representative of the whole population.

However, there are conflicting percentages when exploring the top students for iPad use.

In initial status, only 48% of the top students were in the iPad group although they consisted of 70% of the population. This is consistent with the HLM analysis which showed non-iPad users had an initial status of 5.21 points higher than the iPad users. In the top 25 students for growth, 64% were iPad users, a much better representation of the whole population than initial status.

Although the correlation was not strong, the HLM analysis found the higher achieving students should grow faster than the lower achieving students. However, 11 of the 25 students with the highest growth were not in the top 25 for initial status, which brings up the issue of what may have helped them become some of the top performers.

Nine of those eleven students were from the iPad group. The questions that arise are why were some lower achieving students growing faster than the higher ones and if the iPad helped contribute to those higher amounts of growth. A more in depth look at how those

students were using the iPads and their learning environment characteristics would be beneficial in determining how technology can assist in raising achievement.

Top 25 Students in Science

When analyzing the residual files for science, the representation of iPad users to whole population was similar in both initial status and growth. However, gender was not represented proportionally. Only 28% of the initial status group was female even though the whole population had 46% females. However, in the top 25 highest growths, the distribution was consistent with total population. Research would be beneficial to determine why girls were underrepresented coming into middle school. This would involve another type of study addressing gender in the elementary science classrooms.

None of the students in the top 25 in initial status were found in the top 25 students for highest growth. This is supported by the HLM analysis, which indicated the gap between the high achieving and low achieving students was narrowing. More analysis would be needed to determine what characteristics are contributing to the lower achieving students being able to catch up with the higher students.

Top 25 Students in Growth by School

Also of interest, when analyzing the characteristics of the students who made it into the top 25 highest achieving students who were *not* in the top 25 of initial status, is to look at the students by school. Of the eleven students in mathematics, School A had the most with five of the eleven (45.5%) coming from this iPad school, which had the least number of participants (25.9% of the population). Both the mathematics teachers at School A had nine years of experience with one having a Rank I education and the other having a Rank II. Their constructivist scores ranked as third and sixth among the ten

teachers with the Rank I teacher scoring 3.45 and the Rank II teacher scoring 3.29. These teachers had the highest mean perceived score of reported use of constructivist strategies of the schools. Of the 25 students in science, once again School A had the most with 10 of the 25 (40%) coming from this school. The first teacher, who ranked second out of ten with a constructivist score of 3.52, had fifteen years experience and a Rank I education. The second teacher, who ranked fifth out of ten with a score of 3.32, had eleven years experience and a Rank II education. The third teacher, who ranked last out of ten with a score of 2.58, had twenty -even years experience and a Rank I education. The science teachers at School A had the lowest mean perceived score of the schools.

This emphasizes the need for a more in depth study addressing how the use of constructivist strategies in a one-to-one setting affects students' growth. A study that included a larger sample size of teachers and actual classroom observations to determine the iPads use and constructivist strategies would be beneficial in determining if using iPads in a constructivist-learning environment can be effective in raising academic achievement.

Limitations

In a perfect research design, one would be able to conduct classroom observations and interviews to determine how the iPads were being used and the extent that constructivist teaching strategies were being used in the learning environment. Due to the researcher being a full time teacher, this was not possible so surveys were used instead to collect data from the participants. The qualitative data that observations and interviews provide would allow for more analysis of the teacher's impact and the technology's impact on the student's learning. The surveys focused on the most common ways the

technology was being implemented. However, observations could provide a bigger picture of the iPads' utilization in the classroom and interviews of both teachers and students would allow for a thorough discussion of technology use not observed through classroom visits.

There are also limitations to this study due to the small sample size. Only three schools were included in this study, equating to 112 student participants and 10 teacher participants. Also, the schools themselves are very similar to each other and only provide a glimpse into a small, private, suburban school district. Due to their low diversity and percentage of low socioeconomic students, findings will not translate well to the broader public school system.

Another limitation to having a small amount of teachers is the inability to analyze the teachers' information using HLM. With some students having more than one teacher over the two years in a content area and others having the same teacher, it was not feasible to look at more than the descriptive statistics to determine a broad look at what was occurring in the classroom. If the study had instead looked at growth over one year, it would have been easier to examine teacher characteristics. However, by examining growth over two years, the comparison study was made stronger by providing up to six time points for analysis. Also, due to the small number of teachers, some descriptors had to be addressed more broadly to protect anonymity of responses.

There were some limitations due to the nature of the surveys of technology use. Asking students to remember how much they have used the iPads over the past two years and the most common ways they have used them can be problematic. Some students may be remembering more of their 7th grade years than their 6th grade years. Also, surveys can

only provide a snapshot of the learning environment. In order to find more detailed information of how constructivist strategies are being used in the classrooms and how the iPads are being used, a year long or more study involving multiple classroom observations would be extremely beneficial in providing a more in depth picture of the effects of a one-to-one iPad initiative on middle school mathematics and science classrooms.

Implications and Suggestions for Further Research

Although research has shown through meta-analyses that technology can positively affect mathematics and science achievement (Bayraktar, 2002; Li & Ma, 2010), this study did not show a significant effect with the use of iPads in a one-to-one setting. Li's and Ma's (2010) analysis showed the most effective way to use technology was in a constructivist-learning environment. Some of the parameters of such an environment were reported in the one-to-one classrooms of this study. It is important, first, that the technology is actually being used. Overbay et al. (2010) found teachers who leaned toward a constructivist approach and thought the technology could be a useful tool for learning were more likely to report using the technology. In this study, teachers reported the use of constructivist teaching strategies and frequent use of iPads in the classroom. Teachers also indicated they felt the technology was beneficial for students to use. Students agreed with the teachers' reports of frequent use and stated they felt the iPads assisted them in learning content.

The types of uses of the iPad have also addressed the constructivist approach. For instance, the use of online textbooks, reported as one of the most common uses of the technology, enabled students to access more current information regarding content. ixl

software provided students the opportunity to reflect on their work and receive instant feedback as they practiced. The use of edmodo, an online classroom, promoted communication within and outside the four walls of the classroom. The use of interactive computer models in science class allowed students to create an understanding of the material for themselves as they explored concepts virtually. Although, Li and Ma (2010) determined the type of use did not factor into whether technology had a positive effect on achievement, a constructivist approach did. All of these uses have merit in providing constructivist-learning opportunities in the one-to-one classroom. However, some of the most common uses were not content specific iPad uses. Interactive science apps that allowed for virtual exploration of topics and dynamic mathematics software such as Geogebra, were missing in the most commonly listed ways iPads were utilized.

Some other key components of a constructivist-learning environment were also missing from the schools. For instance, teachers reported their lowest perceived constructivist strategies scores in the area of assessment. Sultan et al. (2011) reported one-to-one technology could provide teachers the opportunity to use multiple forms of assessment, but that was not evident in the teachers' surveys of their teaching styles. Also, there were no references in the surveys that referred to the use of the iPads to complete projects designed to mirror real world situations or provide opportunities to learn through ill-structured domains, both important components of Constructivism. However, the survey asked for the most common uses so that is not to say these type of learning situations were not occurring in the classroom. More involved research analyzing the classrooms throughout the school year could address how much those constructivist strategies are incorporated into the learning environments.

Although some of the key components of a constructivist-learning environment were apparent in the study, significant effects on achievement by iPads were not found. Future research is needed to determine the best ways to attain that achievement with a one-to-one environment. A more in depth study of how the iPads are being used with a larger sample of schools would enable researchers to delve more deeply into how iPads are contributing to a constructivist environment and increased academic achievement. A larger sample size of teachers would be beneficial in order to examine individuals' teaching styles and their C-TPACK in relation to their effects on achievement scores.

One suggestion based on the teacher survey is the need for schools to provide professional development to assist teachers' in their implementation of technology into their instruction. Koh et al. (2014) found some teachers have a lower perceived C-TPACK than of other constructs that do not involve technology. It is important we are providing the training needed for our teachers to use the technology to its utmost potential. Within this study, teachers reported higher perceived uses of traditional strategies than constructivist strategies. This implies that although they are using technology and constructivist strategies, the traditional approach is still quite evident in the classroom.

Conclusion

Choosing the iPad for a one-to-one initiative has many benefits such as portability, affordability, promotion of collaboration, and the ability to individualize learners' experiences (Melhuish & Falloon, 2010). This research study did not find a significant effect on achievement in the mathematics and science classroom. However, other benefits were evident for the students. Hoffman (2010) stated technology could

assist in teaching students 21st century skills, including communication. The iPad schools displayed frequent use of the edmodo classroom, which can provide multiple opportunities for communication between peers and teachers. Heinrich (2012) mentioned the devices had a positive impact on learning as students and teachers reported regular use of the devices. Within this study, both the teachers and the students reported frequent use of the iPads as well as a positive response to the iPads being able to promote learning.

The schools in this research project have answered the charge by the U.S. Department of Education (2010) to use technology to provide engaging and powerful learning experiences for their students. Their classrooms are ones that use the iPads to meet the fifth standard for mathematical practice, use appropriate tools strategically, set forth by the Common Core State Standards for Mathematics (CCSSM, 2010). The Next Generation Science Standards (2013) recognizes the role technology can play in students' abilities to study the natural world. The science classes are able to use iPads to access online textbooks and Internet sites with the most current information for that purpose.

By the implementation of the iPads into activities that are constructivist-based, the schools have begun the process of producing a technology-based constructivist-learning environment. The school district should be encouraged to continue its professional development offerings of how to incorporate technology appropriately to enhance instruction that uses a constructivist approach including applications specific to the content. With more training to develop a teacher's constructivist-oriented technological pedagogical content knowledge, the iPads could be used more effectively and thus possibly result in a positive effect on mathematics and science achievement in the future.

APPENDIX A:
Constructivist Teaching Strategies Survey

Survey for Constructivist Teachings

Teachers will be asked to mark the responses that most accurately reflect their classroom and their classroom activities. (5=Always, 4=Frequently, 3=Sometimes, 2=Rarely, 1=Never)

Classroom/Class Management:

1. Students request permission to leave their seats or the classroom.
2. I correct student behavior.
3. Student work is filed.
4. Student work is displayed.
5. Students raise hands to talk in class.
6. Students work in cooperative groups.
7. Music and/or art are used in the classroom.
8. Student needs determine use of class time.
9. Students have assigned seating.
10. Class activities are student-centered.
11. I determine the physical arrangement of the classroom.
12. Students use social negotiation to solve student to student social problems.
13. The classroom environment/activities demonstrate multicultural diversity.

Teaching/Learning Activities:

14. Coverage of the curriculum is the primary influence on my lesson plans.
15. I teach to multiple student intelligences.
16. I use whole class instruction.
17. I act upon student differences.
18. I am located in front of the class.
19. I teach to the intellectual level of the class.
20. Art and music are used in class activities.
21. "Hands-on" learning activities are provided for the student.
22. Students work in cooperative groups.
23. I monitor student grade point averages.
24. I present the material to be learned.
25. Students make interest-based learning choices.
26. The physical arrangement of the classroom changes to facilitate learning activities.
27. I plan student learning experiences.
28. Students use drill and practice.
29. Students choose from multi-option assignments.
30. Students use critical thinking and problem-solving skills.
31. Students produce videos, simulations, and/or role-play.

32. The textbook is the primary reference.
33. Students are tested for comprehension of information presented in class.
34. Students investigate and solve real-world problems.
35. Students use multiple resources in class.
36. Students select topics for independent study.
37. Social negotiation is a part of the learning process.
38. I serve as a mentor and motivator.
39. Learning is active investigation.
40. Students monitor their own learning.
41. Parents are included in the learning activities.
42. Students give single interpretations of ideas and events.

Assessment:

43. Assessment is at the end of learning.
44. I determine the assessment tool for class activities.
45. I monitor student academic progress.
46. Excellence is defined as percentage of comprehension of material.
47. I determine the grading criteria for learning activities.
48. Standardized tests are used for assessment.
49. Students produce video/simulation/role-play.
50. Tests and final exams are used as primary grades.
51. Students perform authentic tasks.
52. Students self-assess their learning activities.
53. Students take standardized textbook tests.
54. Assessment is based on student performance during authentic activities.
55. Students determine the assessment tool. (rubrics, questions, activities)
56. Students create games based on knowledge they have learned.
57. Students monitor their academic progress.

APPENDIX B:

**STUDENT SURVEY OF IPAD USE
STUDENT SURVEY OF TECHNOLOGY USE**

Student Survey of iPad Use

This is an anonymous survey. Do not write your name on the paper!

1. How often do you use the iPad in *mathematics* class?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
2. How often do you use the iPad in *science* class?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
3. How easy is it to use the iPad?
 Very easy
 Somewhat easy
 Difficult
 Very difficult
4. Has the iPad helped you learn in *mathematics* class?
 Definitely helpful
 Helpful sometimes
 Helpful on rare occasions
 Not helpful at all
5. Has the iPad helped you learn in *science* class?
 Definitely helpful
 Helpful sometimes
 Helpful on rare occasions
 Not helpful at all
6. Name two ways you used the iPad the most in mathematics class.

7. Name two ways you used the iPad the most in science class.

8. Who was your 6th grade math teacher? _____
9. Who was your 6th grade science teacher? _____
10. Who was your 7th grade math teacher? _____
11. Who was your 7th grade science teacher? _____

Student Survey of Technology Use

This is an anonymous survey. Do not write your name on the paper!

1. What type of computer technology, if any, have you used in *mathematics* class?

2. How often do you use computer technology in *mathematics* class?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
3. What type of technology, if any, have you used in *science* class?

4. How often do you use computer technology in *science* class?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
5. How easy is it to use the technology?
 Very easy
 Somewhat easy
 Difficult
 Very difficult
6. Has the technology helped you learn in *mathematics* class?
 Definitely helpful
 Helpful sometimes
 Helpful on rare occasions
 Not helpful at all
7. Has the technology helped you learn in *science* class?
 Definitely helpful
 Helpful sometimes
 Helpful on rare occasions
 Not helpful at all
8. Name two ways you used the technology, if any, the most in mathematics class.

9. Name two ways you used the technology, if any, the most in science class.

10. Who was your 6th grade math teacher? _____
11. Who was your 6th grade science teacher? _____
12. Who was your 7th grade math teacher? _____
13. Who was your 7th grade science teacher? _____

APPENDIX C:

TEACHER SURVEY OF IPAD USE IN MATHEMATICS
TEACHER SURVEY OF IPAD USE IN SCIENCE
TEACHER SURVEY OF TECHNOLOGY USE IN MATHEMATICS
TEACHER SURVEY OF TECHNOLOGY USE IN SCIENCE

Math Teacher Survey of iPad Use

Name: _____

1. How often do students use the iPad in mathematics class?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
2. How often do **you** use the iPad or computer in mathematics class to aid with *instruction*?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
3. How easy is it to use the iPad?
 Very easy
 Somewhat easy
 Difficult
 Very difficult
4. Has the iPad helped students learn in *mathematics* class?
 Definitely helpful
 Helpful sometimes
 Helpful on rare occasions
 Not helpful at all
5. Name two ways the students have used the iPad the most for mathematics class.

6. Name two ways you have used the iPad the most for mathematics class.

7. How many years of experience do you have teaching math? _____
8. What is your current teaching certification and rank?

Science Teacher Survey of iPad Use

Name: _____

1. How often do students use the iPad in science class?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
2. How often do **you** use the iPad or computer in science class to aid with *instruction*?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
3. How easy is it to use the iPad?
 Very easy
 Somewhat easy
 Difficult
 Very difficult
4. Has the iPad helped students learn in science class?
 Definitely helpful
 Helpful sometimes
 Helpful on rare occasions
 Not helpful at all
5. Name two ways the students have used the iPad the most for science class.

6. Name two ways you have used the iPad the most for science class.

7. How many years of experience do you have teaching science? _____
8. What is your current teaching certification and rank?

Math Teacher Survey of Technology Use

Name: _____

1. What type of technology, other than graphing calculators, have students used in *mathematics* class?

2. How often do students use computers in mathematics class?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
3. How often do **you** use computers in mathematics class to aid with *instruction*?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
4. How easy is it to use technology?
 Very easy
 Somewhat easy
 Difficult
 Very difficult
5. Has technology helped students learn in *mathematics* class?
 Definitely helpful
 Helpful sometimes
 Helpful on rare occasions
 Not helpful at all
6. Name two ways the students have used technology, if any, the most for mathematics class.

7. Name two ways you have used technology, if any, the most for mathematics class.

8. How many years of experience do you have teaching math? _____
9. What is your current teaching certification and rank?

Science Teacher Survey of Technology Use

Name: _____

1. What type of computer technology, if any, have students used in *science* class?

2. How often do students use computers in science class?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
3. How often do **you** use computers in science class to aid with *instruction*?
 Daily
 Two to three times a week
 Once a week
 1-3 times a month
 Rarely
4. How easy is it to use technology?
 Very easy
 Somewhat easy
 Difficult
 Very difficult
5. Has technology helped students learn in science class?
 Definitely helpful
 Helpful sometimes
 Helpful on rare occasions
 Not helpful at all
6. Name two ways the students have used the technology, if any, the most for science class.

7. Name two ways you have used the technology, if any, the most for science class.

8. How many years of experience do you have teaching science? _____
9. What is your current teaching certification and rank?

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Education

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Concentration: Instructional Technology Endorsement
Georgetown College, Georgetown, KY

Bachelor of Arts in Mathematics, May, 1989
Major: Mathematics / Minor: Spanish
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Experience

Part-time College Teaching:

Asbury University, Wilmore, KY, Spring 2016

Transylvania University, Lexington KY, Fall 2015- Spring 2016

University of Kentucky, Lexington, KY, Spring 2014 – Fall 2015

Eastern Kentucky University, Richmond, KY, Fall 2013

P-12 Teaching:

Mathematics/ACES (Academic Enrichment) Teacher, 2007-Present
Mary Queen of the Holy Rosary School, Lexington, KY

Mathematics Teacher, 2006-2007
Tates Creek High School, Lexington, KY

Supervision Responsibilities:

KTIP Resource Teacher, 2013-2014.
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Grants/Awards

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Publications

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Organizations

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