IS TECHNOLOGY THE ANSWER?

INVESTIGATING STUDENTS'

ACHIEVEMENT AND ENGAGEMENT IN MATHEMATICS

by

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A DISSERTATION

Presented to the Department of Educational Methodology, Policy, and Leadership
and the Graduate School of the University of Oregon
in partial fulfillment of the requirements
for the degree of
Doctor of Education

March 2016

DISSERTATION APPROVAL PAGE

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Title: Is Technology the Answer? Investigating Students' Achievement and Engagement in Mathematics

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Degree awarded March 2016

DISSERTATION ABSTRACT

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Doctor of Education

Department of Educational Methodology, Policy, and Leadership

March 2016

Title: Is Technology the Answer? Investigating Students' Achievement and Engagement in Mathematics

With millions invested in educational technology, what is its impact on student achievement and engagement? This question formed the basis for a review of the current literature on the impact of iPads and other instructional technology on student academic growth and motivation in public schools. The research supports technology's positive impact on student achievement and engagement, but more research is needed in order to better understand how iPad use impacts students in the early elementary mathematics classroom.

This dissertation study examines the effects of an iPad-based math intervention, as compared to a traditional paper-pencil approach, on second graders' achievement and engagement in mathematics. The students were assigned to treatment and control groups in matched pairs based on sex and pre-test scores. Then students engaged in a four-week math intervention, using either the iPad or paper-pencil. At the end of each intervention, students completed quantitative posttests given by their classroom teachers. Students then switched treatment and control groups for a second four-week math intervention.

Quantitative pre-post assessments include Bridges math unit tests, easyCBM math tests, and a Likert-scale engagement measure. After the two interventions were completed, qualitative focus group data were collected from the teachers involved in the study, giving a more complete view of student engagement.

With finite intervention time and resources, schools need to know how to best improve student achievement and engagement in mathematics. This study fills a documented research gap and will help inform school decisions regarding instructional technology in the early elementary math classroom.

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ACKNOWLEDGMENTS

I wish to express sincere appreciation to Professors Gina Biancarosa, Jo Smith, and Mike Bullis for their assistance in the pursuit of my Doctorate Degree and this research. Their blend of support and high demands kept me motivated and determined to produce my best work. I can't thank them enough for pushing me and believing in me. Special thanks go to my "dream team" of second grade teachers, who were excited, methodical, and dedicated to this research. Your students are so lucky to have you guiding their success. I can't imagine a stronger group of teachers and friends. In addition, thank you to my Principal, who encouraged me to grow and supported my long-term goals in educational leadership and teacher preparation. Finally, thank you to all of my past and future students. Your laughter, joy, and learning make education the best field there is!

This dissertation is dedicated to my family for their unwavering support and unconditional love. Thank you for listening to hours of discussion on educational research and somehow still smiling! Thank you to my husband, Nick Schuetz, my P.I.C. and my love. I am so lucky to walk through life with you. I couldn't be more excited for our adventures ahead. Thank you to my parents, Louie and Marianne Law, who cheered me on every step of the way. From teaching me how to sew, editing my "flated heedes," to building exploding volcanoes, thank you for sharing your love for learning with me- it stuck! You've lead by example, and shown me that through hard work you can learn and do anything. Finally, I thank my grandmother and late grandfather, Martha and Ralph Vertrees, for their incredible support as I chased this dream. I can still hear Papa say "Go Get'em Fireball!"

I love each of you so much. Thank you for being by my side on this beautiful ride.

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CHAPTER I

INTRODUCTION

With millions invested in educational technology, what is its actual impact on fostering student achievement and academic growth (Carr, 2012)? Schools are embracing educational technology in the form of iPad-based applications, but what effects do we see on student engagement and motivation in the elementary mathematics classroom (McKenna, 2012)?

In today's world of educational reform, the United States has looked critically at K-12 public school mathematics instruction and academic success. In international assessments of elementary mathematics, students in the United States generally score below average on the Trends in International Mathematics and Science Study and the Program for International Student Assessment (Carr, 2012). American schools are failing our students, both in their achievement and engagement in math. To foster American students' success, instruction must support all learners, lead to deeper thinking, and promote mastery of a focused curriculum (O'Malley et al., 2013). Research has suggested that instruction with the iPad and other technology could promote student engagement and achievement in mathematics (Haydon et al., 2012; McKenna, 2012).

In the past, research has argued for increased technology in the schools (Carr, 2012; Larkin & Finger, 2011). The U.S. government has invested millions of dollars to ensure that public schools feature up-to-date technology (McKenna, 2012). In the past 30 years, schools have seen advances from computer labs to computers in the classroom; from mobile laptop carts to 1:1 laptop per student initiatives; from overhead projectors to document cameras and SMART boards; and now wifi and the recent innovation of

Apple’s iPad (Carr, 2012; Donovan, Green, & Hartley, 2010; Larkin & Finger, 2011; McKenna, 2012). Before each school invests hundreds of thousands of dollars, it is imperative to look at research on the rate and the way iPads promote math learning (McKenna, 2012; O’Malley et al., 2013).

In 2010, Apple’s release of the iPad expanded the possibilities of instructional use in the mathematics classroom (Carr, 2012). Math intervention programs on the iPad differentiate instruction to specific student achievement needs; now advanced students are being challenged and struggling students are given targeted practice (O’Malley et al., 2013). Students who previously lacked engagement and motivation in school, are finding excitement in game-based math apps (Kebritchi, Hirumi, & Bai, 2010). The iPad has the power to generate enthusiasm while deepening students’ proficiency in mathematics (Li & Pow, 2011; McKenna, 2012). As school districts are investing time and money on 1:1 iPad initiatives (one per student), more research is needed on whether iPad-based math apps actually result in increases to student achievement and engagement (Carr, 2012; Hoffman, 2013; Li & Pow, 2011; McKenna, 2012; Mikalson, 2015).

Mathematics education in the United States is in a downwards spiral past mediocrity. For a country that prides itself on greatness, why are we are settling for scores in mathematics which fall far below international averages (Carr, 2012)? It is critical, for school districts to focus their time and money on improving mathematics education in the United States. Before we jump to assume that iPads are the answer, we must look at current research on:

1. What is the impact of iPad-based math interventions on students' math achievement?

2. What is the impact of iPad-based math interventions on students' math engagement?

The review of the literature inspired my study on the effects of an iPad-based math intervention, as compared to a traditional paper-pencil approach, on second graders' achievement and engagement in mathematics.

CHAPTER II

LITERATURE REVIEW

The literature search followed a traditional digital search process, focused on how technology-based math interventions impacted elementary student engagement and achievement. It was essential to take a broader view of technology (including web-based applications and laptops), as there were only a few iPad studies focused on early elementary mathematics. Due to the recent nature of the iPad's invention in 2010, research is limited. The following section will outline the process of the literature search and the resulting 16 studies that will be reviewed.

The on-line library search used ERIC (Educational Resources Information Center), Google Scholar, PsycInfo, ProQuest Education Journals, and ProQuest Dissertations. I used varying combinations of the keywords including: "iPad," "apps," "mathematics," "elementary," "education," "engagement," and "achievement." A few limiters were used to restrict the date and record type. Due to the time-sensitive nature of technology, I elected to look only at research conducted between 2007 and 2015. For iPad specific studies I looked at 2010 to 2015, as the iPad was released to the public in 2010. I specifically included the code for research reports (143) to ensure that my articles were primary research sources. I also used ProQuest Dissertations to find past dissertations on iPads in the classroom, and looked at the reference sections for published research studies, including international studies.

To determine the relevance of the initial pool of studies and articles, I examined the title for each of my results. When I found a title that was applicable to student achievement and engagement with the iPad; I reviewed the abstract to confirm its usefulness. Due to the recent introduction of the iPad, research studies are limited, especially when restricting those studies to iPad use in the elementary mathematics classroom. Once I located articles, I confirmed that the articles were published in a peer-reviewed journal.

Through the process described above, I found 16 empirical studies (Appendix A) that investigate how teaching with iPads and instructional technologies impact student achievement and engagement. First, I summarize the seven studies focusing on middle and high school students. Next, I review the six studies that evaluate teaching with technology in the elementary grades. Last, I summarize the studies that most closely resemble the goals of my proposed study. These four studies look at the impact of iPads and instructional technology on student achievement and engagement specifically in elementary mathematics. The review of the literature will provide a foundation for the proposed study.

Summary of the Literature Pool

This section summarizes elements of the literature pool. The *type of research* reviewed employs a variety of mixed methods, quantitative quasi-experimental, and qualitative research. All of the studies help inform the literature review on how technology impacts student achievement and engagement. The *subjects* involved in 13 of the 16 studies are public school students in grades K-12 in the United States, but I included three studies with international students to broaden my sample. The *measures* in this pool of literature focus on technology's impact on student academic performance, as measured by achievement tests. I also selected studies looking at technology's impact on student engagement, as measured by surveys and interviews to determine interest and motivation levels. The *results* section will discuss the impact of the iPad and other instructional technology on achievement and engagement in (a) middle and high school, (b) elementary school, (c), and the iPad specifically in elementary mathematics.

Type of Research

Table 1 summarizes the pool of research on educational technology. The body of research contains only one *qualitative* study, using classroom observation to determine levels of student engagement in a 1:1 technology classroom. There are four *quantitative, quasi-experimental* studies. These studies compare treatment and control groups with quantitative data, aiming to measure technology's impact on student engagement and student achievement. The *mixed-methods* approach was employed in 11 of the 16 studies reviewed. In the quasi-experiments, researchers investigated student achievement through quantitative test score data, and student engagement with qualitative interview or survey data. Ke (2008) (as cited in Ross & Morrison, 2004 and Savenye & Robinson, 2004) states that "… researchers in instructional technology should employ mixed, parallel methods to produce the most convincing body of evidence" (p. 1610). Supporting this idea, Glasset and Schrun (2009) suggest that "… combining qualitative and quantitative tools presents a viable method for inquiry and exploration in educational research" (p. 143). For these reasons, I plan to employ the mixed-methods approach in my proposed study.

Participants and Settings

Table 1 summarizes the participants and settings in the pool of instructional technology research. Although there are many apps focused on early elementary students, there was only one research study looking at iPad use in grades K-3 (McKenna, 2012).

This gap inspired my proposed classroom study on the impact of iPads in the second grade mathematics classroom.

Table 1

Research Summary

Method	Quantitative, Quasi-Experimental	Qualitative	Mixed Methods	
	4	1	11	
Participants	Elementary K-3	Elementary 4-6	Secondary 7-12	Special Education
	1	9	6	3
Locations	United States	International	Rural Area	Urban Area
	12	4	6	11
Achievement Measures	Pre-Post Math Test	Standardized Test	Evidence of Work	Reading Test
	6	2	2	1
Engagement Measures	Student Survey / Interview	Classroom Observations	Student Work or Daily Log	Attendance /Discipline Data
	12	8	2	1

Upper elementary school students make up a majority of the population, with nine out of 16 studies of instructional technology focusing on grades 4 through 6. Upper elementary students are closest to my targeted population of second grade students and the literature will help design and lay the foundations for my planned study. There are six studies looking at iPads and instructional technology at the middle and high school levels. Students receiving special education services are the main participants in three of the studies. Students in special education make up about 11% of the population in the United States; and it is important to consider the impact of educational technology on students of all ability levels (McClanahan et al., 2012).

Table 1 summarizes the geographic locations of the current studies. The pool of research represents a diverse sample. There are 12 studies of both rural and urban schools in the United States. With such a wide area of the United States covered and four international studies (Australia, Hong Kong, North Cyprus, and Taiwan), the body of literature provides a representative sample. The international research is very similar in design to the United States studies, and also examines student achievement and engagement using technology. The geographic diversity of the sample helps support the idea that educational technology is applicable worldwide (Yang & Tsai, 2010). The racial and socio-economic demographics were not included in a majority of the research articles.

Measures

Table 1 summarizes the achievement measures in each study. Student achievement is measured in 11 of the 16 studies. There are nine studies examining technology’s impact on student academic performance, as measured by achievement tests. Student achievement was measured in two of the studies by examining the evidence of student work. Although the researchers used coding and data tracking to look at the evidence of student work, the worksheets had not gone through a reliability examination. The nine studies using achievement tests as measures have added reliability since they are using pre-existing tests from the math curriculum or from state standardized testing. Researchers aim to mimic the normal classroom environment by using math tests that are part of the math curriculum. The studies did not provide reliability data for the achievement measures.

Measures of student engagement are described in Table 1. Student interest and active involvement in the classroom is measured in 15 of the 16 studies. Although there were a range of engagement measures in the literature, surveys and classroom observations were most common.

Results

The following section will present the results of the 16 studies examined in this literature review. The findings are organized by first looking at the iPad and instructional technology's impact on student achievement and then on student engagement. The sections on achievement and engagement have been organized by grade level, as the findings vary by student age. This organization of the findings highlights areas where instructional technology is most effective as well as where further research is needed.

iPad and Instructional Technology Findings on Achievement

Table 2 summarizes the achievement findings for instructional technology. There are 11 studies that specifically look at how teaching with iPads and instructional technology impacts student achievement across the K-12 grade levels.

Middle and high school. The advancements in instructional technology have resulted in research on its impact of student achievement in the middle and high school grades (Haydon et al., 2012; Kebritchi et al., 2010; O'Malley et al., 2013). It is important to note that the participants in two of the studies were also enrolled in a special education program (Haydon et al., 2012; O'Malley et al., 2013).

In all studies, students showed positive effects of the technology-based intervention on their math scores (Haydon et al., 2012; Kebritchi et al., 2010; O'Malley et al., 2013). In the study by Kebritchi et al. (2010), students using the online mathematics game had a higher mean increase from pretest to posttest than the control group. Students in another study showed a significant improvement in basic math fluency (O'Malley et al., 2013). In the study by Haydon et al. (2012), students demonstrated "their highest rates of correct responses per minute when the iPad was in effect" (p. 239).

One of the most powerful findings is that "technology promoted active student learning by providing immediate corrective feedback on student errors… if a student responded incorrectly, a prompt was provided to solve the problem again" (Haydon et al., 2012, p. 240). In all studies, students achieved high rates of correct answers and increased the number of problems solved during the technology-based math practice (Haydon et al., 2012; Kebritchi et al., 2010; O'Malley et al., 2013). The research suggests that students benefit from the immediate feedback (correct or instructional) after answering a math problem. "The iPad technology provided immediate feedback on correct responses thus possibly reinforcing each correct response and increasing the probability of responding to questions in the future" (Haydon et al., 2012, p. 240). In comparison, the worksheet practice groups lacked corrective feedback and student practice and performance levels were much lower (Haydon et al., 2012; Kebritchi et al., 2010; O'Malley et al., 2013).

The immediate feedback and math coaching modules in the technology-based math instruction, helped students achieve a higher number of correct answers, as compared to a traditional paper-pencil approach (Haydon et al., 2012; Kebritchi et al., 2010). All three studies showed an increase in mathematics fluency (Haydon et al., 2012; Kebritchi et al., 2010; O'Malley, 2013). The results suggest that the iPad is an effective tool for instruction in mathematics for students in grades 7 to 12, both in the regular and special education classroom.

Elementary school. In six of the seven studies, student achievement was positively impacted by instructional technology. In Ke's (2008) study of computerized math games and achievement, there was no statistically significant difference between the posttest scores of students in the control or experimental group. Ke cited the need for a longer study to produce conclusive results (2008).

In six of the seven technology studies, positive effects were seen on student academic achievement as measured by test scores. A significant positive impact on standardized test scores of students learning with technology was seen in two of the studies (Glassett & Schrun, 2009; Rosen & Beck-Hill, 2012). In Glassett and Schrun's 2009 study of technology-intensive classrooms, students learning with technology scored statistically significantly greater than their non-technology peers on the Language Arts, Mathematics, and Science standardized tests, with a moderate effect size of .63. Rosen and Beck-Hill (2012) looked at yearlong participation in a technology integration study. Compared to the traditional instruction control group, fourth and fifth grade experimental students significantly outperformed the control group on standardized reading (44 points higher; 59 points higher) and math scores (76.3 points higher; 45.9 points higher) (Rosen & Beck-Hill, 2012).

Reading curriculum assessment scores increased in two of the studies when students were learning with technology (McClanahan et al., 2012; McKenna, 2012). In a six-week case study, a student with ADHD learning with an iPad reading intervention showed a 10% increase his in word recognition, representing one year's growth (McClanahan et al., 2012). McKenna's (2012) study of early elementary reading showed increases in both accuracy (1^{st} grade +6.5%, 2^{nd} grade + 9.2%) and fluency (1^{st} grade +15.8%, 2^{nd} grade +11.6 %) when using the iPad.

Mathematics curriculum assessment scores increased in two of the studies when students were using technology to practice math skills (Pilli & Aksu, 2013; Yang & Tsai, 2010). In Pilli and Aksu's 2013 study of a computer based math game, students in the technology treatment group scored statistically higher on two of the three math tests (multiplication: higher mean score of t= 2.32 points, $p < .05$; division: higher mean score of t= 2.76 points, $p < .05$; fractions: no statistical difference). In Yang and Tsai's 2010 study of technology integrated math teaching, students in the experimental technology group scored significantly higher than the traditional teaching control group in both number sense (4.12 points higher mean score) and use of correct problem solving strategies (9.9% higher use). These results suggest that teaching with technology has a positive impact on students' achievement in elementary school.

iPad findings in elementary mathematics achievement. Only two of the 16 studies examined the impact of the iPad on achievement in the elementary mathematics classroom, with mixed results. In Carr's (2012) study, the "iPad intervention did not have a statistically significant impact on students' mathematics achievement" (p. 278). When comparing growth of the control (non iPad) and the treatment groups (iPad), the students using the iPad to learn only scored 0.07% higher on the posttest. In McKenna's (2012) study, however, "both classes (first and second grade) saw significant growth in all three (math) standards using the iPads as opposed to traditional methods" (p. 140). The iPad lessons resulted in mean scores on the three standard-based tests that were 8.88 to 19.06 points higher than the non-iPad lessons (McKenna, 2012). These mixed results and dearth of research affects our ability to draw conclusions on whether teaching with iPads impacts achievement in the elementary math classroom. Recommendations for further research include extending the study's duration, creating "matched" groups at the onset of the experiment, and involving more students and teachers (Carr, 2012).

iPad and Instructional Technology Findings on Engagement

Table 3 summarizes the findings on instructional technology and student engagement. There are 15 studies that specifically look at how teaching with iPads and instructional technology impacts student engagement across the K-12 grade levels.

Middle and high school. The research on technology and engagement in the upper grade levels shows mixed effects. In three out of six studies, increased access to technology led to an increase in motivation to use technology; however use of technology did not always result in increased engagement on academics (Donovan et al., 2010; Hoffman, 2013; Kebritchi et al., 2010). In the classrooms observed, students with the 1:1 laptop or iPad were engaged with the technology, but not always on the assigned academic task (Donovan et al., 2010).

Table 2

Achievement Results

Study	Grades 7-12	Grades K-6	iPad K-6 math	Achievement Measure	Results of Technology Group
4[a]	X			Evidence of Work	Positive Effect
7	X			Pre-Post Math Test	Positive Effect
12	X			Pre-Post Math Test	Positive Effect
3		X		Posttest Standardized	Positive Effect
6		X		Pre-Post Math Test	No Effect
10[a]		X		Reading Inventory	Positive Effect
11[b]		X		Evidence of Work	Positive Effect
14		X		Pre-Post Math Test	Positive Effect
15		X		Pre-Post Standardized	Positive Effect
16		X		Pre-Post Math Test	Positive Effect
1			X	Pre-Post Math Test	No Effect
11[b]			X	Evidence of Work	Positive Effect

[a] Students were also enrolled in special education services. [b] Study 11 investigated iPads in K-6 reading and K-6 math.

Students reported enjoying the technology-based learning, but Kebritchi et al. (2010) found that motivation levels for mathematics were the same in the technology treatment group as the control group. Hoffman's (2013) research found that off-task behaviors were higher during class lectures for the iPad group than the control group, due to the ease of checking email and the Internet. When given a specific academic task with a clear deadline, students in the iPad group exhibited far greater levels of engagement than the paper-pencil group, based on the classroom observation data (Hoffman, 2013). The mixed engagement results suggest that there is a place for technology in education, but more research is needed on technology engagement strategies and application filtering (e.g., blocking social media at school; Hoffman, 2013).

In three of the six studies, there was a positive effect on student engagement in academics when learning with technology. Two of these studies looked at students receiving special education services (Haydon et al., 2012; O'Malley et al., 2013). Student engagement increased dramatically in the treatment group using an iPad for math practice (Haydon et al., 2012; O'Malley et al., 2013). Teachers reported that "students appeared to be eager to participate with the iPad activities" and that "students showed increased interest in content during intervention phases (iPad) and appeared disappointed when returning to baseline phases (paper-pencil)" (O'Malley et al., 2013).

In one study, students were completing 2.5 to 5 times the number of math problems on the iPad, as compared to the number of problems complete on the math worksheet (Haydon et al., 2012). Student overall time on task, as measured by researcher observations, was 31% higher during the iPad condition (Haydon et al., 2012). Students were engaged for more of class time, and their speed of solving problems increased dramatically with the iPad (Haydon et al., 2012; O'Malley et al., 2013). In Larkin and Finger's (2011) research on 1:1 laptop implementation, "the increased availability of the netbooks provided greater flexibility and opportunity for the students to utilize the netbooks in ways which supported student engagement" (p. 526). In these three studies, teaching with technology promoted student engagement in grades 7-12 (Haydon et al., 2012; Larkin & Finger, 2011; O'Malley et al., 2013).

Elementary school. All eight studies showed a significant positive effect of teaching with technology on elementary school student engagement (Glasset & Schrun, 2009; Ke, 2008; Li & Pow, 2011; McClanahan et al., 2012; McKenna, 2012; Pilli & Aksu, 2013; Rosen & Beck-Hill, 2012; Yang & Tsai, 2010). Student engagement was measured by a pre-post survey in three of the eight studies. Ke (2008) study of educational mathematics gaming showed that "there was a significant difference between (the technology) participants' pretest and posttest scores in the ATMI attitudes measure" (p. 1618). Pilli and Aksu (2013) showed a statistically significant impact of the computer math game on students' engagement in school. Students in the computer experimental group had a higher mean score (t = 2.73 points , p=.01) on the *Mathematics Attitude Scale* and on the *Computer Assisted Learning Attitude Scale*. Yang and Tsai (2010), also found that on the postsurvey on Attitudes towards Mathematics, students in the technology experimental group scored 15.4 points higher, which is significantly higher than the control group (t = .002, p < .05). The three studies (Ke, 2008; Pilli & Aksu, 2013; Yang & Tsai, 2010) all made similar statements that "students developed significantly more positive attitudes towards math learning" through the technology treatment (Ke, 2008, p. 1613).

The positive influence of technology had a dramatic increase in observed student engagement, time on task, attitudes, behavior, and attendance (Glasset & Schrun, 2009; Li & Pow, 2011; McClanahan et al., 2012; McKenna, 2012; Rosen & Beck-Hill, 2012). When looking at student motivation, students in the Tablet-PC experimental class scores were "significantly more positive than those in the non-Tablet-PC classes irrespective of their grade levels (Li & Pow, 2011, p. 324). In McKenna's (2012) study of iPads in the reading classroom, student time on task increased by 6.5% at first grade and 11.9% at second grade during iPad lessons. "(T)eachers commented on the substantially better behavior from students due to the motivating forces of technology," (Glasset & Schrun, 2009, p.145). In the study by Rosen and Beck-Hill (2012), student disciplinary issues decreased -62.5% from the previous year in the experimental technology group, where the control group only decreased -15.4%. Not only did behavior improve, Rosen and Beck-Hill (2012) showed a drop in unexcused absences by -29.2% from the previous year, where the control group showed an increase in unexcused absences of +56.6%. In addition to the technology implementation having a significant positive impact on attendance, students exhibited improved attitudes, excitement towards school, and improved behavior (Glasset & Schrun, 2009; Li & Pow, 2011; McClanahan et al., 2012; McKenna, 2012; Rosen & Beck-Hill, 2012).

iPad findings in elementary mathematics engagement. There are two studies out of the 16 reviewed that examine the iPad's impact on engagement in the elementary math classroom (McKenna, 2012; Patterson & Young, 2013). Although a small percentage of the literature on instructional technology focuses on iPads in the elementary math classroom, the two studies showed a very positive impact on engagement. Both studies findings support the idea that student motivation and engagement in math increased with the iPad according to classroom observations (McKenna, 2013; Patterson & Young, 2013). Researchers stated that it was "evident that students were more actively engaged during the iPad lessons than the non-iPad lessons," based on classroom observations (McKenna, 2013, p. 141). In an analysis of time on task, McKenna found that student time on task in math increased by 2.6% at first grade and 2.8% at second grade during iPad lessons. Although both studies report a positive effect on engagement, further research is needed in order to draw larger conclusions due to the sparse research on iPads and engagement in the elementary math classroom.

Table 3

Engagement Results

Study	Grades 7-12	Grades K-6	iPad K-6 math	Engagement Measure	Results of Technology Group
2	X			Observations	Negative Effect
4 [a]	X			Evidence of Work	Positive Effect
5	X			Classroom Observations	Mixed Effect
7	X			Survey	No Effect
8	X			Interview, Observations, Surveys	Positive Effect
12 [a]	X			Observations, Surveys	Positive Effect
3		X		Interviews, Observations	Positive Effect
6		X		Interviews, Observations, Attitudes Measure	Positive Effect
9		X		Daily Student Log	Positive Effect
10 [a]		X		Observation	Positive Effect
11 [b]		X		Survey, Observation, Interview	Positive Effect
14		X		Surveys	Positive Effect
15		X		Attendance, Discipline	Positive Effect
16		X		Pre-Post Survey	Positive Effect
11 [b]			X	Survey, Observation, Interview	Positive Effect
13			X	Survey	Positive Effect

[a] Students were also enrolled in special education services. [b] Study 11 investigated iPads in both K-6 reading and K-6 math.

Discussion and Research Questions

This pool of research supports the use of instructional technology in the K-12 classroom. The findings from 10 of 12 studies suggest that learning with iPads and computers leads to increased student achievement. Student engagement was positively impacted through learning with technology in 11 out of 15 studies. Although more research is needed, the body of research suggests that instruction with technology and iPads can have a positive impact on student achievement and engagement in school.

Implications for Researchers

The findings of this literature review create an impetus for further technology research on (a) student engagement and iPads in grades 7-12, (b) the iPad's impact on achievement in the K-2 math classroom, and (c) the iPad's impact on engagement in the K-2 math classroom. The research on technology's impact on elementary school student's engagement is becoming conclusive, while the upper grades show mixed results. Since this research was conducted, better applications for controlling student use of technology have been created. There are filters to limit student access to social media and other websites in school (Mikalson, 2015). The iPad now has a guided-access feature that can keep students on one assigned app (Apple, 2015). With these advances, which help control off-task behaviors, it would be interesting conduct additional research to see if student engagement in grades 7-12 increases. There is also a need for more research on the impact of teaching with iPads in the early elementary K-2 math classroom, as only one study out of 15 looked at that subject and population.

Implications for Practitioners

The findings from this literature review may help inform district-wide decisions about the impact of a 1:1 iPad program. Teachers and school administrators can use both the positive and negative findings to help structure use of technology in order to foster student achievement and engagement. Teachers can feel confident about their choices to enrich the curriculum through the use of iPads and computers, as the research suggests that is an effective instructional technique. Schools may choose to implement technology due to the increases in motivation, student attendance, and positive behaviors. Grade level teams may choose to use technology-based intervention programs, based on the positive results of studies using iPad interventions to support struggling students in math and reading. Through careful planning and implementation of technology-based teaching teachers can see improved results in student academic growth and motivation.

Conclusion and Research Questions

The findings from this literature review suggest that teaching with iPads and instructional technology may have a generally positive impact on student engagement and achievement. This classroom research study represents an important step in filling the gap in research on iPad use in the early elementary mathematics classroom. The research questions are:

RQ 1: Does an iPad-based math intervention, IXL, affect second-grade students' math achievement as measured by quantitative pre-post unit tests and the math easyCBM?

RQ 2: Does learning with an iPad-based math intervention, IXL, affect students' engagement and interest in mathematics, as measured by a pre-post Likert-scale quantitative measure?

RQ 3: What are teacher perceptions of effects on students' engagement for the iPad-based math intervention versus a paper-and-pencil condition?

RQ 4: What are teacher perceptions regarding implementation challenges for the iPad-based math intervention versus a paper-and-pencil condition?

CHAPTER III

METHODOLOGY

My sequential mixed-methods research examines the effects of an iPad-based math intervention, as compared to a traditional paper-pencil approach, on second graders' achievement and engagement in mathematics. The study took place at Lincoln Elementary (pseudonym used), where at the time of the study, I taught second grade. The four, second grade teachers were trained in Best Practices in Mathematics (week-long training), Bridges in Mathematics (day-long training, paper-pencil math curriculum and intervention), and on the IXL iPad math intervention. The participants in the study included 85 second grade students, with parent consent.

Students were assigned to treatment and control groups in matched pairs based on sex and a prescore (an averaged achievement and engagement pretest score). Following pretest, students engaged in a four-week session of either paper-pencil or iPad-based math intervention, completed quantitative posttest assessments, and then switched interventions. Students knew that after four-weeks they would switch interventions so all students had an equal number of paper-pencil and iPad intervention sessions. This helped control for compensatory rivalry, which can occur between two groups in a study. Students were also assessed at the end of the second four-week session.

Quantitative pre-post assessments included a Likert-scale engagement measure, Bridges unit tests, and easyCBM math tests. These tests were administered by the classroom teachers using a script for uniform directions, in order to mimic standard classroom procedures. Statistical comparisons were made to compare the pretest to posttest for the experimental and control group. After the two interventions were complete, I collected qualitative data from the teachers involved in the study, through a focus group to hear their observations on the impact of the iPad based math intervention on students' engagement in mathematics.

Research Design

My study followed a research design and theoretical framework that is similar to designs found in the quasi-experimental, mixed-methods literature that I reviewed. The study examines the impact of two different interventions on students' achievement and engagement in mathematics. The research design is summarized in Table 4.

Table 4

Research Design

Technology Intervention	Pretest	Part 1	Posttest 1	Part 2	Posttest 2
Tech 1st - Tx1	X	Tx	X	C	X
Tech 2nd - Tx2	X	C	X	Tx	X

Setting and Participants

Setting

My action research took place at Lincoln Elementary (pseudonym), where I taught second grade at the time of the study. Lincoln Elementary School is a suburban, middle-sized K-5 school with about 600 students, located in Oregon. It is a high achieving school and has earned a level 5 on Oregon's report card, indicating that its students are at the very top of Oregon's rating scale (Oregon Report Card, p. 1, 2014). Lincoln Elementary has an upper middle-class socio-economic population, with only 19% of students labeled as economically disadvantaged (Oregon Report Card, p. 1, 2014). Parents are involved with the school though an active Parent Teacher Organization. The school's demographics are summarized in Table 5.

Table 5
Demographics

Group	Percentage
ELL (English Language Learners- 6 languages)	<5%
Special Education	6.1%
Talented and Gifted (TAG)	7.1%
Minority Students	8.3%
Economically Disadvantaged	19%
Students with Disabilities	10%
Students Attending 90% of School Days	92.8%

Participants and Sampling

The participants were 85 students in the four, second grade classrooms at Lincoln Elementary. Each family at Lincoln Elementary, with a student in second grade, received a letter about the study from myself (a second grade teacher and researcher). Participation in the study was defined as allowing the researcher (myself) to collect de-identified student pretest and posttest data on math achievement and engagement tests, during the eight weeks of instruction for Bridges Unit 5. Each student's family had the option to participate in the study, and participants turned in a signed consent form to the main office.

In order to preserve anonymity, teachers were not aware of students who declined participation in the study. As part of the second grade curriculum requirements, all students took the math assessments and participated in the two math interventions. Based on district requirements, all students' test score data was used for the second grade data team meetings and report cards. If a student did not participate in my study, their data was not collected or recorded in my research.

Since I used the predetermined second grade classes at Lincoln Elementary, I am using a non-random, convenience sample. Some consider the "nonprobability (or *convenience* sample)" to be less desirable, since participants are chosen based on their convenience and availability (Creswell, 2014, p.158). However, Creswell also states that in many cases "only a convenience sample is possible because the investigator must use naturally formed groups (e.g., a classroom)… When individuals are not randomly assigned, the procedure is called a quasi-experiment (2014, p. 168).

I wanted to specifically look at the subset of second graders at Lincoln Elementary. This sample helped guide my work as a teacher and as a technology leader in our district, and therefore the convenience sample was purposeful and part of the action research approach. My district is moving towards Digital Conversion, one iPad per student, and this research should be extremely helpful for school leaders as they make decisions about 1:1 implementation. Therefore having a specific population sample from our district matches the goals for the study.

Research Design

The design I employed for this study utilized a quasi-experimental, sequential mixed methods approach to examine the impact of IXL, an iPad-based math intervention, on students' achievement and engagement in mathematics. The sequential mixed methods design utilizes quantitative methods to first measure student achievement and engagement and then qualitative procedures to gain teacher input on the impact of IXL on students' engagement in math. I chose the mixed methods approach, as 11 of 16 studies from the pool of research on educational technology utilized mixed-methods to "produce the most convincing body of evidence" (Ke, 2008, p. 1610). Glasset and Schrun (2009) argue that by combining strengths of both quantitative test score data as well as qualitative interview or observation data, researchers can gain a more complete understanding of the impact of educational technology.

Quantitative Methods

Creswell states that in the quantitative method, "[t]he researcher may *compare* groups on the independent variable to see its impact on a dependent variable" (2014, p. 143). This is the correct approach to help determine the impact of an iPad-based math intervention on student engagement and achievement, as measured by qualitative test and survey data. Creswell cites that quantitative experiments "include *true experiments* and the less rigorous experiments called *quasi-experiments* (2014, p. 12). My research is quasi-experimental, as "quasi-experiments… use nonrandomized assignments" and sampling (Creswell, 2014, p. 13). In an elementary school setting it is difficult to have a true random sample, as the school draws students from the nearest neighborhoods, which are unlikely to be a good random sample of students in a whole country.

Qualitative Methods

The qualitative method provides information about student engagement and achievement from the view of the classroom teachers involved with the study. I interviewed the classroom teachers through an online focus group. Their narratives have supplemented the quantitative data on student achievement and engagement. I used the phenomenological qualitative research method to analyze teachers' significant statements and generate meaning units to describe student engagement and achievement during the quasi-experiment (Creswell, 2014). The addition of the qualitative method creates a more complete view of the iPad-based math intervention, as it incorporates the teachers' observations and experience.

Unit of Analysis

The unit of analysis in my study is individual student achievement and engagement test scores. I used student achievement test scores from both my treatment and control groups to analyze the impact of the iPad based math intervention. The student engagement measure scores were also analyzed to determine the impact of the iPad based math intervention on student engagement in mathematics. Looking at individuals' test scores as a unit of analysis is a long-standing tradition in social research. Babbie states that "... individual human beings are perhaps the most typical units of analysis for social research" (2012, p. 99). Once I collected the individual test scores, I compared group means using RM ANOVA for the treatment and control group. By looking at the group means, I was able to judge the intervention's impact on the grade level as a whole. I supplemented the test score data with the qualitative teacher interview data to analyze the impact of teaching with iPads on students' engagement in math.

Time

My research is a longitudinal study conducted over 8 weeks of classroom instruction. Before the study began, students took two achievement pretests, and one engagement pretest. These results were compared with the achievement posttests and engagement posttest after the math unit has been completed. A "longitudinal study is designed to permit observations of the same phenomenon over an extended period" of time (Babbie, 2012, p. 106). In my study, using the longitudinal model allowed me to look at the impact of the paper-pencil and iPad based math interventions on student achievement and engagement in mathematics. I was able to compare their test scores before and after the intervention, to determine the intervention's impact on student learning and engagement.

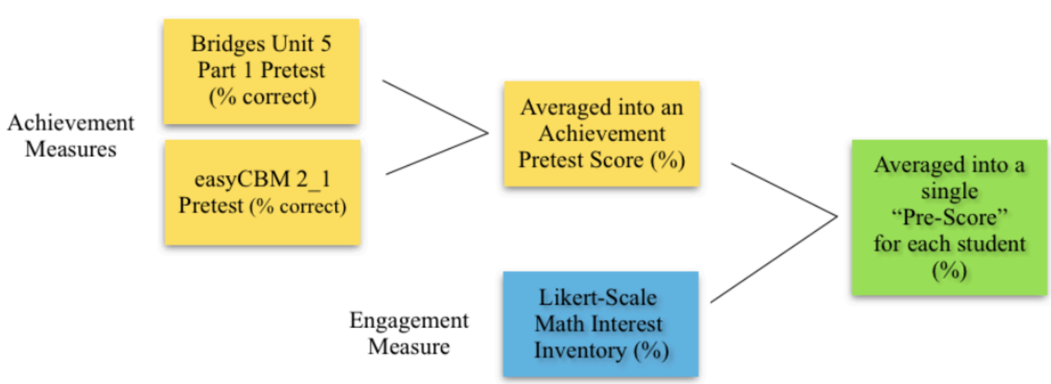
Assignment

My assignment procedure is summarized in Figure 2 and Table 9. I used the statistical technique of matching to assign the grade level participants in half, blocking by sex and matching by achievement and engagement prescores. This formed the group using iPads first (experimental treatment) and the group using paper-pencil first (control). This approach helped with "equating the groups at the outset of the experiment so that participation in one group or the other does not influence the outcome" (Creswell, 2014, p.168). Students who declined participation were still assigned a group, but were not be a part of the statistical matching.

My assignment procedure of matching is common in classroom research. Researchers "match participants in terms of a certain trait or characteristic and then assign one individual from each matched set to each group. For example, scores on a pretest might be obtained. Individuals might then be assigned to groups, with each group having the same numbers of high, medium, and low scorers on the pretest" (Creswell, 2014, p. 168). It was essential to block based on students' sex, due to math-gender stereotypes that have been well researched (Cvencek, Meltzoff, & Greenwald, 2011; Forgasz, Becker, Lee, & Steinthorsdottir, 2010). In one study, students as young as second grade, demonstrated the opinion that math was "for boys," and boys identified more strongly with math than girls did on self-reported and implicit measures (Cvencek, Meltzoff, & Greenwald, 2011).

Following Creswell's model for matching, I first created composite z-scores (percentages) using students' scores from three pretests: Bridges Unit 5, Part 1 pre-assessment, the Numbers, Operations, and Algebra easyCBM 2_1 test, and the engagement Likert-style measure. I averaged the Bridges Unit 5, Part 1 pre-assessment, and the Numbers, Operations, and Algebra easyCBM 2_1 test to create a single achievement pre-score. This achievement pre-score was averaged with the engagement measure pre-score, to establish a single achievement/engagement pre-score for each student. The process I followed to create a pre-score is summarized in Figure 1.

Figure 1.
Establishing a Pre-Score



In each of the four classrooms separately, I rank ordered students from highest to lowest using their pre-score. I assigned to condition by sex, by finding the two females with the lowest pre-scores and randomly assigning one to treatment and one to control, and then doing the same with the two lowest males, and so on for the whole class. The treatment and control group in each of the 4 classes were as similar as possible in gender and incoming student knowledge and engagement. I used a two-way *ANOVA* to compare group means in each of the four classrooms before the experiment. I compared the means between males in groups 1 and 2, the means between females in groups 1 and 2, and lastly the means between the entire group 1 and group 2. My assignment procedures led to as equal grouping as possible in a predetermined elementary classroom. The descriptive statistics for the matching procedure is summarized in Table 6.

Table 6

Matching Groups

Class A				
Group	Gender	Mean	Std. Deviation	N
1	Male	67.30	8.66	5
1	Female	65.50	9.19	7
1	Total	66.25	8.62	12
2	Male	67.15	12.27	5
2	Female	65.25	9.38	7
2	Total	66.04	10.18	12
	Two-Way ANOVA Group Sig.	Two-Way ANOVA Gender Sig.	Two-Way ANOVA Group*Gender Sig.	Passes Levene's Test?
	.961	.655	.990	Yes: .866

Class B

Group	Gender	Mean	Std. Deviation	N
1	Male	70.10	12.05	5
1	Female	67.50	12.12	5
1	Total	68.80	11.48	10
2	Male	69.71	10.51	7
2	Female	66.19	12.58	4
2	Total	68.43	10.81	11

	Two-Way ANOVA Group Sig.	Two-Way ANOVA Gender Sig.	Two-Way ANOVA Group*Gender Sig.	Passes Levene's Test?
	.872	.562	.930	Yes: .984

Class C

Group	Gender	Mean	Std. Deviation	N
1	Male	68.39	10.44	7
1	Female	64.54	14.65	6
1	Total	66.62	12.16	13
2	Male	68.86	11.84	7
2	Female	64.21	18.04	6
2	Total	66.71	14.54	13

	Two-Way ANOVA Group Sig.	Two-Way ANOVA Gender Sig.	Two-Way ANOVA Group*Gender Sig.	Passes Levene's Test?
	.990	.442	.942	Yes: .287

Class D

Group	Gender	Mean	Std. Deviation	N
1	Male	67.58	15.80	7
1	Female	59.44	19.18	4
1	Total	64.61	16.65	11
2	Male	67.21	15.09	7
2	Female	58.81	16.59	4
2	Total	64.16	15.40	11

	Two-Way ANOVA Group Sig.	Two-Way ANOVA Gender Sig.	Two-Way ANOVA Group*Gender Sig.	Passes Levene's Test?
	.947	.268	.985	Yes: .945

Procedures

My study employed a sequential mixed methods, quasi-experimental, matched control group, pretest-posttest research design. The study measured student achievement and engagement through quantitative assessment data and qualitative teacher interview data. The experiment is quasi-experimental, as the sample was predetermined by school enrollment in the second grade. The experimental and control groups were created using the statistical technique of "matching" of pretest scores. Students were then randomly assigned to condition, creating matched control and treatment groups.

The research design and procedures are summarized below in Table 10. The procedure followed the six-step procedure discussed by Creswell (2014) (as cited in Borg & Gall, 2006). First, all students were given a randomized, anonymous math number. They used this math number when completing the measures of the dependent variables, two achievement pretests and one engagement pretest. Second, participants were assigned to matched pairs based on their average achievement engagement prescore and gender. Third, students in each pair were randomly assigned to either the experimental (iPad) group or control (paper-pencil) group. Fourth, the experimental group received the math intervention on the iPad and the control group gets the traditional paper-pencil math intervention. Fifth, the achievement posttests and engagement posttest were given to both groups. Sixth, I analyzed performance of the two groups based on comparing means to determine if the IXL iPad based math intervention had a statistically significant impact on student achievement and engagement and I interviewed the teachers in a focus group to gain their view of student engagement and achievement. The data on student engagement was supported by the qualitative teacher focus group data.

Independent Variable

The independent variable for my proposed study is the group alignment to iPad first or iPad second. I measured the impact of the iPad-based math intervention on student math achievement and engagement, as compared to the control condition of the traditional paper-pencil math intervention.

Math Intervention

All second grade students received one hour of math instruction from their homeroom teacher, five days a week, using the Bridges in Mathematics Curriculum designed by the Math Learning Center. The research covered Bridges Unit 5 (addition, subtraction, and word problems) and lasted for eight weeks. Unit 5 in Bridges in Mathematics is well aligned to the Common Core State Standards. Table 7 summarizes the CCSS standards covered in Unit 5. Appendix B includes the Bridges Unit 5 Planning guides, outlining the lesson for each day, the corresponding intervention (iPad or paper-pencil), and the CCSS standard taught that day.

Table 7

Bridges Unit 5 Common Core State Standards

Unit 5 Part 1	
CCSS 2.OA.1	Represents and solves problems fluently involving addition and subtraction within 100
CCSS 2.NBT.1	Understands place value to 1,000: 100s, 10s and 1s
CCSS 2.NBT. 7	Uses place value understanding to add and subtract within 1,000
CCSS 2.MD. 1, 4, & 5	Measures, estimates and compares lengths in standard units
CCSS 2.NBT.2	Count within 1000; skip-count by 5s, 10s, and 100s.
CCSS 2.NBT.3	Read and write numbers to 1000 using base-ten numerals, number names, and expanded form
CCSS 2.NBT.5	Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction
CCSS 2.NBT.4	Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using >, =, and < symbols to record the results of comparisons
Unit 5 Part 2	
CCSS 2.NBT. 5, 6, & 7	Uses place value understanding to add and subtract within 1,000
CCSS 2.MD. 8	Solves word problems involving dollars and cents
CCSS 2.MD. 9-10	Represents and interprets data using simple graphs
CCSS 2.NBT.8	Mentally add 10 or 100 to a given number 100-900, and mentally subtract 10 or 100 from a given number 100-900
CCSS 2.NBT.9	Explain why addition and subtraction strategies work, using place value and the properties of operations

The math curriculum for Bridges Unit 5 is divided into two four-week sessions (Part 1 and Part 2), which allowed the students to switch math interventions (iPad to paper/pencil; paper/pencil to iPad) halfway through the math unit. In addition to the hour of whole group math instruction, students participated in a math intervention for 25 minutes a day, four days a week, for an additional 600 minutes of math practice. Classroom teachers were given some flexibility in scheduling, as long as no intervention was shorter than 20 minutes, and the 300 minutes were achieved for each of the four-week sessions.

At Lincoln Elementary, teachers have shared access to 48 student iPads on a mobile cart. The teachers explained to students that since Lincoln Elementary only owns 48 iPads, we had to share them during math intervention. Therefore, half of the class (Group 1) used the iPads for 4 weeks (Bridges Unit 5 Part 1), while the other half of the class (Group 2) participated in the traditional paper-pencil math intervention. Then we switched for the last 4 weeks (Bridges Unit 5 Part 2), and half of the class (Group 1) worked on the paper-pencil intervention, while the other half of the class participated with the iPad (Group 2). The students in both groups were working on the same math skill that was taught that day in the whole group Bridges lesson. All students had the same amount of time on paper-pencil and iPads. The math curriculum and matched intervention tasks are listed in the Bridges Unit 5 Part 1 and Bridges Unit 5 Part 2 planning guides, and can be seen in Appendix C.

IXL experimental condition. The treatment is the experimental, iPad-based math intervention called IXL. IXL is a standards-based math application, where students or teachers can choose their grade level and a specific Common Core State Standard to work on. IXL tracks students' progress and rewards them with virtual stickers as they master each area of the curriculum. The application has no game elements and focuses on practice questions with immediate feedback for students. If a student answers a question correctly, a positive word appears on the screen to reinforce their work (e.g. Great Job!; Awesome!; Correct!). If a student misses a question, a detailed explanation of how to solve it correctly appears on the screen. Teachers benefit from detailed class and student progress reports in IXL. In the classroom setting, IXL allows for differentiation to meet individual student needs. Students who master content quickly can move onto more challenging problems, and students needing support can work on more basic skills. In the context of this proposed classroom research, all students were working on the same Common Core State Standard, which matches the standard taught in the lesson for that day from the Bridges in Mathematics Unit 5 Curriculum (and also matches the standard practiced in the paper-pencil math intervention). Although students started each day's math intervention on the same IXL strand, students could progress at their own pace which helped support diverse learners. Example items and teacher reports from IXL can be seen in Appendix D.

Bridges paper-pencil control condition. The control condition is the Bridges paper-pencil practice book, which reinforces Common Core State Standards taught in that day's lesson. The practice book is a series of worksheets, with about two pages matched to skills taught in each day's lesson. If a student finished that day's assigned math worksheets, they worked on other pages from the Bridges practice book. As seen in the IXL intervention, students started each day's math intervention on the same two worksheets, and could progress to additional pages if needed. Example items from the Bridges paper-pencil practice book can be seen in Appendix E.

Fidelity of Implementation

To help insure fidelity to the math intervention, teachers were trained on the Bridges in Mathematics program, which has been in use in our district since 2009. Every teacher in the proposed study has been using the Bridges in Mathematics program for seven years. Since the four teachers have worked together in the same school for the last seven years, they have received identical training. Each teacher has participated in the week long Best Practices in Mathematics training, along with the one-day training from the Math Learning Center on Bridges in Mathematics. Along with being very familiar with Bridges Unit 5, the teachers have an in-depth knowledge of the Bridges Practice Book, used as our paper-pencil math intervention. The Bridges Practice Book correlates paper-pencil practice worksheets to the lessons taught in the math unit.

The teachers involved in the study also received an identical training from their school district on iPads in the classroom in 2014. Since September 2013, there were four iPads for student use in each of the teachers' classrooms. In November of 2014, all teachers were given an iPad for teacher use along with an additional teacher training.

IXL, the iPad based-math intervention chosen for my proposed study, has been used at schools in the district as a math intervention for the last three years. The teachers involved in the study received two hours of training on IXL from myself (the researcher and fellow second grade teacher). The teachers learned how to teach students to log in and navigate to the second grade standard to practice for that day's math intervention. Teachers were trained to use the teacher tools on IXL to monitor individual student time on the intervention and progress towards mastery of math skills. In order to compensate them for their time and additional training, the three other second grade teachers received a $100 stipend from the Lincoln Elementary PTO to support classroom research.

Fidelity rubric. Teachers used a rubric that they completed every day to rate their implementation of the math intervention. The teachers rated the fidelity of the lesson using the rubric provided, and wrote down the number of minutes spent on the math (iPad or paper-pencil) intervention that day. Each week, we reviewed this data as a grade level team, to ensure equal levels of implementation and time on the math intervention. An example fidelity rubric sheet can be seen in Appendix F.

Student Attendance

The teachers also recorded the names of absent students. If a student missed more than three math intervention periods in a part of the unit (absent for more than > 25% of the intervention), their data was not reliable enough to use for the study. The teachers recorded the names of absent students on the daily attendance recording sheets. The researcher coded the student names with the anonymous student math number, and students not participating in the experiment were removed. The attendance data of participating students was transferred to a spreadsheet free of student names. At the onset of the experiment there were 93 students who had consent to participate in the classroom research. After removing 8 students who missed more than 25% of either intervention, I had a final sample size of 85 students. An example attendance-recording sheet can be seen in Appendix G.

Dependent Variables

Student achievement and engagement, the dependent variables, were measured using three different instruments and qualitative teacher focus group data. The second graders began by taking two achievement pretests: the paper-pencil Bridges in Mathematics Unit 5 (Part 1 and 2) pretests (administered by the classroom teacher), and the online easyCBM math numbers operations and algebra pretest. Next the students took an online Likert-scale Math Interest Inventory pretest (Snow, 2011) to judge their engagement in mathematics. Students only recorded their randomized, anonymous math number (no identifiable names) when completing the measures. These three tests were also given as posttests, and data was compared to measure change in achievement and engagement. The detailed administration procedures for each measure are explained in greater depth for each test below. At the conclusion of the experiment, the teachers involved with the study participated in a qualitative focus group to add to the data on student engagement.

Bridges in Mathematics Unit 5 Assessments

Math achievement was measured using the Bridges in Mathematics paper-pencil Unit 5 assessments in a pretest-posttest design. The Bridges in Mathematics Unit 5 assessment (part 1 and part 2) was written by The Math Learning Center, authors of the Bridges in Mathematics curriculum, and modified by the researcher and another second grade teacher in June of 2013. The researcher and her partner were hired by the school district to modify all of the second grade unit tests to fit the changes in the Bridges in Mathematics scope and sequence, due to the introduction of the Common Core State Standards. A few questions on the unit tests from Bridges needed to be moved to different unit tests, to reflect the new CCSS scope and sequence. The modified assessments were reviewed and approved by the school district's math team leader and The Math Learning Center. The assessments were then shared with all second grade teachers in our school district and have been in use as unit tests since September 2013. For the research project, the researcher simply divided the pre-existing Bridges Unit 5 Test into part 1 and part 2, to fit with the time frame of the intervention.

Administration procedures. The Bridges in Mathematics Unit 5 assessments were all given whole group, in the classroom, by the students' homeroom teacher. All students in second grade took the unit assessments for grade-level data; however, only scores for the participating students were recorded for the study data. The students had two forty-five minute class periods to complete the assessments. This mimicked the administration procedures for every Bridges unit test. The teachers read the directions and the math problems word for word, so every second grader receives the same instructions. The test was completed using paper-pencil, and students recorded their math number instead of their name on the top of each test. The assessments were each graded by an educational assistant, not involved with the study, using a non-subjective answer key. All data was recorded with the students' anonymous math number on a spreadsheet. Students pretest scores were compared with the corresponding posttest to measure growth in student achievement using Repeated Measures ANOVA.

Psychometric characteristics. The Bridges in Mathematics Unit 5 Part 1 and Part 2 tests are traditional paper-pencil tests. Students are familiar with the unit test format, as they take the tests with each unit of math study. A strong reason for using the Bridges Unit 5 math test for the achievement measure in the study is that it is part of the district-required curriculum (i.e. the students would be taking this test regardless). In any classroom research, it is advisable to closely mimic the "normal" classroom curriculum, assessments, and environment. The Bridges Unit 5 math assessments have been successfully used in the school district for student achievement data in second grade since 2013. Since there is currently no psychometric data provided by the Math Learning Center for these unit tests, I calculated reliability data for the unit tests. By entering each individual's itemized scores on the pretests, I calculated internal consistency, a measure of reliability. The Bridges in Mathematics Unit 5 Part 1 unit test had a Chronbach's alpha level of .754 and Unit 5 Part 2 was .749. Although an alpha level of .80 is most desirable, I chose to use the district-required, second grade Bridges unit tests as they were the least intrusive to the normal classroom environment. The Bridges in Mathematics Unit 5 assessments can be seen in appendix H.

easyCBM Math Numbers, Operations, and Algebra Assessments

Along with the paper-pencil Bridges Unit 5 assessments, student achievement was measured using the iPad-based easyCBM Math Numbers, Operations, and Algebra 2_1, 2_2, and 2_3 progress monitoring assessments in a pretest-posttest design. The goal in adding a second measure of student achievement was to include both a paper-pencil assessment and an iPad-based math assessment. The two achievement measures were averaged together into one achievement score. The easyCBM is a nationally normed test. Traditionally in second grade, the school district and Lincoln Elementary use both the easyCBM and the Bridges in Mathematics unit assessments to provide a complete view of student achievement. The easyCBM features short, 16-question progress-monitoring assessments, which are designed to give teachers formative assessment data. The math easyCBM measures were designed by University of Oregon, and have been in use at our district for many years.

Administration procedures. The easyCBM assessments were given whole group, in the classroom, by the students' homeroom teacher. All students in second grade took the easyCBM for grade-level data; however, only scores for the participating students were recorded for the study data. The students took the easyCBM on an iPad during a forty-five minute class. This mimics the administration procedures for every easyCBM test. The iPad read the directions and the math problems word for word, so every second grader received the same instructions. An educational assistant, not related to the study, de-identified and coded students' scores with their anonymous math number. The scores were then inputted into the data spreadsheet.

Psychometric characteristics. The easyCBM has been studied to provide practitioners with reliability information. The second grade Winter version of the easyCBM CCSS had high internal reliability with a Chronbach's alpha of .88, while the average Chronbach's alpha was .90 across easyCBM CCSS assessments K-8 (Wray, Alonzo, & Tindal, 2013). The progress monitoring segments used in the experiment have not been specifically studied, but their reliability can be generalized based on the study by Wray, Alonzo, and Tindal (2013):

> "Although only data from the Fall and Winter benchmark assessments were used in this study, the development process used for the measures, in which all alternate forms within a given grade level were designed to be of equivalent difficulty, and the consistent findings across all grades and forms analyzed suggests that the results may well generalize to the other easyCBM CCSS Math

forms, including the Spring benchmark tests and all ten progress monitoring forms at each grade level”

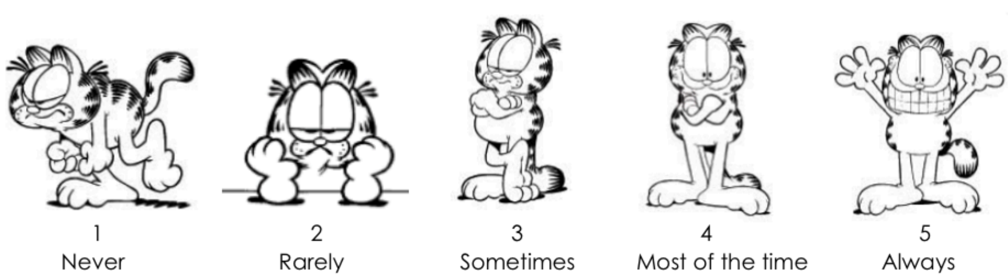
(Wray, Alonzo, & Tindal, 2013, p. 4).

The easyCBM assessments can be seen in appendix I.

Math Interest Inventory (Snow, 2011)

The Math Interest Inventory is used to measure student engagement in mathematics. The Math Interest Inventory was written especially for elementary school students, and is age appropriate. The Math Interest Inventory is a five-point Likert-scale quantitative measure with 20 questions, resulting in a range of possible scores from 20 to 100. In order to help children understand a Likert-scale, I added images from Professor Garfield (1990) (Figure 2.). The original Professor Garfield Likert-scale had four point levels (1990). I added the image for 2 = rarely, as I needed to have a five point Likert-scale. Students, even non-readers, can use the images of Garfield to help them understand the Likert-scale 1-5 rating. Professor Garfield has been used in many reading and writing student engagement measures with great success for younger students (1990).

Figure 2.
Professor Garfield (1990) in the Likert-scale.



Administration procedures. The math interest inventory was administered during one thirty-minute period in the school’s computer lab through a Google Form survey. Each of the four classroom teachers administered the engagement measure to their homeroom class, in a whole group setting. The teacher read a script to the students so all students in second grade received the same directions. Students used their anonymous math number when filling out the measure. The anonymous engagement measure results were collected in a password protected Google spreadsheet, and later were deleted from the Internet and stored on the researcher's computer. The last two items have special directions, as they are written in the negative form and the Garfield images are appropriately reverse ordered. Student answers to these two items were reverse coded at the conclusion of the measure (e.g. a score of 5 was reverse coded to 1; 4 to 2; 3 to 3; 2 to 4; and 1 to 5). The student engagement score (out of 100 possible points) was added up using the sum function in the Google spreadsheet. The teacher directions script and math interest inventory (Snow, 2011) can be seen in appendix J.

Psychometric characteristics. The Math Interest Inventory was created and studied by Snow, in order to create a reliable and valid engagement measure (2011). In the Math Interest Inventory an "overall reliability analysis resulted in a coefficient alpha estimate of .916. Cicchetti (1994) states that any instrument evidencing a coefficient alpha greater than .90 is considered appropriate for diagnostic purposes" (as cited in Snow, p. 26, 2011). Snow conducted a factor loading analysis of the interest measure questions on each factor: Emotion (r = .883), Value (r = .606), Knowledge (r = .830), and Engagement (r = .863) (Snow, 2011). Each scale for the hypothesized factors of Emotion, Knowledge, and Engagement "also meets the internal consistency criterion of r = .80" (Snow, 2011, p. 27). The coefficient alphas suggest that the questions represent each hypothesized factor in math interest. The reliability of the measure was analyzed for each of the hypothesized factors: Emotion (α = .893), Value (α = .712), Knowledge (α = .832), and Engagement (α = .848) (Snow, 2011). Due to the high coefficient alphas, I can use Snow's Math Interest Inventory with confidence in its reliability and validity.

Given the addition of the Garfield pictures to represent the Likert-scale, I reexamined the internal consistency of the measure. By analyzing the 93 students' itemized scores on the math engagement measure given at the onset of the experiment, I calculated the internal consistency, a measure of reliability. The Chronbach's alpha was .904, which justifies the use of the Snow's Math Interest Inventory with the addition of the Garfield images to measure student engagement in mathematics (2011).

Qualitative Teacher Online Focus Group

As seen in 11 of the 16 studies reviewed in the pool of literature, adding a qualitative component can help create a more complete view of the impact of instructional technology. As a result, I conducted an online focus group with the teachers involved with the study.

Administration procedures. At the conclusion of the experiment, I lead an online focus group using the Adobe Connect platform to connect with the three other teachers involved with the study. The focus group was guided by a written protocol of questions to gain their insight on the impact of the iPad-based math intervention on student engagement. Halfway through the online focus group, I shared the results of the experiment with the teachers. I then recorded their observations on the study data. The online focus group was video recorded and transcribed for analysis.

Psychometric characteristics. There are no psychometric characteristic data available for the Qualitative Teacher Online Focus Group. The questions were written by the researcher in order to gain the teachers' view of how student engagement is impacted by the iPad-based math intervention. The qualitative teacher online focus group protocol can be seen in appendix K.

Analysis

Quantitative Analysis

I analyzed the data from the control and treatment groups using Repeated Measures ANOVA from the SPSS software package. RM ANOVA is appropriate because the test compares the outcomes of two groups over time (Creswell, 2014). I compared the pretest to posttest growth for both the treatment and control groups, after part 1 and again after part 2, in order to measure the impact of the iPad and paper-pencil math interventions. The analysis will help answer the research questions, measuring the impact of the iPad-based math intervention IXL on students' achievement (RQ1) and engagement (RQ2) in mathematics.

Achievement data analysis. I ran a RM ANOVA to compare changes between groups over time for the two Bridges in Mathematics unit tests (part 1 and part 2). Next, I used a Repeated Measures ANOVA to also look at the changes between groups over time for the math easyCBM. Analysis of this quantitative data helped me test the non-directional null hypothesis (alpha = .05), which will lead to accepting or rejecting the null hypothesis: the iPad-based math intervention IXL does not have an impact on student achievement, as compared to the traditional paper-pencil Bridges math intervention. The RM ANOVA statistical analysis of measures is summarized in table 8.

Engagement data analysis. I compared the data from the Math Interest Inventory engagement pretest, to the midtest, and to the posttest using the Repeated Measures

ANOVA to provide information on the impact of the iPad-based math intervention on the students' engagement in mathematics. Analysis of this quantitative data will lead me to accept or reject the null hypothesis: the iPad-based math intervention IXL does not have an impact on student engagement, as compared to the traditional paper-pencil Bridges math intervention. The RM ANOVA statistical analysis plan for quantitative engagement data is summarized in Table 8.

Table 8

RM ANOVA Statistical Analysis of Measures

Measure	Pre Study	1st 4-Weeks of Unit 5	Mid Study	2nd 4-Weeks of Unit 5	Post Study
Bridges Math Unit 5 Part 1 Tests	X Pretest Pt. 1	Part 1	X Posttest Pt. 1	Part 2	
Bridges Math Unit 5 Part 2 Tests		Part 1	X Pretest Pt. 2	Part 2	X Posttest Pt. 2
easyCBM 2_1, 2_2, 2_3	X easyCBM 2_1	Part 1	X easyCBM 2_2	Part 2	X easyCBM 2_3
Math Interest Inventory	X	Part 1	X	Part 2	X

Qualitative Data Analysis

I analyzed the qualitative data from the transcription of the online teacher focus group for general trends using the phenomenological method (Creswell, 2014). After reviewing the transcripts of the focus group I used Microsoft Word to code for themes around the topics of engagement, behavior, achievement, differentiation, and valuing of technology. I then analyzed the coded results and shared the teachers' observations on the impact of the iPad-based math intervention through a qualitative written summary. This qualitative data will bring added meaning to the students' quantitative Likert-scale math engagement measure, and will lead me to accept or reject the null hypothesis: the iPad-based math intervention IXL does not have an impact on student engagement, as compared to the traditional paper-pencil Bridges math intervention.

Alpha Level and Power Analysis

My sample of 85 second grade students was divided into two groups: one group receiving the treatment first and one receiving the control group first. Group 1 had a sample size of 43 and Group 2 had 42 students. The alpha level was set at the default of .05, which is the cut-score for significance and an acceptable Type I error rate. Power was set at 1- beta. Beta is the Type II error rate that is acceptable. My power is .8, and my priori Type II error rate is .2. A sample this size (85 second grade students) can produce an effect size of .61. An effect size of .61 is sufficient to detect large effects to determine statistical significance. The statistical program G*Power was used to complete the power analysis.

A gap in the research of iPad use in the early elementary mathematics classroom has been clearly established, as only 1 of the 16 studies in the literature review focused on this population (McKenna, 2012). One cannot assume that the previous research findings will generalize to this proposed classroom research. Regardless of the results, this research study is needed to help inform the overall body of literature on educational technology in the early elementary mathematics classroom. In the next chapter I present the results of my classroom research study.

CHAPTER IV

RESULTS

In this chapter I present the quantitative and qualitative findings for each of my four research questions.

Descriptive Statistics

The descriptive statistics presented herein include the mean and standard error for each measure, by group and for the whole sample, across points in time. The data set is complete for all 85 participants. From the descriptive statistics it is easy to see that the group mean scores increased over time on the achievement measures, showing that all students made academic growth. The group mean scores on the engagement measure stayed very consistent throughout the experiment. The standard error ranges are all acceptable. Table 9 presents the descriptive statistics.

Next, I present the correlation data for the dependent variables: the measures of achievement and engagement in the study. The correlation data are represented using the two-tailed Pearson correlation analysis in SPSS. There is a high correlation (.331 to .697) between measures of achievement: the Bridges in Mathematics Unit Tests (abbreviated as: BPt1Pre/Post, BPt2 Pre/Post) and the easyCBM (eCBM 2_1, 2_2, 2_3) tests. The engagement measure, the Math Interest Inventory (Int. Inv. Pre/Mid/Post), is not correlated with the measures of achievement, as they measure different traits. Table 10 summarizes the correlation data.

Table 9

Descriptive Statistics

Measure	Group	*n*	*Mean T1*	*SD T1*	*Mean T2*	*SD T2*	*Mean T3*	*SD T3*
Bridges 5 Pt1	1	43	56.977	21.228	86.213	9.998	N/A	N/A
	2	42	51.617	23.255	82.143	16.185	N/A	N/A
	All	85	54.297	22.284	84.178	13.492	N/A	N/A
Bridges 5 Pt2	1	43	N/A	N/A	66.945	19.454	95.100	6.840
	2	42	N/A	N/A	64.905	22.341	93.879	7.241
	All	85	N/A	N/A	65.925	20.830	94.490	7.026
easyCBM	1	43	76.599	17.892	85.320	13.698	88.663	9.572
	2	42	71.131	20.565	81.548	16.504	85.863	11.636
	All	85	73.865	19.340	83.434	15.178	87.263	10.672
Math Int. Inv.	1	43	65.884	14.144	67.093	10.120	65.116	12.256
	2	42	69.262	14.360	67.810	16.150	68.286	13.148
	All	85	67.573	14.267	67.451	13.366	66.701	12.729

Table 10

Pearson Correlations Between Measures

Measure	1	2	3	4	5	6	7	8	9	10
1. BPt1Pre	-	-	-	-	-	-	-	-	-	-
2. BPt1Post	**.331**	-	-	-	-	-	-	-	-	-
3. BPt2Pre	**.630**	**.443**	-	-	-	-	-	-	-	-
4. BPt1Pre	**.372**	**.425**	**.469**	-	-	-	-	-	-	-
5. eCBM 2_1	**.679**	**.396**	**.566**	**.391**	-	-	-	-	-	-
6. eCBM 2_2	**.697**	**.525**	**.615**	**.434**	**.653**	-	-	-	-	-
7. eCBM 2_3	**.523**	**.466**	**.606**	**.522**	**.542**	**.643**	-	-	-	-
8. Int. Inv. Pre	.115	.138	.071	.153	.087	.061	.097	-	-	-
9. Int. Inv. Mid	.012	.001	-.005	.075	-.091	-.084	-.058	**.672**	-	-
10. Int. Inv. Post	-.081	.063	.003	.055	-.027	-.062	-.005	**.621**	**.647**	-

Correlations in **bold** are significant at the .01 level (2-tailed)

Research Question One

RQ 1: Does an iPad-based math intervention, IXL, affect second-grade students' math achievement as measured by quantitative pre-post unit tests and the math easyCBM?

My first research question, focused on the impact of the iPad-based math intervention IXL, as compared to the Bridges paper-pencil math intervention, on second grade students’ achievement in math. To answer this research question, I used Repeated Measures ANOVA to compare the results of two quantitative measures over time and between groups, (a) the Bridges in Mathematics Unit 5 part 1 and part 2 tests, administered in paper-pencil form, and (b) the easyCBM Math Numbers, Operations, and

Algebra 2_1, 2_2, and 2_3 progress monitoring assessments, administered on the iPad.

Bridges in Mathematics Unit 5 Part 1 and Part 2

The results of the Bridges in Mathematics Unit 5 part 1 test were analyzed using Repeated Measures ANOVA to compare the growth of the two intervention groups, iPad and paper-pencil, between the pretest (given prior to part 1 of the experiment) and the posttest (administered after part 1 of the experiment). There was no significant interaction between time and group (p=.788), indicating that there was no measurable difference in the academic growth of students between interventions. The students had the same level of achievement when engaged with the iPad-based math intervention IXL or the Bridges paper-pencil math intervention. There was a statistically significant effect of time (p=.000), which indicates that all students in the study made academic growth in math between the pre and posttest. Student in both intervention groups had a statistically similar level of achievement, which leads me to accept the null hypothesis: the iPad-based math intervention IXL does not have an impact on student achievement, as compared to the traditional paper-pencil Bridges math intervention. Table 11 and Figure 3 summarize the results of the Repeated Measures ANOVA for Bridges Unit 5 part 1 pre and posttest.

Next, I used the same Repeated Measures ANOVA to look at the Bridges Unit 5 part 2 pre to posttest growth between groups. The Bridges Unit 5 part 2 pretest was given after part 1 of the experiment and before part 2, and the posttest was given after part 2 of the experiment. There was no statistically significant interaction between time and group (p=.841).

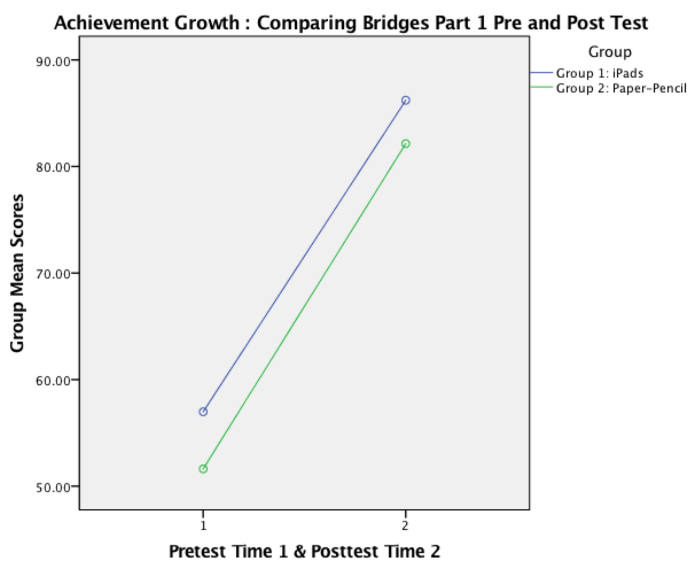
Table 11

RM ANOVA Results for Bridges Unit 5 Part 1 Tests

Source	*SS*	*df*	*MS*	*F*	*p*
			Within Subjects		
Time	37,942.503	1.000	37,942.503	156.516	.000
Time * Group (iPad or pp)	17.689	1.000	17.689	.073	.788
Error	20,120.802	83.000	242.419		

Note. Results are reported with Greenhouse-Geisser correction.

Figure 3.
Achievement Growth: Comparing Bridges Part 1 Pre and Post Tests



Like in Bridges Unit 5 part 1, there was no statistically significant difference in the achievement of students in the iPad-based math intervention IXL, or the Bridges paper-pencil math intervention. Also seen in part 1, there was a statistically significant effect of time (p=.000), and both intervention groups made academic growth between the pre and posttest. In Bridges Unit 5 part 1 and part 2, students in both intervention groups had a statistically similar level of achievement. This finding had lead me to accept the null hypothesis: the iPad-based math intervention IXL does not have an impact on student achievement, as compared to the traditional paper-pencil Bridges math intervention.

Table 12 and Figure 4 summarize the results of the Repeated Measures ANOVA for Bridges Unit 5 part 2 pre and posttest.

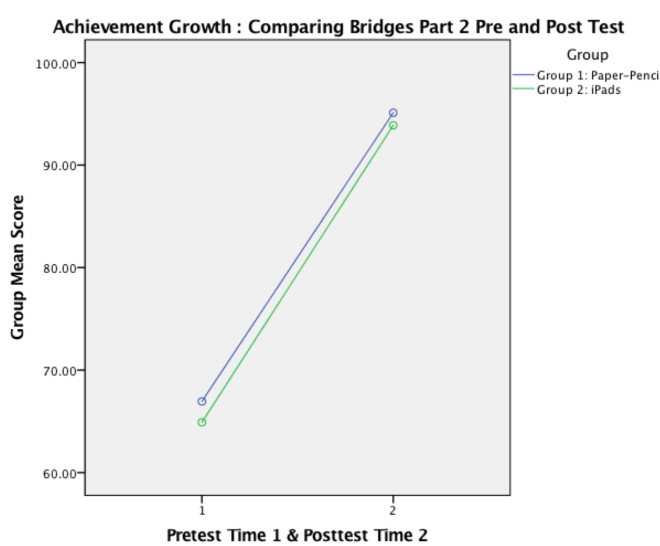
Table 12

RM ANOVA Results for Bridges Unit 5 Part 2 Tests

Source	*SS*	*df*	*MS*	*F*	*p*
			Within Subjects		
Time	34,673.024	1.000	34,643.024	198.070	.000
Time * Group (iPad or pp)	7.125	1.000	7.125	.041	.841
Error	14,529.547	83.000	175.055		

Note. Results are reported with Greenhouse-Geisser correction.

Figure 4.
Achievement Growth: Comparing Bridges Part 2 Pre and Post Tests



easyCBM

The results of the easyCBM progress monitoring assessments 2_1, 2_2, and 2_3 were analyzed with Repeated Measures ANOVA to compare growth between the two intervention groups (iPad and paper-pencil) over three points during the experiment. All students were given the easyCBM 2_1 as a pretest prior to beginning the intervention. The easyCBM 2_2 was given as a midtest at the end of the first intervention. The students then switched intervention programs and the easyCBM 2_3 was given as a posttest at the end of the second intervention. There was no statistically significant interaction between time and group over the three easyCBM tests (p=.664). Similar to the Bridges Unit 5 tests, there was no statistically significant difference in the achievement of students in the iPad-based math intervention IXL or in the Bridges paper-pencil math intervention, as measured by the easyCBM tests. Also seen in the Bridges Unit 5 tests, there was a statistically significant effect of time (p=.000) and all students made academic growth between the easyCBM pre, mid, and posttests. According to the results of the three easyCBM tests, students in both intervention groups had a statistically similar rate of achievement. The similar quantitative results, for the Bridges Unit 5 tests and the easyCBM tests, have lead me to accept the null hypothesis: the iPad-based math intervention IXL does not have an impact on student achievement, as compared to the traditional paper-pencil Bridges math intervention. Table 13 and Figure 5 summarize the results of the Repeated Measures ANOVA for the easyCBM tests.

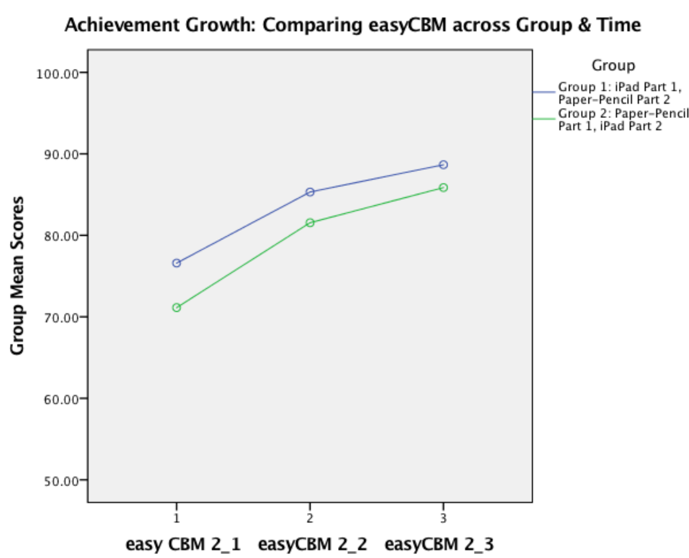
Table 13

RM ANOVA Results for easyCBM 2_1, 2_2, 2_3

Source	*SS*	*df*	*MS*	*F*	*p*
		Within Subjects			
Time	8,094.641	1.768	4,577.216	38.804	.000
Time * Group (iPad or pp)	77.484	1.768	43.814	.371	.664
Error	17,314.060	146.782	117.957		

Note. Results are reported with Greenhouse-Geisser correction.

Figure 5.
Achievement Growth: Comparing easyCBM Across Group & Time



Research Question Two

RQ 2: Does learning with an iPad-based math intervention, IXL, affect students' engagement and interest in mathematics, as measured by a pre-post Likert-scale quantitative measure?

My second research question examined the impact of the iPad-based math intervention IXL, as compared to the Bridges paper-pencil math intervention, on second grade students' engagement in math using quantitative methods. To answer this research question, I looked at the results of the Math Interest Inventory, a quantitative engagement measure employing a 1 to 5 numeric Likert-scale.

Math Interest Inventory

Using Repeated Measures ANOVA I analyzed the engagement scores from the math interest inventory, comparing the scores between the iPad and paper-pencil groups over three time points. This same Likert-scale engagement measure was given over three points in time: (a) prior to the onset of the experiment, (b) after the conclusion of part 1 of the experiment and before part 2 began, and (c) after part 2 was complete. There was no statistically significant interaction between time and group for the Likert-scale engagement measure (p=.487). Similar to the achievement results for RQ1, there was no statistically significant difference in the level of students' engagement in the iPad-based math intervention IXL or the Bridges paper-pencil math intervention, as measured by the Math Interest Inventory. There was also no statistically significant effect of time on students' engagement (p=.744). The quantitative results for the Math Interest Inventory have lead me to accept the null hypothesis: the iPad-based math intervention IXL does not have an impact on student engagement, as compared to the traditional paper-pencil Bridges math intervention. Table 14 and Figure 6 summarize the results of the Repeated Measures ANOVA for the Math Interest Inventory.

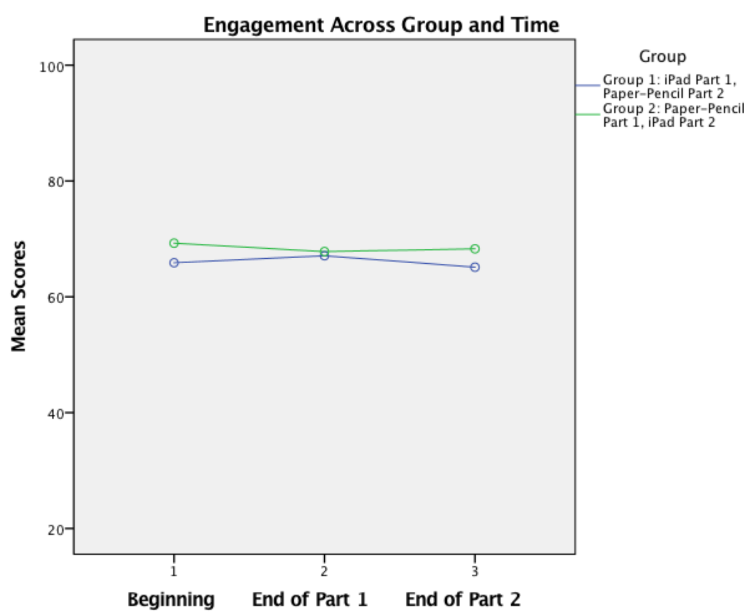
Table 14

RM ANOVA Results for Math Interest Inventory (Pre, Mid, and End)

Source	*SS*	*df*	*MS*	*F*	*p*
		Within Subjects			
Time	37.898	1.981	19.133	.293	.744
Time * Group (iPad or pp)	93.098	1.981	47.002	.721	.487
Error	10,720.542	164.398	65.211		

Note. Results are reported with Greenhouse-Geisser correction.

Figure 6.
Engagement Across Group & Time



Research Question Three

RQ 3: What are teacher perceptions of effects on students' engagement for the iPad-based math intervention versus a paper-and-pencil condition?

To answer my third research question, I analyzed the qualitative data from the teacher focus group to better understand the impact of the iPad-based math intervention IXL, as compared to the Bridges paper-pencil math intervention on student engagement.

Engagement Results Specific to the iPad-based IXL Intervention

When asked about negative elements of student engagement during the iPad-based math intervention IXL, teachers stated that there was nothing negative to share about student engagement. The three teachers in the study expressed only positive observations of student engagement when working with IXL. One teacher shared that math intervention time was her “favorite 30 minutes of the day, because they were all engaged.” Another “wish[ed] it [the experiment] had lasted longer, because the kids liked it and they were really engaged,” and all of the teachers agreed. According to the teachers, there were specific elements of the iPad-based intervention that had a positive impact on student engagement. IXL had a positive impact on students’ motivation and independence by providing immediate, corrective feedback, and differentiation, which will be discussed in the following subsections.

Motivation and excitement. Although the teachers found that both intervention groups were highly engaged, they felt like the iPad group was “...definitely more excited that the paper-pencil kids.” One teacher shared that her students were “...motivated to do it” and that they “...looked forward to that time of day [and their] motivation was pretty important [apparent].” All teachers agreed with one teacher’s statement that “[d]uring this time we didn't have any behavior problems… the kids were really highly engaged… [there was] excitement on who could start first." One shared that she could hear kids saying things like " 'Oh Yeah!' because they moved up a level." The teachers were all surprised that students were so motivated by the picture award that appeared when students completed a section of the CCSS math standard. "It wasn't a sticker or time to do a game, it was just a little picture on a grid and they were so motivated by it!" Another teacher shared that she felt like the "little picture things that they would earn [in IXL]… really meant nothing, but they were incredibly motivating to the kids …Which was surprising because it wasn't like this high-falutin award that they got, it was just these little pictures… but they loved it!" The last teacher agreed that IXL "was just very engaging for them. They enjoyed it… and it made them feel successful." Although both groups were fully engaged, teachers agreed that the iPad group was more motivated and excited.

Independence. All three of the teachers found that kids "on iPads seemed to work more independently than the kids who were on paper-pencil." Another teacher shared that she had "very few students raise their hand and need help with the iPads, unless it was a tech issue; it wasn't an academic issue." The other teachers agreed that they had "very few kids who needed help with iPads," compared to the higher level of support needed for the paper-pencil students.

Immediate, corrective feedback. All three teachers shared that they were impressed with the level of immediate, corrective feedback provided by IXL after each question was answered. The teachers all agreed that this feedback provided students with "scaffolding and help" that "was pretty clear to them, so they didn't need redirection" from the teacher. One teacher shared that students with the iPads were “more excited” because they had “instant feedback whether things were right or wrong.” Another teacher stated, “I liked the fact that it [IXL] could… [give] feedback far faster than I can as a human being. You’ve got 27 kids and you’ve got 27 iPads, and at the same time they were all getting exactly what they needed, without the teacher trying to go around to each kid… [Teachers] don’t have time to go around to each kid” and give that level of immediate, corrective feedback.

Differentiation. The iPad-based program IXL allows students to work at their own pace and unique ability level. All three teachers agreed that this was a strength of the iPad-based program and a clear advantage over paper-pencil interventions. Students who needed extra support could spend more time working on basic problems. IXL also has a read aloud function for struggling readers. All three teachers shared that this was a highly effective support for their struggling readers, allowing them to focus on the math. Students who were successful on the basic problems could move on to more advanced problems, working on the same CCSS standard. The teachers shared that IXL helped keep “quick kids” engaged with extra challenge and above-level problems, in a way that was much more effective than paper-pencil. The differentiated level of support and challenge lead all three teachers to agree that “IXL was better for differentiating and scaffolding” for both below and above level students.

Engagement Results Specific to the Bridges Paper-Pencil Intervention

All three teachers agreed that the student level of engagement was equal between the iPad-based IXL group and the paper-pencil based Bridges group. However, when prompted with the same questions about engagement for the paper-pencil intervention, the teachers didn't share as many positive examples as when they spoke about the iPad-based math intervention. The three teachers shared their surprise that students were "perfectly happy to do the paper-pencil," as they were initially worried that students would be upset if they didn't have the iPad first. All three teachers agreed with one teacher's statement, "I was surprised to find that the kids liked the paper-pencil… but, I think part of it is because our curriculum doesn't use a whole lot of paper-pencil, so there was definitely more engagement there than I thought." The teachers were all impressed that "the paper-pencil kids, when they finished their assigned pages, some of them were kind of fast" and "motivated" to finish each page.

Although the teachers shared that the levels of engagement were equal between both groups, they shared that they spent much more time helping the paper-pencil students to be successful. When analyzing their statements, there are four clear themes around the need for a higher level of teacher support to maintain student engagement with the Bridges paper-pencil intervention: (a) reading questions and directions, (b) differentiation, and (c) corrective feedback.

Reading questions and directions. All three agreed with one teacher who said, "the kids who had paper-pencil, I spent more time helping them." Another added that, "my paper-pencil kids were coming up to me constantly, needing me to read something, or re-explain something to get them going." The last shared that "when it came to paper-pencil, I had to read the question, I had to kind of explain what they needed to do… If there had been somebody there who could read the questions to [each of] them, that would it have made it any easier for the paper-pencil" group. Overall all teachers stated that there was a higher need for teacher support with reading the questions and worksheet directions to students with the Bridges paper-pencil based math intervention.

Differentiation. All three teachers shared that their below-level students needed a higher level of teacher support in order to be successful during the paper-pencil based math intervention. “The kids needed a little more instruction to get them going on the paper-pencil, and so I probably did interact with them more, which probably means that they were having more, not necessarily having bad behaviors, but needing more support or scaffolding.” Another teacher agreed and shared that “with the paper-pencil, the differentiation was that some kids just needed more scaffolding and they were dependent on me to do it.” The third teacher agreed that she thinks she “had to do more scaffolding with the paper-pencil” group. All of the teachers stated that when engaged in the paper-pencil math intervention, students needed their support more and were not as independent as when involved in the iPad-based math intervention.

All three teachers expressed that the greatest challenge to the paper-pencil intervention was providing opportunities for extra challenge for their above-level students. All teachers agreed with one teacher’s statement that “the paper and pencil kids often times needed more challenge, and so it was hard to keep them busy with the next available sheets. They would finish earlier than the iPad kids.” Teachers had to predict how many students each day would need the extra practice sheets that provided additional challenge in the same CCSS standard. Although all worksheets were provided, the teachers were responsible for making copies of the challenge worksheets and for creating a system where students could pick up the challenge sheets specific for that day’s CCSS standard, if they finished the assigned paper-pencil pages early.

Corrective feedback. Another teacher shared that a challenge for the paper-pencil intervention was finding time to give corrective feedback to all students; all three teachers said it was hard to keep up with giving timely feedback to students. One teacher shared that "the paper-pencil kids… had to come see me and get some more support [or feedback], which was kind of hard to keep up." Another teacher also shared that while the iPad students had immediate, corrective feedback, the paper-pencil didn't have that level of "scaffolding and help." A third teacher agreed and shared that "unless I sat one-on-one with a student and put that little sticker as soon as they got it right, that's the only way I could keep up with the feedback they were getting from IXL. With one of me and 20 whatever of them, that was not probably [possible]."

Another concern was that the feedback they were able to provide for the students in the paper-pencil intervention wasn't as exciting as the iPad-based IXL intervention. According to one teacher, "with the paper-pencil… they got me giving them feedback, but it wasn't quite as motivating as probably the IXL was." This teacher had shared that she could hear her IXL students saying things like " 'Oh Yeah!' because they moved up a level" or cheering when they earned a picture for passing a CCSS standard. She did not see that same level of enthusiasm from her corrective feedback given to the paper-pencil group.

Teacher Reactions to the Study Results from the Qualitative Focus Group

Near the end of the focus group, the teachers were shown the quantitative results from RQ1 on achievement and RQ2 on engagement from the study, and were given an opportunity to respond to the findings. Based on the quantitative results, the teachers discussed their future plan for math interventions based on their experiences in the study.

I have captured their reactions to the quantitative results here.

Teacher Reactions to Quantitative Results for Achievement

Two of the three teachers stated that they "were not surprised" at the statistically similar achievement results between groups. They shared that they expected both groups would see similar achievement results, based on the similar engagement levels that they observed between groups. One teacher was very surprised stating that she "thought the technology [and immediate, corrective feedback] would boost scores more than [it] did." All three teachers agreed that they spent "much more time with the paper-pencil kids," while both groups had the same level of achievement. Teachers felt like students could be more independent, with the same achievement outcomes, when engaged in the iPad-based math intervention.

Teacher Reactions to Quantitative Results for Engagement

The three teachers all shared that they weren't surprised that the engagement results were statistically similar between the iPad and paper-pencil intervention groups. All teachers agreed that since the Bridges in Mathematics curriculum is hands-on and group work based, that students found the quiet, independent practice time on the iPad or with paper-pencil to be "novel", "different", and "engaging." "[S]o much of our math is in group work. I think that some of those kids with paper-pencil were just so excited to work on their own, at their own pace, and to get done what they could…that part of it was motivating." One shared, "I don't think I'm too surprised... Going into this study I was convinced that technology would be more motivating and have better results, but then once we were in it, and you kind of saw how [all of] the kids were engaged, it doesn't surprise me too much. But it was definitely different than what I thought going in."

Although the paper-pencil group took much more teacher time, for reading, directions, feedback, and scaffolding, both groups were equally engaged in their math intervention. The quantitative engagement survey results show the same results as the qualitative teacher focus group results, with no statistically significant differences in levels of engagement between groups.

Research Question Four

RQ 4: What are teacher perceptions regarding implementation challenges for the iPad-based math intervention versus a paper-and-pencil condition?

In order to answer research question four, I analyzed the qualitative data from the teacher focus group.

Implementation Challenges for the iPad-based Intervention IXL

As with many new technologies, there were a few implementation challenges that could threaten engagement during the iPad-based math intervention IXL. All teachers agreed that after working with the program for a week, students were comfortable with the routine and had learned the technology. All three teachers agreed that in the beginning "a few kids lost a minute or two of their time, while we got [user names, passwords, lowering iPad volume, or updates] fixed." Another teacher shared that she "would definitely say that these kids [at the onset of the intervention experiment]… weren't used to using a lot of technology in the classroom, like they are used to using it at home with games and stuff. So teaching them to kind of troubleshoot stuff when it went wrong… was a little tricky, but nothing bad!" One teacher responded that "little technical pieces like that would have been the only challenge."

All of the teachers agreed that after the first week with the iPads, the group was proficient with the technology. One teacher shared, “I’d say after the first week they got pretty good... the big problems were fixed. There were always kids who were leaders and would be able to troubleshoot pretty quickly with the others, which was nice.” Another teacher responded, “Yep, I would agree. After that first week, that group was ready to go. And then when we switched from paper-pencil to iPad, then we kind of had that learning week again.” The last teacher felt like the “second go round was a little bit smoother than the first… and maybe part of the learning was on our part too, teaching and learning ourselves how to troubleshoot.”

Implementation Challenges for the Bridges Paper-Pencil Intervention

The implementation challenges that could threaten engagement for the Bridges paper-pencil intervention were the logistics of (a) having only one teacher to provide reading help and feedback for the paper-pencil group, and (b) creating a system for providing extra challenge worksheets for early finishers and above-level math students. One teacher expressed that it was initially challenging to provide “extra paper and pencil work for those who finished early… but we learned that as we went” and created a clear system for picking up extra challenge worksheets. The teachers all expressed that they spend more time working with the paper-pencil intervention group, as IXL provided feedback and extra challenge automatically.

The final chapter discusses the implications of the quantitative and qualitative findings. The results from the two methods, also serve to inform future math intervention practices, and helps to inform future research questions.

CHAPTER V

DISCUSSION

The current study uses a sequential mixed-methods approach to investigating the impact of an iPad-based intervention, IXL, on students' achievement and engagement in math. Based on previous research on the impact of technology in the elementary mathematics classroom, I expected to see an increase in student achievement while engaged in the iPad-based math intervention (Glassett & Schrun, 2009; McKenna, 2012; Pilli & Aksu, 2013; Rosen & Beck-Hill, 2012; Yang & Tsai, 2010). In my study, however, the levels of student achievement were statistically similar in both the iPad and paper-pencil math interventions. Other researchers have also found these null results, with no statistically significant difference between iPad and paper-pencil math achievement scores (Carr, 2012; Ke, 2008).

Based on the literature review of technology in the elementary math classroom, I expected to see an increase in student engagement during the iPad-based math intervention (Glassett & Schrun, 2009; Ke, 2008; Li & Pow, 2011; McKenna, 2012; Patterson & Young, 2013; Pilli & Aksu, 2013; Rosen & Beck-Hill, 2012; Yang & Tsai, 2010). Instead, my quantitative results found that the levels of student engagement were statistically similar between the iPad and paper-pencil math interventions. The qualitative results supported the quantitative findings that students were equally engaged in both interventions. However the qualitative results clarified that the students with paper-pencil were more reliant on teacher help to maintain equal levels of engagement. All teachers found that students on the iPad were more independent, which is a positive factor for engagement. In the research that I reviewed, there were no studies of instructional technology in the elementary math classroom with null engagement results, all had positive results.

Impact of Interventions

In the next section I will discuss the impact of both the iPad-based math intervention IXL and the paper-pencil based Bridges math intervention on students achievement and engagement in math.

Impact of the iPad-based Math Intervention IXL on Student Achievement

My quantitative results from RQ1 examined the achievement growth, as measured by two math tests across groups and time. There was no statistically significant difference between the achievement levels for students learning with the iPad-based math intervention or the paper-pencil intervention. There was strong growth between pretest and posttest, showing the impact of time and the equally positive impact of both IXL and the Bridges paper-pencil interventions. Two of the studies reviewed in my research found the same results (Carr, 2012; Ke, 2008). In both of these studies, the technology group made academic growth at the same rate as the paper-pencil group, showing that both teaching strategies were equally effective (Carr, 2012; Ke, 2008). This was also seen in my study, neither intervention had a greater impact on student achievement in elementary math, as both had an equally positive effect.

Multiple past studies found positive achievement results when integrating technology into the elementary math classroom (Glassett & Schrun, 2009; McKenna, 2012; Pilli & Aksu, 2013; Rosen & Beck-Hill, 2012; Yang & Tsai, 2010). Instead, I found that both the technology based group and the iPad group had statistically similar levels of achievement. This could have been due to my research design. My design helped to control for teacher effects, by dividing each classroom into two equal groups (iPads or paper-pencil). Since the iPad students were found to be much more independent, the teachers could spend their time helping the paper-pencil half of their class. Student independence in the iPad intervention unexpectedly created a smaller teacher to student ratio for the paper-pencil condition. It is possible that the equal achievement between groups was due to this higher level of teacher support for the half of the students using paper-pencil. It would be interesting to see how results would differ if the whole class was engaged in the paper-pencil intervention at once, decreasing the amount of teacher support time per child.

Another factor that could have impacted the results was the level of independent practice in the math curriculum. Teachers shared that prior to the experiment students were not given this amount of independent practice time in school. The Bridges in Mathematics curriculum is very strong in group activities, “hands-on” and game-based learning, but time for independent practice is limited. The teachers stated that their students were highly motivated by the independent practice time that the experiment provided for all students. It is possible that the equal levels of achievement were due to the increase in independent practice for all students.

Impact of the iPad-based Math Intervention IXL on Student Engagement

Results from RQ2 investigated the impact of the iPad and paper-pencil intervention on student engagement, across groups and time. The quantitative results from my study showed that the iPad-based math intervention had the same level of impact on student engagement as the paper-pencil intervention, as measured by the Math Interest Inventory. My qualitative results supported these findings as all teachers agreed that engagement was equal between groups. In my literature review, no study reported equal levels of engagement between the technology and paper-pencil group. All of the studies showed a more positive impact of the technology on engagement, compared to paper-pencil (Glassett & Schrun, 2009; Ke, 2008; Li & Pow, 2011; McKenna, 2012; Patterson & Young, 2013; Pilli & Aksu, 2013; Rosen & Beck-Hill, 2012; Yang & Tsai, 2010). One possible reason for the different findings in my study is that I attempted to control for compensatory rivalry between groups. At the onset of the experiment, teachers told their students that they would spend four weeks in *each* intervention (iPad and paper-pencil). The results could have been different if the students didn't know that the iPad or paper-pencil intervention was coming next. Perhaps their interest in the paper-pencil condition could be explained by their knowledge that in four weeks they would receive an iPad, or vice versa? It would also be interesting to look at how the results would be different if this experiment lasted for the whole school year. If students had to wait half of the school year, to trade interventions, would the iPad be more motivating?

Although there was no statistical difference in the quantitative Math Interest Inventory, the qualitative data indicated that the paper-pencil intervention required a much higher level of teacher input to maintain equal levels of engagement with the iPad group. Students were highly independent and engaged with the iPad-based math intervention. How would the engagement results differ if the whole class were learning with paper-pencil, decreasing the unexpectedly high teacher to student ratio for paper-pencil seen in this experiment? The high level of independence and engagement during the iPad intervention has interesting implications for future practice.

The increased amount of independent practice was reported by teachers to be engaging and enjoyable for all students in both interventions. It is possible that the engagement results might be different if students had more exposure to independent practice during the normal math class. In that case, the independent practice wouldn't be novel, allowing us to compare the different impacts of the iPad and paper-pencil math interventions.

Validity and Reliability

The next section examines the validity and reliability threats for the study, and how the experiment addresses those potential issues**.**

Internal Validity

The following section addresses threats to internal validity.

Selection of participants. In order to improve the internal validity of the experiment, efforts were made to control certain variables. One threat to internal validity is the selection of participants for the experiment. Although I had a predetermined selection of second grade students, I helped ensure equal levels of student knowledge and engagement in both the treatment and control groups. This helped confirm that levels of student achievement and engagement are "equally distributed among the experimental group" and the control group (Creswell, 2014, p. 175). I divided students in their homeroom class by "matching" treatment and control groups based on achievement pretest and engagement pretest scores. By using a *t* -test to compare group means before the experiment, I confirmed that groups were as equal as possible. "Matching" helped to control for the level of student knowledge and engagement coming into the experiment and added validity to the selection process.

History. A second threat to internal validity was history, "because time passes during an experiment, events can occur that unduly influence the outcome beyond the experimental treatment" (Creswell, 2014, p. 174). In order to control for history, each classroom was divided equally into experimental and treatment groups, and the two groups experienced "the same external events" (Creswell, 2014, p. 174). By dividing each classroom into experimental and treatment groups, I ensured that both groups in a classroom received the same level of instruction and implementation by the same teacher. One unexpected factor was that the independence of the iPad group allowed the teacher to spend more time with the paper-pencil group, at a smaller teacher to student ratio. This could have positively impacted the achievement results for students when they were in the paper-pencil group.

Compensatory demoralization and rivalry. Compensatory demoralization and compensatory rivalry were important threats to address in my study. It is important to recognize the potential for the control group to feel that "the benefits of an experiment may be unequal or resented when only the experimental group receives the treatment" or that the control group feels devalued because they do not experience the treatment (Creswell, 2014, p. 175). To help minimize this threat to internal validity, the control and treatment groups switched interventions (iPad or paper-pencil) halfway through Unit 5. All students were told that since the school only has 48 iPads, we must share, but everyone will receive the same amount of time on the iPads. For Unit 5 part 1, half of the class used an iPad for math intervention and then they switched to paper-pencil math intervention for Unit 5 part 2. The attempt to control for compensatory rivalry could be a possible reason for the equal levels of engagement. It would be interesting to know how the achievement and engagement results might change if the experiment was much longer, or students did not know that they would be switching groups.

External Validity

There were two main threats to external validity, the interaction of selection, setting, or history on treatment. "A researcher cannot generalize the results" to different groups, different settings, and to past or future situations (Creswell, 2014, p.177). This means that one cannot generalize the findings from the study to all students, because the results are only valid for the second grade students selected, who attend the setting of Lincoln Elementary, during the 2015 school year. In order to increase the external validity of the experiment, I would recommend replicating the study on a much larger scale with a variety of schools and grade levels.

Reliability

The main threat to reliability is researcher bias, since I am the researcher and am also one of the second grade teachers in the study (Babbie, 2012). In order to help with this, all of the second grade teachers, including myself, followed a script when giving the engagement measure and the two measures of achievement. By following a script, there was greater reliability in the measures' data. Researcher bias is also controlled because the researcher and the second grade team of teachers did not grade any of the measures and assessments. All measures involved with the study were pre-coded with the anonymous student number and were graded by an educational assistant, who was not involved with the study.

Limitations

The main limitation to my study is generalizability. My study included a small sample size of one upper-middle class elementary school, with four teachers, and 85 second graders. Time is also a factor, as the two sessions of math intervention were only four weeks each. The limited scope of my sample and short duration of the experiment makes the generalizability of the quantitative and qualitative findings to be limited. However, the use of both quantitative and qualitative data (i.e., achievement tests, engagement measures, and the focus group) adds to the depth of analysis and improves internal validity (Glasset & Schrun, 2009). The effort to match groups at the onset of the experiment, along with switching conditions, improves internal validity as well (Carr, 2012).

Implications for Future Practice

This research will better inform the Digital Conversion efforts taking place in Lincoln elementary next year and many other schools in our district (Mikalson, 2015). As a member of the elementary iPad app committee, this research will help the district decide if IXL is an app that they would like to continue to support for math interventions. On a larger scale, school leaders are making large investments in educational technology, and this proposed research will provide more information about the impact of teaching with iPads in the early elementary mathematics classroom (McKenna, 2012).

This research provides ideas for how teachers can best plan their instructional and intervention times. During the focus group, the teachers involved in the study shared how the experiment and its findings will shape their future math instruction. Based on the results from RQ1 and RQ2, all three teachers expressed that they would like to use IXL and other instructional technology to support students during math interventions, independent math practice, or homework in the future. All three teachers also plan to increase the time dedicated to independent math practice in their classrooms using either an iPad or paper-pencil approach.

One teacher stated that she hoped that the daily Bridges curriculum would "have a piece that follows along with it… where you can incorporate technology into your regular curriculum so its all connected, which I'm sure is the direction where we're headed in." Although each day's IXL practice was aligned to the exact CCSS skill as the Bridges practice-book, she said it would be easier and faster for teachers to have a math curriculum that also included an iPad-based intervention or independent practice piece. Another teacher agreed that she would like a math curriculum with "a direct [technology] tie in, to allow for kids to more independently practice their math skills as part of the daily math" work in class and at home where levels of parent support vary greatly. The research findings show that students are highly independent and engaged during the iPad-based math intervention, and require very little teacher interaction. This led teachers to wonder how they could incorporate IXL into their homework, where levels of home support vary in ability and frequency. All teachers agreed that the iPad would be a strong support for at-home practice. All three teachers agreed that the paper-pencil practice was strong, but required more teacher time, and students were less independent. The teacher shared that they would use instructional technology for the fluency-building computational tasks and they would choose paper-pencil for more critical thinking and problem solving exercises.

Fluency-building computational tasks. All three teachers shared that they would choose instruction technology over paper-pencil in the future for gaining fluency and computational tasks. One shared "instructional technology is good, more so for computation and repetitive tasks like that." Another agreed and shared that iPad-based practice was great for "concepts like math facts and telling time, where its just constant repetitiveness and they need more practice, then that could come in really handy." The last teacher agreed and shared that her "kids right now are using iPads for telling time. I find it so much more engaging for them and so much more instant feedback and they can do a lot more problems in a minute than I can whole group when I'm using the big Judy clock." All three teachers agreed that they will use iPad-based programs in the future for building fluency and computation, for the clear advantages of differentiating for each student and immediate corrective feedback.

Critical thinking and problem solving tasks. All three teachers shared that they would prefer to use paper-pencil to practice math tasks involving higher levels of critical thinking. One stated I would use instructional technology for computational tasks, "but not so much for complex tasks" and another added that she agreed that "as far as critical thinking" she preferred paper-pencil practice.

Implications for Future Research

This study provides a framework for future research in educational technology. I believe that this study should be replicated on a larger scale, for a longer duration in order to look again at the impact of an iPad-based math intervention on students' achievement and engagement in math. A larger study, with a diverse group of schools should produce results that would be more generalizable to all early elementary mathematics classrooms.

Educational technology provides exciting opportunities for students. It is essential that teachers and school leaders act as critical consumers of technology and look to research to ensure that they are providing the best instruction for our students' success.

APPENDIX A

LITERATURE REVIEW

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APPENDIX B

BRIDGES MATH PLANNING GUIDES WITH CCSS

Bridges Math Planning Guide with Common Core State Standards Alignment:

Unit 5 Part 1

Bridges Math Planning Guide Unit 5 Part 1

Session & Date	Lesson Name	Paper-Pencil	iPad IXL	CCSS
Day 1 Session 3, Pt. 1 Mon. Jan. 26th	Problems and Investigations: Presents & Parcels: Looking at Picture Problems # 1-3	Pages 1 & 2: Bowls & Vans, Puzzles about Ten & More	E.12, E.18, E.20 Addition Word Problems, then continue to any of E	2.OA.1 2.OA.2 2.NBT.5 2.NBT.9
Day 2 Session 3, Pt. 2 Tues. Jan. 27th	Problems and Investigations: Presents & Parcels: Looking at Picture Problems # 4-6	Pages 3 & 4: Books & Granola Bars, More Facts Than You Need	F.9 Subtraction Word Problems, than continue to any of F	2.OA.1 2.OA.4a 2.NBT.5 2.NBT.9 2.MD.8
Day 3 Session 4 Wed. Jan. 28th	Presents & Parcels: Creating Story Problems, Part 1	No Math intervention	No Math intervention	2.OA.1
Day 4 Session 5 Thurs. Jan. 29th	Presents & Parcels: Creating Story Problems, Part 2	Pages 5 & 6: Ants & the Number Box, More Fact Family Triangles	G.9, G.14, G.16 Addition Word Problems, then continue to any of G	2.OA.1 2.NBT.5
No School Fri. Jan. 30th				
Day 5 Session 7 Mon. Feb. 2nd	Presents & Parcels: Shopping for Story Problems, Part 1	Pages 7 & 8: Apples & Snow People, Sharing Stories	H.9 Subtraction Word Problems, then continue to any of H	2.OA.1 2.OA.4a 2.NBT.5 2.NBT.9

Bridges Math Planning Guide Unit 5 Part 1 Continued

Session & Date	Lesson Name	Paper-Pencil	iPad IXL	CCSS
Day 6 Session 8 Tues. Feb. 3rd	Presents & Parcels: Shopping for Story Problems, Part 2	Pages 9 & 10: Pet Shop Equations, Nuts & Carrots	L.3, L.9 Addition & Subtraction Word Problems, then continue to any of L.	2.OA.1 2.OA.2 2.OA.4a 2.NBT.5 2.NBT.7 2.NBT.9
Day 7 Session 11 Wed. Feb. 4th	Each One Teach One: How Well Did We Follow the Guidelines? Grading our Peer's Solutions to our Story Problems	No Math Intervention	No Math Intervention	2.OA.1 2.NBT.5 2.NBT.9
Day 8 Supplement Thurs. Feb. 5th	Supplement A5 Number & Operations: Multi-Digit Addition & Subtraction Act. 2: Jump-a-Ten	Pages 11 & 12: Different Ways ...300 , Different Ways... Same Number	All of M. Place values	2.NBT.1 2.NBT.2 2.NBT.3
Day 9 Supplement Fri. Feb. 6th	Supplement A5 Number & Operations: Multi-Digit Addition & Subtraction Act. 3: Jump-a-Hundred	Pages 13 & 14: Adding & Subtracting Tens, Tens & Ones	M. Place Values Continued	2.NBT.1 2.NBT.2 2.NBT.3 2.NBT.5 2.NBT.8 2.MD.8
Day 10 Supplement Mon. Feb. 9th	Supplement A9 Act. 3: Introducing the Open Number Line	Pages 15 & 16: Make Tens to Subtract, Hundreds, Tens, Ones	A.4, A.9, A.13, Number Lines, and continue to any of A.	2.OA.3 2.NBT.1 2.NBT.2 2.NBT.3

Session & Date	Lesson Name	Paper-Pencil	iPad IXL	CCSS
Day 11 Supplement Tues. Feb. 10th	Supplement A9 Act. 4: Height & Length Problems	Pages 17 & 18: Shopping & the Number Box, Base Ten Addition	S.4, S.10, Measurement Word Problems, then continue to any of S	2.OA.1 2.NBT.2 2.NBT.5 2.NBT.6 2.MD.4 & 8
Day 12 Supplement Wed. Feb. 11th	Supplement A9 Act. 5: Greatest Difference Wins	No Math Intervention	No Math Intervention	2.NBT.2
Day 13 Session 15 Thurs. Feb. 12th	Problems & Investigations: Scoop 100 & Find the Mass	Pages 19 & 20: Shopping Problems, Place Value Practice	H. Subtraction - two digits	2.OA.1 2.NBT.1 2.NBT.2 2.NBT.3 2.NBT.5 2.MD.8
Day 14 Session 13 Fri. Feb. 13th	Problems & Investigations: Handfuls of Treasure	Pages 21 & 22: Coin Problems, Adding & Subtracting Tens & Nines	H. Subtraction - two digits continued	2.OA.1 2.NBT.5 2.NBT.9 2.MD.8
* No School * Monday Feb. 16th				
Day 15 Supplement Tues. Feb. 17th	Number Corner Place Value and Greater Than / Less Than	Pages 23-25: Sam's Hot Dog Stand, Comparing Numbers to 300, Place Value Review	B. Comparing and Ordering if you haven't finished M. Place Value, you can do that too	2.NBT.1 2.NBT.2 2.NBT.3 2.NBT.4

Bridges Math Planning Guide with Common Core State Standards Alignment: Unit 5 Part 2

Bridges Math Planning Guide Unit 5 Part 2

Session & Date	Lesson Name	Paper-Pencil	iPad IXL	CCSS
Day 1 Session 16 Mon. Feb. 23rd	Problems & Investigations: Base Ten Triple Spin	Pages 1 & 2: More Place Value Practice, Pencil Puppy and Pal	M. Place Value	2.OA.1 2.NBT.1 2.NBT.2 2.NBT. 3
Day 2 Session 18 Tues. Feb. 24th	The Candy Color Project Pt.1	Pages 3 & 4: The Pet Graph, Wheels	R. Data & Graphs	2.OA.1 2.NBT.5 2.NBT.6 2.MD5 2.MD.10
Day 3 Session 19 Wed. Feb. 25th	The Candy Color Project Pt.2	No Math Intervention	No Math Intervention	2.MD.5
Day 4 Session 20 Thurs. Feb. 26th	The Candy Color Project Pt.3	Pages 5 & 6: Grandma's Button Box, The Second Graders Clean Their Desks	R. Data & Graphs Continued	2.OA.1 2.NBT.4 2.MD.5 2.MD.10
Day 5 Supplement Fri. Feb. 27th	Supplement A9: Act. 1 Modeling the Standard Algorithm for Double-Digit Addition	Pages 7 & 8: 2-Digit Addition, More 2-Digit Addition	G. Addition- Two Digits	2.OA.1 2.NBT.5
Day 5 Supplement Mon. March 2nd	Supplement A9: Act. 2 Recording the Standard Algorithm	Pages 9 & 10: 2-Digit Addition	G. Addition- Two Digits Continued	2.OA.1 2.NBT.5

Bridges Math Planning Guide Unit 5 Part 2 Continued

Session & Date	Lesson Name	Paper-Pencil	iPad IXL	CCSS
Day 6 Session 21 Tues. March 3rd	Problems & Investigations: Make 100: Under or Over?	Pages 11 & 12: Estimation Problems, Numbers & Clocks	G. Addition- Two Digits Continued and I. Addition – Three Digits	2.OA.1 2.NBT.1 2.NBT.2 2.NBT.5 2.NBT.9
Day 7 Session 22 Wed. March 4th	Problems & Investigations: Which Makes the Most Sense?	No Math Intervention	No Math Intervention	2.NBT.9
Day 8 Session 23 Thurs. March 5th	Problems & Investigations: Pick 2	Pages 13 & 14 Which Makes the Most Sense, Time & Money Problems	N.1, N.5 Estimation	2.NBT.5 2.NBT.9 2.MD.8
Day 9 Session 24 Fri. March 6th	Problems & Investigations: Race to 100 & Back	Pages 15 & 16: Cubes & Homework, Missing Numbers	P. Money	2.OA.1 2.NBT.2 2.NBT.5 2.NBT.6 2.NBT.9 2.MD.8
Day 10 Supplement Mon. March 9th	Supplement A9 Act. 6: Modeling the Standard Algorithm for Multi-Digit Subtraction	Pages 17 & 18: Base Ten Subtraction, 2-Digit Subtraction	H. Subtraction- Two Digits	2.OA.1 2.NBT.5
Day 11 Supplement Tues. March 10th	Supplement A9 Act. 7: Recording the Standard Algorithm for Multi-Digit Subtraction	Pages 19 & 20: More 2-Digit Subtraction, & Adding	H. Subtraction- Two Digits Continued	2.NBT.5

Bridges Math Planning Guide Unit 5 Part 2 Continued

Session & Date	Lesson Name	Paper-Pencil	iPad IXL	CCSS
Day 12 Session 25 Wed. March 11th	Problems & Investigations: Shopping for Key Chain Charms: A Savings Game	No Math Intervention	No Math Intervention	2.OA.1 2.NBT.5 2.NBT.6 2.NBT.9
Day 13 Session 26 Thurs. March 12th	Problems & Investigations: Hawaiian Dream Vacation	Pages 21 & 22: Lines & Buttons, Digits & Number Riddles	P. Money Continued	2.OA.1 2.NBT.1 2.NBT.2 2.NBT.3 2.NBT.7 2.MD.8
Day 14 Supplement Fri. March 13th	Number Corner: Coins & Money Problems & Number String Review	Pages 23-25: Addition & Subtraction Practice, Shapes Shop, Time & money	P. Money Continued	2.OA.1 2.NBT.5 2.MD.8

APPENDIX C

BRIDGES MATH UNIT 5

Unit 5 Part 1

Session 3, Pt. 1 Mon. Jan. 26	Session 3, Pt. 2 Tues. Jan. 27	Session 4 Wed. Jan. 28	Session 5 Thurs. Jan. 29th	*No School* Fri. Jan. 30th
Bridges Lesson: Problems and Investigations: Presents & Parcels: Looking at Picture Problems # 1-3 **P/P: Pages 1 & 2: Bowls & Vans, Puzzles about Ten & More** **iPad:** **E. 12, E. 18, E.20 Addition Word Problems, then continue to any of E** **<u>Homework 17</u>**	**Bridges Lesson:** Problems and Investigations: Presents & Parcels: Looking at Picture Problems # 4-6 **P/P: Pages 3 & 4: Books & Granola Bars, More Facts Than You Need** **iPad:** **F. 9 Subtraction Word Problems, then continue to any of F**	**Bridges Lesson:** Presents & Parcels: Creating Story Problems, Part 1 **no math intervention**	**Bridges Lesson:** Presents & Parcels: Creating Story Problems, Part 2 **P/P: Pages 5 & 6: Ants & the Number Box, More Fact Family Triangles** **iPad:** **G.9, G. 14, G. 16 Addition Word Problems, then continue to any of G**	
Session 7 Mon. Feb. 2nd	**Session 8 Tues. Feb. 3rd**	**Session 11 Wed. Feb. 4th**	**Supplement Thurs. Feb. 5th**	**Supplement Fri. Feb. 6th**
Bridges Lesson: Presents & Parcels: Shopping for Story Problems, Part 1 **P/P: Pages 7 & 8: Apples & Snow People, Sharing Stories** **iPad:** **H.9 Subtraction Word Problems, any of H, <u>HW 18</u>**	**Bridges Lesson:** Presents & Parcels: Shopping for Story Problems, Part 2 **P/P: Pages 9 & 10: Pet Shop Equations, Nuts & Carrots** **iPad: L.3, L.9 + / - Word Prob., any of L.**	**Bridges Lesson:** Each One Teach One: How Well Did We Follow the Guidelines? Grading our Peer's Solutions to our Story Problems **no math intervention**	**Bridges Lesson:** Supplement A5 Number & Operations: Multi-Digit Addition & Subtraction Act. 2: Jump-a-Ten **P/P: Pages 11 & 12: Different Ways …300 , Different Ways Same #** **iPad:** **All of M. Place values**	**Bridges Lesson:** Supplement A5 Number & Operations: Multi-Digit Addition & Subtraction Act. 3: Jump-a-Hundred **P/P: Pages 13 & 14: + & - Tens, Tens & Ones** **iPad: M. Place Values Continued**

Supplement Mon. Feb. 9th	Supplement Tues. Feb. 10th	Supplement Wed. Feb. 11th	Session 15 Thurs. Feb. 12th	Session 13 Fri. Feb. 13th
Bridges Lesson: Supplement A9 Act. 3: Introducing the Open Number Line **P/P: Pages 15 & 16: Make Tens to Subtract, Hundreds, Tens, Ones** **iPad:** **A.4, A.9, A.13, Number Lines, and continue to any of A.** **<u>NO Homework</u>**	**Bridges Lesson:** Supplement A9 Act. 4: Height & Length Problems **P/P: Pages 17 & 18: Shopping & the Number Box, Base Ten Addition** **iPad:** **S.4, S.10, Measurement Word Problems, then continue to any of S**	**Bridges Lesson:** Supplement A9 Act. 5: Greatest Difference Wins **no math intervention**	**Bridges Lesson:** Problems & Investigations: Scoop 100 & Find the Mass **P/P: Pages 19 & 20: Shopping Problems, Place Value Practice** **iPad:** **H. Subtraction - two digits**	**Bridges Lesson:** Problems & Investigations: Handfuls of Treasure **P/P: Pages 21 & 22: Coin Problems, Adding & Subtracting Tens & Nines** **iPad:** **H. Subtraction - two digits continued**
No School Mon. Feb. 16th	Supplement Tues. Feb. 17th	Post-Assessment Wed. Feb. 18th	Post-Assessment Thurs. Feb. 19th	Pre-Assessment Fri. Feb. 20th
	Bridges Lesson: Number Corner Place Value and Add on Greater Than / Less Than **P/P: Pages 23-25: Sam's Hot Dog Stand, Comparing Numbers to 300, Place Value Review** **iPad:** **B. Comparing and Ordering if you haven't finished M. Place Value, you can do that too** **<u>Homework 19</u>**	**easyCBM Math Nums Ops and Algebra 2_2 (iPads, one 45 minute class period)** **Bridges Unit 5 Pt. 1 Post-Test (On paper, two 45 minute class periods)**	**Math Post-Survey (Computer Lab, 30 minutes)** **Finish Bridges Unit 5 Pt. 1 Post-Test (On paper, two 45 minute class periods)** **Bridges Unit 5 Pt. 2 Pre-Test (On paper, two 45 minute class periods)**	**Math Period: Bridges Unit 5 Pt. 2 Pre-Test (On paper, two 45 minute class periods)**

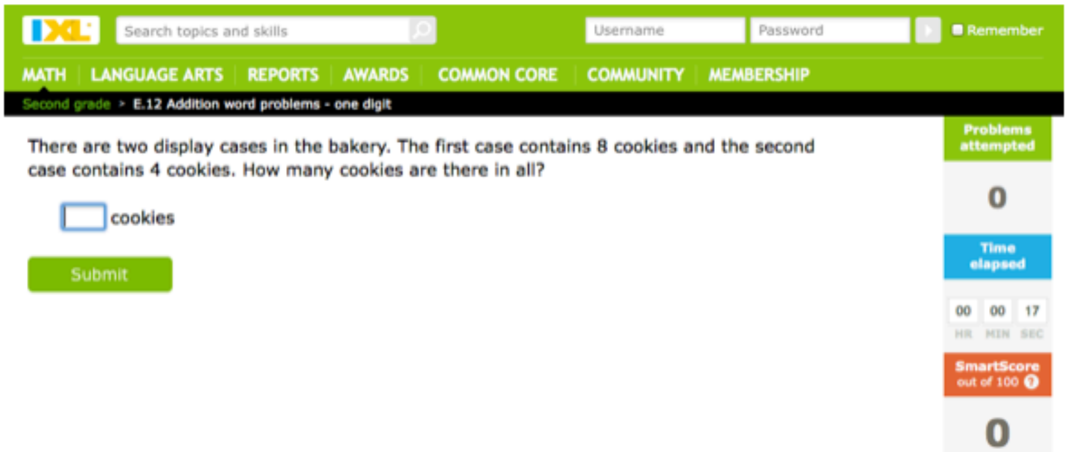
Unit 5 Part 2

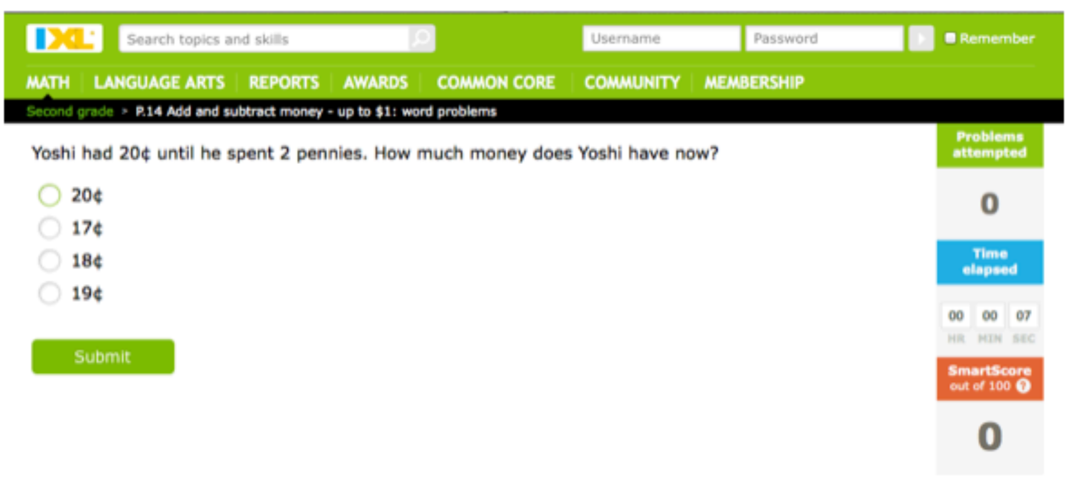
Session 16 Mon. Feb. 23rd	Session 18 Tues. Feb. 24th	Session 19 Wed. Feb. 25th	Session 20 Thurs. Feb. 26th	Supplement Fri. Feb. 27th
Bridges Lesson: Problems & Investigations: Base Ten Triple Spin **P/P: Pages 1 & 2: More Place Value Practice, Pencil Puppy and Pal** **iPad:** **M. Place Value** **Homework 20**	**Bridges Lesson:** The Candy Colors Project, Part 1: Predicting Color Frequency **P/P: Pages 3 & 4: The Pet Graph, Wheels** **iPad:** **R. Data & Graphs**	**Bridges Lesson:** The Candy Colors Project, Part 2: Graphing Color Frequency **Wednesday- no math intervention**	**Bridges Lesson:** The Candy Colors Project, Part 3: Analyzing the Data **P/P: Pages 5 & 6: Grandma's Button Box, The Second Graders Clean Their Desks** **iPad: R. Data & Graphs continued**	**Bridges Lesson:** Supplement A9 Act. 1: Modeling the Standard Algorithm for Double-Digit Addition **P/P: Pages 7 & 8: 2-Digit Addition, More 2-Digit Addition** **iPad: G. Addition - two digits**
Supplement Mon. March 2nd	**Session 21 Tues. March 3rd**	**Session 22 Wed. March 4th**	**Session 23 Thurs. Mar 5th**	**Session 24 Fri. Mar 6th**
Bridges Lesson: Supplement A9 Act. 2: Recording the Standard Algorithm for Double-Digit Addition **P/P: Pages 9 & 10: 2-Digit Addition Practice, Adding & Subtracting Practice** **iPad: G. Addition - two digits continued** **Homework 22**	**Bridges Lesson:** Problems & Investigations: Make 100: Under or Over? **P/P: Pages 11 & 12: Estimation Problems, Numbers & Clocks** **iPad: G. Addition - two digits continued or continue to I. Addition - three digits**	**Bridges Lesson:** Problems & Investigations: Which Makes the Most Sense **Wednesday- no math intervention**	**Bridges Lesson:** Problems & Investigations: Pick 2 **P/P: Pages 13 & 14: Which Makes the Most Sense, Time & Money Problems** **iPad: N.1, N.5, Estimation**	**Bridges Lesson:** Problems & Investigations: Race to 100 & Back **P/P: Pages 15 & 16: Cubes & Homework, Missing Numbers** **iPad:** **P. Money**

Supplement Mon. March 9th	Supplement Tues. Mar 10th	Session 25 Wed. Mar 11th	Session 26 Thurs. Mar 12th	Supplement Fri. March 13th
Bridges Lesson: Supplement A9 Act. 6: Modeling the Standard Algorithm for Multi-Digit Subtraction **P/P: Pages 17 & 18: Base Ten Subtraction, 2-Digit Subtraction** **iPad:** **H. Subtraction - two digits** **Homework 21**	**Bridges Lesson:** Supplement A9 Act. 7: Recording the Standard Algorithm for Multi-Digit Subtraction **P/P: Pages 19 & 20: More 2-Digit Subtraction, Adding & Subtracting** **iPad:** **H. Subtraction - two digits continued**	**Bridges Lesson:** Problems & Investigations: Shopping for Key Chain Charms: A Savings Game **Wednesday- no math intervention**	**Bridges Lesson:** Problems & Investigations: Hawaiian Dream Vacation **P/P: Pages 21 & 22: Lines & Buttons, Digits & Number Riddles** **iPad:** **P. Money continued**	**Bridges Lesson:** Number Corner Coins & Money Problems & Number String Review **P/P: Pages 23-25: Addition & Subtraction Practice, Another Trip to the Shapes Shop, Time & Money** **iPad:** **P. Money continued**
Post-Assessment Mon. Mar 16th	Post-Assessment Tues. Mar 17th	Post-Assessment Wed. Mar 18th	Post-Assessment Thurs. Mar 19th	Post-Assessment Fri. Mar 20th
Bridges Unit 5 Pt. 2 Post-Test: (On paper, two 45 minute class periods)	**Finish Bridges Unit 5 Pt. 2 Post-Test: (On paper, two 45 minute class periods)**	**easyCBM Math Nums Ops and Algebra 2_3: (On iPads, one 45 minute period)**	**Math Post-Survey: (Computer Lab, 30 minutes)**	**Any last absent kids?**

APPENDIX D

EXAMPLES FROM IXL MATH INTERVENTION

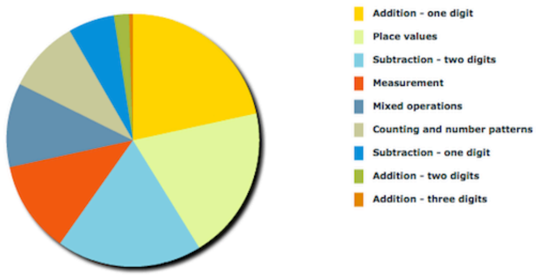




IXL TEACHER REPORT EXAMPLE PER STUDENT

Time spent

Math - time spent by category

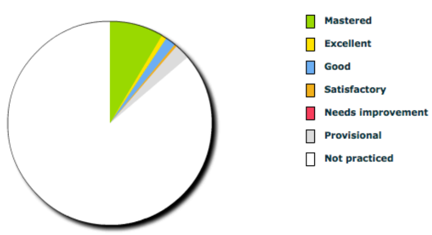


Skills practiced

Rank ▲	Skill	Time spent	Problems attempted	SmartScore
1	S.4 Customary units of length: word problems (Math)	0 hr 24 min	38	91 (excellent)
2	L.3 Addition and subtraction word problems - up to 20 (Math)	0 hr 22 min	50	84 (good)
3	H.9 Subtraction word problems - up to two digits (Math)	0 hr 17 min	29	84 (good)
4	E.20 Add four or more one-digit numbers: word problems (Math)	0 hr 15 min	29	100 (mastered)
5	E.18 Add three one-digit numbers: word problems (Math)	0 hr 14 min	36	100 (mastered)
5	H.1 Subtract multiples of 10 (Math)	0 hr 14 min	57	100 (mastered)
7	E.12 Addition word problems - one digit (Math)	0 hr 10 min	28	100 (mastered)
7	M.3 Place value models - up to thousands (Math)	0 hr 10 min	19	100 (mastered)
9	A.13 Number lines - up to 1,000 (Math)	0 hr 9 min	41	100 (mastered)
9	F.9 Subtraction word problems - up to 18 (Math)	0 hr 9 min	35	100 (mastered)

- Achieved **higher** scores.
- Attempted **more** questions.
- Spent a similar amount of time practicing.
- Mastered **more** skills.
- Practiced **more** skills.

Performance on all skills



Performance by category

Category/skill	Skills practiced	Score on skills practiced	Cumulative score	Percentile in class	Rank in class
Counting and number patterns (14 skills)	4	100 (mastered)	400/1,400 (29%)	86	7
Comparing and ordering (6 skills)	0	-	-	-	-
Names of numbers (6 skills)	0	-	-	-	-
Patterns (3 skills)	0	-	-	-	-
Addition - one digit (24 skills)	4	100 (mastered)	400/2,400 (17%)	98	1
Subtraction - one digit (13 skills)	2	96 (excellent)	192/1,300 (15%)	90	4
Addition - two digits (16 skills)	1	78 (satisfactory)	78/1,600 (5%)	69	15
Subtraction - two digits (12 skills)	4	92 (excellent)	368/1,200 (31%)	69	16
Addition - three digits (7 skills)	1	86 (good)	86/700 (12%)	98	1
Subtraction - three digits (7 skills)	0	-	-	-	-
Properties (5 skills)	0	-	-	-	-
Mixed operations (14 skills)	1	84 (good)	84/1,400 (6%)	45	28

APPENDIX E

EXAMPLES FROM BRIDGES MATH INTERVENTION

Use after Unit 5 Session 3

1

NAME ______________________ DATE __________

Bowls & Vans

1 Josh got 12 goldfish. He wants to put 3 goldfish in each little fishbowl. How many little fishbowls will he need? Show your work.

Josh will need ________ little fishbowls.

CHALLENGE

2 36 kids are going to the park. Each van can hold 6 kids. How many vans will they need to take all the kids to the park? Show your work.

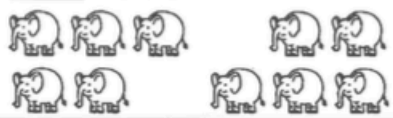
They will need ________ vans to take all the kids to the park.

NAME ______________________ DATE ____________

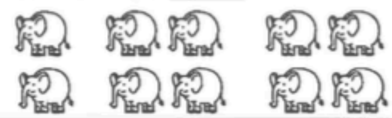
Puzzles about Ten & More

1 Fill in the missing numbers to solve these equations. Use the pictures to help.

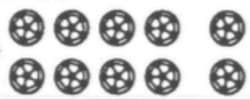
a ______ = 5 + 5



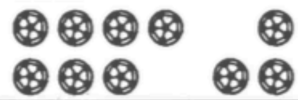
b 10 = 2 + 4 + ______



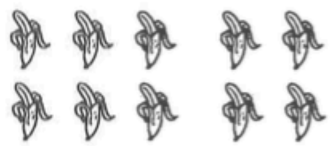
c 10 = ______ + 2



d 7 + ______ = 10

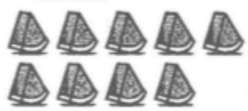


e 10 – ______ = 4

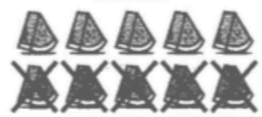


f 10 – ______ = 7

g 4 + 5 = ______ + 7



h 10 – 5 = 2 + ______



2 Fill in the missing numbers to solve these equations.

5 + 4 + 1 = ______	6 + 4 + ______ = 13	5 + ______ + 9 = 19
16 – ______ = 6	14 – ______ = 7	12 – 6 = ______
10 – 3 = 2 + ______	12 – 6 = 2 + ______	16 – 8 = ______ + 1

CHALLENGE

3 Fill in the missing numbers to solve these equations.

90 – 30 = 20 + ______   143 – 11 = 127 + ______   160 – 18 = ______ + 15

APPENDIX F

LESSON PLAN & INTERVENTION IMPLEMENTATION RUBRIC

Unit 5 Part 1- Lesson Plan & Intervention Implementation Rubric

For each day, please score the lesson plan & intervention (iPad and Paper-Pencil) based on this rubric (Carr, 2012):

4	3	2	1	0
Lesson & interventions (iPads & paper-pencil) were implemented exactly as planned. All students were able to participate in their intervention.	Lesson & interventions (iPads & paper-pencil) were implemented. All students were able to participate in their intervention.	The majority of the lesson & Intervention (iPads & paper-pencil) was implemented. Most students (80%) were able to participate in their intervention.	The lesson & Intervention (iPads & paper-pencil) was implemented, but only some of students (50%) were able to participate in their intervention.	Lesson & Interventions (iPads & Paper-Pencil) was not implemented.

Session 3, Pt. 1 Mon. Jan. 26	Session 3, Pt. 2 Tues. Jan. 27	Session 4 Wed. Jan. 28	Session 5 Thurs. Jan. 29th	*No School* Fri. Jan. 30th
Bridges Lesson: Problems and Investigations: Presents & Parcels: Looking at Picture Problems # 1-3 **P/P: Pages 1 & 2: Bowls & Vans, Puzzles about Ten & More** **iPad:** **E. 12, E. 18, E.20 Addition Word Problems, then continue to any of E** **Homework 17**	**Bridges Lesson:** Problems and Investigations: Presents & Parcels: Looking at Picture Problems # 4-6 **P/P: Pages 3 & 4: Books & Granola Bars, More Facts Than You Need** **iPad:** **F. 9 Subtraction Word Problems, then continue to any of F**	**Bridges Lesson:** Presents & Parcels: Creating Story Problems, Part 1 **no math intervention**	**Bridges Lesson:** Presents & Parcels: Creating Story Problems, Part 2 **P/P: Pages 5 & 6: Ants & the Number Box, More Fact Family Triangles** **iPad:** **G.9, G. 14, G. 16 Addition Word Problems, then continue to any of G**	
_________ minutes spent on iPad & Paper-Pencil Intervention	_________ minutes spent on iPad & Paper-Pencil Intervention		_________ minutes spent on iPad & Paper-Pencil Intervention	
_________ Rubric Score for Lesson Plan & Intervention Implementation	_________ Rubric Score for Lesson Plan & Intervention Implementation	_________ Rubric Score for Lesson Plan Implementation	_________ Rubric Score for Lesson Plan & Intervention Implementation	

APPENDIX G

ATTENDANCE RECORDING SHEET

Unit 5 Part 1- Attendance
Teacher:___________________

For each day, please write the first names of any of your students who missed the lesson and/ or intervention. This is important, as I can only include the data for students with greater than 75% attendance in each part of the study.

Session 3, Pt. 1 Mon. Jan. 26	Session 3, Pt. 2 Tues. Jan. 27	Session 4 Wed. Jan. 28	Session 5 Thurs. Jan. 29th	*No School* Fri. Jan. 30th
Bridges Lesson: Problems and Investigations: Presents & Parcels: Looking at Picture Problems # 1-3 **P/P: Pages 1 & 2: Bowls & Vans, Puzzles about Ten & More** **iPad:** **E. 12, E. 18, E.20 Addition Word Problems, then continue to any of E** **Homework 17**	**Bridges Lesson:** Problems and Investigations: Presents & Parcels: Looking at Picture Problems # 4-6 **P/P: Pages 3 & 4: Books & Granola Bars, More Facts Than You Need** **iPad:** **F. 9 Subtraction Word Problems, then continue to any of F**	**Bridges Lesson:** Presents & Parcels: Creating Story Problems, Part 1 **no math intervention**	**Bridges Lesson:** Presents & Parcels: Creating Story Problems, Part 2 **P/P: Pages 5 & 6: Ants & the Number Box, More Fact Family Triangles** **iPad:** **G.9, G. 14, G. 16 Addition Word Problems, then continue to any of G**	
Absent Students?	Absent Students?	Absent Students?	Absent Students?	

APPENDIX H

MATH INTEREST INVENTORY

Verbal Script for Giving Math Survey

Today class you will be taking a survey about how you feel about math. This survey is anonymous, which means that your parents and your teacher will not know how you answer. The main goal is for people to get an idea of how students feel about math. Remember, no one will know how you answer, so be honest about how you feel about math. There are no right or wrong answers.

I will read each question to you. Then you will answer on a scale of 1 to 5. 1 means n ever, and look how Garfield looks like he never wants to do it. 2 means rarely, and see how Garfield looks like he rarely wants to do it. 3 means sometimes, and look how Garfield looks like he only sometimes wants to do it. 4 means most of the time, and look how Garfield looks like he wants to do it most of the time. 5 means always, and look how Garfield looks like he always wants to do it.

(Then you, as the teacher, will read the survey directions:) Math Survey Please answer the questions below. Honestly, there are no right or wrong answers. Your teacher or parents will not see your answers, so answer how you really feel! For your math number, please type in your three digit code. If you forget, your code is on a sticker on the inside of your math folder. It is important that you type in your code correctly. But no one looking at your survey will know that it is you.

(Read question #1 through #18)

For the last two questions #19 and #20, notice that the questions are negatively worded. Look and see how the Garfields are in a different order. Now: 1 means never, but Garfield is happy because he is happy he never feels this way.

5 means always but Garfield looks like he is not happy because he always feels this way. Look at the pictures carefully to choose how you feel. (Read questions #19 & #20). Thank you for filling out the survey!

Math Survey

Please answer the questions below. Honestly, there are no right or wrong answers.

Your teacher or parents will not see your answers, so answer how you really feel!

Survey was designed by Gabrielle M. Snow (2011). Garfield Likert-Style Survey was designed by ProfessorGarfield.com for educational and classroom use.

* Required

What is your math number? *

1	2	3	4	5
Never	Rarely	Sometimes	Most of the time	Always

1. Math is Interesting. *

1	2	3	4	5
○	○	○	○	○

2. I like math. *

1	2	3	4	5
○	○	○	○	○

1 Never | 2 Rarely | 3 Sometimes | 4 Most of the time | 5 Always

3. Math is fun. *

1 2 3 4 5

4. Math is cool. *

1 2 3 4 5

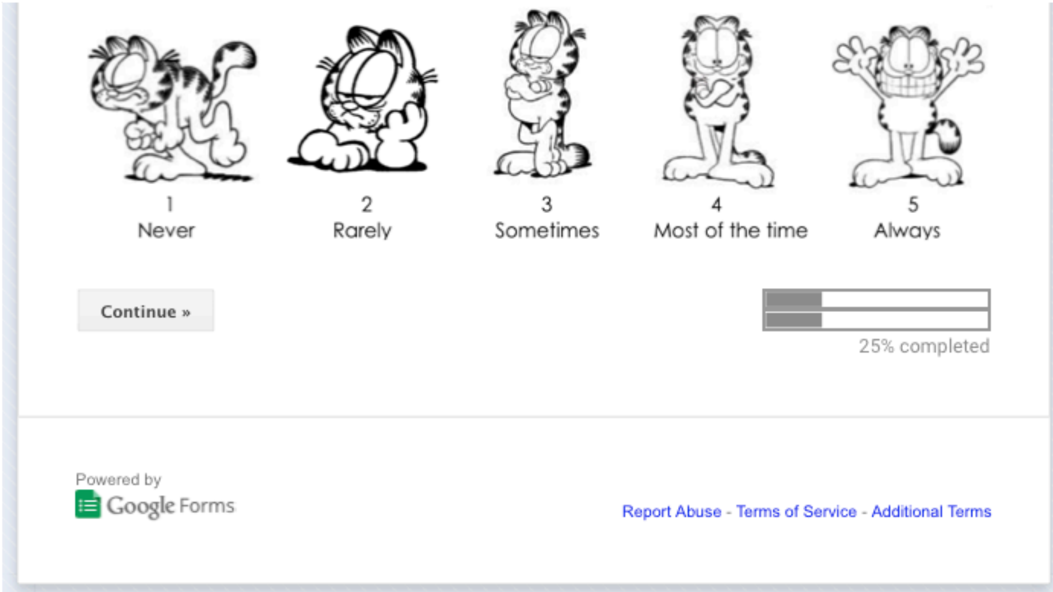
1 Never | 2 Rarely | 3 Sometimes | 4 Most of the time | 5 Always

5. Learning about math is important. *

1 2 3 4 5

6. Learning about math is helpful. *

1 2 3 4 5



1	2	3	4	5
Never	Rarely	Sometimes	Most of the time	Always

Continue »

25% completed

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Math Survey

* Required

Math Survey Page 2

1	2	3	4	5
Never	Rarely	Sometimes	Most of the time	Always

7. What I learn in math is useful. *

1	2	3	4	5
○	○	○	○	○

8. I know a lot about math. *

1	2	3	4	5
○	○	○	○	○

1	2	3	4	5
Never	Rarely	Sometimes	Most of the time	Always

9. I am good at math. *

1	2	3	4	5

10. I do well in my math classes. *

1 2 3 4 5

1 Never | 2 Rarely | 3 Sometimes | 4 Most of the time | 5 Always

11. Math is easy for me. *

1 2 3 4 5

12. I talk to my family or friends about things I learned in math class. *

1 2 3 4 5

1 Never | 2 Rarely | 3 Sometimes | 4 Most of the time | 5 Always

« Back Continue »

50% completed

Math Survey

* Required

Math Survey Page 3

1 Never | 2 Rarely | 3 Sometimes | 4 Most of the time | 5 Always

13. I watch television shows about math outside of school. *

1 2 3 4 5

14. I look at websites about math outside of school. *

1 2 3 4 5

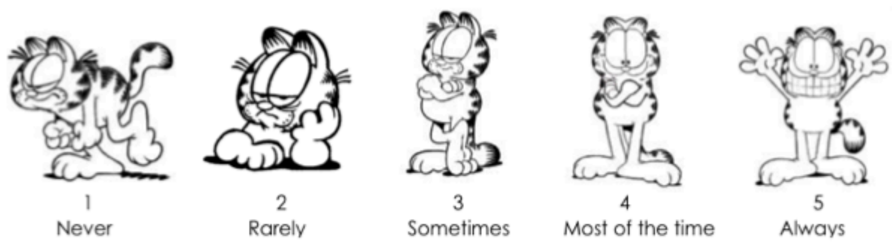
1 Never | 2 Rarely | 3 Sometimes | 4 Most of the time | 5 Always

15. I play math computer games outside of school. *

1 2 3 4 5

16. I read books about math outside of school. *

1 2 3 4 5

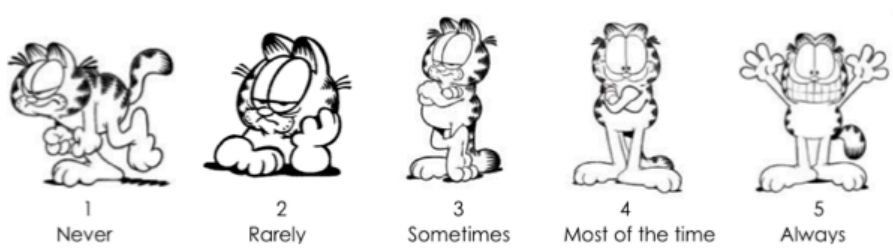


17. I go places to learn about math outside of school. *

1 2 3 4 5

18. I like to do math problems outside of school. *

1 2 3 4 5



« Back Continue »

75% completed

Math Survey

* Required

Math Survey Page 4

For the last two questions, the Garfield pictures are in the opposite order.

Look at the pictures carefully to choose how you feel about math.

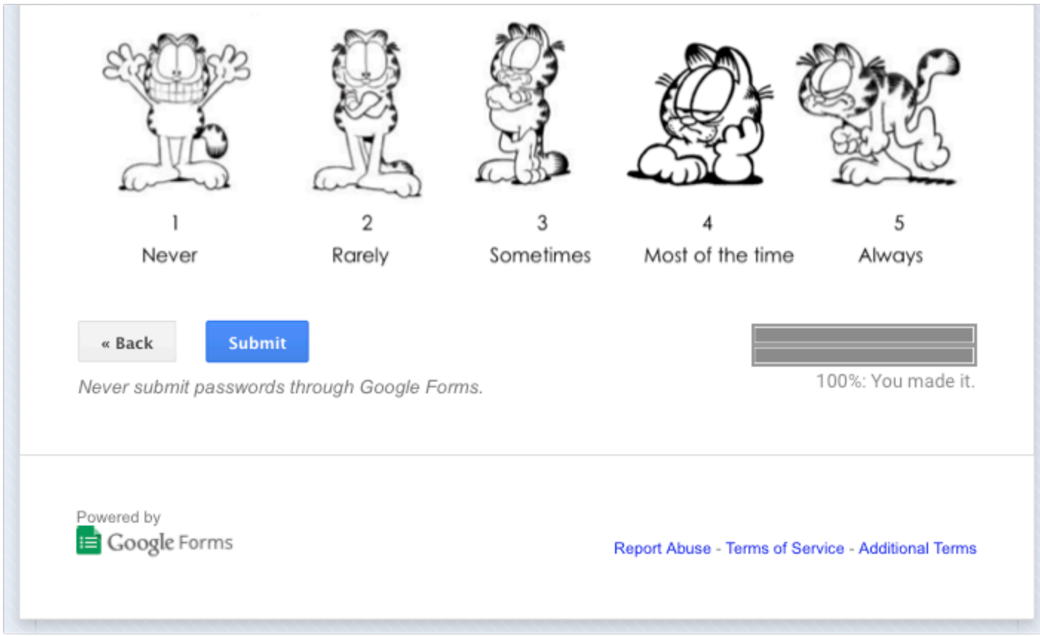
1	2	3	4	5
Never	Rarely	Sometimes	Most of the time	Always

19. Math is boring. *

1 2 3 4 5

20. Math is hard for me. *

1 2 3 4 5


1 Never
2 Rarely
3 Sometimes
4 Most of the time
5 Always

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APPENDIX I

BRIDGES MATH PRE/POST ASSESSMENTS UNIT 5 PART 1 AND 2

NAME | DATE

Unit 5 Part One
Pre/Post Assessment page 1 of 7

Score: ____ out of 28 points

Unit 5 Part 1 Pre/Post Assessment : _____ %

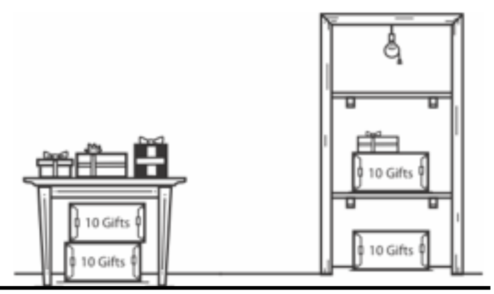
Question 1 assess CCSS 2.OA.1
Represents and solves problems fluently involving addition and subtraction within 100

0- 1 point (0-49%) = 1
2 points (50-74%) = 2
3 points (75-100%) = 3

CCSS 2.OA.1 total points scored: ____

CCSS 2.OA.1 Grade: ____

1. Zach's presents are on the table. Bart's presents are in the closet. Who has more presents, Zach or Bart? How many more? Show your work.



_______________ has _______ more presents than _______________.

#1
___ of 3 points

Scoring Guide:
1 pt. for who has more
1 pt. for how many more
1pt. for showing work

NAME | DATE

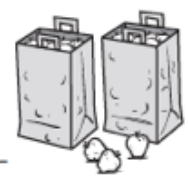
Unit 5 Part One
Pre/Post Assessment page 3 of 7

Question 6 assesses CCSS 2.NBT. 7
Uses place value understanding to add and subtract within 1,000
0 - 1 points (0-49%) = 1
2 points (50-74%) = 2
3 points (75-100%) = 3

CCSS 2.NBT.7 total points scored: _____

CCSS 2.NBT.7 Grade: _____

6.
Angela and her mom are picking apples. There are 29 apples in the first bag and 24 apples in the second bag. Angela put 15 more apples in the second bag. How many apples are there in all?



My equation: ________________________________

#6

___ of 3 points

Scoring Guide:
1 pt. for how many in all
1 pt. for equation
1pt. for showing work

NAME ______________________________ | DATE ____________

Unit 5 Part One
Pre/Post Assessment page 4 of 7

Question 7 assess CCSS 2.MD. 1, 4, & 5
Measures, estimates and compares lengths in standard units
0- 1 point (0-49%) = 1
2 points (50-74%) = 2
3 points (75-100%) = 3

CCSS 2.MD. 1-4 total points scored: _____

CCSS 2.MD. 1-4 Grade: _____

7. Little Inch Worm is going to visit her grandma. Her grandma lives 75 inches away. Little Inch Worm has already crawled 32 inches. How many more inches does she have to crawl? Label your number line and your jumps.

Little Inchworm has to crawl ___________ more inches.

#7
___ of 3 points

Scoring Guide:
#7 is worth 3 pts.
1 pt. answer
1 pt. number line jumps
1 pt. label number line

NAME ____ | DATE ____________________

Unit 5 Part One
Pre/Post Assessment page 5 of 7

Questions 8 - 9 assess CCSS 2.NBT.2
Count within 1000; skip-count by 5s, 10s, and 100s.
0 -1 point (0-49%) = 1
2 points (50-74%) = 2
3 points (75-100%) = 3

CCSS 2.NBT.2 total points scored: _____

CCSS 2.NBT.2 NOT on Report Card

8. Count by 5s to fill in the missing numbers.

a 85, _____, _____, _____, _____, _____

#8
___ of 1 points
Scoring Guide:
1 pt. for each full, correct line

9. Count by tens or hundreds to fill in the missing numbers.

a 25, 35, ______, ______, 65, ______, 85, _____, _____, _____, 125

b 138, 148, _______, 168, ______, ______, 198, ______, ______, ______

#9
___ of 2 points
Scoring Guide:
1 pt. for each full, correct line

Question 10 assess CCSS 2.NBT.3
Read and write numbers to 1000 using base-ten numerals, number names, and expanded form
0 - 1 point (0-49%) = 1
2 points (50-74%) = 2
3 points (75-100%) = 3

CCSS 2.NBT.3 total points scored: _____

CCSS 2.NBT.3 NOT on Report Card

10.
Fill in the empty boxes in the table below.

Number	Number Name in Words
	Four hundred thirty-eight
759	
	Two hundred eighty-five

#10
___ of 3 points
Scoring Guide:
1 pt. for each correct answer (spelling does not count)

NAME | DATE

Unit 5 Part One
Pre/Post Assessment page 6 of 7

Question 11 assesses CCSS 2.NBT.5
Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction
0 points (0%) = 1
1 - 2 points (50%) = 2
3 points (100%) = 3

CCSS 2.NBT.5 total points scored: _____

CCSS 2.NBT.5 NOT on Report Card

11.

Small = 8 crayons   Medium= 24   Large = 64 crayons

You can get boxes of crayons in 3 different sizes at the store. Use the pictures above to help solve the problem.

Emma wants to get a medium box of crayons for her sister and a large box of crayons for herself. How many crayons will that be in all? Show your work. Mark the answer clearly.

#11
___ of 3 points

Scoring Guide:
#11 is worth 3 pts.

1 pt. picture
1 pt. equation
1 pt. correct, labeled answer

NAME | DATE

Unit 5 Part One
Pre/Post Assessment page 7 of 7

Question 12 assesses CCSS 2.NBT.4
Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using >, =, and < symbols to record the results of comparisons
0 - 1 point (0-49%) = 1
2 points (50-74%) = 2
3 points (75-100%) = 3

CCSS 2.NBT.4 total points scored: _____

CCSS 2.NBT.4 NOT on Report Card

12.

Write the >, =, or < sign on the line between each pair of numbers to compare them.

a 352 ___ 355 **b** 711 ___ 698 **c** 909 ___ 912

#12
___ of 3 points

Scoring Guide:
#12 a-c are worth 1 pt. each

NAME ____ | DATE ____________________

Unit 5 Part Two
Pre/Post Assessment page 1 of 5

Score: _____ out of 28 points

Unit 5 Part 2 Pre/Post Assessment : ______ %

Questions 1 & 2 assess CCSS 2.NBT. 5, 6, & 7
Uses place value understanding to add and subtract within 1,000
0 - 5 points (0-49%) = 1
6 - 8 points (50-74%) = 2
9 - 10 points (75-100%) = 3

CCSS 2.NBT.7 total points scored: _____
NBT. 5 and 6 not on report card

CCSS 2.NBT.7 Grade: _____

1. Add these four numbers. Show your work. Use numbers and words to explain how you got the answer.

23 + 24 + 47 + 56 = ___

#1
___ of 2 points

Scoring Guide:
#1 is worth 2 points

1 pt. for correct answer

1pt. for showing work

NAME | DATE

Unit 5 Part Two Pre/Post Assessment page 2 of 5

2a. Add. Show your work.

$\begin{array}{r} 34 \\ +\ 34 \\ \hline \end{array}$	$\begin{array}{r} 48 \\ +\ 26 \\ \hline \end{array}$

#2 a & b
___ of 8 points

Scoring Guide: Each question in #2 a-b is worth 2 points

1 pt. for correct answer

1pt. for showing work

2b. Subtract. Show your work.

$\begin{array}{r} 37 \\ -\ 9 \\ \hline \end{array}$	$\begin{array}{r} 25 \\ -\ 15 \\ \hline \end{array}$

NAME | DATE

Unit 5 Part Two Pre/Post Assessment page 3 of 5

Questions 3 - 4 assess CCSS 2.MD. 8
Solves word problems involving dollars and cents
0 - 1 point (0-49%) = 1
2 - 3 points (50-74%) = 2
4 - 5 points (75-100%) = 3

CCSS 2.MD. 8 total points scored: _____

CCSS 2.MD. 8 Grade: _____

3. This box shows all the coins Maria has in her pocket. How much money does Maria have in her pocket?

Maria has _____¢ in her pocket.

#3
___ of 1 point

Scoring Guide:
1 pt. for correct total

---

4. Josh and Matt are going to the school store. This picture shows how much money each boy has to spend.

a How much money does Josh have in his hand? _______ ¢

b How much money does Matt have in his hand? _______ ¢

c How much more money does Josh have than Matt? Use numbers, labeled sketches, and/or words to solve the problem. Show your work.

#4
___ of 4 points
Scoring Guide:
#4 a-b are worth 1 pt. each
#4c is worth 2 pts.
1 pt. for correct answer
1 pt. for showing work

NAME ______________________________ | DATE ______________

Unit 5 Part Two Post-Test page 4 of 5

Question 5 assess CCSS 2.MD. 9-10
Represents and interprets data using simple graphs
0- 1 point (0-49%) = 1
2- 3 points (50-74%) = 2
4- 5 points (75-100%) = 3

CCSS 2.MD.9-10 total points scored: _____

CCSS 2.MD.9-10 Grade: _____

5. Marco asked the kids in his class which color they liked best—red, blue, green, or purple. The table below shows the results.

Color	Number of Kids
Red	8
Blue	10
Green	3
Purple	6

a Make a picture graph to show Marco's data.
Give your graph a title.

Title ______________________________

Red										
Blue										
Green										
Purple										

#5
___ of 5 points

Scoring Guide:
1 pt. for reasonable title

1 pt. each for correct color graphed

NAME | DATE

Unit 5 Part Two Pre/Post Assessment page 5 of 5

Question 6 assesses CCSS 2.NBT.8
Mentally add 10 or 100 to a given number 100-900, and mentally subtract 10 or 100 from a given number 100-900
0 - 1 point (0-49%) = 1
2 - 3 points (50-74%) = 2
4 - 5 points (75-100%) = 3

CCSS 2.NBT.8 total points scored: _____

CCSS 2.NBT.8 NOT on Report Card

6. Solve each problem.

600 + 20 + 8 = ________

100 + 10 + 3 = ________

$$\begin{array}{r} 200 \\ 60 \\ +\ \ 0 \\ \hline \end{array} \qquad \begin{array}{r} 400 \\ 40 \\ +\ \ 4 \\ \hline \end{array} \qquad \begin{array}{r} 100 \\ 10 \\ +\ \ 7 \\ \hline \end{array}$$

#6
___ of 5 points
Scoring Guide:
worth 1 pt. each

Question 7 assesses CCSS 2.NBT.9
Explain why addition and subtraction strategies work, using place value and the properties of operations (explanations can be supported by drawings or objects)
0 - 1 point (0-49%) = 1
2 points (50-74%) = 2
3 points (75-100%) = 3

CCSS 2.NBT.9 total points scored: _____

CCSS 2.NBT.9 NOT on Report Card

7. Solve the problem. Show your work. Explain how your strategy worked.

$$\begin{array}{r} 39 \\ +\ 25 \\ \hline \end{array}$$

#7
___ of 3 points
Scoring Guide:
#7 is worth 3 pts.
1 pt. answer
1 pt. show work
1 pt. explain strategy with words

APPENDIX J

EASY CBM MATH ASSESSMENTS 2_1, 2_2, 2_3

Math Numbers Operations and Algebra 2_1

Student Name:______________________________ Date:__________________

1.

$$\begin{array}{r} 5 \\ 5 \\ +\ 6 \\ \hline \end{array}$$

A. 17

B. 16

C. 15

2.

$$\begin{array}{r} 6 \\ +\ 6 \\ \hline \end{array}$$

A. 12

B. 13

C. 11

3.

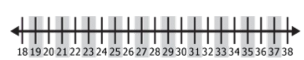
$$\begin{array}{r} 761 \\ +\ 135 \\ \hline \end{array}$$

A. 896

B. 886

C. 906

4.



Start at 20. Move forward 11.

Where are you now?

A. 32

B. 31

C. 30

5.

Karen saw 40 pigs. Wendy saw 36 pigs.

About how many pigs in all?

A. 75

B. 70

C. 80

6.

$$\begin{array}{r} 19 \\ -\,17 \\ \hline \end{array}$$

A. 2

B. 3

C. 1

7.

$$\begin{array}{r} 935 \\ -\,221 \\ \hline \end{array}$$

A. 714

B. 704

C. 724

8.

$$\begin{array}{r} 11 \\ -\;\;7 \\ \hline \end{array}$$

A. 3

B. 4

C. 5

9.

You have 1 quarter and 2 pennies. How much money do you have?

A. $0.32

B. $0.27

C. $0.22

10.

You have 1 half dollar, 1 dime, and 1 penny. How much money do you have?

A. $0.56

B. $0.54

C. $0.61

11.

You have 1 half dollar, and 13 pennies. How much money do you have?

A. $0.69

B. $0.71

C. $0.63

12.

You have 1 half dollar and 7 nickels, and 2 pennies. How much money do you have?

A. $0.87

B. $0.77

C. $0.68

13.

$$\begin{array}{r} 772 \\ -\,107 \\ \hline \end{array}$$

A. 665

B. 655

C. 675

14.

Rick saw 20 birds. Sue saw 23 birds.

About how many birds in all?

A. 50

B. 45

C. 30

15.

Rudy saw 22 crows. Beth saw 24 crows.

About how many crows in all?

A. 45

B. 50

C. 35

16.

$$\begin{array}{r} 15 \\ -\ \ 8 \\ \hline \end{array}$$

A. 6

B. 7

C. 8

Math Numbers Operations and Algebra 2_2

Student Name:________________________________ Date:____________________

1.

$$\begin{array}{r} 2 \\ 3 \\ \underline{+\ 3} \end{array}$$

A. 8

B. 9

C. 7

2.

You have 3 quarters. How much money do you have?

A. $0.68

B. $0.75

C. $0.70

3.

Dan had 20 balloons.
4 broke.

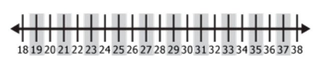
About how many does he have left?

A. 10

B. 15

C. 20

4.



Start at 23. Move forward 11.

Where are you now?

A. 34

B. 35

C. 33

5.

You have 1 quarter, 5 dimes and 3 pennies. How much money do you have?

A. $0.78

B. $0.81

C. $0.74

6.

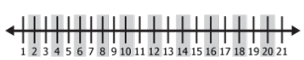
$$\begin{array}{r} 2 \\ +\,10 \\ \hline \end{array}$$

A. 16

B. 14

C. 12

7.



Start at 17. Move back 9.

Where are you now?

A. 9

B. 8

C. 7

8.

$$\begin{array}{r} 693 \\ -\,450 \\ \hline \end{array}$$

A. 233

B. 243

C. 253

9.

$$\begin{array}{r} 73 \\ +25 \\ \hline \end{array}$$

A. 99

B. 97

C. 98

10.

$$\begin{array}{r} 11 \\ -\ 9 \\ \hline \end{array}$$

A. 3

B. 2

C. 1

11.

Rob has 40 peas. June has 52 peas.

About how many peas in all?

A. 90

B. 80

C. 75

12.

Bill has 13 pens. Rob has 11 pens.

About how many pens in all?

A. 25

B. 30

C. 20

13.

$$\begin{array}{r} 878 \\ -\underline{116} \end{array}$$

A. 772

B. 752

C. 762

14.

Jill has 11 marbles. Jane has 13 marbles.

About how many marbles in all?

A. 25

B. 20

C. 30

15.

You have 1 quarter, 4 nickels, and 6 pennies. How much money do you have?

A. $0.50

B. $0.55

C. $0.51

16.

$$\begin{array}{r} 954 \\ -\underline{804} \end{array}$$

A. 140

B. 160

C. 150

Math Numbers Operations and Algebra 2_3

Student Name:________________________________ Date:____________________

1.

$$\begin{array}{r} 8 \\ +9 \\ \hline \end{array}$$

A. 16

B. 17

C. 18

2.

$$\begin{array}{r} 10 \\ -\ 5 \\ \hline \end{array}$$

A. 6

B. 4

C. 5

3.

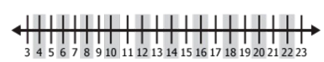
$$\begin{array}{r} 7 \\ +8 \\ \hline \end{array}$$

A. 14

B. 15

C. 16

4.



Start at 7. Move forward 4.

Where are you now?

A. 11

B. 10

C. 12

5.

Phil has 95 airplanes.
He gives 21 away.

About how many does he have left?

A. 65

B. 75

C. 70

6.

Bill has 22 grapes. Jane has 20 grapes.

About how many grapes in all?

A. 30

B. 50

C. 40

7.

$$\begin{array}{r} 3 \\ 8 \\ +\ 8 \\ \hline \end{array}$$

A. 19

B. 20

C. 18

8.

Rick has 5 balloons. Rose has 4 balloons.

About how many balloons in all?

A. 10

B. 6

C. 12

9.

$$\begin{array}{r} 9 \\ -\ 1 \\ \hline \end{array}$$

A. 8

B. 9

C. 7

10.

$$\begin{array}{r} 12 \\ -\ 8 \\ \hline \end{array}$$

A. 3

B. 5

C. 4

11.

You have 7 dimes and 1 nickel. How much money do you have?

A. \$0.70

B. \$0.75

C. \$0.65

12.

$$\begin{array}{r} 831 \\ -\ 109 \\ \hline \end{array}$$

A. 712

B. 722

C. 732

13.

$$\begin{array}{r} 604 \\ +\ 359 \\ \hline \end{array}$$

A. 963

B. 973

C. 953

14.

$$\begin{array}{r} 584 \\ -\ 42 \\ \hline \end{array}$$

A. 552

B. 532

C. 542

15.

Dan has 75 raisins.
He gives 28 away.

About how many does he have left?

A. 55

B. 50

C. 45

16.

$$\begin{array}{r} 14 \\ -\ 7 \\ \hline \end{array}$$

A. 8

B. 7

C. 6

APPENDIX K

FOCUS GROUP PROTOCOL

Focus Group Protocol
To be held online through Adobe Connect

Facilitator (Rachael Schuetz):
"Welcome and thank you for coming to this focus group discussion. I look forward to hearing your observations of the students' engagement and excitement towards learning math during both the iPad-based and paper-pencil based math interventions. We'll start by discussing your observations about your experiences in the IXL experiment, especially as it relates to student behavior, engagement, and interest and your ability to differentiate instruction. After that, I will share the results from the study with you and ask for some more of your observations."

"Remember there are no right or wrong answers, so just speak about your experiences. Also, because we are in a group, please speak up if you had a different experience. Part of what I'd like to hear about is the ways in which the experiment may have played out differently for each of you. If you have a similar experience, please let me know so I can begin to gauge how common or shared a perspective is. Everyone's experience is valid and will be respected completely."

"As a reminder, the consent you signed indicates I will keep your contributions here completely confidential. Anything I share will be anonymous. You also have the right to discontinue your participation at any time. Please let me know if you would like to do so. This focus group is a safe space to share ideas, confidentially in this group. If anyone would like to share anything privately, I would be happy to speak with you one-on-one."

ASSENT:
"Is everyone willing and ready to begin? Please say YES or NO aloud as I call your name."

Questions to guide discussion:

What did you notice about the student engagement when working with the iPad-based math intervention IXL? with paper-pencil?

What changes did you see in students' behavior when they were working with the iPad-based math intervention IXL? with paper-pencil?

How did teaching with IXL affect your ability to differentiate? How did that compare to when students worked with paper-pencil?

What was the best thing about students learning through IXL and iPad-technology?

What was the most challenging thing about students learning through IXL and iPad-technology?

What surprised you about the math experiment?

What might you like to see done differently if the experiment was replicated?

<u>Share a PowerPoint presentation (seen on next page) of the study results with the Focus Group</u>

What are your reactions to the research findings?

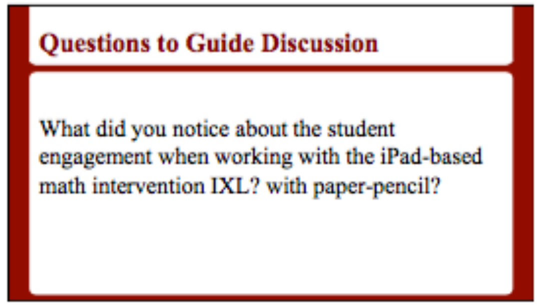
What surprises you about the findings?

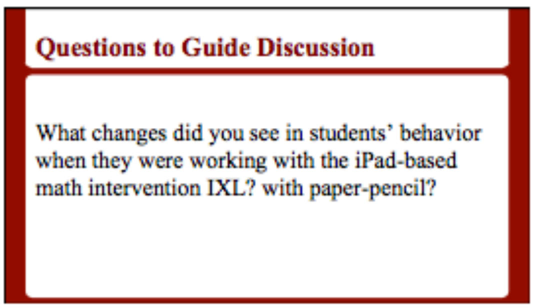
How do you think these research findings would impact your instructional decisions regarding math intervention practices?

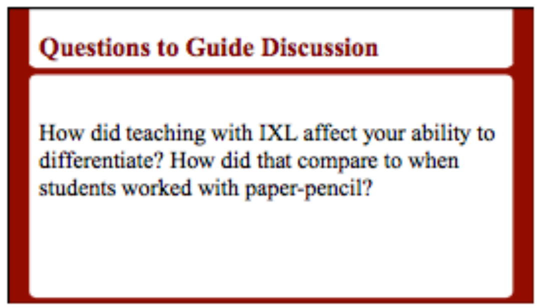
Is there anything else that you would like to share?

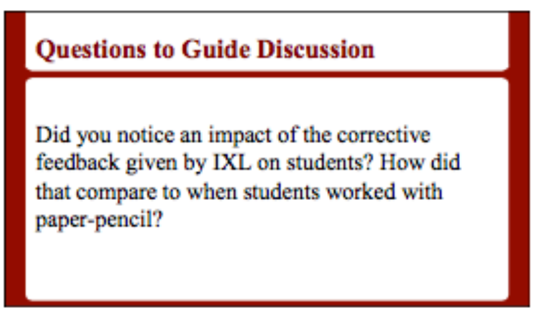
CLOSING
"Thank you so much for your time and for your role in moving educational technology research forward! I really appreciate your time and your thoughtfulness today."

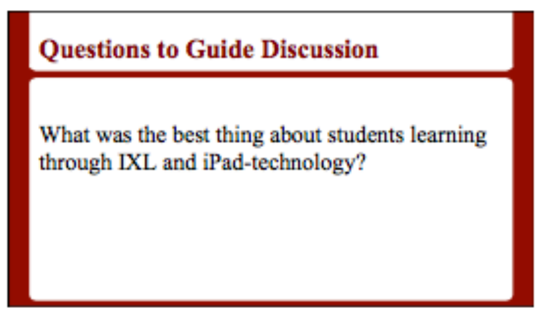

Are iPads the Answer?
Investigating Students' Achievement and Engagement in Math
Rachael Schuetz
National Board Certified Teacher, M.Ed, D.Ed in Progress
Instructor & Elementary Cohort Lead MAT Program OSU Cascades


Questions to Guide Discussion
What did you notice about the student engagement when working with the iPad-based math intervention IXL? with paper-pencil?


Questions to Guide Discussion
What changes did you see in students' behavior when they were working with the iPad-based math intervention IXL? with paper-pencil?


Questions to Guide Discussion
How did teaching with IXL affect your ability to differentiate? How did that compare to when students worked with paper-pencil?


Questions to Guide Discussion
Did you notice an impact of the corrective feedback given by IXL on students? How did that compare to when students worked with paper-pencil?

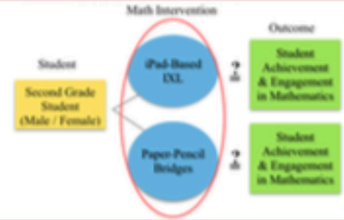

Questions to Guide Discussion
What was the best thing about students learning through IXL and iPad-technology?

Gap in the Research

Only 1 study addressed the impact of iPads in the early-elementary math classroom.

As more classrooms are using the technology, this research gap cannot be ignored.

Theoretical Framework



Research Questions

RQ1. Does the iPad-based math intervention, IXL, affect second-grade students' math achievement as measured by quantitative pre-post unit tests and the math easyCBM?

RQ2. Does learning with the iPad-based math intervention, IXL, affect students' engagement and interest in mathematics, as measured by a pre-post likert-scale, quantitative measure and qualitative teacher interview?

Math Intervention Research Methods

- Mixed Methods, Quasi-Experimental
- 2 sessions of a 4-week Math intervention (iPads / paper-pencil)
- Time Aspect: Longitudinal
- Unit of Analysis:
  - 2 Measures of **achievement**: 2 Quantitative Math Tests
  - 2 Measures of **engagement**: 1 Quantitative Student Measure & 1 Teacher Questionnaire on Student Engagement

Setting, Participants, & Assignment

Setting:
Lincoln Elementary (*pseudonym*), affluent suburban Oregon, 600 kids

Sample:
Non-random, convenience sample of 4 second grade classes

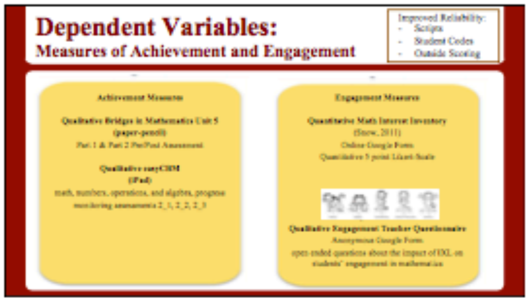
Teachers:
4 second grade teachers with equal training
Fidelity / time rubrics for equal implementation of the intervention

Participants:
95 second graders with parent consent
Attendance data (> 75% of the intervention)

Assignment:
Statistical "matching" of two groups within one classroom
Helps fight threats to validity, as both groups have the same teacher

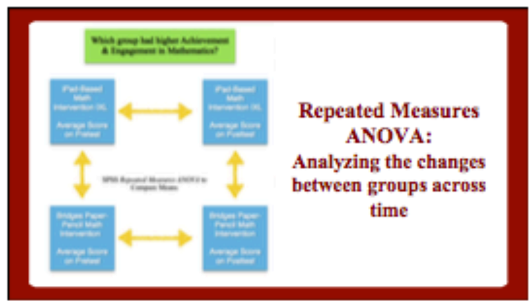
Independent Variable:

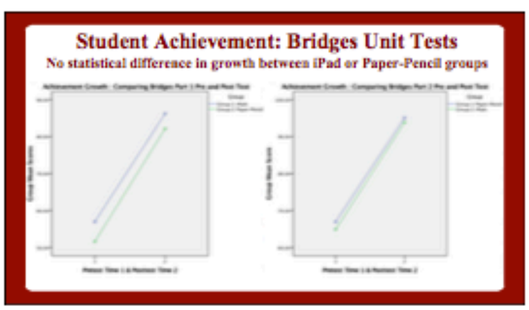
IXL iPad-based Math Intervention

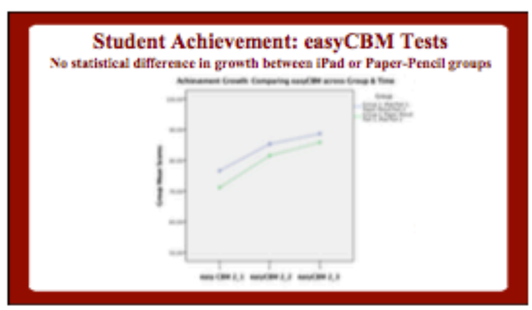

Dependent Variables:
Measures of Achievement and Engagement
Improved Reliability:
- Scripts
- Student Codes
- Outside Scoring
Achievement Measures
Qualitative Bridges in Mathematics Unit 5
(paper-pencil)
Qualitative easyCBM
(iPad)
Engagement Measures
Quantitative Math Interest Inventory
Online Google Form
Qualitative Engagement Teacher Questionnaire
Anonymous Google Form


Analysis
Average Growth
iPad-Based Math Intervention IXL
SPSS Repeated Measures ANOVA to Compare Means
Average Growth
Bridges Paper-Pencil Math Intervention
Which intervention produced higher Achievement
& Engagement in Mathematics?


Any Questions or Discussion Prior to Results?

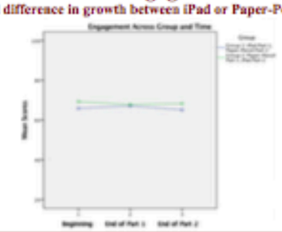

Repeated Measures ANOVA:
Analyzing the changes between groups across time


Student Achievement: Bridges Unit Tests
No statistical difference in growth between iPad or Paper-Pencil groups


Student Achievement: easyCBM Tests
No statistical difference in growth between iPad or Paper-Pencil groups

Student Engagement

No statistical difference in growth between iPad or Paper-Pencil groups



Group Discussion & Questions After Results

What are your reactions to the research findings?

What surprised you about the findings?

Group Discussion & Questions After Results

How do you think these research findings would impact your instructional decisions regarding math intervention practices?

Group Discussion & Questions After Results

Is there anything else that you would like to share?

Thank you!

Thank you!
Your participation has helped move research on educational technology forward.

REFERENCES CITED

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