

IPADS IN THE ELEMENTARY MATH CLASSROOM: WHAT IS THEIR EFFECT
ON STUDENT LEARNING?

by

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ABSTRACT

This study investigated the effects of iPads on second grade students' understanding of math concepts and the students' attitudes toward using iPads in math class. For five units, one second grade class alternated by unit between iPad and non-iPad activities to practice math skills. During the final unit of the study each student chose whether or not to use the iPad. To understand the iPad's effect on student learning, the following data was gathered: scores of unit pretests and posttests, student confidence surveys, tracking of on task/off task behavior, teacher field notes, and student interviews. To understand students' attitudes toward iPads, the following data was gathered: pre- and post-treatment attitude surveys, teacher field notes, and student interviews. Results from the study indicated that iPads did not have a greater effect on posttest scores than more traditional methods of practicing math skills. Results also indicate that iPads do not have a stronger effect on students' confidence levels in math. However the data indicated that students were more engaged in math activities when using iPads than when not using iPads. Additionally, when given the choice between using the iPad and non-iPad activities, students more frequently chose the iPad to practice math skills. Students reported positive attitudes toward using the iPad in math class at the conclusion of the study.

INTRODUCTION AND BACKGROUND

I currently teach second grade at Brimmer and May School in Chestnut Hill, Massachusetts. As stated on the Brimmer and May website (2014), “Brimmer and May is a coed pre-kindergarten through grade twelve independent day school. Brimmer and May school is an inclusive, caring community committed to maintaining high academic standards while implementing innovative educational ideas.” Three hundred ninety-eight students attend Brimmer and May from over fifty communities of the greater Boston area and seven foreign countries. Thirty percent of the students receive some form of financial aid (“Diversity,” n.d., para. 2). I currently teach ten students (five boys and five girls). All of them are enthusiastic, capable learners.

In the fall of 2013, my school began a one-to-one iPad program to provide each teacher and student full access to an iPad to use in school for educational purposes. The rationale behind the iPad program is explained on Brimmer and May’s website:

Teaching with tablets augments the curriculum, provides flexibility in the learning environment, and enhances learning outcomes. Our school mission states in part that the school’s goals are “to use emerging technologies effectively. . . . and to develop informed, engaged, and ethical citizens and leaders for the global community.” Being part of our global community calls for digitally ready students who use the available tools to enhance their learning.

Classroom instruction is a blend of instructional practices. The iPad provides a platform that helps students create multimedia content, offer collaborative and individualized learning opportunities, and increase their digital

literacy (“iPad Information and Resources,” 2014).

My students use their iPads regularly in class in a variety of subjects. For instance using an iPad application (app) called ShowMe, my students practice phonics strategies writing words with their fingertips on a digital whiteboard. My students also take virtual field trips to distant places using the GoogleEarth app in social studies. During our human body unit in science class, the students are able to take a closer look at the major systems of the body with the interactive Human Body app. In math class my students practice basic addition facts on the Math Facts app. Students also often choose to use their iPads during their weekly “choice” time when they engage in an activity of their choosing. During this time they use their iPads in different ways such as recording videos or creating digital artwork.

Since this is only the second year of my school’s one-to-one iPad program, I am looking for more ways to incorporate the iPad into the second grade curriculum. Brimmer and May’s Lower School math specialist Ellinor Wareham and I tested a variety of math-based apps, and we found a handful of them that compliment our second grade math curriculum. Therefore I decided it would be worthwhile to incorporate the students’ iPads into my daily math instruction. Currently I conclude most math periods with an activity that reinforces that day’s concept. With the different math apps available, I can have the students use their iPads to practice their math skills at the end of class.

From my informal observations of the students over the past year and a half, I can see that they enjoy using their iPads. However I do not have any concrete evidence as to how the device affects student learning. As an educator using this new technology daily

in the classroom, it would be helpful to have that evidence to understand if using iPads in school benefits my students' education.

Since the school's iPad program is relatively new, and because I want my students to use their iPads more during math lessons to reinforce math skills, I have created my focus question, *What is the effect of the iPad on students' learning of math concepts?* In addition, I will investigate the following sub-question, *What are the students' attitudes toward using the iPad in math class?*

CONCEPTUAL FRAMEWORK

Schools all over the United States are integrating technology into their classrooms. Some high schools in Connecticut, Alabama, and New Jersey use computer software to supplement more traditional methods of teaching math (Pane, Griffin, McCaffrey, & Karam, 2014). Other schools like Bethke Elementary School in Colorado provide a personal laptop to each student in grades three through five to complete assignments in class ("Technology at Bethke," 2015). At McKeel Elementary Academy in Lakeland, Florida fourth graders use websites to make digital storybooks (Blair, 2012). High school students in Roslyn Heights, New York, use tablet computers for tasks such as submitting digital assignments and compiling work in digital portfolios (Hu, 2011).

The push for technology in education is strong. In the United States alone, an estimated \$9.94 billion dollars was spent on technology for education in 2014 (Murphy, 2014). According to the United States Office of Educational Technology, President Barack Obama has put forth a plan called the ConnectED Initiative with the goal of providing internet access to ninety-nine percent of U.S. students in the next five years. "The

initiative sets clear goals to transition to digital learning including: preparing teachers to use technology effectively to improve student learning, upgrading broadband and high-speed wireless connectivity, and providing access to educational devices and digital content” (OET, 2015). Additionally, the U.S. Department of Education is creating a plan that incorporates internet-based programs into classrooms across the country (Johnson, Krueger, Becker, & Cummins, 2014).

It is not only the U.S. government stressing the importance of technology in schools. Education scholars Kent and McNergney (1999) explain that knowing how to use current technology effectively is essential to students’ future success in the workforce. Blair (2012) also supports this claim explaining that today’s students, “21st century learners”, must have “access to a constantly evolving array of technological tools and activities that demand problem solving, decision-making, teamwork, and innovation” (p. 10).

Why is there such a strong push for technology in education? Technology can help the teacher differentiate content to meet the varying needs of every student in a classroom. Additionally, technology such as computers is important in education because of its versatility in the classroom. Computers can be used in a variety of ways such as “statistical analysis or word processing...graphic design or musical composition...communicating or publishing” (Kent & McNergney, 1999). Another important benefit of technology in education is its ability to engage the students and to “captivate their attention” (Kenney, 2011, p 68).

One of the most recent forms of technology to enter classrooms is the iPad, a tablet

computer that was first released by Apple Inc. in 2010 (Clark & Luckin, 2013). The latest reiteration of the tablet, called the iPad Air 2, weighs about one pound, measures about six millimeters in thickness, and has a 9.7 inch screen (“iPad Air 2”, n.d., para. 2). The iPad's multi-touch display “allows for various gestures (pinch, flick and stretch) to be used in applications” (Murray & Olcese, 2011). It is internet compatible and can run a variety of applications, called apps, many of which can be used for educational purposes in the classroom (Murray & Olcese, 2011; Smith & Evans, 2014; Wilson, 2010).

Schools are interested in iPads for various reasons. The tablets have a battery life of up to ten hours, which means they can be used the entire school day. Another benefit of iPads is their light weight, making them very portable (Quillen, 2011). Additionally, iPads are intuitive and accessible because students can “interact directly with the screen” (Read, 2012). Harvard University Innovation Education Fellow Tony Wagner further explains the iPad's benefits in education:

the iPad has made using most computer-based learning applications far more accessible and intuitive. You no longer need to take students to a special room full of computers for that occasional experience...and students don't need hours of training to learn how to use the device or its applications. Secondly, the comparative ease of creating and distributing an iPad app...has given rise to a dramatic increase in the number of education related applications being created and disseminated. In short, the iPad has enabled greater access for both the education consumer and the creator. (Rubin, 2012)

Tablets are increasingly being used in classrooms globally (Clark & Luckin, 2013). As of July 2014, 13 million iPads had been purchased by education customers around the

world (Cavanagh, 2014). In 2010, a high school in Roslyn Heights, New York began piloting an iPad program for some of its humanities students; while in Chicago, over 200 public schools began their own iPad initiatives (Hu, 2011). In the town of Egmond-Binnen, Netherlands, schools bought their students the tablets to enrich the curricula and to give students the option to complete assignments off campus (Teffer, 2013). The Los Angeles Unified School district purchased 30,000 iPads for students in grades kindergarten through twelve in September 2013 (Leonard, 2013). Over 4,500 of the tablets were purchased by schools in Prince George County, Maryland, for students of low income families (Chandler & Tsukayama, 2014).

Despite the strong interest in using iPads in education, limited research about the impact of the tablets on student learning is available (Milman et al. 2012). However, there are studies that show positive outcomes after iPads have been incorporated into the classroom. One reported positive outcome is increased student engagement. Iasevoli (2013) found that first grade students who use iPads in language arts class were excited and highly engaged. Additionally students who were initially reluctant to talk in class were more willing to do so when they were asked to record their voices while telling stories on their iPads. In another study conducted by Haydon, Hawkins, Denune, Kimener, McCoy, and Basham, (2012) teachers taught a math lesson and then had students practice the math skill by either completing worksheets or using iPads. The study showed that students who used the iPads were more engaged and worked more efficiently than the students who worked on the paper worksheets. Milman, Carlson-Bancroft, and Boogart (2012) found that students' interest in using the iPad in the

classroom remained strong even after months of continued use. They also reported that the students were observed to remain engaged in their assignments on the iPad for extended periods of time.

Other studies show improved academic performance in students who use the iPad. O'Malley, Jenkins, Wesley, Donehower, Rabuck, and Lewis (2013) investigated the use of iPads to improve basic math fluency in students with moderate to severe learning disabilities. The results of the study show that students were able to answer more problems correctly while using an iPad than when using paper and pencil. Additionally, surveys completed by the teachers indicated that the teachers felt the iPads were worthwhile tools for math instruction. Hutchinson, Beschorner, and Schmidt-Crawford (2012) found that fourth grade students who used iPads to read digital books successfully learned how to use different features on the tablet and the students even demonstrated skills not seen by their peers who were reading printed books. For example, some students used their iPads to take notes on their reading, whereas students reading print copies of their books did not take notes. Reyes (2014) conducted another study that involved using iPads in literacy instruction. In the study different apps were used in second and third grade literacy after-school programs. Results of the study indicate that the apps improved literacy achievement and helped the instructor differentiate instruction for the students.

While the above research illustrates some benefits of iPads in education, the tablet does have its detractors. One concern people have about iPads in education is that if they are not properly monitored, they can become a distraction for students (Chandler &

Tsukayama, 2014). A study conducted in Quebec, Canada supports this claim. In 2013, 6,057 elementary and high school students and 302 teachers were surveyed to learn about the perceived benefits and challenges of using iPads in the classroom. Survey feedback showed that even though iPads improved the quality of student presentations and the ability to access information, the students and teachers also reported that at times the tablets distracted the students during class (Karsenti & Fievez, 2013). Other researchers go further, citing evidence that iPads do not promote student learning. For example in a study by Culen and Gasparini (2011), an elementary teacher was interviewed about her use of iPads to teach her students story composition. The teacher explained that the children enjoyed using the tablets, but when she compared the writing of students who had used their iPads with the writing of students who had not, the composition skills of the students who used the iPad were not as strong.

Even though it has received some mixed reviews from students and teachers, the iPad has gained significant popularity in education. Because of its documented positive impacts on student learning and its growing presence in classrooms, the iPad has the potential to be a powerful educational tool.

METHODOLOGY

The study was carried out for ten weeks over the course of five math units. Each math unit lasted between seven to ten days. During the study the students learned the following concepts: two-digit addition, two-digit subtraction, geometry, money, and data. There were two treatment periods, two non-treatment periods, and one modified treatment period. Each treatment period lasted for one unit and was followed by a non-

treatment unit. During the treatment periods, math concepts were reinforced using the iPad. During non-treatment periods, math concepts were reinforced using activities and games that did not utilize the iPad. Weeks nine and ten of the study were a modified treatment period. During this time, the students had the choice of practicing math concepts with or without their iPads.

The treatment and non-treatment periods followed similar formats. Each day of the treatment period, the students first listened to a five to fifteen minute mini lesson that introduced the math skill for that day. The students then completed a corresponding written assignment that consisted of 8 - 20 math exercises. After the students completed the written work, they used apps, such as Splash Math, on their iPads to practice the math skill. Splash Math is an app that presents a student with two-digit addition problems that progressively increase in difficulty as the student answers the problems correctly. Additionally during the last two days of each treatment period, the students created a short presentation to teach a math skill they learned that week using one of the following apps: ShowMe, Pic Collage, or Educreations. ShowMe and Educreations act as a digital white boards upon which the students can write while recording themselves speaking and writing or drawing. Pic Collage allows the user to create digital posters with text, illustrations, and photos.

Similar to the treatment period, each day of the non-treatment periods, the students listened to a mini lesson and completed the corresponding written assignment. After completing their written work, the students engaged in games and activities to practice math skills they learned that day without their iPads. For example, to practice coin

counting, students played the game “Collect a Dollar” in which students took turns rolling two dice, counted the dots shown on the dice, and then collected the corresponding amount of money in coins. The student who collected one dollar first won. During each non-treatment period, the students also created a short presentation to teach a math skill using classroom supplies other than their iPads, such as a whiteboard and dry erase markers.

The study concluded with a modified treatment period in which each student made the choice each day of whether or not to use his or her iPad to practice that day’s math skill. Each student also created a short presentation about a skill they learned in the unit with the choice of using the iPad or other materials without the iPad.

In order to collect data for this study, both quantitative and qualitative data were gathered (Table 1). To learn more about the students’ attitudes toward using iPads in math class, every student in the class took the iPad Attitude Survey before the study began (Appendix A). The answers to the survey provided a baseline of the students’ feelings toward using iPads in math class. The teacher read aloud each survey question to each student individually and recorded the student’s responses. All of these sessions were audio recorded using the Voice Memo app on the teacher’s iPad. The attitude survey followed a rating-scale format. In this scale, a score of 4 represented *Strongly Agree*, a 3 represented *Agree*, a 2 represented *Disagree*, and a 1 represented *Strongly Disagree*. At the conclusion of the study, the teacher re-administered the iPad Attitude Survey using the same methods. For each question on both surveys, the responses *Strongly Agree* and *Agree* were grouped together and the responses *Disagree* and *Strongly Disagree* were

grouped together. This data was compared to determine if there was a change in the students' attitudes regarding iPads in math class from before treatment to after treatment. The change was represented in the form of percentages.

A second type of data obtained during the study was the teacher's observational data of student behavior during class time when students were practicing math skills either with or without the iPad. This data was recorded each day, approximately every three to four minutes, using a Behavior Chart (Appendix B). On the chart, the teacher used checkmarks to record whether or not a student was on task. The behaviors of four students were tracked as follows: one student who required no math support, one student who required some math support, one student who required regular math support, and one randomly chosen student. At the end of the study, the checkmarks from both categories of the checklist were totaled. The number of checkmarks from the treatment weeks was compared to the checkmarks from the non-treatment weeks to determine if there was a difference in student engagement between treatment and non-treatment weeks.

A third type of data collected during the study came from the scores of the Pre and Post Unit Tests which were given at the beginning and conclusion of each math unit (Appendix C). Before students received any instruction for each unit, they took a pretest that covered the material to be taught over the next two weeks. At the end of each unit the students took a posttest that followed the same format and content as the pretest, but with different numeric values and/or geometric shapes. The difference between the Pre and Post Unit Tests for each student was calculated and then averaged for each unit. The

average difference for each unit was compared to determine if there was a greater difference in Pre and Post Test scores between treatment and non-treatment weeks. This information was graphed using a bar graph.

Before starting a new unit, the students took the Math Skills Confidence Surveys (Appendices D - H). To administer the surveys, the teacher met one-on-one with each student and read the questions aloud in order to ensure the students clearly understood the questions. These questions asked students about their confidence levels in the math skills they would learn in each unit during the course of the study. The four available answers were assigned a numeric value so that the data could be coded as *strongly agree* = 4, *agree* = 3, *disagree* = 2, and *strongly disagree* = 1. After the teacher read each question aloud, the student gave his or her answer and the teacher recorded the student's response. At the end of each unit, the Math Skills Confidence Surveys were administered again following the above procedure. Scores from each question of both the pre-unit and post-unit surveys were compared to determine the change between students' confidence levels in their math abilities before and after each unit. The differences in the scores to the survey responses from both treatment and non-treatment weeks were compared using bar graphs to determine if using iPads had an effect on the students' confidence in their math abilities.

Daily student work was collected and reviewed to gain a better understanding of how the iPad affected the students' understanding of new math material and to keep record of student engagement in the math activity. For example, when working with the geometry app, Geoboard, students saved electronic copies of illustrations they created

with the digital geoboard. Such artifacts provided the teacher with evidence of student learning. Additionally, each day the teacher took field notes to record overall student engagement in the math activities. The teacher noted items such as on task and off task behavior, collaboration between students, and statements made by students while they were working. The field notes were used to provide detailed, anecdotal information that helped further illustrate the other data collected.

At the conclusion of the study, each student was interviewed with the iPad Interview Questions (Appendix I). All of these sessions were audio recorded using the Voice Memo app on the teacher's iPad. This interview was used to obtain anecdotal information about the students' thoughts regarding iPad use in math and whether or not the students felt the iPads helped them learn new math concepts. The students' answers helped the teacher understand what the students enjoyed about using the iPads and what they did not enjoy about using the iPads. To analyze the data, the teacher found similarities between the responses of each question and grouped like responses together as themes. The responses were also used to explain other data collected in the study.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix J).

Table 1
Data Triangulation Matrix

Research Questions	Data Source 1	Data Source 2	Data Source 3	Data Source 4	Data Source 5
What is the effect of iPads on the students' understanding of math concepts?	Student interviews	Behavior chart and field notes	Pre and post unit quiz scores	Math skills pre and post confidence surveys	Student work
What are the students' attitudes toward using iPads in math class?	Student interviews	Field notes	Pre and post treatment attitude surveys		

DATA AND ANALYSIS

The results of the iPad Attitude Post Survey indicated that 100% of the students felt the iPad can help them learn math ($N=10$). The number of students who *strongly agreed* to this statement increased from 30% on the pre-survey to 60% on the post-survey. One student explained that when learning how to regroup in double-digit addition, “One time I did it incorrectly. [The iPad] showed me how to regroup and then I got the questions right.” One hundred percent of the students interviewed at the conclusion of the study felt that the iPad made math more interesting. The percentage of students who *agreed* or *strongly agreed* with this statement increased from 90% before the study to 100% at the conclusion of the study. One student explained that the iPad made math more interesting “because [on the iPad] there are fun games we get to play with math.” Field notes substantiated this statement. During the study it was noted that

the students “seemed excited about moving up levels [in Splash Math]” and “it seemed as if [the students] didn’t even realize they were practicing their math skills.”

The number of students who *strongly agreed* when asked if when learning a new math skill, they prefer to use the iPad over not using the iPad remained the same from the iPad Attitude Pre-Survey to Post-Survey at 40%. However, the number of students who *disagreed* with this statement increased from 10% to 20%. To help explain this increase one student stated, “When I learn a [math skill], I don’t only want to do it on the iPad. I want to do it on paper.” Data from the modified treatment period illustrated the students’ preference of either using the iPad or using other materials to practice a math skill (Table 2). According to this data, on five of the six days the iPad was offered, more students than not chose to use the iPad. On three of those days every student in the class chose to use the iPad to practice that days’ math skill.

Table 2

Number of Students Using iPads During Modified Treatment Unit, (*N* range 8 to 10).

Day #	Activity	Percentage of Students Using iPads
1	Creating Posters of Data Terms	25%
2	Splash Math: Data	63%
3	Data Scavenger Hunt Using QR Code Reader	100%
4	Data Scavenger Hunt Using QR Code Reader	90%
5	Creating Data Presentation	100%
6	Splash Math: Data	100%

Finally the number of students who felt that they understood math concepts better when they used iPads increased from 80% before the study to 90% at the conclusion of the study. One student commented that the iPad “helps because some apps tell you what you got wrong and lets you think harder so you can remember things.”

Data from the Behavior Chart showed that students were on task a higher percentage of time when using iPads than when not using iPads. On average, the four students tracked during the study were on task 93% of the time when using iPads. During non-treatment weeks, the same four students were observed to be on task about 82% of the time when not using iPads. The four students’ engagement levels are illustrated in Figure 1. It should be noted that the discrepancy in checkmarks recorded on the behavior chart is due to student absences, snow days, and slight variations in the length of math lessons and units. The high level of engagement in iPad activities was not limited to the four tracked students. A high level of engagement of the entire class during treatment weeks was also recorded in field notes. On many of the treatment days it was noted that the students were “very engaged.” One day while the students were being observed using iPads, it was noted, “There were no behavior management issues because the students were really focused on their work.”

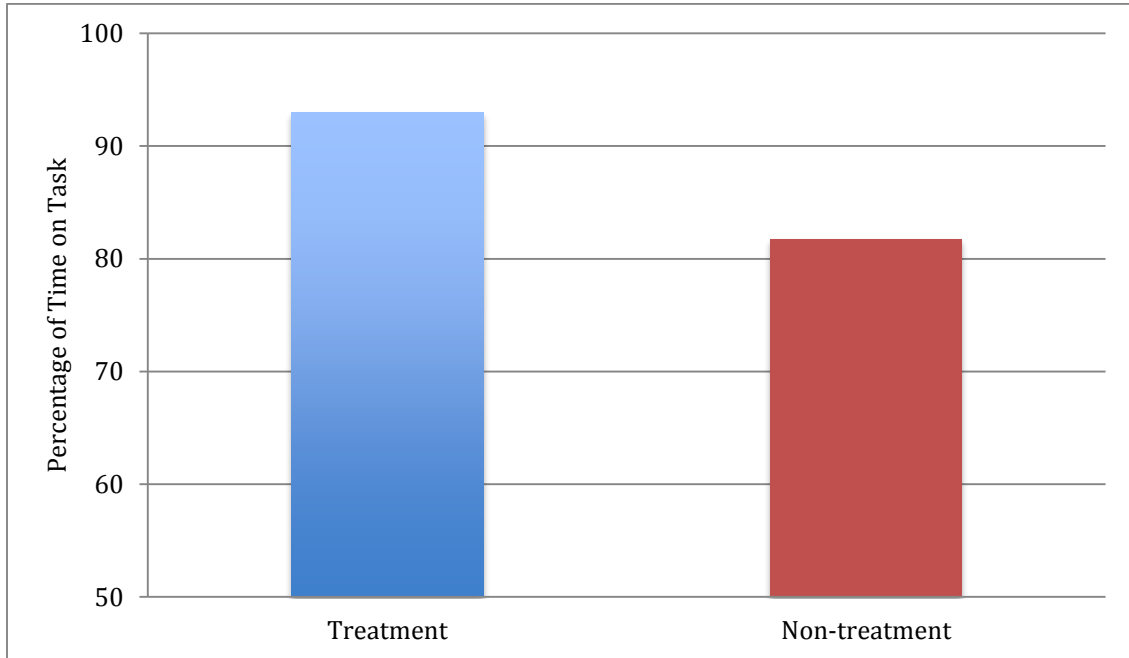


Figure 1. Amount of time students were on task, ($N=295$ checkmarks for treatment and 235 checkmarks for non-treatment).

Data from the Unit Tests showed there was no significant difference between the mean treatment and non-treatment posttest scores (Figure 2). The mean posttest score of treatment week 1 was 99 points, and the mean posttest score of non-treatment week 1 was 97.4 ($N=9$). This is a difference of 1.6 points. The mean posttest score of treatment week 2 was 85.3 points, and the mean posttest score of non-treatment week 2 was 83.4. This is a difference of 1.9 points. The Unit Test scores also show that the greatest average gain from pretest to posttest scores happened in non-treatment period 1. This was a 69.1 point increase. However, the smallest average gain happened during non-treatment period 2. This was an increase of 14.1 points. The average gains in both treatment periods were similar. Treatment period 1 had an increase of 55.5 points. Treatment period 2 had an increase of 58.9.

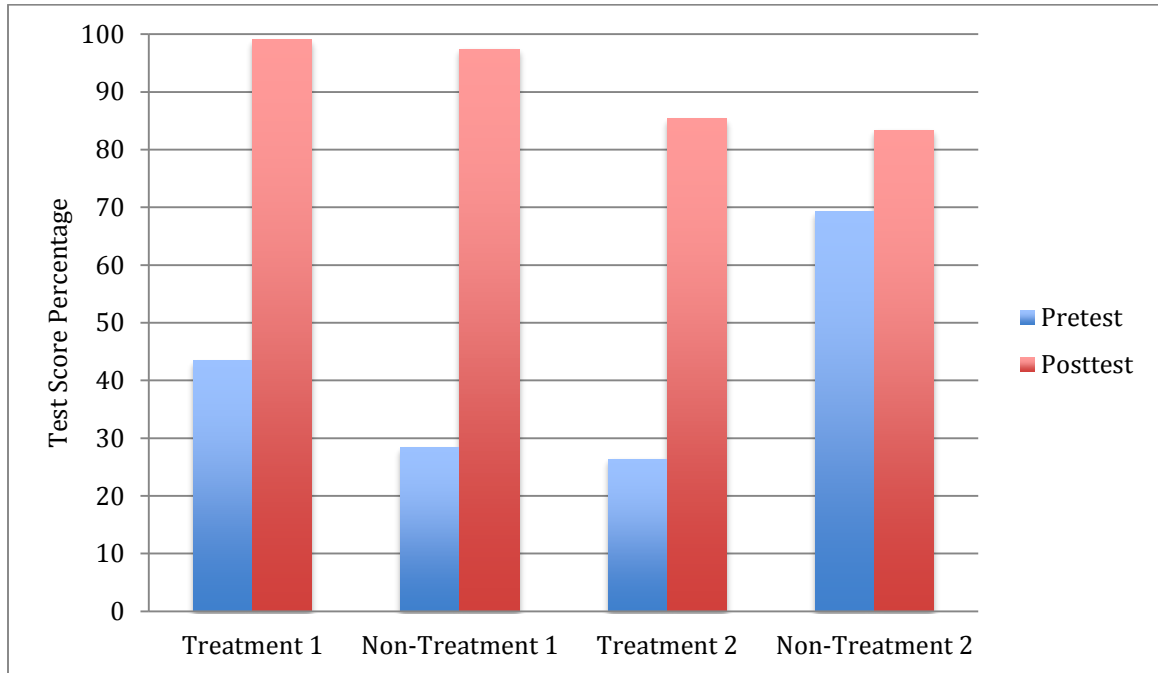


Figure 2. Difference in mean pretest and posttest scores by unit, ($N=9$).

Results of the Pre- and Post-Confidence Surveys indicated that students were slightly more confident in their math abilities at the conclusion of non-treatment units than treatment units. During non-treatment units, students strongly agreed 81% of the time to questions about their abilities in different math skills from those two units. During treatment units, students strongly agreed 74% of the time to questions about their abilities in different math skills from those two units. However, there was a bigger increase in the percentage of *strongly agree* responses from Pre- to Post-Confidence surveys during treatment units than non-treatment units. There were 11 *strongly agree* responses on confidence pre-surveys during treatment units and there were 59 *strongly agree* responses on confidence post-surveys, which is a 60% increase ($N=80$). During non-treatment units,

there were 26 *strongly agree* responses on confidence pre-surveys and there were 65 strongly agree responses on confidence post-surveys. This is a 48% increase (Figure 3).

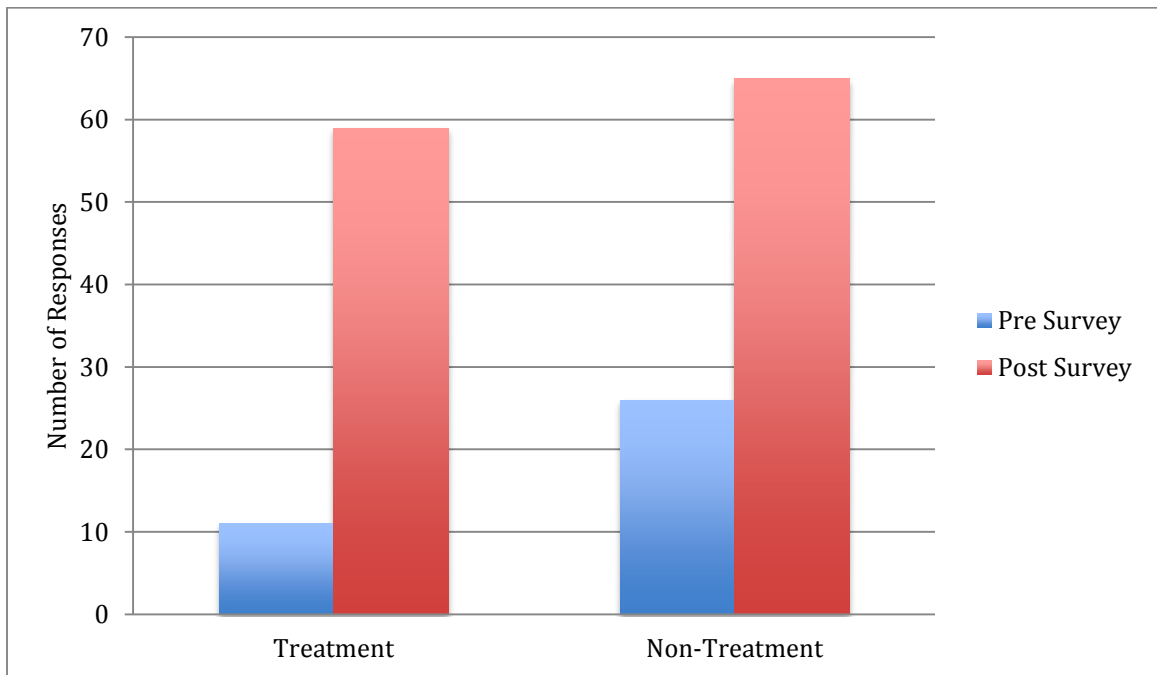


Figure 3. Difference in number of strongly agree responses to math skills confidence surveys, ($N=80$ responses).

INTERPRETATION AND CONCLUSION

This study provided evidence that iPads had a positive effect on second grade students' math experiences. In answering my primary research question about the effect of iPads on students' learning of math concepts, the study showed that the iPad had a positive effect on student engagement when it was used to practice daily math skills. In general, I noticed that the students were highly engaged when they used their iPads. They were focused on the apps they were using, regardless of whether the app was being used to create a presentation or to practice a skill in a game-type format. However, it is

important to note that most of the iPad activities in this study required the students to work independently. This is partly a function of the iPad itself; it is primarily designed to be a personal device. The fact that my students were working independently more frequently during treatment weeks than non-treatment weeks may have played a role in their engagement level because the students were presented with less distractions from classmates than they would have had if they had been working collaboratively.

There was no significant difference between the average posttest scores of treatment and non-treatment periods 1 and treatment and non-treatment periods 2. Therefore, it cannot be determined if iPads had a greater effect on the students' understanding of math concepts than more traditional methods of practicing math skills. Additionally, both the largest and smallest gains in average pretest to posttest scores occurred during non-treatment weeks. A few factors may explain this discrepancy. Different material was taught in each unit, and, therefore, students may have had more prior exposure to certain topics than others. Some topics are also more complex in nature than others. Also, some students might have felt more comfortable with the material taught in some units over others, which could have had an effect on test scores.

The sub question of the study sought to investigate students' attitudes toward using the iPad in math class. At the beginning of the study, students already had positive perceptions of the iPad. This might have been due to the fact that we had used the iPads in class prior to this study. Some of the students also regularly use iPads at home. The study shows that using iPads in math class improved students' perceptions of the iPad as a tool for helping them learn math. At the end of the study a majority of the students

strongly agreed that the iPad not only made math more interesting, but it also helped them learn math. Additionally, almost the entire class felt that they understood math concepts better when they used the iPad than when they used more traditional methods of practicing math skills. One of the clearest indicators of students' attitudes toward iPads occurred during the modified treatment period when the students were given the choice each day about whether to practice their math skills with or without the iPad. Most of the days of this period either a majority of students or the entire class chose to use their iPads.

Another aspect of student learning I investigated in the study was the iPad's effect on students' confidence levels in their math skills. A higher percentage of students reported stronger confidence levels at the end of non-treatment periods. However, as was stated above in the data analysis section, there was a bigger increase in *strongly agree* responses from pre survey to post survey during treatment periods. There are many factors that can affect a student's confidence in a particular math skill, and, therefore, it is not possible from this study to determine if iPads affect students' confidence levels in math.

VALUE

This study impacted my teaching in a variety of ways. The most obvious impact was the increased use of iPads in the math classroom. One reason I carried out this study was to learn how the iPad could be used in the classroom in ways that were beneficial to my students' education and my teaching. I was pleased with the students' positive response to the study and their level of engagement when using the iPads. Based on my

observations of my students, I will find other ways to have my students use the iPad in the future. The study also refreshed my teaching. Prior to this research project, I did not use technology on such a regular basis in math class. One day I wrote in my daily field notes, “I feel excited and invigorated. I’m thrilled to have the students use iPads in math. I’m happy that they enjoyed math and they were motivated to keep working.”

I changed the schedule of my daily math class as a result of implementing this research project. In the past, I had all of my students complete the same amount of classwork before they moved onto a cooperative math activity or independent math project. This meant that if a student took more time to complete the daily math work, he or she missed time working on that day’s activity or project. For this study I reduced the amount of required seatwork, and I allotted a fixed amount of time for the work to be completed. If students finished early, they completed bonus questions. If students required more time, I had them continue their seatwork at a different time that day. This allowed me to set aside at least fifteen minutes at the end of each math class for all of my students to practice their math skills either with the iPad or other materials. I will continue to use this schedule for my math classes indefinitely because the students responded so positively to using the iPads. According to my field notes, the students were consistently eager to complete the bonus questions. However, students who required more time were not always able to complete their seatwork. A future study could investigate if there is a connection between the amount of math problems students complete each class and their math achievement.

After reviewing the data, especially my field notes, it is important to note that although student engagement was high during treatment weeks, I will not completely use iPad-only math activities in the future. I believe that a mix of non-iPad activities and iPad-based activities serves the students best. In certain situations manipulatives and hands-on materials provide an experience that cannot be replicated with an iPad. For example, when students learned how to count money and how to make change, I think it was valuable for students to use real or replica currency so that they are better prepared to use money in the real world. Another reason I will not switch completely over to iPads is because some students indicated in the interview that at times they prefer using more traditional methods of practicing math over using the iPad. Future studies could investigate what types of activities students prefer to do with iPads and what activities they prefer to do with other materials.

It should be noted that during the non-treatment units, the level of student interaction and collaboration was high. This was largely because the non-treatment units included many collaborative activities. I observed student interaction and collaboration during treatment units, but it was not as pronounced during non-treatment units. According to the Partnership for 21st Century Skills, collaboration is an essential skill students must develop to be successful in the workforce (Framework for 21st Century Learning, 2011). Because student collaboration is important and because my students gave such positive feedback regarding the iPads, I think it is worthwhile to find ways to use iPads that foster collaboration in the math classroom in addition to collaborative non-iPad activities.

An important advantage of using the iPads was the amount of differentiation they provided my students on a regular basis. A recurring theme in my daily field notes was that different apps were well-suited for a range of student abilities. Many times the students were able to move at their own pace during the math activities. For example, on a day my class was practicing double-digit addition I wrote, "I've never had so many students move onto three-digit addition so quickly in this unit." The iPad presented different levels of material in a way and at a pace that felt natural for the students. And since a lot of the differentiation is built into the apps, it did not require additional work for me to create multiple versions of activities for all of the different learners in my class.

There were limitations to the study. There were different factors that could have affected the discrepancy between the difference in pretest and posttest scores of treatment versus non-treatment weeks. These include students' varying comfort levels with the material taught in each unit and the fact that some students were absent on days during the study. Other limitations include the small sample size of students and the fact that most iPad-based activities were individually based and most non-iPad activities were collaboratively based. Future studies that investigate the effect of iPads on students' understanding of math concepts should use larger sample sizes and have a balance of collaborative and individual activities for both treatment and non-treatment weeks.

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APPENDICES

APPENDIX A
IPAD ATTITUDE SURVEY

iPad Attitude Survey

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Prompt: I am going to audio record your answers to this survey to make sure I correctly understand your answers. I will read the question and you will tell me if you strongly agree, agree, disagree, or strongly disagree. I will circle your answer on this sheet. After some questions, I may ask you to explain your answer so that I better understand your thinking.

Student:

Date:

1) I like math.

Strongly Agree Agree Disagree Strongly Disagree

2) The iPad can help me learn math.

Strongly Agree Agree Disagree Strongly Disagree

Why do you think this?

3) Using the iPad in math class makes math more interesting.

Strongly Agree Agree Disagree Strongly Disagree

Why do you think this?

4) I know how to use the iPad to help me learn math.

Strongly Agree Agree Disagree Strongly Disagree

5) When I learn a new math skill, I prefer to use the iPad than not to use the iPad.

Strongly Agree Agree Disagree Strongly Disagree

Why do you think this?

6) I understand new math concepts better when I use the iPad.

Strongly Agree Agree Disagree Strongly Disagree

Why do you think this?

APPENDIX B
BEHAVIOR CHART

Week # ____

Date: _____

Behavior	Student # 1	Student # 2	Student # 3
On task			
Off task			

APPENDIX C
EXAMPLE OF UNIT TEST

Name:

Date:

Unit 8 Pretest

Directions: Add. Use the regrouping box when necessary.

1)

	Tens	Ones
	<input type="text"/>	
	5	8
		7
+		

2)

	Tens	Ones
	<input type="text"/>	
	7	0
	2	6
+		

3)

	Tens	Ones
	<input type="text"/>	
	3	8
	2	4
	1	1
		4
+		

4)

	Tens	Ones
	<input type="text"/>	
	2	5
	2	7
		2
+		

- 5) Do you have to regroup to solve these addition sentences? Circle *Yes* or *No*.

$71 + 23 = ?$ Yes No

$33 + 29 = ?$ Yes No

$57 + 18 = ?$ Yes No

$36 + 31 = ?$ Yes No

- 6) Leo drove 66 miles yesterday. He drove 29 miles today. How many miles did he drive?

_____ + _____ = _____

- 7) Zora had 23 yo-yos in his collection. His sister gave him 9 more. How many yo-yos does Zora have altogether?

_____ + _____ = _____

- 8) Circle the problem you need to regroup.

$71 + 8$

$55 + 2$

$23 + 9$

Explain how you know.

APPENDIX D

ADDITION SKILLS CONFIDENCE SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Name:

Date:

1) I know how to regroup ten ones for one ten.

Strongly Agree Agree Disagree Strongly Disagree

2) I know how to add a one-digit number plus a two-digit number using regrouping.

For example:

$$\begin{array}{r} 65 \\ + 7 \\ \hline \end{array}$$

Strongly Agree Agree Disagree Strongly Disagree

3) I know how to add a two-digit number plus a two-digit number using regrouping.

For example:

$$\begin{array}{r} 46 \\ + 27 \\ \hline \end{array}$$

Strongly Agree Agree Disagree Strongly Disagree

4) I know how to add more than two numbers together when at least two of them are two-digit numbers.

For example:

$$\begin{array}{r} 25 \\ 34 \\ 11 \\ + 7 \\ \hline \end{array}$$

Strongly Agree Agree Disagree Strongly Disagree

APPENDIX E
SUBTRACTION SKILLS CONFIDENCE SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Name:

Date:

1) I know how to regroup one ten for ten ones.

Strongly Agree Agree Disagree Strongly Disagree

2) I know how to subtract a two-digit number minus a one-digit number.

For example:

$$\begin{array}{r} 65 \\ - 7 \\ \hline \end{array}$$

Strongly Agree Agree Disagree Strongly Disagree

3) I know how to subtract a two-digit number minus a two-digit number.

For example:

$$\begin{array}{r} 46 \\ - 27 \\ \hline \end{array}$$

Strongly Agree Agree Disagree Strongly Disagree

4) I know how to use addition to check the answer to a subtraction problem.

Strongly Agree Agree Disagree Strongly Disagree

APPENDIX F
GEOMETRY SKILLS CONFIDENCE SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Name:

Date:

1) I know how to identify solid figures by their faces, edges, and vertices.

Strongly Agree Agree Disagree Strongly Disagree

2) I can name and draw different types of shapes.

Strongly Agree Agree Disagree Strongly Disagree

3) I can correctly count the number of sides and vertices of shapes.

Strongly Agree Agree Disagree Strongly Disagree

4) I know how to divide an object into halves, thirds, and fourths.

Strongly Agree Agree Disagree Strongly Disagree

APPENDIX G
MONEY SKILLS CONFIDENCE SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Name:

Date:

1) I can identify all of these coins: half dollar, quarter, dime, nickel, and penny and I know their values.

Strongly Agree Agree Disagree Strongly Disagree

2) I can count a group of coins to get the total amount of money.

Strongly Agree Agree Disagree Strongly Disagree

3) I can show the same amount of money using different coins.

Strongly Agree Agree Disagree Strongly Disagree

4) I can count money up to \$5.00.

Strongly Agree Agree Disagree Strongly Disagree

APPENDIX H

GRAPHING AND DATA SKILLS CONFIDENCE SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Name:

Date:

1) I can graph data using a line plot.

Strongly Agree Agree Disagree Strongly Disagree

2) I can use data on a line plot to find the range, median, mode, and outliers of the data.

Strongly Agree Agree Disagree Strongly Disagree

3) I can use data on the line plot to answer questions about data.

Strongly Agree Agree Disagree Strongly Disagree

4) I can use a bar graph to answer questions about data.

Strongly Agree Agree Disagree Strongly Disagree

APPENDIX I
STUDENT INTERVIEW QUESTIONS

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Prompt: I am going to audio record this interview so that I make sure I correctly understand your answers. I will read each question aloud and please answer with as much detail as you can.

Student:

Date:

- 1) What are your thoughts about using the iPad in math class?

- 2) What did you like about using the iPad in math class?

- 3) What did you dislike about using the iPad in math class?

- 4) a) Do you feel the iPad helped you learn math? Why do you think this?

b) If you answered yes, what topics did the iPad help you learn? How did the iPad help you?

- 5) Is there a way the teacher can use the iPad differently next year to better help students learn math?

- 6) Do you feel more challenged in math when you use the iPad? Explain.

- 7) If you were given the option to use the iPad in math or to not use the iPad in math class, which would you choose? Why?

- 8) Is there anything else you want me to know?

APPENDIX J
IRB EXEMPTION APPROVAL



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
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MEMORANDUM

TO: Andrew Stattel and John Graves
FROM: Mark Quinn, Chair *Mark Quinn Cj*
DATE: November 20, 2014
RE: "The Effects of Incorporating iPads into the Second Grade Math Classroom on Student Learning"
 [AS112014-EX]

The above research, described in your submission of November 20, 2014, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.