# Digital versus Traditional Methods of Teaching Mathematics: What Works Best for Second-Grade Students

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**Abstract**

Many students enter second grade lacking automaticity with basic subtraction math facts. This action research will examine which method of practicing subtraction math facts works best. Eighteen individuals participated in this study. During phase one of the study participants practiced their subtraction math facts in traditional ways. These ways included flash cards, wrap ups, and a card game. During phase two of the study participants practiced subtraction facts digitally by using online gaming sites such as Xtra Math, Freckle, Splash Learn Games, and a website called Education Games. During both phases, participants practiced math facts for fifteen minutes, three days a week. Each phase lasted three weeks. At the end of each week participants were assessed using weekly subtraction fact tests. The weekly tests were composed of varying subtraction problems each week. Week one was simple subtraction facts with digits 1-18. Week two was 2-digit subtraction facts with no regrouping. Week three was 2-digit subtraction facts with some regrouping. A pretest was also given at the beginning of each phase. The results showed that when comparing phase one, week one test to phase two, week one test, participants improved in the number of problems correctly answered during phase two of the study. Participants improved their automaticity with subtraction facts during each week of phase two compared to phase one. Overall, participant scores improved during the three weeks of practicing their facts using technology.

Keywords: *automaticity, subtraction, technology*

# Digital versus Traditional Methods of Teaching Mathematics: What Works Best for Second-Grade Students

Using technology proves to have many benefits over using traditional teaching methods. Technology offers high-quality feedback. High-quality feedback is one-way technology-based strategies differ from print strategies. In order to be high-quality, feedback should be timely, informative, reliable, consistent, clearly communicated, and specific (Nutbrown, Higgins, & Beesley, 2016). The feedback that is timely promotes student engagement. Feedback should also be informative. This requires the feedback to explain the students' mistakes. The feedback should also be reliable and consistent; if it were wrong twice in a row the same feedback should be given each time. Easy to read feedback should also be considered. If the mistakes aren't well communicated the students may have a hard time seeing what mistakes they made (Nutbrown, Higgins, & Beesley, 2016). Providing students with immediate feedback has been found beneficial in motivating students (Mohrweis & Shinham, 2015).

Using technology allows students to receive feedback immediately. When students are practicing math facts via flashcards, it can be hard for the teacher to tell if they're answering correctly and mastering the math facts. The teacher is unable to provide feedback to each student while they're practicing math facts via flashcards. The online program Xtra Math provides the teacher with an individualized student report. The color-coded map allows the teacher to determine levels of mastery. Students also receive feedback which allows them to see exactly which problems they missed. Xtra math provides repeated practice for the problems that are being missed frequently. This repetition is consistent and reliable feedback for students. This online program provides students with instant feedback which is also motivating.

Students are more engaged when using technology. Students need a sense of purpose that will give them motivation and direction when completing instructional activities (Nitonde, 2018). Gamification of technology programs helps keep students motivated and engaged. In the game Freckle, students practice all of their math facts and earn coins for each correct answer. Students see programs like this as a reward and don't look at it as completing lessons. Students are more motivated to learn when they're using technology. Using gamification in the classroom is more entertaining than traditional learning methods, which creates a higher level of student motivation (Sanchez-Mena & Marti-Parreno, 2017). Students' attention span is also increased from using technology as a strategy of learning. Students tend to see this as learning while having fun (Sanchez-Mena & Marti-Parreno, 2017). Technology-based strategies that are motivating can help students achieve higher math scores.

Speed and competency are important when learning math fact fluency. Automaticity in math is very important. There is often a correlation between students who struggle with automaticity and low performing students in math, overall. Fluency benefits students who achieve low scores in math. Likewise, students who have an enhanced number sense are better at mental computation and tend to excel in math (O'Rourke, Main, & Hill, 2017). Researchers have found that math fact automaticity has become a barrier for struggling students (Stickney, Sharp, & Kenyon, 2012). Students wishing to excel in math fact fluency need to attempt a number of ways to practice. They should also practice using the speed of retrieval. It was found that low achieving students lagged in the speed of completing math facts (Stickney, Sharp, & Kenyon, 2012). Daily practice of math facts will help struggling students improve their math automaticity. Likewise, students have less anxiety and less demand when completing more complex math problems when they are proficient in math fact fluency (Musti-Rao & Plati, 2015).

The overall purpose of the study is to investigate if using technology will help students achieve higher subtraction math scores. In the past, it has been proven that students are more motivated and enjoy learning more when technology is involved. Technology-based strategies increase student motivation and provide immediate feedback for the students (Musti-Rao & Plati, 2015). There are many benefits to using technology as a teaching strategy. Findings from this study will inform educators on what works best for second-grade students: the strategy of traditional math fact practice or digital math fact practice.

Two research questions guided this study:

1. Does using digital methods help students memorize subtraction math facts?
2. Which methods of memorizing subtraction math facts; digitally or traditionally, help second-grade students better learn subtraction?

The study hypothesized that using digital interventions to practice subtraction math facts will help participants memorize subtraction math facts. The study also hypothesized that participants in second grade will be more effective at memorizing subtraction math facts using technology strategies versus memorizing subtraction math facts after using traditional strategies. In the following literature review, the researcher discussed different forms of technology strategies that are often used in a classroom. The variety of methods and strategies educators can choose from when incorporating technology into the classroom was discussed. The review also explores the impact technology has on student motivation.

**Using Technology for Student Engagement and Motivation**

Students today rely on technology to provide them with an engaging and motivating learning experience. Rather than listening to lectures, students are now connected to technology at a young age to provide them with the information they need to learn the content. Motivation

in a school setting is considered anything that makes a student more eager to learn. This academic motivation is referred to as intrinsic motivation; it determines the student's attitude toward academic tasks (Khan, Sadia, Hayat, & Tahir, 2019). There are many technology strategies used to engage and motivate students in the classroom. One highly effective approach to benefiting visual and interactive learners is to incorporate technology-based strategies (Lumpkin, Achen, & Dodd, 2015). When students enjoy the learning process they are more likely to be motivated and engaged in their learning content. In order to avoid poor integration of technology into teaching and learning, it is essential that educators select appropriate teaching strategies with relevant technology (Simelane-Mnisi & Miji, 2019). Technology-based strategies provide engagement to students through many different avenues including, but not limited to: PowerPoint-slides, student response systems, gamification, and online blogs. Technology can also be used as an effective tool to differentiate instruction among students.

A study was conducted at Hong Kong University to determine students' motivation using technology for learning (Yau, Cheng, & Ho, 2015). Engineering students were surveyed in eight constructs: confidence, perceived personal ability, satisfaction, social influence, relevance, perseverance, interest, and anxiety. The results of the study showed that the confidence level was high, when using technology for the engineering program. Their perceived personal ability, satisfaction, and social influence were all near the neutral level. This implied that the students tended to be satisfied with the technology programs, and they were influenced by their classmates when using technology for learning (Yau, Cheng, & Ho, 2015). When reviewing the relevance category, students agreed that using technology was useful and relevant to their learning. However, students found it hard to persevere through the difficulty of the programs when using technology. Some students found difficulty in learning programming technology

and therefore said they weren't interested in using programming for education. A majority of students stated that they did not feel technology increased their anxiety level while learning (Yau, Cheng, & Ho, 2015). Student motivation is derived from many different influences. Motivation comes from direct and indirect student experiences and shapes student behavior (Alkaabi, Alkaabi, & Vyver, 2017). Learning outcomes are improved when students have a higher motivation level (Hima, Nusantara, Hidayanto, & Rahardjo, 2019).

**Technology-Nested Strategies**

Theorists identify teaching strategies as the approach's educators take to create an environment conductive to learning (Simelane-Mnisi & Andile, 2019). Technology-based teaching strategies encourage students to maintain a high level of interest and motivation when learning the content. The learning strategies explored are PowerPoint slides, student response systems, gaming, and online blogs. Each of these avenues for delivering content to students is engaging and provides a motivating, learning experience to students. "Technology-nested strategies engage students actively in their learning and help reinforce information previously presented, especially as a change of pace punctuating traditional lectures" (Lumpkin, Achen, & Dodd, 2015 , p. 123).

**PowerPoint slides provide an engaging experience for students.** Educators can better focus their learning material and discussions by using PowerPoint slides. Watching and listening is more engaging than just listening for students. Students can better maintain interest when they are active in the discussion, and PowerPoints are a way of actively involving students in the presentation of content. Since many students are visual learners, this method of teaching content is more likely to engage the learners (Lumpkin, Achen, & Dodd, 2015).

Students in four undergraduate courses and one graduate course participated in providing quantitative and qualitative data examining technology-nested instructional strategies (Lumpkin, Achen, & Dodd, 2015). They were asked which strategies had a positive impact on their learning. Well-over the majority of undergraduate students rated PowerPoint slides as positively impacting their learning. About half of the graduate students rated PowerPoint slides as having a positive impact on their learning, while a third said it sometimes had a positive impact on them (Lumpkin, Achen, & Dodd, 2015). Overall, both graduate and undergraduate students rated PowerPoints as being an enjoyable technology strategy to learn from, which in turn creates more engagement (Lumpkin, Achen, & Dodd, 2015).

**Student Response Systems (SRS) encourage collaborative learning**. SRS are used in classrooms to collect and present live feedback. This can be done with a device such as a Chrome book, laptop, or cell phone. They are used to help teachers determine students' misconceptions of content, while keeping the data confidential. Many teachers use a SRS for polling, quizzing, and discussion (Lumpkin, Achen, & Dodd, 2015). SRS initiate collaborative learning for students, which fosters interaction among their peers (Mork, 2014).

The SRS called Socrative was used in a qualitative study among several classes at Tokyo Woman's Christian University and Meiji University. Two-hundred fourteen students responded to the qualitative survey after using this SRS named Socrative. Socrative was used as a formative assessment tool in this study. Students anonymously shared thesis statements in which the rest of the class could provide feedback to one another using the app Socrative (Mork, 2014). When students were asked about enjoyment from using Socrative, very few students said they did not enjoy this method for learning. On a four-point Likert scale, about a third of the students felt that using Socrative for the first time was an okay experience. While well-over the majority

of the students rated the program as very easy or easy to use. Very few students claimed Socrative was difficult to use. Generally, the findings were that Socrative had a positive effect on student's learning (Mork, 2014). SRS have the ability to get students engaged in classroom discussion and comprehension checks. They provide an opportunity for group interaction, peer assessment, and self-assessment. Socrative was used in this study to rate peer work, and students commented overall that it was easy to provide peers with feedback.

A combined qualitative and quantitative study was done in South Africa with 240 participants using SRS in their classroom (Simelane-Mnisi & Miji, 2019). Students used the SRS in a mathematics class. They were requested to provide information about receiving feedback on assessments while using SRS. Students commented that they preferred using response systems because feedback is immediate, rather than paper pencil where feedback could take a week (Simelane-Mnisi & Miji, 2019). Overall, the results of this study showed the use of response systems used for learning activities in Mathematics promoted engagement, participation, and interaction among the students. Specifically, students commented on the ability to receive immediate feedback provided by the SRS and how it assisted the students in understanding concepts and the ability to identify and correct mistakes when solving mathematical problems (Simelane-Mnisi & Miji, 2019).

Student motivation is a clear benefit of SRS. Methods associated with technology, such as SRS, create an engaging and motivating environment for students to learn in. When SRS are used during class, they positively influence student engagement and provoke active learning. Student response systems are effective and helpful in keeping the students active through classroom activities. They also improve critical thinking abilities among students (Simelane-Mnisi & Miji, 2019).

**Does gamification affect students' learning performance and motivation?**

Gamification is the application of using games for the purpose of increasing motivation and engagement in learning (Alsawaier, 2018). Gamification provides a remedy for many students who find themselves bored by the traditional methods of instruction. Using gamification could provide a solution to the decline in learners' motivation (Alsawaier, 2018). Games in the classroom are changing the way teachers present content. Students are more engaged in a learning-centered classroom rather than a teacher-centered classroom. Digital games provide more engagement to students in a better learning environment (Wichadee & Pattanapichet, 2018). Games make learning more enjoyable for students. Digital games are gaining more preference over traditional games, because technology can provide games that suit a certain learning style (Wichadee & Pattanapichet, 2018). When students are more engaged, their knowledge of the content is increased. Students are able to enjoy a more relaxed and fun atmosphere with the gaming technique as part of a classroom's daily routine.

Kahoot is one game that was used in a study to determine how game-based learning effects performance and motivation. At a Thailand University, 77 students were divided into an experimental group and a control group. The experimental group was given quizzes on the digital game Kahoot while the control group was given paper and pencil type quizzes. The results of the study indicated that the experimental group was much more motivated than the control group (Wichadee & Pattanapichet, 2018). Many students reported that when gaming was used in the classroom as the source of content retrieval; their content knowledge improved (Ling, 2018). This qualitative review determined students find gaming fun and engaging. Many students thrive off competition, which is a major benefit to using gaming for learning content. Students feel less pressure when quizzes are given in a game format rather than a pencil paper

format (Ling, 2018). Gaming as a technology strategy can increase student knowledge while providing a fun, engaging environment (Wichadee & Pattanapichet, 2018).

**Online blogs are gaining popularity in the classroom**. Blogging can be an effective classroom tool to improve students' literacy skills and engaging students in the discussion (Featro & DiGregorio, 2016). Research has pointed to many ways blogging can be used as an instructional tool effectively. Blogging can be used to help English Language learners communicate with each other and other students beyond the classroom. Blogs promote student reflection when writing to learn, and students are able to respond knowledgeably to their peers (Lumpkin, Achen, & Dodd, 2015). Participants of a study done to determine students' views on blogging, showed that blogging as an instructional tool gained a positive response from students (Featro & DiGregorio, 2016). ESL students were interviewed after their experiences with blogging. ESL students are benefited from blogging as a learning technique because they are communicating with an authentic audience (Featro & DiGregorio, 2016). This pedagogical tool is an ideal avenue to facilitate student learning.

**Technology as a Tool for Differentiation**

Differentiating instruction is done to best meet the needs of each student. Digital differentiated instruction is shown to provide improved results when compared to other non-digital methods of differentiating instruction. Student commitment and motivation can also be increased with digital differentiation (Haelermans, Ghysels, & Prince, 2015).

In the Netherlands, a study was conducted to determine which group of participants receiving differentiated instruction had better results: digital or traditional (Haelermans, Ghysels, & Prince, 2015). This field experiment was conducted over 12 weeks. The digital instruction was a combination of online sections of the book digitized by the teacher, online portions of the

publisher edition, and online resources such as puzzles, video clips, and exercises (Haelermans, Ghysels, & Prince, 2015). The second group did not change their curriculum. They received their instruction via printed text and paper pencil worksheets. The teacher gave students printed material and instructed by the lecture method for 12 weeks. In the traditional classroom setting, the teacher had less time to answer individual questions, due to the amount of time spent teaching (Haelermans, Ghysels, & Prince, 2015). In the treatment group, the teacher had more time to devote to answering questions of individuals, because of the curriculum being digitalized. The teacher was able to walk around the room and devote more time to individual needs.

In this study, both the treatment and control group of students were tested weekly and were placed into one of three categories: practical prevocational track, theoretical prevocational track, and a higher general track (Haelermans, Ghysels, & Prince, 2015). The weekly testing meant they could follow a different track of curriculum week to week. The practical prevocational track level used simple language and fewer words; the sentences were less complicated which meant students studied a minimum number of topics in that track. Students were given differentiated instruction by digital methods and differentiated instruction by printed traditional teaching methods in the two groups. The group that received the digital methods showed a significant amount of growth over the traditional group (Haelermans, Ghysels, & Prince, 2015). Using technology to differentiate instruction allowed the students to work at their own pace. After pretests and posttests were given among each group, it was determined that digital differentiation showed a significant effect on the increase of the posttest score (Haelermans, Ghysels, & Prince, 2015). All in all, differentiation via digital materials showed to improve learning in a classroom setting over traditional learning (Haelermans, Ghysels, & Prince, 2015).

**Educators are differentiating instruction with fact fluency practice.** This is one area that students are often receiving differentiated instruction in, because this concept does not come easily for struggling students. It often requires differentiated instruction due to all of the different levels' students perform at. Math fact fluency requires students to respond to the four operations of math facts (i.e., addition, subtraction, multiplication, and division) (Musti-Rao & Plati, 2015). Fluency interventions increase math fact fluency among students. Detect-practice-repair (DPR) is one strategy used to increase fact fluency. This is a non-digital strategy in which students complete a paced assessment. They then determine which problems need repaired and continue practicing those (Musti-Rao & Plati, 2015). Technology-based strategies increase student motivation and provide immediate feedback. A study among third-grade students in a co-teaching classroom took place to determine which strategy had better results, DPR or the digital fact fluency strategy, Math Drills. One benefit of using the Math Drills app was that students received immediate feedback for their responses. The teacher from the study reported that the class preference for fact fluency differentiation was the Math Drills app. Ease of implementation, student independence, and increased motivation level from students were reasons behind this conclusion (Musti-Rao & Plati, 2015). Results from this study concluded that the iPad intervention, Math Drills, was preferred over the DPR method. Digital instruction is gaining popularity among teachers and students. Using classroom technologies to differentiate instruction was proven to have a positive effect on the students studied (Musti-Rao & Plati, 2015).

## Conclusion

There is no denying how prevalent technology has become in our society today. It was shown many times throughout this research how the technology strategy favored the non-digital

strategy of teaching. Researchers and educators showed how each specific strategy improved student learning. With teachers willing to explore technology strategies, students can be more motivated and engaged in their learning experience. The research was gathered from different parts of the world to show that the consensus remains the same; technology is the preferred method. Not only do the teachers prefer the methods of technology but the students did as well. A plethora of different technology strategies have been explored and methods have been tested. This paper explores the technology strategies of PowerPoint slides, Student Response Systems, gaming, blogging and differentiating instruction using technology. These methods were proven to gain more student engagement, motivation, and provide better pedagogical results compared to traditional methods of teaching.

## Methods

The research conducted was a quantitative study approach that used a quasi-experimental design. The researcher collected data for a total of six weeks from second-grade participants in the researcher's classroom during the spring semester of 2020. The researcher did a comparative study comparing test results after participants practiced math facts traditionally for three weeks and digitally for three weeks. The following information details the participants, setting, data source and research materials, and data collection procedures.

### Participants and Setting

The participants in this study were from the researcher's second-grade classroom in East-Central Illinois. Of the 18 participants, 12 were boys and 6 were girls. All participants were Caucasian. The participants were between the ages of 8-9 years old. Participants remained in one large group for this study. There were no special needs among the participants. The location of the study was in a second-grade classroom.

The participating school has an enrollment of 561 students ranging from pre-school to sixth grade. According to the 2018-2019 school report card, the school is 98.4 % white, 0.2 % Asian, 0.2% Hispanic, 0.4% Black, and two or more races 0.9% (Teutopolis Community School District). Only 1% of the participants are considered low income. The school has a rating of exemplary, which means they performed in the top 10% of the state. There is an average of four classrooms per grade level at the grade school, excluding pre-school. Additionally, this school has two administrators, a nurse, two speech and language pathologists, two reading specialists, three special education teachers, an occupational therapist, a school psychologist, a school social worker, and six paraprofessionals.

**Data Source and Research Materials**

Data for this source was collected using four instruments during a six-week time span. This study was completed in two phases. A timed pre-test was given on day one of phase one and again on day one of phase two. Participants had five minutes to complete each pre-test. Phase one (weeks 1-3) used traditional subtraction methods and interventions to practice subtraction math facts. Phase two (weeks 4-6) used digital subtraction methods and interventions to practice subtraction math facts. Participants completed three different post-tests. For each post-test, participants were given five minutes to complete the assessment. Post-test 1 was given after weeks 1 and 4. Post-test 2 was given after weeks 2 and 5. Post-test 3 was given after weeks 3 and 6. Each post-test consisted of 100 subtraction math facts. Test 1 contained 100 subtraction facts from 1-18. Test 2 contained subtraction facts using 2-digit numbers minus another 2-digit number and no regrouping. Test 3 contained subtraction facts using double digit numbers minus another double-digit number with some regrouping involved. The data sets were compared after the six-week study was complete. See Table 1 below.

Table 1.

*Weekly Intervention Instruments for Traditional and Digital Methods*

| Methods/Week/Test | 1 | 2 | 3 |
|---|---|---|---|
| Phase One-<br>Traditional Methods | Test 1<br>Subtraction Facts 1-18 | Test 2<br>Subtraction Facts with 2 digits and no regrouping | Test 3<br>Subtraction Facts with 2 digits using some regrouping |
| Methods/Week/Test | 4 | 5 | 6 |
| Phase Two-<br>Digital Methods | Test 1<br>Subtraction Facts 1-18 | Test 2<br>Subtraction Facts with 2 digits and no regrouping | Test 3<br>Subtraction Facts with 2 digits using some regrouping |

**Procedures of Data Collection**

The research study took place for a total of six weeks. All individuals in the second-grade classroom participated in the interventions. During the six-week study, all participants received math interventions for fifteen minutes, three days a week. During phase one of the study, participants completed traditional interventions for subtraction facts. This included subtraction facts from 1-18, subtraction facts with regrouping, and subtraction facts without regrouping. The traditional interventions during weeks 1-3 included practicing subtraction flashcards, a subtraction war game that involved 2-digit subtraction using borrowing and completing subtraction fact wrap-ups. Participants were familiar with all these interventions as they were a part of their daily fact practice routine. The participants continued using these practice methods during weeks 1-3.

Phase one activities contained a mixture of activities that have already been used throughout the year. Participants were familiar with the activities, so they did not require any

additional instruction. When practicing flashcards, participants had the option to work with a partner or work by themselves to recite subtraction facts on flashcards. The card game participants used was based on the card game War. In pairs, participants each turned over a card with a two-digit subtraction problem on it. The participant with the lower answer keeps the cards. Partners played until one player collected all of the cards or the time was up. Subtraction wrap-ups are a tool used in the classroom by participants. The wrap-up is a plastic key device with a string attached. The problems are on the left and the answers are on the right. In this matching game, participants pull the string to match the subtraction math problem with the answer, and then secure the string. They continue matching subtraction facts down the key until all of the problems have been answered and the string runs out. See Table 2 below.

Table 2.

*Phase 1 Interventions*

| Phase | Interventions |
|---|---|
| One | Subtraction |
| Weeks 1, 2, 3 | Flashcards, Subtraction War, Wrap-ups |

During phase two (weeks 4-6) participants practiced interventions only digitally three days a week for 15 minutes. The digital interventions included subtraction fact games on Freckle, Xtra Math, Splash Learn Games, and Education.com. Participants used their chrome books to participate in the digital interventions during weeks 4-6 of the study. Participants were already familiar with using their Chrome books for these websites and games. Figure 1 and Figure 2 are illustrated data sources for phase two study. Figure 1 shows a subtraction game from the free site Splash Learn Games. Figure 2 shows a borrowing subtraction game on the free site Education.com. See Figure 1 and Figure 2 below.

Figure 1.

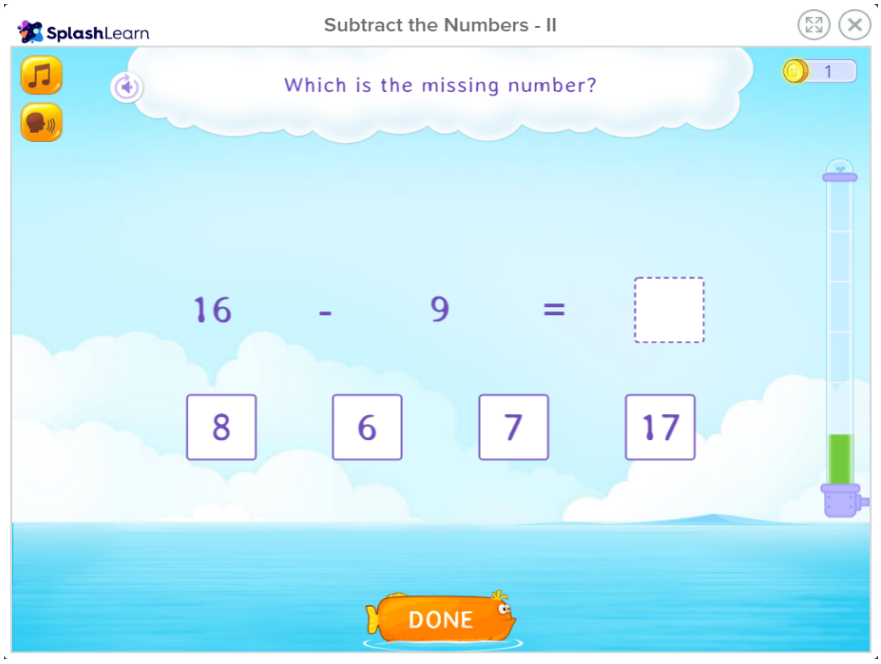
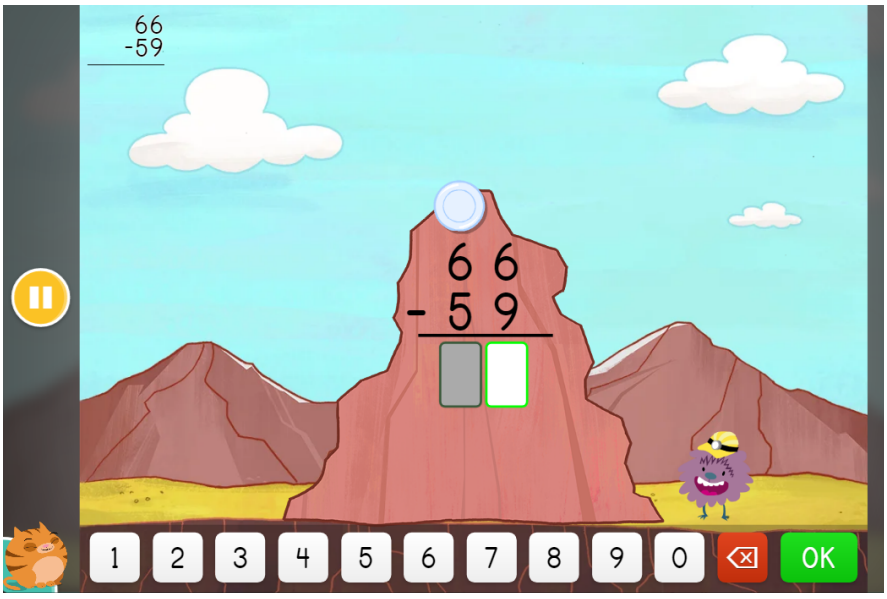



Figure 2.




Freckle is a site where participants are assigned subtraction questions by the researcher and then they receive coins for correctly answering problems. Participants are able to take their

coins to an online piggy store and purchase things for their animated pig. On Xtra Math, participants are racing against the computerized teacher to answer quickly. This free site continues to drill the problems missed more frequently. Participants were able to choose which sites they practiced during weeks 4-6. See Table 3 below.

Table 3.

*Phase 2 Interventions*

| Phase | Interventions |
|---|---|
| Two | Subtraction |
| Weeks 4, 5, 6 | Freckle, Xtra Math, Splash Learn Games, Education.com |

## Data Analysis and Results

The goal of this study was to analyze two comparative sets of data. Additionally, which way do students better memorize subtraction facts, traditional methods or digital methods? Students were assessed with pre-test/post-test timed test of 100 subtraction facts. Answers given within the five-minute time frame were accepted. Data was analyzed quantitatively. Eighteen participants took part in this study; they were from the researcher's second-grade classroom. The researcher collected scores in two phases for a total of six weeks. For both phases, tests were given at the end of week one, two, and three.

### Data Analysis

A pretest was given at the beginning of each phase. Then, each week the researcher collected data after participants practiced subtraction math facts either traditionally in phase one or digitally in phase two. The table below shows each participant's scores in both pretests, phase

one pretest and phase two pretest. In Figure 2, the bar graph shows a comparison between phase one, week one test and phase two, week one test. In Figure 3, the bar graph shows a comparison of phase one, week two test and phase two, week two test. In Figure 4, the bar graph compares phase one, week three test and phase two, week three test.

**Results**

Data was analyzed comparing phase one to phase two to determine if using digital methods helps students memorize subtraction math facts. It was also done to review which methods of memorizing subtraction math facts helped second-grade students learn subtraction. Overall results from three weeks of practicing subtraction facts traditionally and three weeks of practicing subtraction facts digitally showed that participants had greater scores after the digital subtraction practice.

The first step was to figure out the starting points before each phase. So, participants were given a pretest before Phase 1 and the same pretest before Phase 2. The mean for pretest one was 53.83 with a standard deviation of 9.52. The mean for pretest two was 56.17 with a standard deviation of 9.25. Table 1 below shows participant scores in pretest Phase 1 and pretest Phase 2 and the difference between the two is only 2.34. Participants started Phase One and Phase Two in slightly different positions to begin the week one.

Table 1.

*Phase 1 pretest and Phase 2 pretest mean and difference*

| Phase | Mean | SD |
|---|---|---|
| Phase 1 pretest | 53.83 | 9.52 |
| Phase 2 pretest | 56.17 | 9.25 |
| Overall Difference | -2.34 | -0.27 |

Table 2 below shows each participant score for pretest 1 and each participant score for pretest 2. A total of eighteen participants were studied for the six-week time frame.

Table 2

*Participant's Scores on Phase 1 Pretest and Phase 2 Pretest. (n= 18)*

| Participant | Pretest Phase 1 | Pretest Phase 2 |
|---|---|---|
| 1 | 69 | 71 |
| 2 | 51 | 54 |
| 3 | 49 | 52 |
| 4 | 64 | 65 |
| 5 | 68 | 70 |
| 6 | 48 | 52 |
| 7 | 72 | 75 |
| 8 | 46 | 47 |
| 9 | 42 | 46 |
| 10 | 59 | 61 |
| 11 | 47 | 51 |
| 12 | 41 | 45 |
| 13 | 53 | 55 |
| 14 | 48 | 49 |
| 15 | 51 | 54 |
| 16 | 53 | 55 |
| 17 | 46 | 46 |
| 18 | 62 | 63 |

**Research Question One: Does using digital methods help students memorize subtraction math facts?**

Figure 1 below shows the percentage scores collected between the data collection period in both phases. The highest score was 100% by participant 1, during Phase Two of digital subtraction methods. The lowest score was a 37% by participant 3 during Phase One of traditional subtraction methods. Overall, Phase Two of digital subtraction interventions provided higher scores, which proves these methods helped students memorize subtraction math facts.

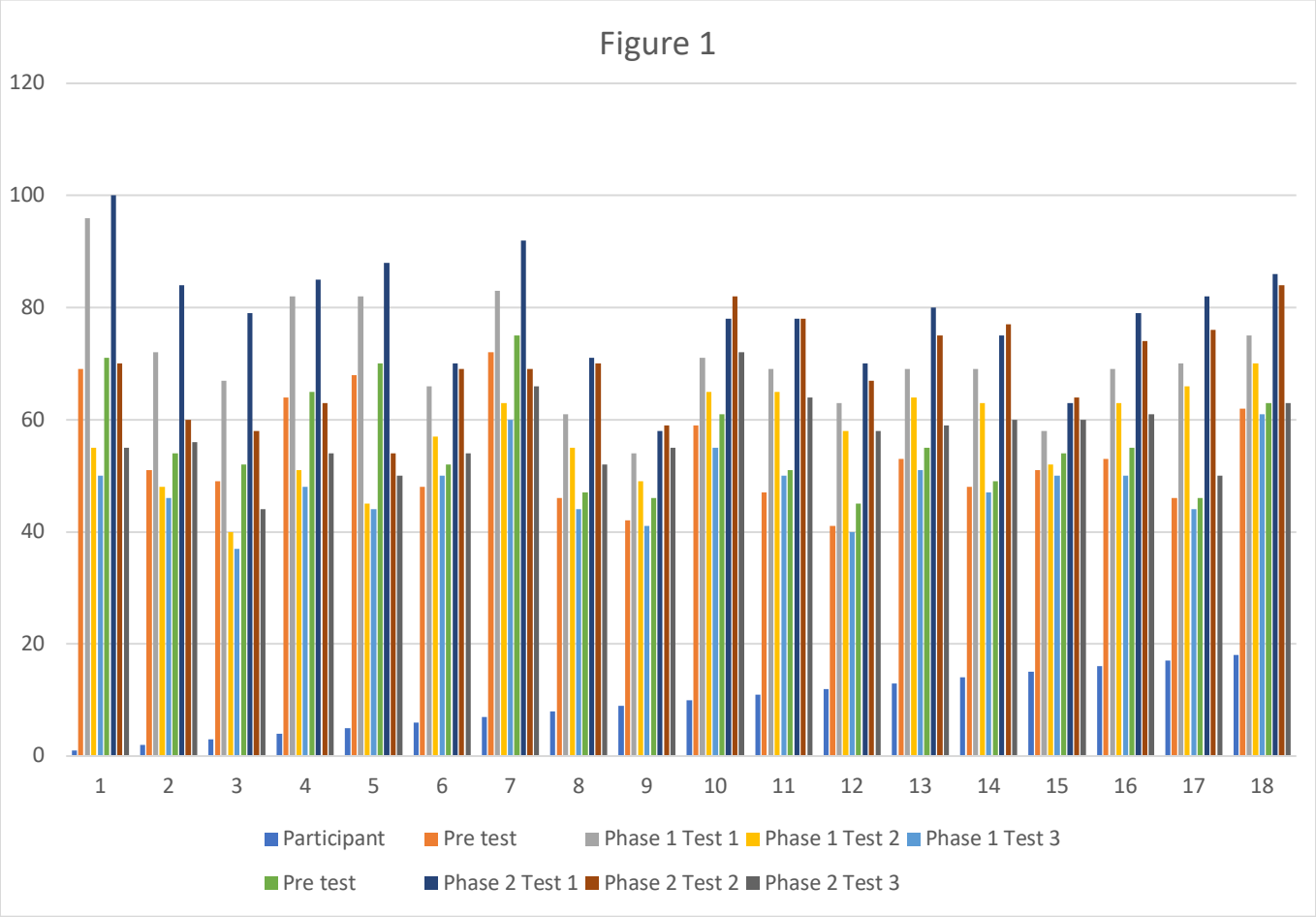



*Figure 1.* Participant scores during Phase One and Phase Two.

Figure 2 below shows the comparative scores between weeks 1, Phase One and Phase Two. Participants who participated in traditional subtraction math facts during Phase 1 did not

perform as high as the participants who participated in digital subtraction math facts during Phase 2. The mean of Phase One, week one test was 70.89. The mean of Phase Two, week one test was 78.78. Figure 2 shows an average increased score of 7.89 during Phase Two. Participant 1 had the highest score, which went from 96 in phase one to 100 in phase two. Participant 9 had the lowest score which went from 54 in phase one to 58 in phase two. On the test given at the end of these weeks, participants had to answer 100 simple subtraction problems using facts 1-18 in a 5-minute time frame. The average number of problems increased from Phase One to Phase Two during week one was 7.89.

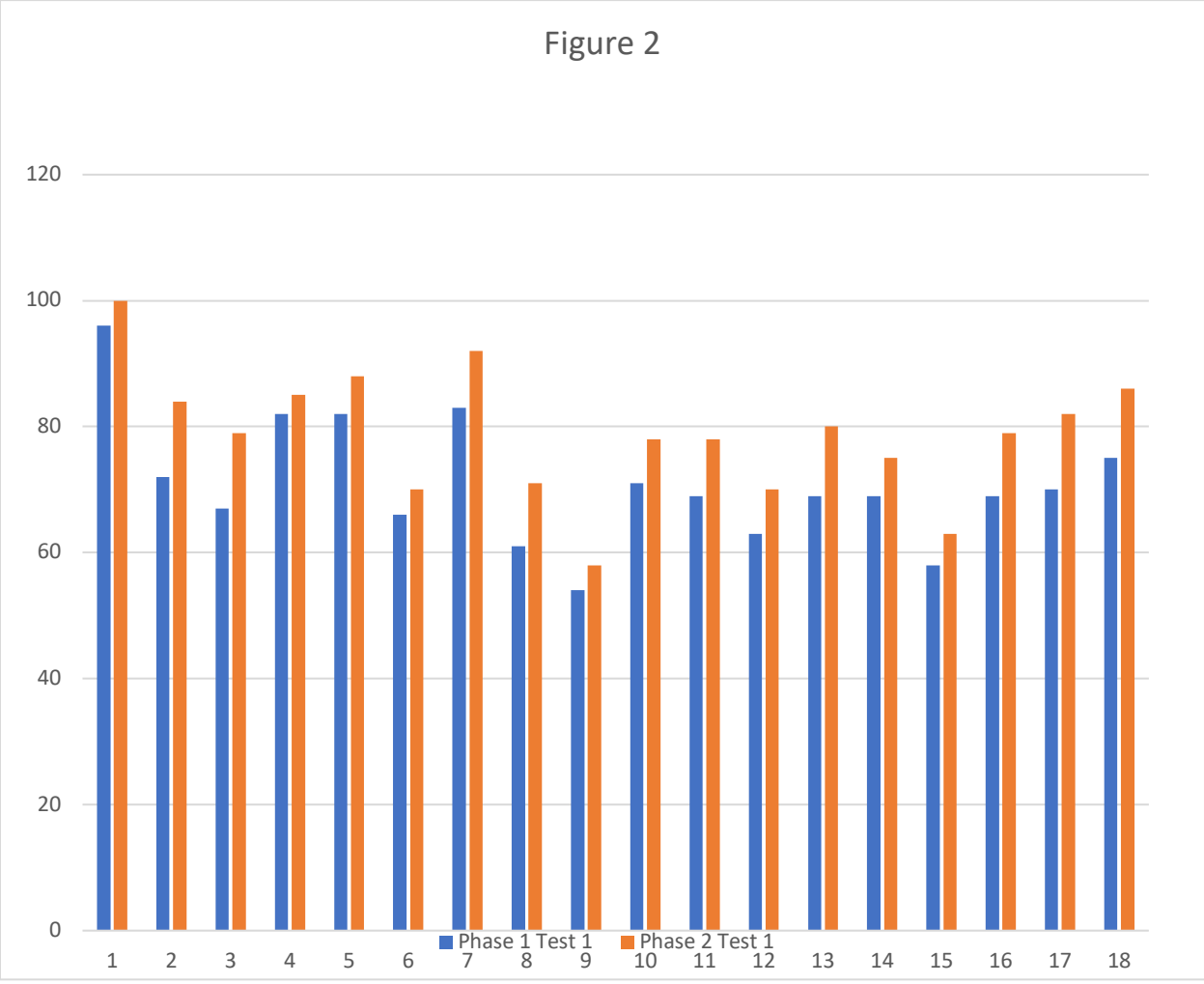



*Figure 2.* Participant scores after week 1 in Phase One and Phase Two.

All eighteen participants completed subtraction fact practice traditionally during Phase One, week 2 and digitally during Phase Two, week 2. The test given at the end of week 2 focused on subtraction with double digits. Participant 3 had the lowest score in Phase One which was 40, but participant 5 had the lowest score in phase 2 which was 54. The highest score was from participant 18 in both phases. Participant 18 had a score of 70 in Phase One and 84 in Phase Two. Below, Figure 3 shows participant scores from Phase One test 2 and Phase Two test 2. The mean during Phase One, week two was 57.17. The mean during Phase Two, week two was 69.39. Figure 2 shows an average increased score of 12.22 during Phase Two.

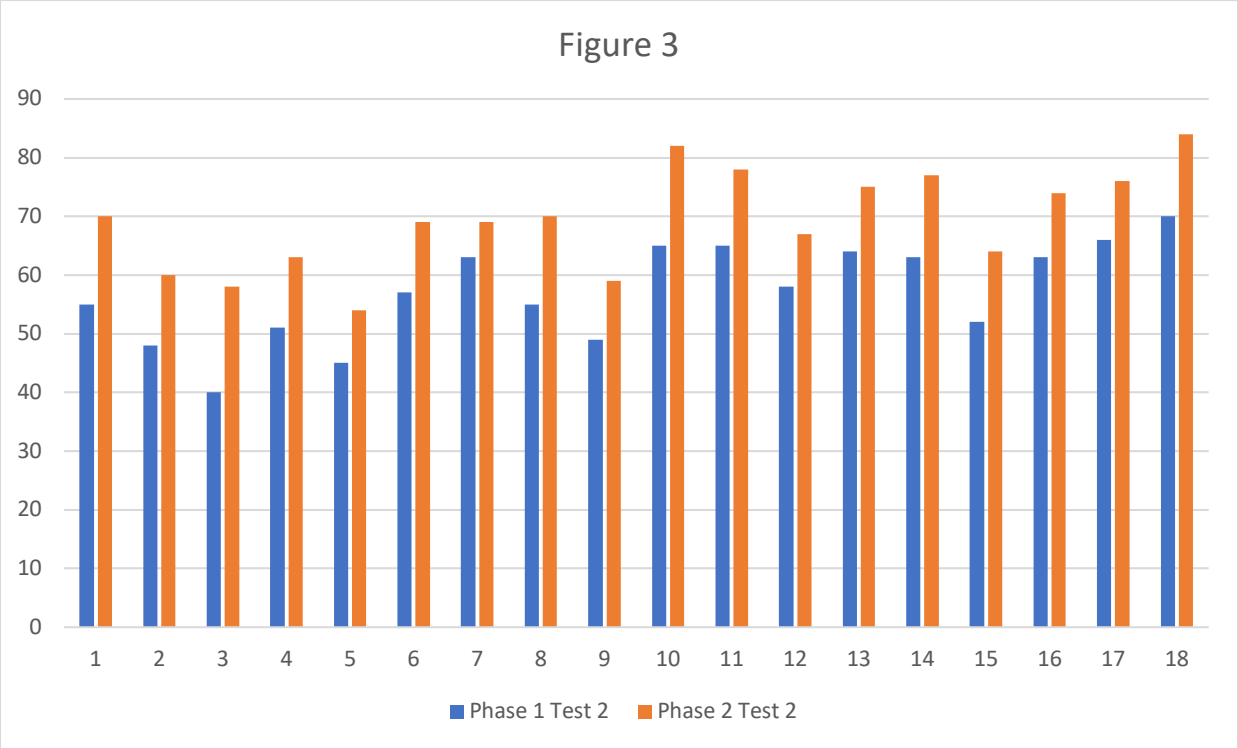



*Figure 3.* Participant scores during phase 1, week 2 and phase 2, week 2.

During the final weeks of both phases, participants continued practicing subtraction facts only using traditional methods during Phase One and only using digital methods during Phase Two. The test at the end of Phase One, week 3 and Phase Two, week 3 was the most challenging

test. So, overall scores were the lowest during these weeks. Participants were given 100 double-digit subtraction facts with some of the facts using the borrowing technique. The highest participant score was participant 18 during Phase One with a score of 61, but participant 10 had the highest score during Phase Two with a score of 72. The lowest score was from participant 3 with a score of 37 during Phase One and a score of 44 during Phase Two. Figure 4 shows participant scores from Phase One test 3 and Phase Two test 3. The mean was 48.22 for Phase One, week 3, and the mean for Phase Two, week three was 57.39. Figure 4 shows an average increased score of 9.17 during week three of Phase Two.

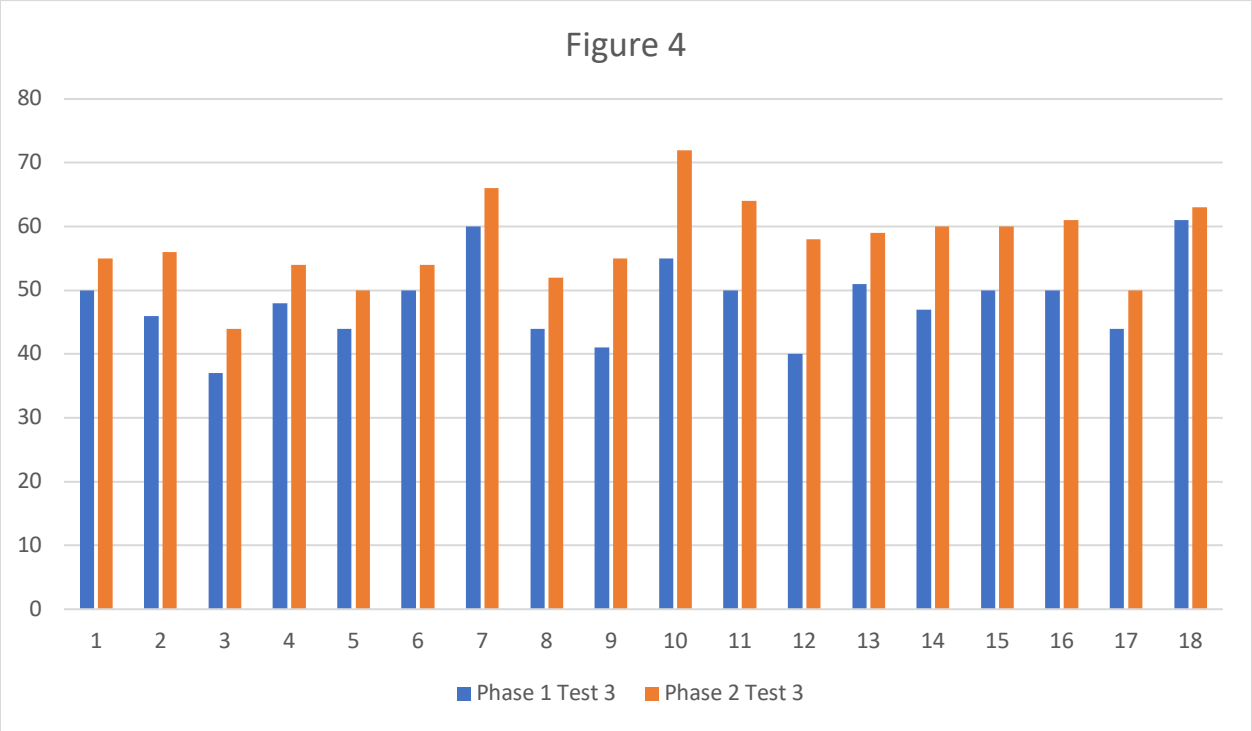



*Figure 4.* Participant scores during phase 1, week 3 and phase 2, week 3.

**Research Question Two: Which methods of memorizing subtraction math facts; digitally or traditionally, help second-grade students better learn subtraction?**

The overall results show that participants achieved higher scores after practicing math facts using online websites instead of traditional methods, such as flash cards, wrap ups, and card games. Table 3 below shows the mean and differences from each phase overall. The overall mean during Phase One, when students practiced subtraction facts using only traditional methods was 58.75. Additionally, Table 3 shows the mean of all scores during Phase Two of technology interventions was 68.51. There was an overall difference between the average scores in Phase One and the average scores in Phase Two of -9.76. This is a significant change between the two phases showing that second-grade students were able to better learn subtraction after three weeks of digital subtraction interventions. During these last three weeks of the study, when second-grade students improved their scores, they practiced subtraction facts using technology gaming sites and digital practices.

Table 3.

*Phase 1 and Phase 2 mean and difference*

| Phase | Mean |
|---|---|
| Phase 1 | 58.75 |
| Phase 2 | 68.51 |
| Overall Difference | -9.76 |

# Findings, Implications, Limitations

## Findings

The findings of this study were that using technology helps students achieve higher subtraction math scores. In the past, it has been proven that students are more motivated and enjoy learning more when technology is involved. The findings from this study inform educators on what works best for second-grade students: the strategy of digital math fact practice. Based on the data collected during this study, subtraction math fact scores will increase after practicing the facts digitally over practicing the facts using traditional interventions. The purpose of this study was to investigate if using technology would help students achieve higher subtraction math scores. The study concluded that during each week of using technology to practice subtraction math facts, participants achieved higher scores compared to the weeks where traditional methods were used. Overall, phase 2 of this study had a better outcome of student scores on subtraction math tests.

## Implications

Teachers are always looking to find ways to better motivate their students. The results of this study show that using technology as motivation can help students perform at a higher level. The study results indicate that the students improved their scores after their three weeks of using technology as interventions. These indications show that students were more motivated, or that using the gaming technique resulted in higher scores overall and each week individually. The students had higher mean scores during phase two of the study. Just by simply practicing subtraction in the classroom daily, participants' scores did have a significant increase. Providing a motivating and engaging learning environment indicated that students would achieve and perform at a higher level.

### Limitations

One limitation of this study was that only one class was researched. Eighteen participants are an overall small number to use when completing research. A larger sample of students, such as the whole second-grade group of 78 students would have provided more in-depth research and better numbers for comparing. More reliable results could come from multiple classes and multiple teachers. To receive even more reliable data, this study could have been completed using a younger grade such as kindergarten, since subtraction would be a brand-new concept for kindergarten aged students. To determine if technology increased scores in math overall, the study also could have conducted research among multiple avenues of math concepts such as addition, subtraction, multiplication, and division.

## Reflection and Action Plan

### Reflection

Student performance has been proven repeatedly to increase when technology is involved. Students currently often rely on technology. Technology increases student motivation and student engagement. Playing games as an intervention provides students with the opportunity to have fun while they're learning. The site Xtra math was one website that challenged students to complete their math facts quickly and race the teacher. Student scores increased day after day, and they were able to digitally see this using the different websites. When conducting this study, the researcher was able to show that participant scores increased after digital interventions took place.

Despite the fact that only 18 participants were in this study, the researcher feels comfortable that even with more participants involved, technology would still prove to increase

scores. Scores were increased due to student motivation and student engagement being higher when technology is involved.

**Action Plan**

The researcher plans to implement technology as part of the daily math practice in the classroom. Daily math fact practice is imbedded in the second-grade curriculum at the school where the research took place. Instead of beginning daily subtraction fact practice using flash cards and wrap ups, technology will be implemented from day one. The researcher will also share the findings to the other grade levels to implement technology in more than just one classroom. The data and findings of the study will be shown using Power Point slides and a poster.

The researcher suggests that more research be done on whether technology improves subtraction math automaticity among second-grade students. To collect more reliable data, the researcher suggests a larger participant sample, multiple grade levels, multiple math concepts, and possibly a longer time frame. In the meantime, the researcher will implement technology strategies into the classroom in place of daily printed strategies to increase math fact fluency.

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**Appendix A**

Pretest

Name _____

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 58 - 32 | 88 - 53 | 87 - 25 | 89 - 16 | 48 - 11 | 87 - 10 | 93 - 10 | 96 - 13 | 76 - 11 | 87 - 34 |
| 88 - 60 | 68 - 15 | 98 - 14 | 78 - 26 | 61 - 11 | 88 - 51 | 98 - 15 | 79 - 13 | 79 - 11 | 96 - 10 |
| 88 - 77 | 86 - 65 | 72 - 22 | 38 - 10 | 59 - 27 | 73 - 13 | 83 - 41 | 89 - 25 | 46 - 32 | 59 - 25 |
| 8 - 8 | 11 - 5 | 4 - 3 | 4 - 4 | 11 - 1 | 11 - 5 | 18 - 6 | 15 - 3 | 16 - 15 | 16 - 10 |
| 14 - 8 | 9 - 9 | 3 - 0 | 17 - 6 | 12 - 0 | 18 - 15 | 10 - 6 | 5 - 5 | 2 - 2 | 17 - 3 |
| 18 - 14 | 16 - 0 | 12 - 9 | 12 - 12 | 11 - 5 | 10 - 6 | 18 - 6 | 10 - 8 | 10 - 7 | 18 - 10 |
| 86 - 16 | 38 - 31 | 47 - 21 | 60 - 7 | 82 - 60 | 48 - 9 | 96 - 38 | 55 - 39 | 94 - 41 | 92 - 85 |
| 97 - 6 | 77 - 42 | 63 - 6 | 78 - 77 | 62 - 53 | 83 - 76 | 8 - 4 | 40 - 35 | 88 - 77 | 55 - 23 |
| 26 - 19 | 44 - 39 | 72 - 13 | 55 - 32 | 80 - 8 | 53 - 38 | 15 - 6 | 70 - 43 | 84 - 44 | 77 - 47 |
| 22 - 21 | 59 - 14 | 62 - 24 | 86 - 6 | 64 - 63 | 99 - 65 | 76 - 15 | 43 - 43 | 74 - 64 | 93 - 57 |

## Appendix B

Name: _____

Date: _____

Score: _____

test #1

Math Worksheet

Math Fact Cafe™



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8 − 8 = | 11 − 5 = | 4 − 3 = | 4 − 4 = | 11 − 1 = | 11 − 5 = | 18 − 6 = | 15 − 3 = | 16 − 15 = | 16 − 10 = |
| 14 − 8 = | 9 − 9 = | 3 − 0 = | 17 − 6 = | 12 − 0 = | 18 − 15 = | 10 − 6 = | 5 − 5 = | 2 − 2 = | 17 − 3 = |
| 18 − 14 = | 16 − 0 = | 12 − 9 = | 12 − 12 = | 11 − 5 = | 10 − 6 = | 18 − 6 = | 10 − 8 = | 10 − 7 = | 18 − 10 = |
| 13 − 2 = | 18 − 16 = | 17 − 1 = | 13 − 9 = | 12 − 5 = | 13 − 5 = | 17 − 13 = | 5 − 4 = | 12 − 6 = | 1 − 1 = |
| 12 − 11 = | 3 − 3 = | 15 − 11 = | 2 − 1 = | 11 − 5 = | 17 − 7 = | 18 − 10 = | 17 − 6 = | 15 − 3 = | 17 − 8 = |
| 11 − 2 = | 15 − 12 = | 5 − 2 = | 16 − 4 = | 12 − 7 = | 13 − 11 = | 9 − 5 = | 16 − 1 = | 17 − 11 = | 17 − 15 = |
| 4 − 1 = | 18 − 18 = | 6 − 3 = | 16 − 3 = | 7 − 6 = | 9 − 4 = | 11 − 1 = | 15 − 11 = | 9 − 1 = | 18 − 7 = |
| 18 − 18 = | 10 − 7 = | 17 − 7 = | 17 − 16 = | 18 − 1 = | 14 − 7 = | 12 − 1 = | 14 − 14 = | 11 − 10 = | 15 − 14 = |
| 1 − 0 = | 7 − 6 = | 16 − 14 = | 10 − 4 = | 5 − 3 = | 8 − 7 = | 13 − 2 = | 10 − 6 = | 15 − 1 = | 10 − 7 = |
| 2 − 1 = | 13 − 8 = | 16 − 8 = | 14 − 9 = | 4 − 4 = | 11 − 2 = | 11 − 4 = | 16 − 1 = | 12 − 12 = | 18 − 12 = |

**Appendix C**

Name Test #2

Two-Digit Subtraction; No Regrouping (A)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 99 - 10 | 88 - 10 | 47 - 10 | 69 - 13 | 77 - 50 | 67 - 11 | 97 - 12 | 62 - 31 | 79 - 36 | 95 - 15 |
| 89 - 64 | 83 - 42 | 79 - 61 | 89 - 10 | 99 - 40 | 59 - 13 | 84 - 11 | 94 - 12 | 68 - 21 | 89 - 43 |
| 77 - 10 | 96 - 31 | 78 - 54 | 34 - 20 | 77 - 51 | 77 - 13 | 76 - 14 | 57 - 12 | 58 - 10 | 78 - 57 |
| 57 - 30 | 89 - 20 | 68 - 14 | 67 - 47 | 96 - 14 | 39 - 20 | 75 - 33 | 59 - 38 | 95 - 11 | 57 - 22 |
| 58 - 32 | 88 - 53 | 87 - 25 | 89 - 16 | 48 - 11 | 87 - 10 | 93 - 10 | 96 - 13 | 76 - 11 | 87 - 34 |
| 88 - 60 | 68 - 15 | 98 - 14 | 78 - 26 | 61 - 11 | 88 - 51 | 98 - 15 | 79 - 13 | 79 - 11 | 96 - 10 |
| 88 - 77 | 86 - 65 | 72 - 22 | 38 - 10 | 59 - 27 | 73 - 13 | 83 - 41 | 89 - 25 | 46 - 32 | 59 - 25 |
| 88 - 20 | 98 - 13 | 69 - 20 | 65 - 23 | 77 - 10 | 84 - 20 | 77 - 16 | 29 - 16 | 78 - 11 | 76 - 61 |
| 83 - 11 | 99 - 10 | 79 - 15 | 86 - 71 | 58 - 15 | 89 - 40 | 87 - 60 | 95 - 25 | 79 - 12 | 99 - 10 |
| 75 - 14 | 97 - 11 | 89 - 15 | 83 - 13 | 59 - 20 | 56 - 32 | 85 - 20 | 83 - 33 | 97 - 21 | 89 - 38 |

## Appendix D

Name: _____

Date: _____

Score: _____

Test #3

Math Worksheet



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 60 - 31 | 21 - 16 | 58 - 5 | 61 - 29 | 99 - 35 | 81 - 20 | 85 - 79 | 86 - 53 | 76 - 42 | 48 - 48 |
| 19 - 4 | 92 - 34 | 65 - 3 | 96 - 79 | 56 - 36 | 28 - 26 | 90 - 20 | 97 - 77 | 88 - 4 | 64 - 48 |
| 66 - 66 | 61 - 30 | 54 - 31 | 99 - 33 | 54 - 46 | 54 - 39 | 97 - 52 | 73 - 11 | 96 - 86 | 91 - 10 |
| 90 - 6 | 68 - 48 | 64 - 31 | 70 - 26 | 94 - 72 | 29 - 26 | 63 - 35 | 67 - 59 | 19 - 16 | 81 - 61 |
| 11 - 9 | 62 - 26 | 92 - 40 | 99 - 57 | 92 - 33 | 80 - 18 | 92 - 42 | 58 - 13 | 84 - 64 | 27 - 11 |
| 86 - 24 | 67 - 40 | 71 - 62 | 51 - 31 | 86 - 8 | 93 - 59 | 93 - 82 | 24 - 5 | 95 - 95 | 32 - 18 |
| 86 - 16 | 38 - 31 | 47 - 21 | 60 - 7 | 82 - 60 | 48 - 9 | 96 - 38 | 55 - 39 | 94 - 41 | 92 - 85 |
| 97 - 6 | 77 - 42 | 63 - 6 | 78 - 77 | 62 - 53 | 83 - 76 | 8 - 4 | 40 - 35 | 88 - 77 | 55 - 23 |
| 26 - 19 | 44 - 39 | 72 - 13 | 55 - 32 | 80 - 8 | 53 - 38 | 15 - 6 | 70 - 43 | 84 - 44 | 77 - 47 |
| 22 - 21 | 59 - 14 | 62 - 24 | 86 - 6 | 64 - 63 | 99 - 65 | 76 - 15 | 43 - 43 | 74 - 64 | 93 - 57 |

## Appendix E

January 27, 2020

Randi Yager
Sham'ah Md-Yunus
Teaching Learning and Foundations

Dear Randi,

Thank you for submitting the research protocol titled, "Digital Versus Traditional Methods of Teaching Mathematics: What Works Best for Second Grade Students" for review by the Eastern Illinois University Institutional Review Board (IRB). The IRB has reviewed this research protocol and effective 1/27/2020, has certified this protocol meets the federal regulations exemption criteria for human subjects research. The protocol has been given the IRB number 20-013. You are approved to proceed with your study.

The classification of this protocol as exempt is valid only for the research activities and subjects described in the above named protocol. IRB policy requires that any proposed changes to this protocol must be reported to, and approved by, the IRB before being implemented. You are also required to inform the IRB immediately of any problems encountered that could adversely affect the health or welfare of the subjects in this study. Please contact me, or the Compliance Coordinator at 581-8576, in the event of an emergency. All correspondence should be sent to:

Institutional Review Board
c/o Office of Research and Sponsored Programs
Telephone: 217-581-8576
Fax: 217-581-7181
Email: eiuirb@www.eiu.edu

Thank you for your cooperation, and the best of success with your research.

John Bickford, Chairperson
Institutional Review Board
Telephone: 217-581-7881
Email: jbickford@eiu.edu

**Appendix F**

# Teutopolis Community Grade School

309 E Main Street * Teutopolis, IL 62467 * (217) 857-3232

January 23, 2020

Dear Institutional Review Board Members,

As principal of Teutopolis Grade School, I approve the appropriateness of Mrs. Randi Yager's project study titled *Digital Versus Traditional Methods of Mathematics: What Works Best for Second-Grade Students*. Mrs. Yager discussed the components of the study as well as the expected outcomes. I understand that the curriculum for her second-grade students will not be altered. The project is age appropriate for her second-grade students. Conducting the project at Teutopolis Grade School is very feasible and should be completed by the end of the semester. If you have any questions, please contact me.

Sincerely,

Angela Sheehan
Teutopolis Grade School Principal

## Appendix G

Parent Notification

Dear Parents/Guardians:

As part of my graduate work in Curriculum and Instruction at Eastern Illinois University, I am conducting an Action Research project in my classroom this semester. This research project is a requirement to fulfill my master's degree course work.

I will be conducting a study that will assess students by using a 100 subtraction math fact test. I will be implementing both digital and traditional practice methods for fifteen minutes a day, 3 days a week, for 6 weeks. The results gathered from this study will be used for the purpose of this project.

All data will remain confidential, and the outcomes of the study will be presented in a way that does not identify any information about a child. As parents or guardians, you have the option to exclude your child from the study. Please contact me if that is the case.

I have been granted approval by the school to conduct this research project in my classroom. If you have any questions or concerns about this project, please feel free to contact me at any time.

Thank you,

Randi Yager

Teutopolis Grade School

yagerr@ttown.k12.il.us