Examining the Impact of Frustration Levels on Multiplication Automaticity

Jessica Hanna

Eastern Illinois University

Abstract

The purpose of this action research was to examine the effectiveness of the Rocket Math program when working to develop multiplication automaticity with third grade students. Additionally, the study also examined which intervention, the Rocket Math app or paper and pencil, produced greater gains and how student frustration levels correlate to performance. A total of 18 third grade students were participants in this four-week study. A pretest and posttest was used to establish a baseline and measure student growth during the study. Participants used the Rocket Math app and Rocket Math practice sheets throughout the study to practice multiplication facts. A student questionnaire was also used to measure and monitor student frustration levels. It was concluded that Rocket Math does help students to improve multiplication automaticity. The study also determined that 89% of participants who used the Rocket Math app produced greater gains and experienced fewer frustrations than students who used paper and pencil to develop multiplication automaticity.

Keywords: Rocket Math, Rocket Math app, multiplication automaticity, mathematics, technology, paper and pencil

Examining the Impact of Frustration Levels on Multiplication Automaticity

Timed math tests have been used by elementary school teachers for many years. Most people can remember the rush that was felt before the teacher said, *Go*! Students moved their hands as fast as possible and tried to remember all those facts that the teacher had taught. That one-minute seemed to fly by so quickly and then the test was over. It was nerve-wrecking and exciting all at the same time. Some tests were frustrating while others left a feeling of accomplishment.

In my own classroom teaching and retaining multiplication facts has always been a struggle. Each year my students are moved onto fourth grade, and each year I am asked if I even taught multiplication to my students the previous year. The question leaves me frustrated and agitated because I dedicate a great amount of time to learning and mastering multiplication facts. However, it still seems like learning and mastering these facts is a constant struggle for my students.

In this study, I worked to determine if there are any emotional factors that impact students' ability to learn and master multiplication facts. The study targeted my third grade classroom. Participants used Rocket Math (2009-2015) to practice their multiplication facts. Some participants used paper and pencil to practice and other participants used the Rocket Math app (2015), which is a software program or application that is designed for a specific purpose. In this study the purpose of the app is to practice multiplication facts. Participants participated in timed tests and questionnaires throughout the study. The research was guided by three questions. Does Rocket Math appear to help participants develop multiplication automaticity? Are there greater gains achieved by participants who practice on the app or with paper and pencil? Are

participant's frustrations or engagement more noticeable when they are doing one method versus the other? This study focused on the above questions in order to discover how to aid students in developing multiplication automaticity.

Literature Review

Timed math tests have been used by teachers for many years in order to help students achieve fact fluency in mathematics. In the past, flashcards and worksheets have consistently been used to help students practice, learn, and eventually master facts. However, technology is changing the ways in which teachers and students approach mastering these facts (Musti-Rao, Lynch, & Plati, 2015). Today, there are applications and website based programs that allow students to practice and master facts through engaging games and resources. Many students are engaged by these technological applications, yet teachers are unaware of their efficacy (Linnell, 2004). Furthermore, state and national initiatives have changed how students learn and master math facts. The Common Core State Standards Initiative (CCSS) (National Governors Association Center for Best Practices & Council of Chief State School [NGA & CCSS], 2010) and the Partnership for Assessment of Readiness for College and Careers (PARCC, 2012) have contributed to many of these technological and mathematical changes.

State Standards and Assessments

Today, school curricula and assessments are commonly aligned with the new state and national initiatives. In order to prepare students for state assessments, teachers must be knowledgeable with the CCSS and PARCC. By using this knowledge, teachers can prepare lessons and units for instruction that will allow students to master the necessary skills they need at that particular grade level.

Common Core State Standards. The CCSS outline expectations that have been set for students in mathematics (NGA & CCSS, 2010). The CCSS list standards that students should practice and master by the end of each grade level. The CCSS challenge children and take into consideration children's learning progressions over time (Otten & De Araujo, 2015). The intent of CCSS is for students to graduate from high school with the skills and knowledge necessary to be successful in college and careers (NGA & CCSS, 2010).

The CCSS are intended to guide teachers' instruction in mathematics. The CCSS include Standards for Mathematical Practice (SMPs), or mathematical ways of thinking. The shift to the CCSS offers students high quality mathematics instruction that will aid them in their future education or career (Gaddy, Harmon, Barlow, Milligan, & Huang, 2014). However, the SMPs have caused debate over the CCSS (Otten & De Araujo, 2015). There are arguments made that a disconnect is present between older generations and today's present students, meaning that parent's math expectations for their children may vary from what the CCSS requires of them (Otten & De Araujo, 2015). Older generations learned math in more traditional ways, focusing on speed and correctness, but the CCSS emphasize the importance of reasoning and understanding (Otten & De Araujo, 2015). Those in support of the CCSS believe that the standards will create focused, coherent, and rigorous curricula (Gaddy et al., 2014).

The CCSS state that students in third grade should understand the relationship between multiplication and division. More specifically, students need to know single digit products from memory (NGS & CCSS, 2010). If students do not achieve multiplication fact fluency, then they will spend more time focusing on solving simple

multiplication problems rather than learning more meaningful, advanced applications (Wallace & Gurganus, 2005). The implementation of the CCSS allows teachers to prepare students for state assessments, such as PARCC.

Partnership for Assessment of Readiness for College and Career. Recently, the state of Illinois adopted PARCC to test students in mathematics (PARCC, 2012). PARCC is used to evaluate students and educators on their performance of standards met throughout the year. When implemented properly, PARCC and CCSS allow educators to provide students with the mathematical education that is needed to be college and career ready.

Math Pedagogy

Multiplication is a mathematical skill that all students need to acquire in order to participate in higher-level mathematical problems, and master math skills that are crucial to success. Multiplication is taught to students at a young age and built on throughout the rest of their mathematical education. In the past, timed paper and pencil tests were used in order to enhance multiplication fluency. However, technology, new multiplication programs, and the CCSS have changed the ways in which students learn multiplication facts.

Multiplication. Multiplication is a mathematical skill that is introduced to students at grade three. Researchers are still working to discover the best and most effective ways to develop multiplication facts fluently. Multiplying with fluency incorporates noticing relationships between numbers and using strategies to solve problems (Kling & Bay-Williams, 2015). One researcher explores the concept of teaching multiplication facts through strategies stating that specific recommendations for

multiplication strategies vary significantly due to the nature of students' learning (Woodward, 2006). The basic rules of multiplication, such as the commutative property, should be taught to students in order for students to see and recognize patterns in multiplication (Woodward, 2006). The focus should not be on memorizing facts, but rather on truly understanding how to solve multiplication problems (Heege, 1985). Teachers should reconsider the focus of memorizing math facts and enforce the importance of understanding multiplication. For example, a typical math practice strategy that teachers use in the classroom is timed-test, where students are given a certain amount of minutes to complete a set number of problems. Research argues that timed practice drills do not assess for understanding but simply teach students to recall a math fact without needing to understand the mathematical concept (Burns, 1995).

The use of timed tests can cause math anxiety for students (Boaler, 2014). Many teachers still turn to the use of timed tests to help students improve multiplication automaticity; however, these tests leave students feeling anxious and frustrated with their math abilities (Boaler, 2014). Many districts believe that timed tests are the best, most efficient, and easiest way for students to develop automaticity. Researchers believe that timed tests leave students with negative feelings and opinions towards learning math, which in turn can impact their future mathematical education (Boaler, 2014). Instead of using timed tests, other methods of learning and mastering multiplication facts should be used and considered for instruction.

In order to develop multiplication fluently, three steps need to be taken: understand fluency, integrate sequencing and developing strategies, and create meaningful practice (Kling & Bay-Williams, 2015). First, it must be understood that

fluency cannot be developed through rote memorization. Students must participate in explicit reasoning strategies that allow students to learn and master facts, as well as develop strategies to recall forgotten facts (Kling & Bay-Williams, 2015). After an understanding of fluency has been developed, students should first learn the multiples of 1, 2, 5, 10, and squares. The rest of the facts should be introduced after the foundational facts have been learned (Kling & Bay-Williams, 2015). Various strategies and properties of multiplication should be used to teach these facts to students (Kling & Bay-Williams, 2015). Lastly, students should be exposed to meaningful practice with multiplication facts, such as games that are engaging and promote problem solving, thinking, and reasoning (Kling & Bay-Williams, 2015).

Educators should work to integrate explicit strategy instruction, or strategies that will lead to understanding of multiplication, and timed practice drills into their curriculum in order to change how multiplication is being taught to students (Woodward, 2006). Teachers should teach facts explicitly and with concrete examples (Wallace & Gurganus, 2005). These strategies can be visual aids, class discussions, arrays, or number lines (Woodward, 2006). Strategy instruction alone will not lead to fluency; therefore, the use of timed practice drills is essential in order for fluency to be achieved (Woodward, 2006). While there are several ways to practice math, new technologies are being implemented into math classrooms in order to improve students' learning.

Technology. The role of technology in the classroom has increased over the last several years. Technology has impacted the ways in which teachers present math instruction to students. When using technology in the mathematics classroom, the teacher must ensure that the technology being used is age appropriate for students

(Linnell, 2004). Students should be able to developmentally and physically use the technology, program, or app that is being used (Linnell, 2004).

Apps have been developed to help students achieve multiplication fact fluency. The Math Drills app allowed students the opportunity to practice multiplication facts and work to achieve automaticity (Musti-Rao et al., 2015). Research has shown that math apps are helpful to support math instruction and math apps helps improve students' performance on multiplication fact fluency (Musti-Rao et al., 2015).

When choosing whether or not to use technology to support math instruction, teachers must consider the advantages and disadvantages that are associated with technology in the mathematics classroom. Two advantages are individualized student instruction and a modern way of learning (Askov & Turner, 1990). Technology can individualize learning for students and provide students with the instruction that is needed at their level and pace (Askov & Turner, 1990). Technology can also provide students with a modern way of learning.

As there are many advantages with using technology, there are disadvantages as well. Two major disadvantages of using technology in the mathematics classroom are lack of training and curriculum integration (Askov & Tuner, 1990). School districts often fail to adequately train teachers to use new technologies; therefore, teachers struggle to integrate technology into already existing curriculum effectively (Askov & Turner, 1990). Although integrating technology into a set curriculum poses challenges, teachers must closely examine the curriculum and discover the best and most influential ways to integrate new technologies (Askov & Turner, 1990). The Math Drills app is an example

of the ways in which technology, when implemented effectively, can make learning more enjoyable, thus creating greater understanding (Linnell, 2004).

Rocket Math (2009-2015). Rocket Math is a mathematics program that was created by Don Crawford to increase computational fluency (Smith, Marchand-Martella, & Martella, 2011). Rocket Math provides a sequence for learning multiplication facts that students need to master. Before students can begin using the program, a pretest is given to determine the writing speed of each student (Smith et al., 2011). After the pre-test, students work through 26 different multiplication worksheets, typically taken with paper and pencil and self-timed. These worksheets become increasingly more difficult as students advance (Smith et al., 2011).

Two studies were conducted to assess the effectiveness of Rocket Math. One study worked to improve multiplication fact fluency for fifth grade students (Rave & Golightly, 2014). The other was conducted on a first grade student at risk of failure (Smith et al., 2011). The fifth grade students spent time practicing multiplication facts and participating in a pre-test, bi-weekly tests, and a post-test which were collected and graphed to analyze student progress and the overall effectiveness of the Rocket Math program (Rave & Golightly, 2014). The first grade student participated in fact practice in order to gain fluency (Smith et al., 2011). As a result, the student increased his rate of correct problems per minute from ten to 21 (Smith et al., 2011). The results from both studies concluded that Rocket Math was an effective fluency-building program to help students improve automaticity.

There were a number of limitations that were encountered while research was being conducted in the studies. The first grade case study failed to include an

experimental control, and it only examined one student instead of multiple participants (Smith et al., 2011). More instructors implementing the program should have been included in the study, as well as noting the student's additional math instruction history (Smith et al., 2011). Lack of time, lack of follow-up, and the focus on multiplication facts were all limitations in the other study (Rave & Golightly, 2014). The study should have been conducted over a longer period of time to gain more substantial data, and researchers should have continued to follow up on student progress to determine long-term retention of facts (Rave & Golightly, 2014). Both studies concluded that Rocket Math was effective to use, but both only focused on one mathematical operation. Rocket Math can be used to develop automaticity in addition, subtraction, multiplication, and division (Rave & Golightly, 2014). In order to truly assess the quality of the Rocket Math program, the studies should have tracked and included student progress in all four mathematical operations. Rocket Math has a plethora of benefits; however, paper and pencil also leads to learning math facts fluently.

Paper and pencil. While new technologies provide engaging learning opportunities for students, some still prefer to primarily use paper and pencil. One study compares results in math fact fluency gains from using a computer-based program to paper and pencil (Duhon, House, & Stinnett, 2010). The results of the study concluded that gains obtained through paper and pencil practice transferred to the computer performance; however, the computer practice did not result in gains that transferred to paper and pencil performance (Duhon et al., 2010). Another study that compared the use of paper and pencil to that of a computer- based program concluded that the paper and pencil method was more effective because students were less confused on what they were

supposed to do (Landeen & Adams, 1988). Greater gains were made in math fluency and participants experienced fewer frustrations with the paper and pencil method (Landeen & Adams, 1988).

Mastering multiplication facts fluently is essential for students to develop in order to be successful in math instruction as they progress through school. It is the role of educators to provide students with the instruction that they need to develop multiplication automaticity. Although there are multiple methods and strategies that can be used to develop multiplication automaticity, I am going to use Rocket Math to measure students' improvements in multiplication fact fluency, and I will also compare the impact of using technology versus paper and pencil to see which method produces greater gains.

Methods

The study was conducted over a four-week period during the spring of 2016. As the teacher-researcher, I used my own general education classroom as the setting for the study. The following paragraphs describe the purpose, protocol, setting, instruments, procedure, and participants of the study.

Purpose

This research focused on measuring student frustration levels as they participated in multiplication practice tests. These multiplication tests are intended to improve participants' fluency in multiplication. The study worked to determine whether or not participants were more frustrated when using the app or paper and pencil and if that frustration influenced their ability to improve multiplication fluency.

Design Protocol for Curriculum

The participants in this study learned strategies to solve multiplication facts for several months before the study began using their everyday math curriculum. The CCSS require that students in grade three should learn and master multiplication facts by the time they move to fourth grade (NGA & CCSS, 2010). In order to ensure that participants were meeting this standard, this study focused on improving multiplication facts with the use of the Rocket Math program and the Rocket Math app. Participants partook in daily practices and timed tests that were intended to aid learning in the area of multiplication. The study focused on participants' attitudes towards multiplication and the tools that were used to practice multiplication facts.

Setting

The site of this study took place in a small rural town in Illinois. The elementary school in the study has a student population of 425 with the average class size of 19 students (Illinois Report Card, 2014-2015). Of these 425 students enrolled 49% come from a low-income home, and 21% of students have a disability (Illinois Report Card, 2014-2015). Sixteen percent of students are also English Language Learners (ELLs) (Illinois Report Card, 2014-2015). The elementary school consists of students from kindergarten through sixth grade.

Participants

The participants in this study consisted of 18 students, all between the ages of eight and 10. The participants were students in the researcher's general education mathematics classroom, which is taught every week day afternoon for one hour. These participants were purposely selected because the researcher interacts with these

participants on a daily basis. In this study, there were eight females and 10 males. Of the 18 participants, 10 were Caucasian and eight were Hispanic. Four participants were ELLs, and one participant had a math Individualized Education Plan (IEP). This participant was accommodated during this study. The researcher set appropriate skill level goals that were attainable by this participant. This participant took the writing speed test which determined how many numbers that participant should be able to write per minute, and a goal was created. This goal was adjusted throughout the study to better meet the participant's needs. Two other participants had math IEPs previously during the 2015-2016 school year; however, services were dropped but these participants were still closely monitored. Each participant of this study was given a number/letter identification code, such as B1, B2, G3, G4.

Instruments

This study used several instruments: a student questionnaire (Appendix A), Rocket Math practice sheets and weekly timed tests (Appendix B), and a Rocket Math pre-test, post-test, and writing test (Appendix C). Appendix A, entitled *Student Questionnaire*, was given to students once a week, typically on Friday, to gauge students' feelings and frustration levels. Participants were asked to share what method they used to practice their facts, as well as asked to share any frustrations they encountered. Appendix B, entitled *Rocket Math Practice Sheets and Weekly Timed Tests*, enabled the researcher to collect data daily and weekly on participants' progress with their multiplication facts. The Rocket Math app was also used as another method to practice multiplication facts. The Rocket math practice sheets and app were used throughout the study to practice multiplication facts daily. Appendix C, entitled *Rocket Math Pretest, Posttest, and*

Writing test, were given at the beginning and end of the study by the researcher. The researcher used these instruments to determine and set student goals. They also helped the researcher track and monitor participant progress throughout the study. The use of the above instruments allowed the researcher to collect data on the various components of this study.

Data Collection Procedure

In order to begin research, the researcher gave participants a Rocket Math writing test. This test was used to determine the speed at which participants write. Based on the results, the researcher set individual multiplication goals for each participant. For example, one participant had to complete 25 facts in one minute and another student had to complete 40 multiplication facts in one minute. After setting goals, participants were given a two-minute multiplication pre-test at the beginning of the study. Over the next four weeks, participants participated in multiplication fact practice everyday during mathematics.

Participants were divided into two groups, Group A and Group B. Group A practiced multiplication facts with the use of the Rocket Math app, while Group B practiced multiplication facts using multiplication practice sheets with a partner. The two groups were purposely-selected heterogeneous groups that were created by the researcher. Both groups were composed of four girls and five boys. Each group also had four Hispanic participants and five Caucasian participants, and the ELL participants were split evenly between the two groups. Group B included the participant with the math IEP.

The Rocket Math program was used in both the whole group setting and small group setting, meaning that participants used the program independently and with the aid of the teacher. Each Friday, participants were given a questionnaire asking them what method (app or practice sheets) they used that week. Participants were also asked to express any frustrations they experienced throughout the week when practicing their facts. A one-minute multiplication test was also given every Friday to track participant progress. At the end of the study, participants completed the same two-minute multiplication test that they were given at the beginning of the study to measure growth in multiplication fluency. Each group spent approximately four minutes a day practicing their facts. The weekly schedule for Group A and Group B was as follows.

Table 1.

Group A and B's Multiplication Practice Schedule

Week of Practice	Group A	Group B
One	Rocket Math App	Rocket Math Practice Sheets
Two	Rocket Math App	Rocket Math Practice Sheets
Three	Rocket Math App	Rocket Math Practice Sheets
Four	Rocket Math App	Rocket Math Practice Sheets

Note. Group A used the iPad independently to practice their multiplication facts and Group B practiced their facts using the Rocket Math practice sheets with a partner. Students practiced with different partners each day.

Data Analysis and Results

There were multiple purposes for conducting this research. This research worked to discover whether or not Rocket Math is an effective program to use when helping students to develop multiplication automaticity. The study also looked to determine if greater gains were achieved when using paper and pencil or when using the Rocket Math

app. Participant frustration and engagement levels were also examined throughout the study to see if one method of practice caused more frustration than the other. The participants were placed into two groups, Group A and Group B. Group A used the Rocket Math app to practice multiplication facts, and Group B used paper, pencil, and a partner to practice their facts. All participants were given a pretest at the beginning of the study using paper and pencil (Figure 1).

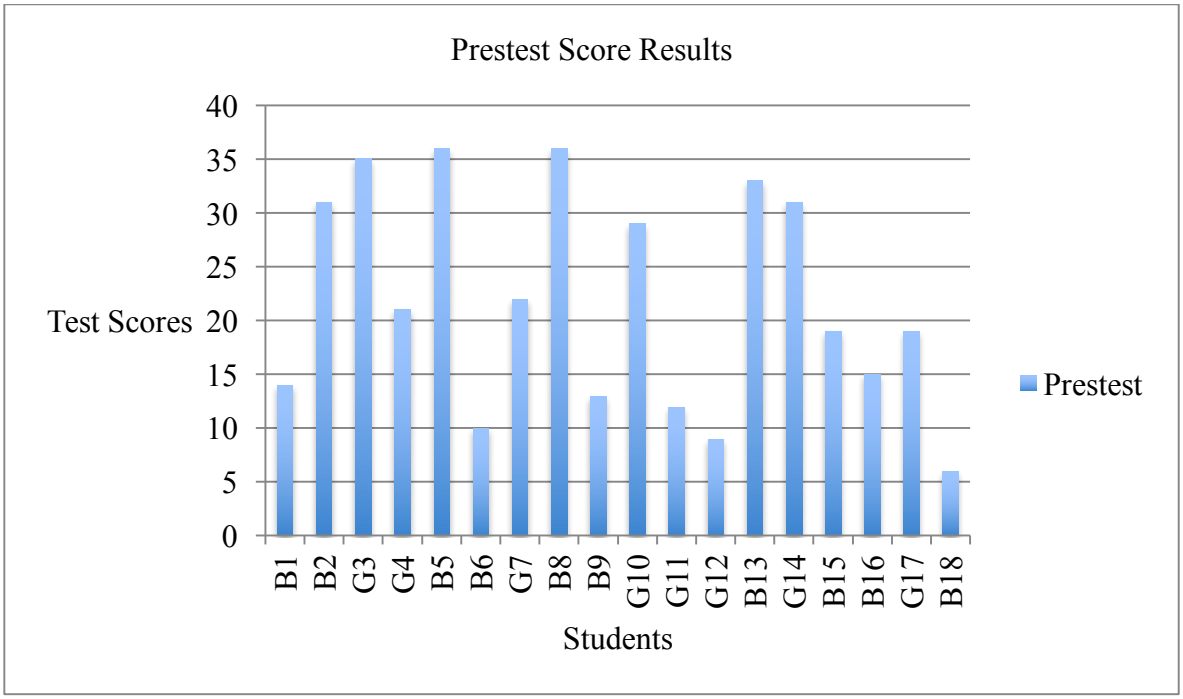

Figure 1. Pretest score results for all participants on two-minute multiplication fact test.

The pretest results set a baseline for the participants in this study. Participants in Group A collectively answered 197 multiplication problems correctly on the initial pretest that was given, and Group B collectively answered 180 multiplication problems correctly on the initial pretest. Participants in Group A averaged a score of 21.8 problems answered correctly in two minutes, and participants in Group B answered an averaged of 20 problems answered correctly in two minutes. The data from the pretest was used to determine whether or not participants made improvements in developing

multiplication automaticity throughout the study. The results for Group A (Figure 2) and Group B (Figure 3) can be seen below.

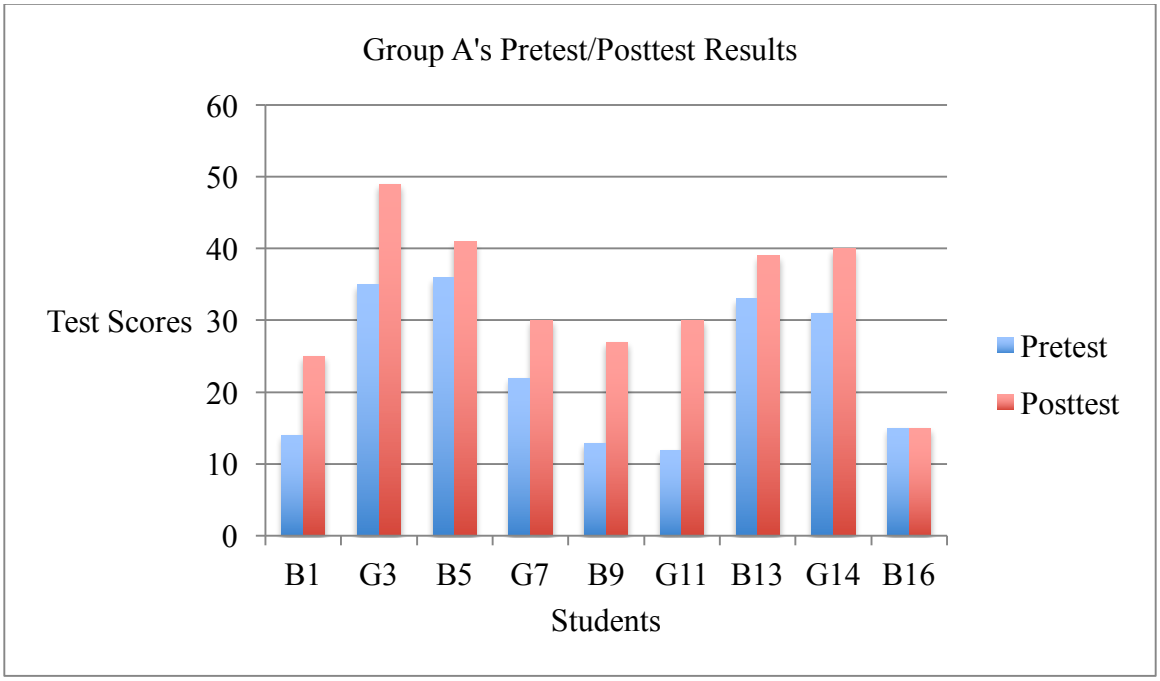

Figure 2. Pretest/Posttest scores for Group A on two-minute multiplication fact test.

All but one of the participants in Group A made improvements from the pretest to the posttest. The participant who did not increase the initial pretest score performed exactly the same on the posttest as the initial pretest. This participant (B16) scored a 15 on the pretest and the posttest, and this participant's pretest score do not improve or change. Group A used the Rocket Math app to practice multiplication facts throughout the course of the study. The data revealed that the app was useful in helping participants learn and develop multiplication facts over the course of the study.

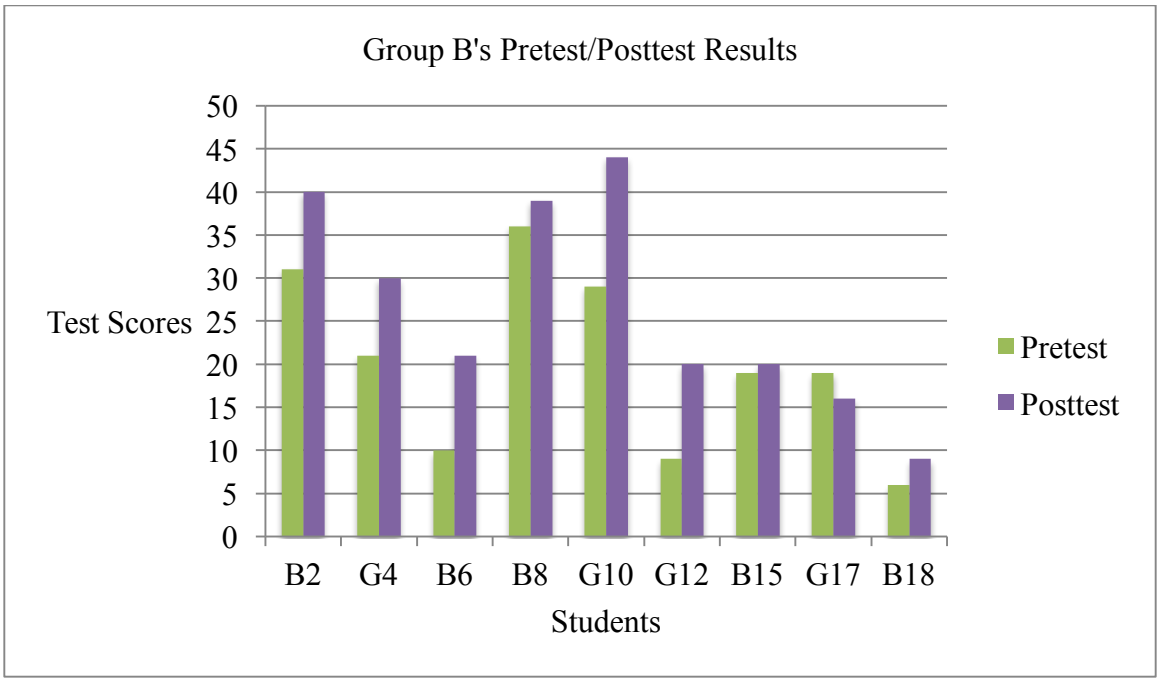

Figure 3. Pretest/Posttest scores for Group B on two-minute multiplication fact test.

Overall, almost all participants improved their scores from the beginning to the end of the study. Of the 18 participants in this study, 16 made improvements from the initial pretest. Eighty-nine percent of participants made an improvement during this study. One participant (B16) had the same score (15) on both the pretest and posttest, and another participant (G17) scored one point lower on the posttest than on the initial pretest. Therefore, five percent of students scored the same on the pretest and posttest, and six percent of students scored lower on the posttest than the pretest. The results of

student growth are displayed below (Figure 4).

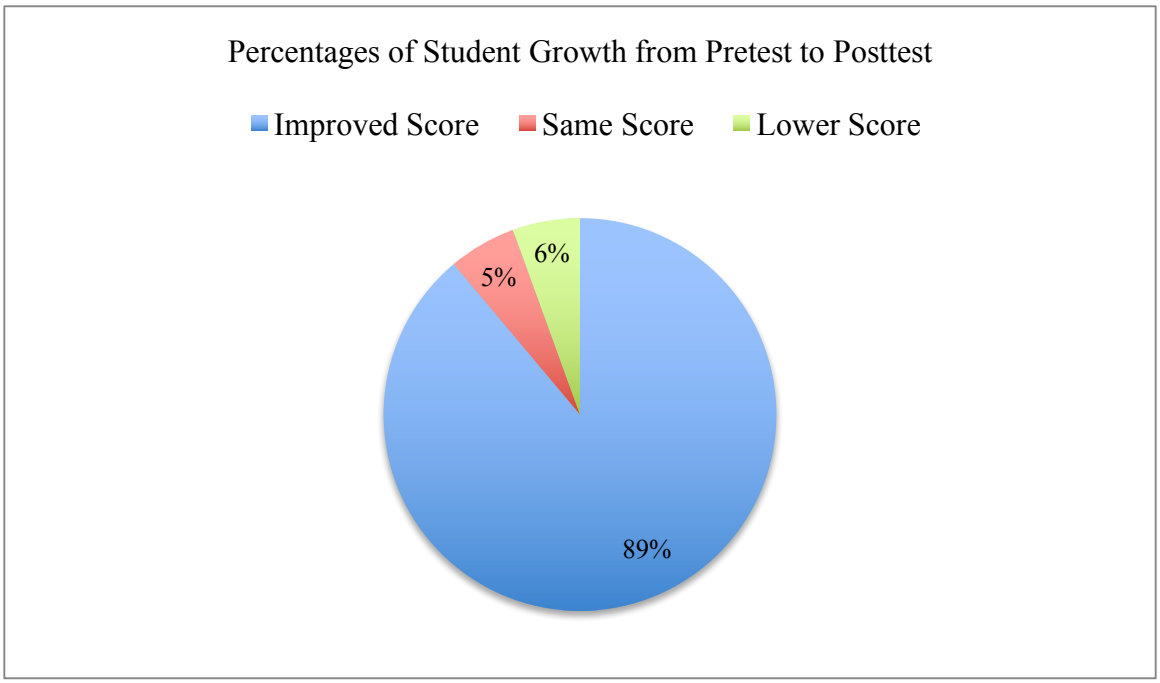

Figure 4. Percentages of participants that scored higher, lower, or the same on the posttest.

From these results, it can be concluded that the use of the Rocket Math program helped participants to develop and improve multiplication automaticity. These results suggested that automaticity programs can be used in the classroom to help students learn and master necessary facts that will continue to be reinforced and used in following grade levels

This study also worked to determine if participants made more gains in multiplication fluency using the Rocket Math app or paper and pencil. Throughout the course of the study, Group A practiced multiplication facts everyday using the Rocket Math app, while Group B practiced multiplication facts using Rocket Math with paper practice sheets, a partner, and a pencil. In order to determine which method produced greater gains, the researcher ran a t-test of participants' scores from the pretest and

posttest for Group A and Group B. Table 2 displays the results that were gathered during the study.

Table 2.

Means and Standard Division Pre and Posttest Scores between Group A and Group B

	Mean		Standard Division	
	Pretest	Posttest	Pretest	Posttest
Group A	23.44	31.77	10.26	10.08
Group B	20.00	26.55	10.47	12.18

Note. p, <0.5

By calculating the mean and the standard deviations, Group A seems to have made more gains than Group B. Table 2 shows that Group A made greater gains while using the Rocket Math app, as opposed to Group B who used the paper and pencil practice sheets. Based on this data, it is suggested that the Rocket Math app produced greater gains in developing multiplication automaticity.

In order to determine whether or not Rocket Math is an effective program to use when working to develop multiplication automaticity, the researcher used a t-test to compare the pretest and posttest scores for both Group A and Group B. The t-test determined that the results of this study were statistically significant with a *p* value of <0.5. In other words, the data collected indicates that the gains made by participants in Group A and Group B were significant, and that both Group A and Group B made improvements from the original pretest that was given at the beginning of the study. The gains that were made by Group A and Group B were both greater than .05, thus suggesting that Rocket Math is an effective program to use when developing

multiplication automaticity. Table 3 displays t-test results from the pretest and posttest for Group A and Group B.

Table 3.

T-tests results for Group A and Group B

	Pretest	Posttest
Group A	6.855	9.454
Group B	5.727	6.537

Note. p, < 0.5

From the t-test it can be determined that both groups made gains that were statistically significant. Group A went from 6.855 to 9.454 (p, <0.5), and Group B went from 5.727 to 6.537 (p, <0.5). Group A's results were more significant than Group B's results. This suggests that using the Rocket Math app is more effective than using the Rocket Math paper and pencil method. The t-test reported that Rocket Math is an effective program to use when working to increase multiplication automaticity. It can also be concluded that practicing with the Rocket Math app produces greater gains in developing multiplication automaticity.

The last aspect of this research examined how participant frustration levels influenced their overall performance and results in improving multiplication automaticity. Each Friday during the study, participants were given a short survey gauging their feelings towards the method of practice being used and the levels of frustration that were being experienced. After reviewing the surveys that participants took from week to week, it was evident that participants in Group B answered that they were frustrated more often than participants in Group A. Figure 6 below breaks down the number of

participants in Group A and Group B that answered that they were frustrated while practicing multiplication facts each week throughout the study.

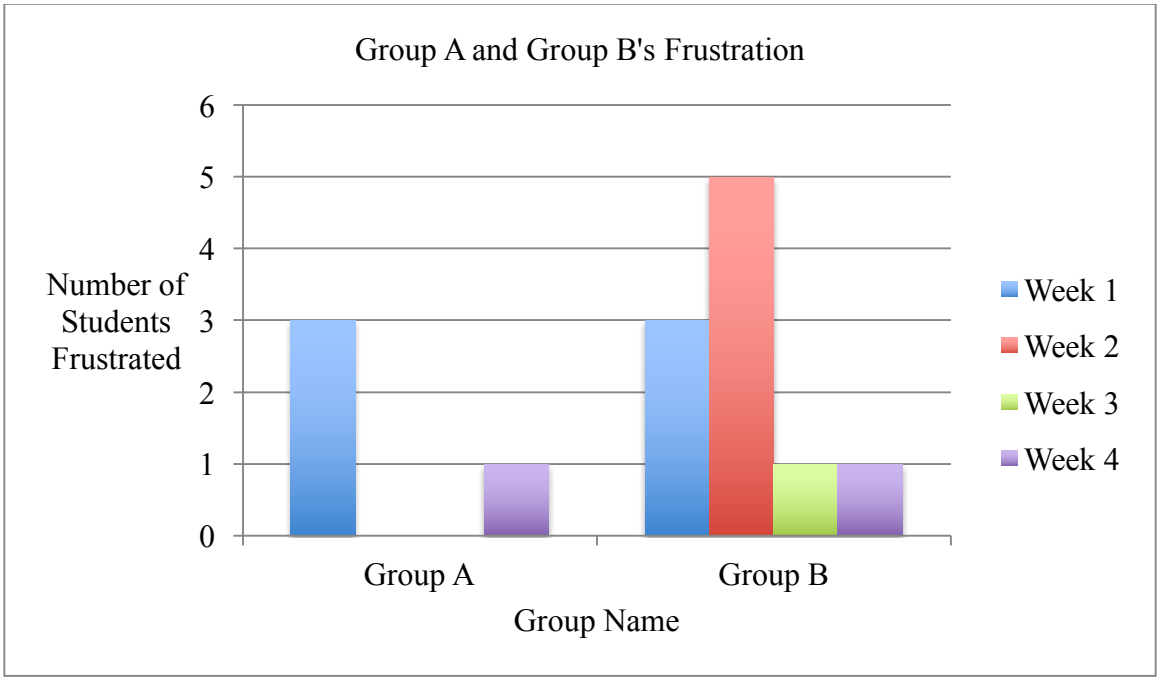

Figure 6. The number of times participants marked that they were frustrated throughout the course of the study from week to week.

The participants in Group B marked that they were more frustrated continually throughout the study. During week two and week three of the study, no participants in Group A indicated that they were frustrated. Participants in Group A and Group B who marked that they were frustrated were also asked to explain what was frustrating them. Of the four participants that marked that they were frustrated in Group A, three of them indicated that they were frustrated because the Rocket Math app was timing them and they were not being given enough time to think. They indicated that the app rushed them to answer quickly. The other participant in Group A who marked that they were frustrated could not pass to the next level of multiplication in the Rocket Math program. In Group B, participants answered that they were frustrated because they wanted to use

the app instead of paper and pencil or they could not pass to the next level of multiplication in the Rocket Math program. From this data, it is evident that participants in Group A were often frustrated with the technology; however, this frustration did not seem to influence overall performance throughout the study. Group B indicated frustration more often than Group A. Group B's results show that a smaller improvement was made. The use of technology in developing multiplication automaticity was frustrating to some participants; however, participants who used the Rocket Math app made greater gains than those participants who did not.

Participants were also asked to indicate which method they would prefer to use each week. The figure below shows which method participants preferred to use to study their multiplication facts. Fifty-six percent of participants preferred to use the Rocket Math app to study their facts, while 22% of participants preferred to use the paper and pencil method. Twenty-two percent of participants were split between using the Rocket Math app or paper and pencil.

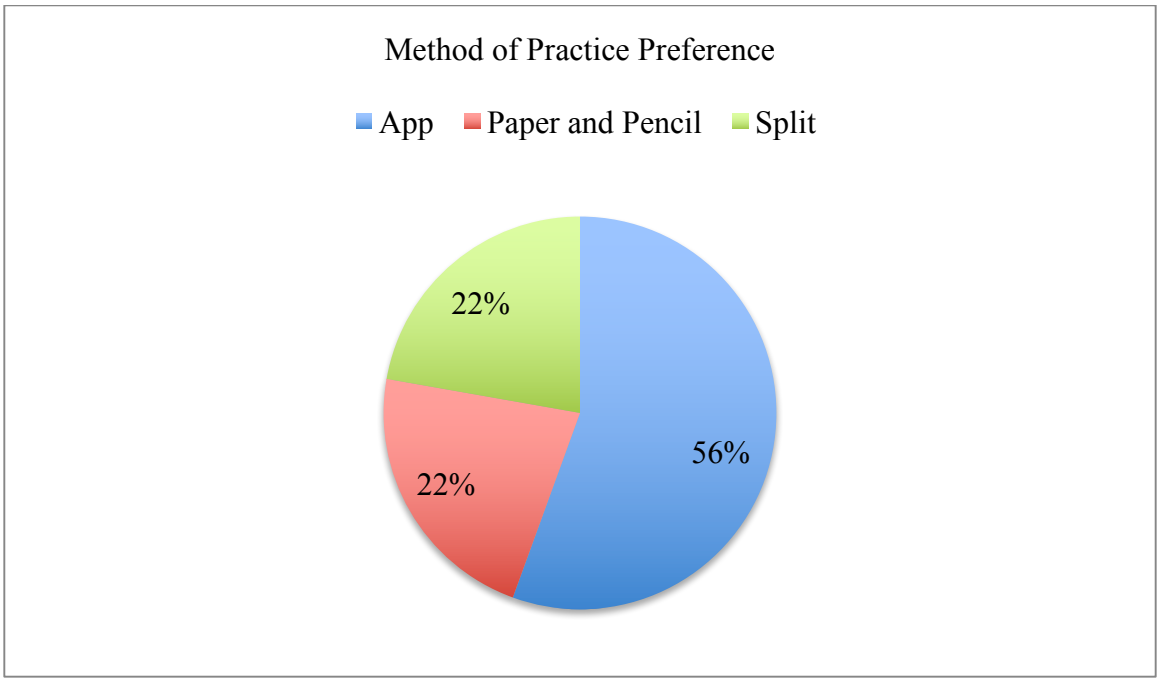

Figure 7. Percentages of the methods that participants preferred to use when practicing multiplication facts during the study.

Figure 7 suggests that more students preferred to use the app than the paper and pencil practice sheets to practice Rocket Math. The qualitative results of this study correspond with the quantitative results. The qualitative results suggested that more participants preferred to use the Rocket Math app, and the quantitative results determined that practicing with the Rocket Math app produced greater gains in developing and achieving multiplication automaticity. Therefore, participants who practiced with the Rocket Math app were less frustrated and were able to make greater gains in developing multiplication automaticity.

Discussion of Findings

The importance of learning and mastering multiplication facts in third grade is crucial to a student's success in subsequent grade levels. However, students often leave third grade without knowing their multiplication facts. This study worked to discover if

multiplication programs, such as Rocket Math, can help students improve multiplication automaticity. This study also worked to determine whether or not students performed better when technology was used to practice multiplication facts, and whether or not student frustration levels impact their overall performance when working to master multiplication facts.

The study indicated that both Group A and Group B made improvements in developing multiplication automaticity; however, greater gains were achieved by Group A, who used the Rocket Math app to practice their multiplication facts. The data from the survey also showed that Group B was frustrated more often than Group A, thus impacting their overall performance in developing multiplication automaticity.

From the findings of this research, one can conclude that Rocket Math is effective to use when working to help students develop multiplication automaticity. One can also conclude that students prefer to practice multiplication facts with the use of technology, and students are less frustrated when they are using technology to aid them in learning their multiplication facts. Although the study answered the initial research questions, there are some limitations that must be taken into account.

Limitations

One limitation of this study is the limited data pool. The research was conducted in one particular classroom in one particular school district. The participants in the study are from a similar population; therefore, the findings in this study are relevant to the participants involved. However, it is hard to determine whether or not these same findings would correlate with students at a similar grade level in another school or district. One may assume that the results would be the same in a similar classroom;

however, populations vary from school to school and different findings can be determined. The study can also not be reproduced with the same pool of participants. The participants in this study cannot repeat the same interventions because the content would be too redundant. The time frame that the study was completed in is another limitation to the study. This study was completed in a four-week time frame. During the third week of the study, there was no school for the President's Day holiday and during the fourth week of the study school was cancelled for two days due to snow. These cancellations and school holidays impacted the time frame of the study. In order to produce more significant results, the study should have been conducted over a longer period of time. The following study was also conducted during the second half of the school year after participants had already been introduced to multiplication facts during the first half of the year. Earlier in the year participants were introduced to different strategies and methods that can be used in order to solve multiplication problems. Participants began this study with prior knowledge of multiplication facts; however, most of the participants were still struggling to master multiplication facts. In order to see more improvements in multiplication automaticity, this study should be conducted at the beginning of the school year before students are exposed to multiplication strategies and methods explicitly.

Reflection and Action Plan

The results of this research show that participants made improvements in developing multiplication automaticity throughout the study, and students who did not have the opportunity to use technology when practicing facts tended to make less improvements but experienced more frustrations. Both groups made overall

improvements from the pretest to the posttest, and all but two participants made gains in multiplication automaticity.

As an educator, I can learn from the results of this study and work to enhance learning for the students in my classroom. Learning and mastering multiplication facts is crucial for students in third grade. Students must work to master multiplication facts in order to use this knowledge throughout the rest of their education. Often times, students leave third grade without this crucial prerequisite skill. In order to make sure that students learn and master multiplication facts, I will implement the Rocket Math program into my daily math routine. I will allow students to select which method they would like to use, the Rocket Math app or paper and pencil. By allowing students to have choice, I hope that they will experience less frustration when practicing multiplication facts. I will use the Rocket Math program in various ways in my mathematics classroom. I will use it for whole group instruction and in a smaller group setting. I will also start using Rocket Math earlier in the school year so students can be exposed to learning and mastering these facts earlier.

In the future, I would like to conduct further research on Rocket Math and multiplication automaticity. As stated above, when implementing Rocket Math into the daily math routine I would allow students to choose the method in which they wish to practice and learn their multiplication facts. A future study I would like to work on would examine whether or not allowing students to choose their method of practice impacts their overall performance and improvement in developing multiplication automaticity. I would also examine frustration levels to see if levels of frustration decrease when students are provided with choice. Through this research, I would be able

to determine the impacts that student choice can have on learning and mastering multiplication facts.

Through this study I have been able to learn and grow as an educator. The results of this study will impact the multiplication programs that I use within my classroom. As an educator, this study has displayed the importance of examining programs carefully before implementing them into the classroom. Although my study includes limitations, I hope that other educators will use these results to guide their instruction when working to help students to develop multiplication automaticity.

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Appendix A

Student Questionnaire

Questionnaire

Read the questions below and circle or write an answer.

1. Did you use the Rocket Math App or paper and pencil?

   Paper and pencil App

2. Do you think this method helped you learn your multiplication facts better?

   Yes No

3. How do you think you did today while doing Rocket Math?

   I did awesome! I did ok. I did not do well.

4. Did you try your best?

   I tried my very best! I could have tried harder. I didn't try.

5. How did you feel while you were doing Rocket Math today?

   _____
   _____
   _____

6. If you were frustrated, please share what frustrated you below:

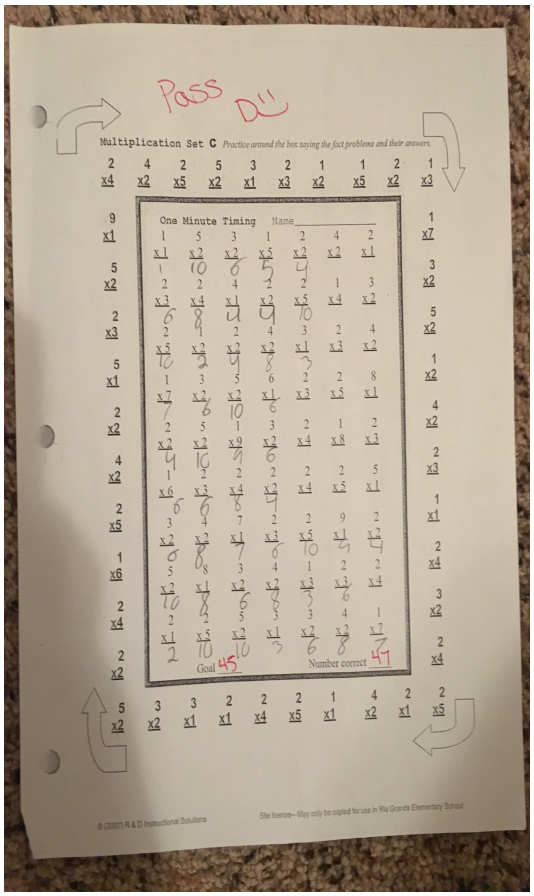
   _____
   _____

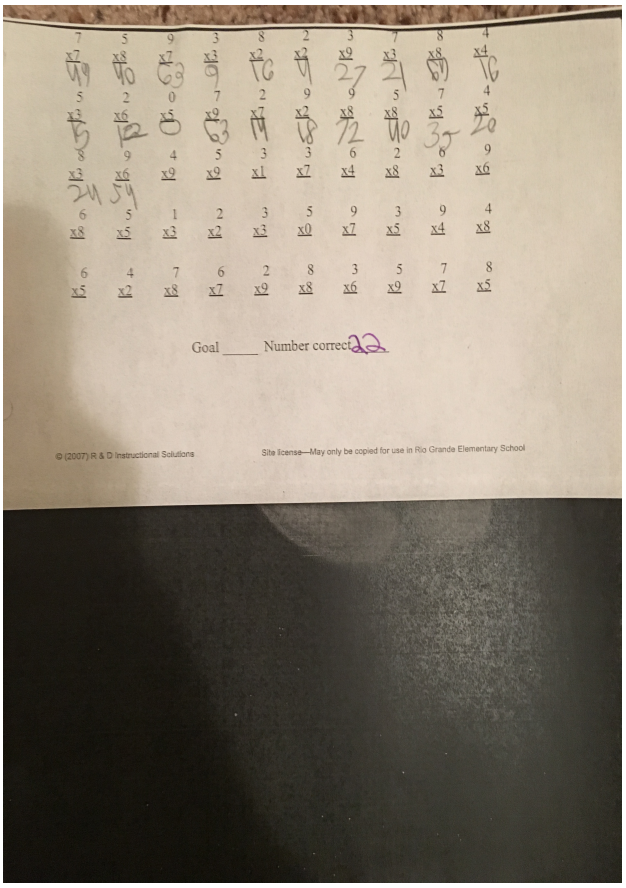
7. Which would you rather use to study your facts? Please explain your answer.

   _____
   _____
   _____

Appendix B

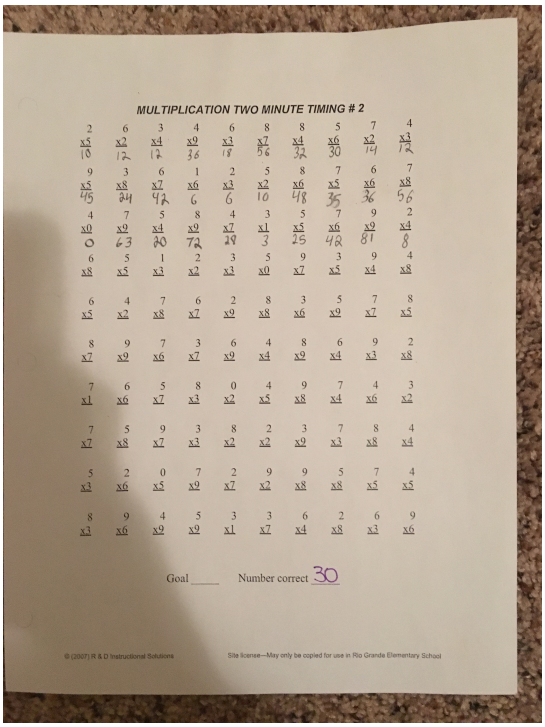
Rocket Math Practice Sheets and Weekly Timed Tests





Appendix C

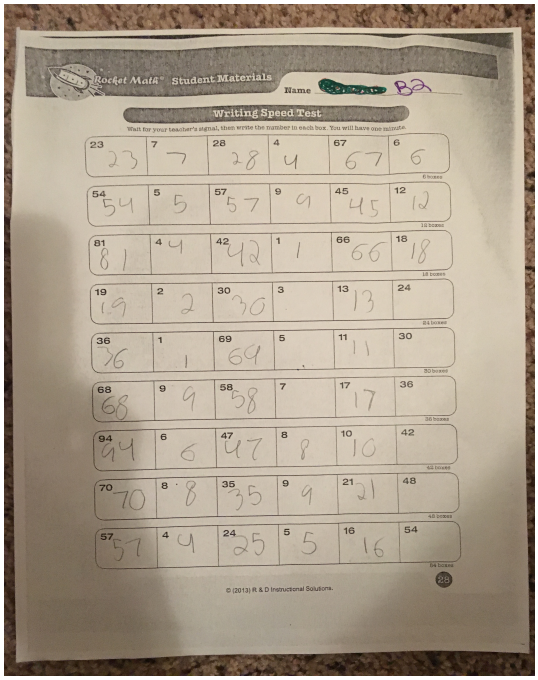
Rocket Math Pretest, Posttest, and Writing Test



MULTIPLICATION TWO MINUTE TIMING # 2

2 x5 10	6 x2 12	3 x4 12	4 x9 36	6 x3 18	8 x7 56	8 x4 32	5 x6 30	7 x2 14	4 x3 12
9 x5 45	3 x8 24	6 x7 42	1 x6 6	2 x3 6	5 x2 10	8 x6 48	7 x5 35	6 x6 36	7 x8 56
4 x0 0	7 x9 63	5 x4 20	8 x9 72	4 x7 28	3 x1 3	5 x5 25	7 x6 42	9 x9 81	2 x4 8
6 x8	5 x5	1 x3	2 x2	3 x3	5 x0	9 x7	3 x5	9 x4	4 x8
6 x5	4 x2	7 x8	6 x7	2 x9	8 x8	3 x6	5 x9	7 x7	8 x5
8 x7	9 x9	7 x6	3 x7	6 x9	4 x4	8 x9	6 x4	9 x3	2 x8
7 x1	6 x6	5 x7	8 x3	0 x2	4 x5	9 x8	7 x4	4 x6	3 x2
7 x7	5 x8	9 x7	3 x3	8 x2	2 x2	3 x9	7 x3	8 x8	4 x4
5 x3	2 x6	0 x5	7 x9	2 x7	9 x2	9 x8	5 x8	7 x5	4 x5
8 x3	9 x6	4 x9	5 x9	3 x1	3 x7	6 x4	2 x8	6 x3	9 x6

Goal ____ Number correct 30



Rocket Math® Student Materials Name B3

Writing Speed Test

Wait for your teacher's signal, then write the number in each box. You will have one minute.

23	23	7	7	28	28	4	4	67	67	6	6	6 boxes
54	54	5	5	57	57	9	9	45	45	12	12	18 boxes
81	81	4	4	42	42	1	1	66	66	18	18	18 boxes
19	19	2	2	30	30	3	3	13	13	24		24 boxes
36	36	1	1	69	69	5		11	11	30		30 boxes
68	68	9	9	58	58	7		17	17	36		36 boxes
94	94	6	6	47	47	8	8	10	10	42		42 boxes
70	70	8	8	35	35	9	9	21	21	48		48 boxes
57	57	4	4	24	25	5	5	16	16	54		54 boxes