Improving the Automaticity of Multiplication Facts with Fourth Grade Students

Kelli Wells

Eastern Illinois University

Abstract

Many students enter fourth grade lacking automaticity with the basic facts, which hinders their performance in most of the fourth grade mathematics standards. The purpose of this action research project was to examine the most effective way to enhance automaticity in those basic facts with fourth graders. A total of 36 students participated in the study in two separate groups. Group One students studied their multiplication facts using practice tools already used in the classroom such as flash cards and board games. Group Two students used an entirely online program called *Xtra Math*. Both groups practiced their facts for ten minutes a day for four weeks, and they were assessed using a 100 fact, four minute timed test at the beginning and end of the study. Although most students made growth, no statistically significant results were found when comparing each group's pretest and posttest overall. However, when breaking the students into smaller subgroups for gender, significant results were found from both groups. Both Group One and Group Two made similar growth from the beginning to the end of the study. Therefore, both methods of practice improved the automaticity of multiplication facts for fourth grade students.

Improving the Automaticity of Multiplication Facts with Fourth Grade Students

The acquisition of the basic multiplication facts is vital for elementary students because those facts lay the foundational skills for more difficult math concepts including fractions, decimals, ratios, proportions, and much more (O'Donnell & SanGiovanni, 2011). Students leaving third grade are expected to be fluent in the four basic operations including multiplication (O'Donnell & SanGiovanni, 2011). Because of this requirement, not a lot of instructional time in fourth grade is devoted to the learning of the facts, since students technically should have those mastered. The truth for this researcher is that most students come into the fourth grade every year with a lack of automaticity with the basic facts. This lack of fluency causes struggles for many students in the fourth grade curriculum because almost all concepts require a knowledge of those basic facts. The fourth graders in the following study were taught mathematics using the Envision Math series. Core concepts throughout the series that require multiplication fluency and are also found in the Common Core State Standards (hereafter CCSS) include basic multiplication and division stories, basic division with remainders, multi-digit multiplication and division, comparing fractions, equivalent fractions, factors, and multiples (NGA, 2010; Pearson Education, Inc., 2012). When a student struggles with the basic facts, he or she seems to struggle with all of those fourth grade concepts as well and only a very short section of the textbook is devoted to the review of those basic facts.

The following study is based on the researcher's experience teaching fourth grade and examines the best way for fourth grade students to develop automaticity with multiplication facts. This research was guided by two main questions. What is the most efficient and effective way for fourth grade students to memorize multiplication facts? Are there specific strategies that best facilitate students' automaticity in multiplication? This researcher finds that extra time in

the classroom is scarce, so the first question is vital. Students need to practice the facts but do it in an efficient and effective manner. Also, automaticity of those facts is critical. Students need to be able to recall the basic facts with quickness and accuracy. Much research has been done on the importance of automaticity, but the methods used to practice those facts have varied. Although many technological programs are available to help with those crucial facts, not much research has been done on the effectiveness of many of those programs. This research should provide fourth grade teachers with an idea of the most effective method of practicing multiplication facts for students. Two instructional methods will be considered including in classroom instruction and computer assisted instruction to evaluate the most effective way to improve automaticity in fourth grade students.

Review of Literature

When math teachers across grade levels are asked for their wish for their students, the recall of the basic math facts is always a top priority (O'Donnell & SanGiovanni, 2011). Over the years, ideas have varied on the best way to teach those basic facts in mathematics, and on the necessity of the fluency of those facts for students. Many changes have been made or suggested throughout the years, but most researchers today agree that automaticity in math is very important for children to acquire. State tests and standards have placed an emphasis on this knowledge as a prerequisite for higher level thinking skills in mathematics. Without fluency in those simpler facts, higher order math skills are very difficult for students. Those basic facts translate into almost every aspect of mathematics in later years. Teachers in the classroom are still struggling with the best strategy to implement to teach math fluency especially since many students continue to struggle with that knowledge on a daily basis.

National and State Initiatives

Education is continuously changing. Reforms and changes in educational laws require teachers to think differently about the way teaching is happening in classrooms. In 2010, the National Governors Association Center for Best Practices and Council of Chief State School Officers (hereafter, NGA) created the Common Core State Standards (hereafter CCSS) as national norms for mathematics (2010). These standards have caused educators across the nation to take a look at the instructional strategies and assessments in all subject areas. Following the development of the CCSS, the Partnership for Assessment of Readiness for College and Careers (hereafter PARCC) was established in order to create an assessment designed to test a student's knowledge of the CCSS (PARCC, 2012). Both CCSS and PARCC are huge topics in the education systems today.

Common Core. CCSS have changed how teachers and students think about all subjects areas especially math. Math knowledge and understanding among students in the United States was considered to be weak when compared to other high performing countries (NGA, 2010). These standards were created in order to create more focused and coherent classrooms, and were implemented throughout all grades from Kindergarten through twelfth grade (NGA, 2010). Math CCSS seeks to prepare students for college, careers, and life in general (NGA, 2010). In one part of the standards, the initiative called for a focus on the procedural and fluency skills in math. Students needed to be fluent with basic computation in order to solve more rigorous problems using those computational skills. For example, students should be fluent with all operations of single digit numbers by the end of grade five (NGA, 2010; Stickney, Sharp, & Kenyon, 2012). Specifically in fourth grade, standards 4.NBT.5 and 4.NBT.6 ask for students to be fluent in multi digit multiplication as well division problems with up to four digit dividends (NGA, 2010). If students do not have fluency with the basic multiplication facts, these two

standards become nearly impossible for fourth graders to achieve. This automaticity of math computation is something that teachers must focus on or provide additional supports for in the classroom to ensure that all students are learning those skills competently (NGA, 2010). This need for automaticity poses a challenge in classrooms for many teachers in the United States. This is especially important since that automaticity will affect students' ability to perform on assessments tied to these standards in the classroom.

PARCC. Soon the CCSS will be assessed in the new assessment tool called PARCC. On this assessment, student's math knowledge and application will be assessed (PARCC, 2012). Also, because of the PARCC, technology skills are becoming more prevalent in classrooms across the United States. The PARCC assessment is an entirely computer based assessment (PARCC, 2012). In mathematics, students will be asked to solve problems based on their grade level content, solve real-life mathematical situations, and model their understanding that content (PARCC, 2012). Weak computer skills may affect a student's math performance. Then a student cannot adequately portray his or her knowledge of their grade level standards because of those computer skills. Many teachers and school districts are going to have to find a way to expose students to the technology required for the assessment ahead of time. Many other components are going to need to be addressed in the classroom in order to help students succeed on this assessment.

Importance of Speed and Competency in Mathematics

With one core component of the CCSS focused on procedural and fluency skills in math, automaticity is a common topic in math classrooms today. Automaticity in math is defined as being able to give an accurate response to a posed math question without giving conscious thought to the calculation (Bloom, 1986; O'Connell & SanGiovanni, 2011; Parkhurst et al.,

2012; Poncy, Skinner, & Jaspers, 2006; Stickney et al., 2012). Automaticity of facts in mathematics greatly enhances a student's chance to be successful with more complex math problems. If the process of retrieving facts is too demanding, it often creates errors in other aspects of the task (O'Connell & SanGiovanni, 201; Parkhurst et al., 2012; Poncy et al., 2006; Woodward, 2006). Once a skill has become automatic for a student, it takes very minimal effort and practice to maintain that knowledge (Bloom, 1986). If students are not fluent in those foundational facts, all other math tasks will seem intimidating (O'Connell & SanGiovanni, 2011). The application of those math facts in other math problems is one of the most fundamental tasks in all math classrooms (Nelson, Burns, Kanive, Ysseldyke, 2013). The lack of those foundational facts inhibits students in other math areas such as ratios, fractions, division, algebraic factoring, and trigonometry (Flowers & Rubenstein, 2010). This importance of automaticity in math skills for students makes the application in a classroom absolutely necessary to better develop proficient math students.

Because automaticity in mathematics learning is so important, there is often a correlation between low performing students in mathematics and students labeled as learning disabled with a deficit in automaticity of math facts (Parkhurst et al., 2010; Stickney et al., 2012). Stickney et al. (2012) found that in comparison to high achieving students, low achieving students struggled in all areas of automaticity. They required more practice to obtain automaticity, and even their speed of retrieval was behind the other students. Parkhurst et al. (2010) also studied ways to remedy automaticity in math facts for students. The researchers found that overall the method they used *Detect, Practice, Repair* worked in the group of students studied. However, the students that were in the highest group "Mastery" made more significant gains than other students. Therefore, automaticity in the math classroom needs to be practiced early and often

beginning at a young age. Students need to establish those automatic skills so that cognitive space is available for the higher ordered thinking problems as they get older.

How Students Engage in Mathematics

Students in this country seem to be falling further and further behind in mathematics. In this researcher's classroom, each year many students do not grasp the basic skills and automaticity of math facts in order to perform higher level functions in math. A study performed by the National Assessment of Education Progress in 2005 found that almost 64% of fourth graders and 70% of eighth graders are not performing at grade level standards (Poncy et al., 2006, p. 27). Especially now with the higher standards in the CCSS, teachers are looking for answers on how to engage their students better in the mathematics classroom, particularly on being fluent in the basic math facts, which will carry over into all other skills in the math classroom. Students who tend to be slow in responding to mathematics questions, although they are accurate, tend to not engage in mathematics as much as their peers who show fluency in math knowledge. This limits them from being able to maintain their grade level math skills (Poncer, Skinner, & Axtell, 2010).

In order to improve fluency of math skills, one common theme was found throughout the research. Practice makes perfect. Various strategies of instruction and practice can be successful with students, but in order to improve math facts recall, frequent instruction and practice is vital to a student's success (Stickney et al., 2012). Some students need even more help and support than others to acquire those math skills. Students that are often labeled with a learning disability often need even more practice than other students (Burns, Kanive, & DeGrande, 2012; Burns, Ysseldyke, Nelson, & Kanive, 2014; Stickney, et al., 2012). Burns et al., (2014) also found that students at certain grade levels take a certain number of repetitions of

math facts before storing them in memory. The number of repetitions required per grade level decreases as students get older. Students with higher math achievement took much fewer repetitions to become fluent with math facts, and the more difficult facts from four to nine took more practice to learn than the basic facts of two and three. Therefore, what students need the most in order to retain fluency with math facts is practice. Becoming fluent with math facts at a young age will help students feel successful and want to continue to participate fully in mathematics for the rest of their years in the school.

Technology in Mathematics

Students value technology, especially in math because students are exposed to technology in all aspects of their lives today. In schools, the dynamics of technology have changed. Today it is estimated that in all U.S. public schools there is one computer accessible for every four students (Duhon, House, & Stinnett, 2012). Computer software can be found to aid students in all subject areas, and offer some great resources for teachers as well. Programs can provide educators with efficient access to students' growth charts and achievement indicators (Burns et al., 2012). Findings have been shown that these programs can facilitate growth in math fluency (Burns et al., 2012; Duhon et al., 2012; Nelson et al., 2013). Often, computer based instruction programs for math facts allow students to work at their own independent pace, therefore mastering the facts quicker overall (Duhon et al., 2012; Wong & Evans, 2007). Many studies have been completed on the effectiveness of computer based instruction programs on the acquisition of math facts in students.

Wong and Evans (2007) studied the effectiveness of systematic practice on the computer versus paper pencil methods on acquiring multiplication facts with year 5 students in Australia. Overall, this study found that both paper pencil and computer programs had a positive effect on

the acquisition of the basic math facts. Students in the study also tended retain the information over period of time following the study.

Duhon et al. (2012) completed a similar study, but used second grade students with basic facts in subtraction. The researchers wanted to see if fluency gained in math facts on the computer transferred to paper pencil assessments and vice versa. Surprisingly the study revealed that knowledge gained on the computer did not always transfer to the paper pencil modality, although both methods did create growth in students' fluency. The computer program used was created by one of the researchers, and contained only one fact per page. The researchers' recommendations were to make assessment and practice modalities the same, in order to better assess the students' understanding.

Burns et al. (2012) also studied the effectiveness of a computer program on math facts of third and fourth grade math students. The computer program in this study, *Math Facts in a Flash*^{TM}, was used strictly as a supplemental intervention for students that were at risk for struggling in mathematics. Overall, this computer program was found to be an effective intervention for students having difficulty with math facts.

Websites to Improve Math Fact Automaticity

There are a wide variety of computer websites and programs available to teachers and students to improve math fact automaticity. Many offer varying appeals to both students and teachers. The main considerations for the following websites were ease of use in a classroom for multiplication facts, cost, and appeal for students.

Math Facts in a Flash. *Math Facts in a Flash* is a computer based assessment program that allows students to practice basic math facts and assess automaticity (Stickney et al., 2012). The program uses timed assessments as well as multiple choice questions, to measure a student's

knowledge on both accuracy and automaticity of the facts. This program uses engaging instruction to cover all the basic facts in the four operations of math. Students are able to move on their own level through the facts in all four areas (Stickney et al., 2012). Teachers are provided with reports on students' progress through the facts. This program is costly though and is about $1,600 per school. Through research, this program has been found to be an effective math intervention tool (Stickney et al., 2012).

FASTT math (2007). FASTT Math is another computer based software program that is designed to help students build math fluency in their basic facts (Troutner, 2006). FASTT Math is developed by Scholastic and is built with 18 engaging games that help students develop automaticity in their math facts. It is individualized and adaptive to each student and allows them to progress at their own pace. This program is also costly for the school district and costs about $7.50 per student. Computers need to be available for all students to use this program.

Fun 4 the Brain (2008). A free website useful for multiplication facts is Fun 4 the Brain. This website included many engaging games for kids to practice their math facts through. The games are designed around topics that children enjoy. Students can also take quizzes and tests on this website as well to assess their knowledge of the basic facts. This website is available for any computer that has access to the internet to use.

Xtra math (2009 – 2014). Another website recommended for math fluency is Xtra Math. This is a free website available to teachers, students, and parents, and it is designed to help students will fluency in all four operations. Teachers can set up a class and create logins for each students. Students work their way independently through all of the facts in basic activities. Teachers and parents can create assignments and can get detailed progress reports regularly about student's progress.

Multiplication.com (2014). Multiplication.com is another free and useful website for students practicing multiplication facts. This website has a wide array of practice strategies for students including multiplication games, practice strategies, and tips and tools for learning the facts. Students can work at their own pace to study the facts and choose different activities to reinforce their learning. The games are an interactive way to practice the facts. Multiplication.com is recommended by many teachers and websites as a beneficial website for students.

Conclusion

From studying the research, automaticity is a vital skill for students' success in mathematics. With the higher standards of the CCSS and PARCC assessment, students need to be fluent in their basic facts in order to free up cognitive space to perform higher level math algorithms. Many resources and strategies can be used to help students learn these basic math facts as long as students are practicing early and often. One resource that has been proven to be effective for math fluency is computer programs. There are many great websites that can be utilized in a classroom to help students with their automaticity in math. It is important for teachers to understand which strategies work best in their particular classroom with the population of students at their particular grade level. When effective strategies are implemented, students will achieve fluency of the fundamental math skills and be ready for higher level thinking, which is what all math teachers strive for.

Methods

The study was conducted over a four week period during the spring semester of 2015. As the teacher-researcher, I used my classroom as the setting for the study. The following

paragraphs describe the participants, setting, instructional, and assessment methods used during the research period.

Location

This study was completed at a rural school in central Illinois with a population of 650 students. The school contained students in the fourth, fifth, and sixth grades within 23 different classrooms. Almost half (43.2%) of the school's students were considered low income and received free and reduced lunch services. About one-tenth (11.8%) of the school's students were on an Individualized Education Plan (IEP) and received special education services. The mobility rate of students in the school was 11.1% (Charleston Community School District).

Participants

A total of 36 fourth grade students participated in this study. All students were between the ages of nine and ten years old. The sample of students included most of the students that were taught Math in my classroom during the school day. One student was eliminated from the study because the student had to receive speech services two days each week during the study. Another was eliminated because the student was absent from school for most of the research period. Seven other students were eliminated from the research because they scored a 100% on the pretest. Since those students already had a perfect score, there was no need for them to participate in the study. The participants were divided into two separate groups based on their homeroom class for the study. These groups were already divided during the school day prior to the study. These two heterogeneous classes were a representative sample of the school population. Students were both male and female and performed at many various levels in mathematics. One class is taught mathematics in the morning, while the other comes to math in

the afternoon. During data research, I explored the possible impact of time of day on both groups.

In Group One, there were 15 total participants in the study. Out of those students, nine were female and six were male. One student in this group was of Asian heritage, while all others were white or Caucasian. One of the students was on a 504 plan while two students in this group received Title One services for reading (which includes the 504 student). All students in this class participated in the regular education classroom for math without any additional accommodations or assistance.

In Group Two, there were 21 total students in the study. Out of those students, 11 were female, and 10 were male. All of the students participating in the study were of white or Caucasian heritage. In this group, one child was on a 504 plan, and five students received Title One services for reading. All students in this group participated in the regular math classroom without any extra support or services.

Procedures

The research study took place for a total of four weeks. All students in my mathematics classes participated in the intervention, as all fourth grade students benefited from multiplication facts practice. The students' intervention varied based on whether they were in the morning math class or the afternoon. The morning class will be referred to as Group One while the afternoon will be Group Two. According to the research, practice is vital for multiplication facts fluency. Therefore, for the research, both groups of students had ten minutes of multiplication facts practice every day. In Group One, their practice varied week by week and was based on common multiplication facts practice already utilized in my classroom throughout the year. All

classroom activities had already taken place throughout the year and should not have been new to the students. The weekly schedule for Group One's practice was as follows.

Table 1.

Group One's Multiplication Practice Schedule.

Week of Practice	Classroom Activity
One	Flash Cards
Two	Multiplication Board Games
Three	Multiplication Card Game
Four	Student Choice of All Three

Group One's activities contained a mixture of activities that have already been used throughout the year. Students were familiar with the activities, so they did not require any additional instruction. During the board game activities, students were able to choose from a variety of board games in my classroom including Math Dash and Multiplication Bingo. The card game students used was based on the game *War*. In pairs, students each turned over a card in the deck, and the first student to correctly multiply the two cards together was able to keep both cards. Partners played until one player collected all of the cards or the time was up.

Group Two used an entirely online program to study their multiplication facts for the ten minute daily time. The program used was found on the website *Xtra Math*. This program was a free website created to help students with their basic facts. I created a teacher account and then created separate logins for each of my students in Group Two. When students came to the computer lab each day, they logged into the computers with this login and practiced their multiplication facts. This computer program tracked the students' progress and designed

activities and tasks for them based on the facts that they needed assistance with. All students began the program with taking an entrance quiz. The program designed the games and activities based on the facts the student struggled with on the entrance quiz. Students in this group did this same online program for the entire study. If a student completed the entire multiplication program during the study, they began working on their division facts using the same program.

The seven students that scored 100% on the pretest were given the choice to participate in the activities. Those students still could participate in the activities with the class on multiplication facts to improve automaticity, but they were not included with the research for the rest of the study. Instead of the multiplication activities, they were given the option to work in their math folders, which contain advanced math practice on topics we are covering in class. Some of these topics included long division and longer multiplication problems, which are a direct application of using multiplication facts.

Data Collection

Although students in both groups were studying multiplication facts through different methods, both groups participated in the same assessment. Students in this study were all assessed according to the same four minute timed multiplication facts test (Appendix A). The assessment involved 100 randomly sorted basic multiplication facts from one through nine. The students only had four minutes to complete the test. Answers were only taken if completed within the four minute time frame. Students were assessed on the first day of the intervention to establish baseline data, and at the end of each week during the study for a total of five assessments. All assessments consisted of the exact same format. Students were familiar with taking multiplication timed tests throughout the year, so the timing portion of the assessment should not have created any extra anxiety for the students.

When collecting the data, students were given a randomly assigned number to keep all of the student names anonymous. Data was collected on the paper pencil tests and stored electronically in a file. The data was used to look for scores from the pretest to the posttest as well as improvements at the end of each week of the study.

Data Analysis and Results

The goal of this study was to analyze the most efficient way to facilitate the automaticity of multiplication facts with fourth graders. Students were assessed with a pretest/posttest timed test of 100 multiplication facts. Only answers given in four minutes were counted as correct.

To begin with, a t-test was run from the pretest scores to determine that both classes were not statistically significantly different from each other. The result was $p < 0.940$. Both classes were not statistically different, and therefore their scores could be compared to each other. Following the study, multiple t-tests were analyzed to compare the results of the two classes. The following table represents the results of these t-tests.

Table 2.

Overall t-test Results

t-test	*p*
Group 1 Pretest/Posttest	< 1.149
Group 2 Pretest/Posttest	< 2.036
Group 1 Posttest/ Group 2 Posttest	< 0.322

From these results, this study did not produce results that were statistically significant in any measure. The activities performed during Group One's practice did not have a statistically significant impact on the posttest results in that group, and the same results occurred with group

Two. Also, the comparison between both posttest shows that there was not a statistically significant difference between the two groups' posttest results. Neither multiplication intervention was significant enough to say that it should be used with all fourth grade classes to improve their automaticity. This is important to teachers because it helps them make a decision on what to use in their classroom to enhance the automaticity of multiplication facts. In this research, although most students made gains, neither intervention was significant. Teachers may decide to try a different type of intervention or choose the method that fits easiest into their classroom.

Because of these results, I decided to further investigate the data to see if there were any smaller group sets where the results might have been statistically significant. To do this, the subgroups of low socioeconomic status (SES), male, female, and struggling students were examined. For the subgroup of struggling students, only the students that scored below the middle of the year benchmark in Mathematics on the Measures of Academic Progress (MAP) test were used, which all Jefferson Elementary Students have to take three times a year. The middle of the year benchmark for Math was 208.7, so only students that scored below that were used for that t-test (Northwest Evaluation Association, 2015). The following table shows the results of the t-test for those four subgroups within Group One and Group Two.

Table 3.

t-test Results for Four Subgroups

	Group One	Group Two	Both Groups
Subgroup	p	P	p
SES	<.005	<.0007	<3.830
Male	<.004	<.002	<9.347
Female	< .002	< .0002	<3.131
Struggling Students	< .033	< .006	< .0002

Examining subgroups yielded some statistically significant results. The male and female subgroups in both Group One and Group Two had results of $p < .05$, which means both groups were statistically significant when comparing their pretest to posttest results. However, when combining all the females in Group One and Group Two together, once again the result was a $p > .05$. This means that together both groups of females were not significantly different in their results. This was the same for males. The separate male groups yielded statistically significant results, but that changed when combining both male groups together. These results were also true for the low SES group. For the group of struggling students, significant results were found in all three groups. Clearly this result shows that the extra practice did benefit all the struggling math students, which is the group that a teacher would like to see the most improvement in. Most of the time the struggling math students tend to struggle with fluency as well, and this intervention demonstrates a way that these students can be helped in the classroom. This shows that this research did have a positive effect on the acquisition of multiplication facts for the struggling students in both groups.

Although the overall scores for the students were not statistically significant, the majority of the students in both groups made improvements throughout the study. The average growth in score in Group One was about 15 points from the pretest to the posttest. Group Two saw a growth of almost 19 points as an average from the beginning to the end. The following two graphs show the growth of each student from the pretest to the posttest.

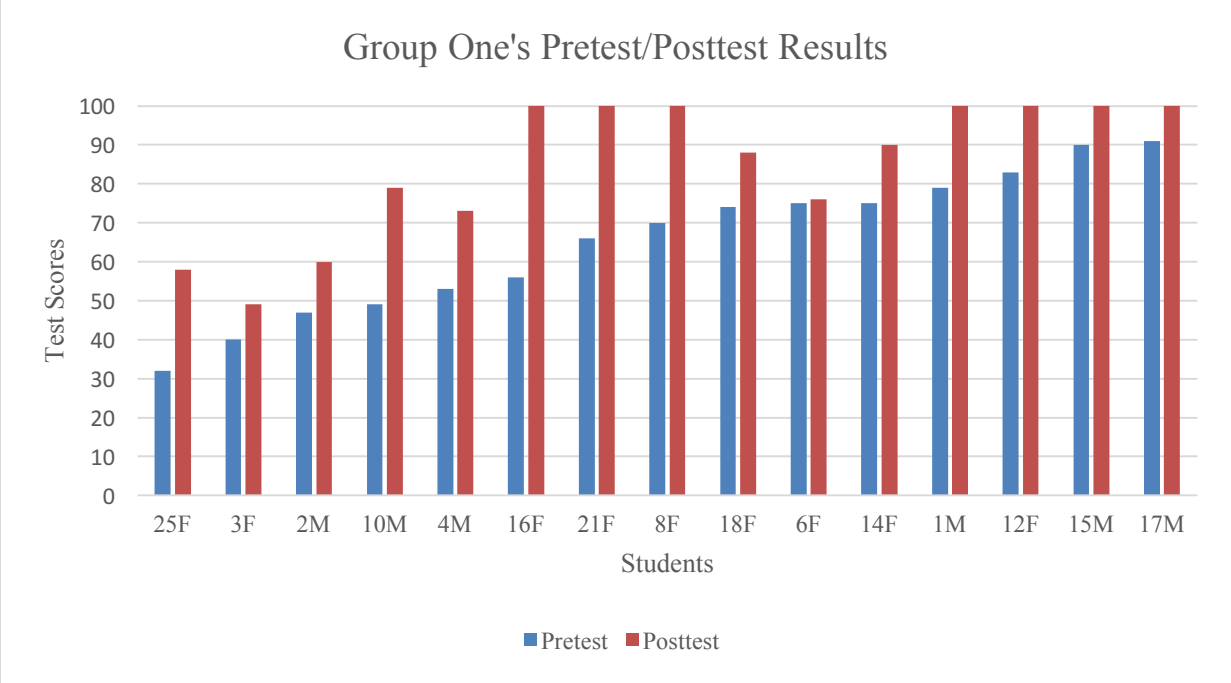

Figure 1. Pretest/Posttest scores for Group One on 100 multiplication facts test.

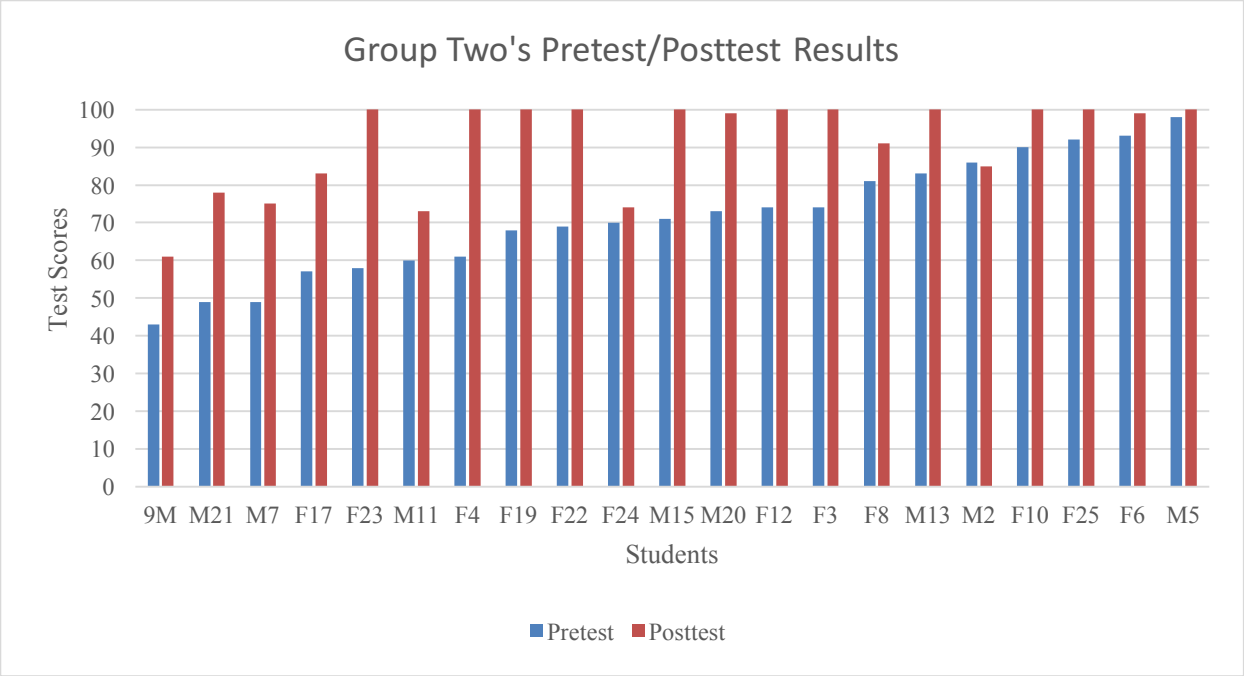

Figure 2. Pretest/Posttest scores for Group Two on 100 multiplication facts test.

Overall, almost all students improved their scores from the beginning to the end of the study. By studying the graphs, most of the students' posttest scores were much higher on the graph than the pretest scores. Some of the students that scored very high on the pretest did not show as much improvement because they didn't have as much room to improve on the pretest since it was out of 100, and they began the study close to 100. Therefore, although the overall results were not statistically significant, almost all students made progress in both groups throughout the study.

Discussion of Findings

This study with both groups overall indicated that neither intervention method to study multiplication facts resulted in statistically significant results. However, when broken down into subgroups, significant results were found. That shows that students did make improvements throughout the timeframe of the study. Both intervention methods, resulted in similar improvements from the two groups. Perhaps, most importantly, significant data was found in all

three subgroups of struggling students. This is helpful because those students working below grade level in math are most often the ones that struggle the most with the automaticity of multiplication facts. This intervention strategy was beneficial for those students in the classroom.

When looking back at the underlying questions that guided this research, both methods were about equally efficient in improving multiplication facts in fourth graders. Both normal class interventions (flash cards and games) as well as the online *Xtra Math* intervention allowed students to make gains in their fluency of multiplication facts. The research also suggested that there may be other more efficient methods for learning multiplication facts available as well. According to the research studied, practice is vital in improving facts. This study suggested that point as well. The method used did not make a difference, but the fact that students were practicing their facts helped them make improvements.

Implications

Because of the significant results in the smaller subgroups, I think both of these intervention methods could be considered by teachers to help students improve multiplication facts especially with struggling students. Both intervention methods were successful with helping the students struggling in math with their multiplication facts. Teachers could use these strategies as small group interventions in their classrooms for those students that need a little extra support than their peers. Overall, though, the results did not show that this method should absolutely be used by every teacher to improve fluency with the facts for the entire class. There are likely other methods out their available to teachers that would have similar results with students or even better results than this study. This research, as well as ones in the past, does show that practicing, even for a small amount of time each day, can improve automaticity with

facts. Therefore, teachers should devote some time to practicing multiplication facts in the classroom, but they should choose a method that fits best into their classroom. Using a website may not be the most accessible for some teachers that do not have access to many computers, or it may work well for teachers that have sets of classroom tablets or computers. Teachers should make a decision about what works best for them and their group of students.

Limitations

One limitation of this study is the limited data pool. This study was completed in one classroom at a particular school with a mostly homogeneous population of students. The findings are relevant to that population of students. One can assume those findings would correlate to similar students at the same grade level, but every population of students can be different. This study also cannot be reproduced with the same pool of students. Once the students have learned the multiplication facts then they do not need the same interventions in the study, and will not do the same activities over again. The study was completed under a limited time frame of four weeks, which creates another limitation. One of the weeks of the study was even shorter because of a snow day that cancelled school and the President's Day holiday. Because of the short time frame, this study focused on only quantitative data methods to see the improvements in the learning of basic multiplication facts. If a longer study was performed in the future, qualitative data methods could be used to study the attitudes of the participants towards the instructional methods used in the study. Finally, this study was performed during the second half of the school year when students have already been studying their multiplication facts for seven or more months. This intervention method would show more improvements towards the beginning of the year when students have not been exposed as much or studied their multiplication facts already for many months. Although that is a limitation of the study, a

majority of the students still began the study lacking automaticity with many of the multiplication facts and saw growth throughout the study.

Reflection and Action Plan

The results of this research showed that students did make improvements on their multiplication facts throughout the study. Both groups performed similar from the beginning to the end of the study, so both methods of practice improved the students' fluency about the same. The overall results of the study were surprising. The performance in both groups was not statistically significant within the larger groups, but when broken down into smaller subgroups many significant results were found in the groups of females, males, and low SES. I believe this has to do with examining a much smaller number of students in the subgroups than the larger groups. Because this study was completed during the third quarter of the year, many students began the study by scoring very high on the pretest. We have practiced multiplication facts for most of the year, and many students have been studying them for a long time. Therefore, they did not have a lot of room to make improvements throughout the study, and this may have influenced the statistical results as well. I would be interested in seeing how much different the results would be if the same study was performed at the beginning of the year, when students would start out lower on the pretest and have more room for improvements. This is especially true because the subgroup of struggling students had statistically significant data. Those students were the ones that most of the time began the test with a lower score and had more room to grow. Also, if I were to do the study again, I would keep the timed assessment, but I would let the students work as long as they could on problems. For example, they could get 200 problems done in four minutes instead of 100. That would be a way to show more improvements for those higher scoring students as well.

In the future, I would like to continue this multiplication practice intervention in my classroom but use it at the very beginning of the year to examine those results. I plan on using the online *Xtra Math* program again next year during computer lab time in both of my classes. I heard many positive comments from students about the program, and many asked for the password so they could continue the practice at home. I have also noticed in my math instruction that many students seem to be much quicker and accurate with their facts. I give weekly timed tests on the basic facts 1 – 12, and the students take one test at a time and move up as they pass. One of the students who participated in the *Xtra Math* practice has passed three timed tests in a row since the study when it took that same student over a month to pass the last test before the study. Although many of the results of this study were not considered significant, I was very impressed with the improvements in many of my students. Many students are much more confident with their fluency of the facts and that translates into better performance throughout the many topics we teach in fourth grade.

References

Bloom, B.S. (1986). Automaticity: the hands and feet of genius. *Educational Leadership*, 70-77.

Burns, M., Kanive R., & DeGrande M. (2012). Effect of a computer-delivered math fact intervention as a supplemental intervention for math in third and fourth grades. *Remedial and Special Education*, *33*(3), 184–191. doi:10.1177/0741932510381652

Burns, M., Ysseldyke, J., Nelson, M., & Kanive, R. (2014). Number of repetitions required to retain single-digit multiplication math facts for elementary students. *School Psychology Quarterly*. Advance online publication. http://dx.doi.org/10.1037/spq0000097

Charleston Community Unit School District. Retrieved January 30, 2015, from http://www.charleston.k12.il.us/district-information/district-report-card.asp

Duhon, G. J., House, S. H., & Stinnett, T. A. (2012). Evaluating the generalization of math fact fluency gains across paper and computer performance modalities. *Journal of School Psychology*, *50*, 335–345. doi: 10.1016/j.jsp.2012.01.003

Flowers J. M. & Rubenstein R. N. (2010) Multiplication fact fluency using doubles. *Mathematics Teaching in the Middle School*, *16*(5), 296-301.

Fun 4 the Brain. (2008). *Multiplication Games*. Retrieved from http://www.fun4thebrain.com/mult.html

Krimsten Publishing. (2014). *Multiplication.com*. Retrieved from http://www.multiplication.com

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics.* Washington, DC: Authors.

Nelson, P., Burns, M., Kanive, R., Ysseldyke, J. (2013). Comparison of a math fact rehearsal and a mnemonic strategy approach for improving math fact fluency. *Journal of School* Psychology, *51,* 659-667. doi:10.1016/j.jsp.2013.08.003

Northwest Evaluation Association. (2015) *Measure of Academic Progress*. Portland, OR: Authors.

O'Connell, S., & SanGiovanni, J. (2011). *Mastering the Basic Facts in Multiplication and Division*. Portsmouth: Heinemann.

Parkhurst, J., Skinner, C. H., Yaw, J., Poncy, B., Adcock, W., & Luna, E. (2010). Efficient class-wide remediation: using technology to identify idiosyncratic math facts for additional automaticity drills. *International Journal of Behavioral Consultation & Therapy*, *6*(2), 111–123.

Partnership for Assessment of Readiness for College & Careers (2012). *PARCC Models Content Frameworks: Mathematics, Grade 3-11, 3rd Version*. Washington, DC: Authors.

Pearson Education, Inc. (2012) Envision math Common Core. Upper Saddle River, New Jersey: Pearson Education.

Poncy, B. C., Skinner, C. H., & Axtell P. K. (2010). An investigation of detect, practice, and repair to remedy math-fact deficits in a group of third-grade students. *Psychology in the Schools*, *47*(4), 342-353. doi: 10.1002/pits.20474

Poncy, B. C., Skinner, C. H., & Jaspers K. E. (2007). Evaluating and comparing interventions designed to enhance math fact accuracy and fluency: cover, copy, and compare versus taped problems. *Journal of Behavioral Education*, *16,* 27-37. doi: 10.1007/s10864-006-9025-7.

Stickney, E. M., Sharp, L. B., & Kenyon, A. S. (2012). Technology-enhanced assessment of math fact automaticity: patterns of performance for low- and typically achieving students. *Assessment for Effective Intervention*, *37*(2), 84–94. doi:10.1177/1534508411430321

Wong, M, & Evans, D. (2007). Improving basic multiplication fact recall for primary school students. *Mathematics Education Research Journal, 19*(1), 89-106.

Woodward, J. (2006). Developing automaticity in multiplication facts: integrating strategy instruction with timed practice drills. *Learning Disability Quarterly*, *29*, 269–289.

XtraMath. (2009-2014). *Help kids master basic math facts.* Retrieved from http://xtramath.org/