Memorizing Basic Math Facts

in a Primary Classroom

by

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Abstract

The purpose was to conclude whether giving students answers to addition facts during timed drills would aid in automaticity of known facts, and show an increase in the number of problems students were able to solve correctly. This study compared two third-grade math classes. The researcher sought the answer to the following questions: Will providing math fact answers on top of math drill sheets improve student learning of math facts? What learning activities do students do at home that might help them learn their math facts? Does weekly practice in school, coupled with practice at home, aid in retention? A student and parent survey were administered and examples of tests are included. A student survey asked children to think about strategies used to help them study math facts, and the purpose of the parent survey was to find out how often their child studied and whether or not a child received assistance in studying facts at home. The

researcher found that students in both math classes showed an increase in math fact retention. There was not a significant improvement in math fact retention found when comparing the results between the control math group and experimental group. The automaticity of both groups increased, as well as their speed, but not significantly in the amount of time the research was conducted.

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Chapter I: Introduction

"The foundation of any kind of mathematical enterprise is memory, and a great deal of learning mathematics involves committing mathematical facts ... to memory" (Brennan, 2006). Math facts such as addition, subtraction, multiplication and division give students problems well into junior high because they were never memorized in earlier grades. Brennan (2006) supports this statement when she writes "...memorization of facts will be critical to their later success in mathematics." The problem this causes is that many math teachers in the upper grades have to go back and re-teach math facts, yet again, and devote much of their teaching time to standards and facts students should have already mastered, thus taking time away from the standards they are accountable for teaching at their grade level. Caron (2007) states, "Developing automaticity frees up cognitive capacity for problem solving." When students are counting on their fingers, or staring blankly when asked to solve a math operation, time is lost on learning and mastering new objectives.

There are numerous approaches to helping children master their math facts that teachers have used to help their students become successful in memorization: games such as Around the World, where two students are paired against one another in a race to be the first to call out the answer and advance through their classmates is one method. Also, online resources and games on the internet, using parent volunteers within the classroom environment to work one-on-one, or in small groups, quizzing children on facts can be employed. Having each child make their own set of flashcards or playing games such as "War" with a deck of cards; the list could go on and on.

The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase (NCTM, 2000). Our society is moving along a technological super-highway that shows no signs of slowing down. Children may feel that with computers, calculators and Smart Phones at their fingertips, knowing how to add is not a priority for them; they can acquire the answer more quickly and accurately with a calculator. However, calculators and technology can make errors- human errors- and a person would have to have the capacity to analyze whether or not the output answer is correct, or at least reasonable, based on their own ability to estimate an answer in their head, whether by addition, subtraction, multiplication or division. Therefore, the memorization of basic math fact skills that are being taught in the primary math grades are essential for building a foundation of learning for life.

This research was based on retention of basic math facts in elementary school, in two third grade classes. Specifically, the researcher explored techniques to ensure students have automaticity of basic math facts, so that as they move on through the elementary grades and into junior high, more time can be devoted to mastering new math learning objectives.

Statement of the Problem

Children are having difficulty showing retention of math facts. Not knowing math facts quickly takes up time while waiting for a student to count on their fingers or draw tally marks in order to come up with the sums, or the child says nothing at all. Not intrinsically knowing math facts is slowing up time in math class that should be devoted to teaching other standards, or even other concepts that build off of knowing sums.

One of the third grade math classes used for this research, the control group, was introduced to a new method of timed math drills. The math timed test with answers was created by the researcher. Having the answers at the top of the drill sheet allowed to look at the correct answers for help if they needed it. It is the goal of the researcher that over time, students will come to be less dependent on looking at the answers at the top of their paper and will have intrinsically learned their addition facts. If they have memorized the facts, the number of problems they are able to solve in the given amount of time should increase. Also, memorization of basic math facts would aid in future math lessons that involve addition, or build upon knowing facts quickly.

The experimental math group was given the same fact test. However, the answers were not given at the top of the page of the timed math test. Students were expected to employ whichever strategy benefited them in recalling basic math fact sums to generate the correct answer.

Timed tests were given to both math groups, during math time, three times a week.

Purpose of Study

The purpose of this study was to find an intervention to increase retention of facts for third grade students, which can be carried over into subsequent grades and third grade classes if success of automaticity was proven. An intervention that would prove all students leaving the two third grade math classes know their addition facts would be the driving force. The researcher would like all students to consistently show mastery on informal assessments, instead of progress, on one or two formal assessments.

The following questions were addressed in this study:

1. Will providing math fact answers on the top of the page of math drill sheets improve student learning of math facts?
2. What learning activities do students do at home that might help them learn their math facts?
3. Does weekly practice in school, coupled with practice at home, aid in retention?

Assumptions of the Study

1. It is assumed that students will enter third grade having exposure to timed drill tests.
2. It is assumed that students have had fundamental exposure to constructing meaning of the base ten system and counting strategies in Kindergarten, 1st and 2nd grades.
3. It is assumed that students have been taught reasoning strategies and are able to determine if an answer "looks right." The student should use known number facts to solve those facts not yet retained.
4. It is assumed students will enter third grade knowing addition and subtraction are inverse operations.

Definition of Terms

Automaticity- the ability to engage and coordinate a number of complex sub-skills and strategies with little cognitive effort. Children who can do 50 basic math facts in two and half minutes correctly show automaticity of math facts.

Basic Math Facts- computations involving the four basic math operations: addition, subtraction, multiplication, and division; using the single-digit numbers,

0 – 9. For the purpose of this study, the researcher will be focusing on addition only.

Computational Fluency- having efficient and accurate methods for computing.

Retention- the ability to retain information. For the purpose of this study, the ability to retain basic math facts.

Limitations of the Study

1. Due to occasionally high absence rates, the instruction some children received may be more sporadic than others.
2. This study was geared to mainstreamed, self-contained students.
3. Although there were two math classes being used for the study, the number of students in each class was small.

Chapter II: Literature Review

Introduction

The key to mastering basic math facts is a solid foundation in what numbers represent. If a student does not have comprehension of what the relationships between numbers are, the foundation upon which fact acquisition is to happen cannot occur (Van de Walle, 2006). Either students frequently practice using their math skills to solve basic facts or they run the risk of losing those skills (May, 1998). There is no doubt that teachers of almost every grade level are spending a lot of time devoted to learning how to add, subtract, multiply and divide. Students generally spend the bulk of their instructional time in math learning arithmetic process and practicing them with paper-and-pencil drill (Burns, 1992). If this is the case, why are so many teachers in the upper grades spending time re-teaching skills students should have mastered and memorized in elementary school? The fact that many students in fourth and fifth grades have not mastered addition and subtraction facts and students in middle school and beyond do not know their multiplication facts strongly suggests that this method (paper and pencil) simply does not work well. Premature drill will certainly be ineffective, waste valuable time, and for many students contribute to a strong distaste for and a faulty view of learning mathematics (Van de Walle, 2009).

What are basic math facts?

Basic math facts are defined as computations involving the four basic math operations: addition, subtraction, multiplication, and division; using the single-digit number, 0-9. Mastery of a basic fact means that a child can give a quick response (in about three seconds) without resorting to nonefficient means, such as counting. (Van de

Walle, 2006). As well, fluency with the basic facts is developed through a strong understanding of the four operations (addition, subtraction, multiplication and division) and an emphasis on conceptual strategies for retrieving the facts (Van de Walle, 2006).

Why are basic math facts important to learn?

Basic math facts form the foundation of all subsequent computational fluency; students will need to know basic math facts before they move into harder, more complex problems. Information-processing theory supports the view that automaticity in math facts is fundamental to success in many areas of higher mathematics. Without the ability to retrieve facts directly or automatically, students are likely to experience a high cognitive load as they perform a range of complex tasks. The added processing demands resulting from inefficient methods such as counting (vs. direct retrieval) often lead to declarative and procedural errors (Cumming & Elkins, 1999; Goldman & Pellegrino, 1987; Hasselbring, Goin, & Bransford, 1988). Gagne (1983) emphasized that the process of computation that underlies all problem solving must be "not just learned, not just mastered, but automatized" (Caron, 2007). Developing automaticity frees up cognitive capacity for problem solving. Educators agree that automatic recall is best developed through drill and practice (Hasselbring, Goin, & Bransford, 1988). Additionally, focusing on math facts has an important place in children's math education. Children are able to reason more quickly and flexibly when armed with the basic facts. If they do not have basic addition, subtraction, multiplication, and division facts memorized as they progress to algebra and other higher-level math concepts, stopping to multiply by counting or adding slows them down. Important math processes like estimation and

mental computation are based on recall of math facts, which can empower learners and give them confidence to be problem solvers (Waite-Stupiansky, 1998).

One way to help students achieve mastery of basic math facts is through drills. Drills play a significant role in fact mastery, and the use of old-fashioned methods such as flash cards and fact games can be effective if used widely (Van de Walle, 2006). Woodward (2006) notes that there are two approaches to developing automaticity in facts: one is grounded in the use of strategies for teaching facts; the other emphasizes the use of timed practice drills. He goes on to say, "Recent research indicated that students might benefit from an integration of these two approaches" (p. 269). Research further supports Woodward in the same argument. The Frederick County Public Schools System (2008) encourages their educators and parents to practice with students in order to aid quick recall: Using highly organized and planned practice for the purpose of devoting facts to memory...practice (and/or drill) with specific groups of facts through fact cards, games, paper/pencil practice, and the use of software specifically designed for this purpose (November, 2009). All in all, a student must understand, as well as the parent and teacher, that in order for a child to grow in math, they must commit the facts to memory (Brennan, 2006).

Early approaches to teaching basic math facts

Many agree that before timed drills should be given to children, they need to have an understanding of number sense. Appropriate development needs to be undertaken in the primary grades, and if it is, there is no reason that all children cannot master their facts by the end of third grade (Van de Walle, 2006). Giving children meaningful experiences using math facts in the earliest years of schooling lays a firm foundation for

later mastery. Giving children experiences with arranging, counting and manipulating objects, as well as games and other engaging activities that use addition and subtraction give children the chance to solve problems over and over. Children will begin to associate meaning to the number. Then, they begin to grasp the consistency of the facts (Waite-Stupiansky, 1998). If the foundation has been laid and children understand numbers and their relationships, they will be able to solve problems abstractly by moving to paper-and-pencil, and less time will have to be devoted in upper-elementary and middle school classes to going over basic math facts again, thus freeing up instructional time for their own grade level standards.

It is especially important in the early years for every child to develop a solid mathematical foundation. Number activities oriented toward problem solving can be successful even with very young children and can develop not only counting and number abilities but also such reasoning abilities as classifying and ordering (NCTM, 2000). Each child is unique, and it is also important for a teacher of mathematics in the younger grades to allow for differentiation. As children are beginning school, they are sponges, ready to soak up just about everything laid at their feet. That is why it is critical for a math teacher of younger children to give students their math foundation. During playtime, sorting rocks can become a classifying activity. Young students can match the number of toy cars to a number on a page. Building roads with blocks leads to a discussion of longer versus shorter, wider versus narrow. Allowing young children the opportunities of exploration and supporting them by using mathematical words in discussion will give them the confidence necessary to feel they can move on to the next level and apply reasoning strategies.

An understanding of equality in addition and subtraction problems must be developed. Using manipulatives and giving children opportunities for hands-on experiences will help lead to this understanding. A strong foundation in number sense paves the way for basic facts. Mathematics learning for students at this level must be active, rich in natural and mathematical language, and filled with thought-provoking opportunities (NCTM, 2000). Memorization of basic facts should occur only after the meaning of the facts is in place (Waite-Stupiansky, 1998). Instruction by teachers should engage students in the math they are expected to learn. By allowing students to interact with and struggle with the mathematics using their ideas and their strategies, the math they learn will be integrated with their ideas; it will make sense to them, be understood, and be enjoyed (Van de Walle, 2006).

Playing games helps ensure students grow to have an understanding of math facts. Games with dice and cards allow students to add up the numbers. Children need frequent practice of math facts in order to master them (May, 1998). As students play games, they not only practice working with the basic facts, they learn to scan the facts for rapid recall. Math activities and games that support the learning taking place in the classroom reinforce instruction being taught and help children learn the content of basic facts. A game or other repeatable activity may not look like a problem, but it can nonetheless be problem based. The determining factor is this: Does the activity cause students to be reflective about new or developing mathematical relationships? (Van de Walle, 2006).

Once a child has developed the ability to construct meaning and counting strategies, and has had ample opportunity to reason with numbers and choose strategies

and operations, they will be better equipped to move to the abstract application and be ready for paper and pencil timed drills, automaticity, and computational fluency.

This purpose of this research was to determine a method that would help primary third grade students retain basic addition facts in math, specifically to investigate if giving students the answers to the addition problems at the top of the page aided in their retention and longevity of facts learned over a six week period or not. The study sought to establish that students leaving third grade have a good foundation in number sense and automaticity of recalling the basic facts of addition.

Chapter III: Methodology

This study investigated the effects of frequent practice of math facts and student automaticity in recalling facts. The research focused on two groups of third grade math students, over a six-week period, from a large American school (630 students) in a small German town. The Department of Defense Education Activity (DoDEA) schools served the children of military service members and Department of Defense civilian employees throughout the world. All schools within DoDEA were fully accredited by U.S. accreditation agencies. The researcher collected data from two math classes, differentiating teaching methods for each group.

Subject Selection and Description

The researcher studied two groups of third grade math students. At the beginning of the year, students were given an Inventory Test over third grade math objectives. This information, along with a review of student's cumulative files and in some cases recommendations from second grade teachers, was used to help determine which math group each student would be placed in. The math groups were ability grouped. The researcher collaborative-taught with a colleague during the year. Based on end of the year assessments and standardized testing, both were curious at results, and whether or not ability grouping their students would be beneficial and show greater gains and improvement, or whether or not a substantial improvement would be noted.

Because the community was transitional due to military transformations and realignments, students were constantly moving in and transferring out. Therefore, the number of students fluctuated. The researcher's sample consisted of thirty-three math students. The sample included twelve boys and twenty-one girls, all between the ages of

eight and ten. The students in the researcher's first sample consisted of three African-Americans, nine Caucasians, two Hispanics and two Multi-racial. The second group of third graders consisted of four African-Americans, eight Caucasians, and five Multi-racial. Sixty-three percent of the students in these two classes qualified for free or reduced lunch. All students were labeled as regular education math students.

Description of Setting

The researcher's school was located in northeastern Bavaria, Germany, in the Oberpfalz region. This community was a large training post for soldiers. The majority of our students lived in family housing on post, with approximately 30% living in off-post housing. Some students traveled to school on the bus for an hour or more. The post had an elementary school and high school. There was an elementary school, as well as the middle school for both locations, on another base about 15 miles away. Approximately three percent of the student populations were dependents of Civilians who worked for the Department of Defense. The remainder of the students were dependents of military personnel.

A closer look at our student population revealed the following: Our total enrollment was 630. Two students were American Indian or Alaskan Native, 4.6% were Asian, 19% were African American, 58% were Caucasian, 4% were Hawaiian or Pacific Islander, and 6% were Multi-racial. Six percent declined to answer, and 0.4% gave no information. Our school offered Sure Start, which is a pre-school program for at-risk children, and grades K-5.

The setting for the administration of timed drill tests was in the math classroom. Each math group received 50 minutes of math instruction daily.

Instrumentation

The researcher used four main instruments to collect data for this study. The first instrument was a Pre Test (Appendix A), which consisted of 50 mixed addition facts. This same instrument was also used at the end as a Post Test. The instrument was created by the researcher for the purpose of this study. The purpose was to compare computational fluency between the groups from the beginning to the end of the study. There were no answers given on the Pre or Post test, as the researcher was interested in noting how many facts children knew at the beginning of the study and how many they were able to recall at the end of the study, after participating in six weeks of weekly timed drills.

The researcher also designed the second instrument to be used with the experimental group. This instrument was used three times during each week in the researcher's math class as a way of helping students with automaticity and retention of their addition facts. This instrument consisted of 50 problems, all addition, expressed both vertically and horizontally. It was created using an idea developed by Caron (2007), whereby the answers to the problems on the math drill page are given to students in an answer box at the top of the paper. Samples of the weekly addition timed tests for each of the two groups are found in the Appendix. (Appendices B-E). Only the students in the experimental math group were given the answers. The students in the control math group had the same test, but no answers to rely on.

The third instrument, the Student Survey (Appendix F), was utilized to discover what students did at home that might have helped them learn their math facts. The researcher sought to find out what the students thought was the best way to memorize

math facts, and what strategies they used to help them solve math problems. The Student Survey was conducted by the researcher in class. The researcher administered this Student Survey during the first and last week of the study period.

The final instrument was a Parent Survey (Appendix G) which was used to elicit information from the parents about their child's study habits at home, how often they practiced or reviewed their math facts and what type of activities they participated in at home to aid them in their computational fluency. The Parent Survey was sent home with the students during the course of the study period.

No measures of validity or reliability were documented since these instruments were designed specifically for this study.

Data Collection Procedures

Data was collected from the researcher's two math classes. The first math class, which was the experimental group, took the test three times per week and the answers to the problems were listed at the top of the page. The pre and post test were administered to the experimental math class at the beginning of the study (pre) and again at the end of the study (post). The researcher also administered the student survey at the beginning of the study and at the end, and a parent survey was sent home during the middle of the study. Data was collected in an on-going manner by the researcher. The students in the researcher's class graphed their individual timed math results and kept track of their progress on personal graphs, which were kept in their personal Data Notebooks. There were on-going discussions about how to increase automaticity and students shared what they did to help them memorize their facts with classmates.

The control math group was also given a timed test three times a week. Their test did not have any answers on it; students were to generate sums from memory. The pre and post test were administered to the math class at the beginning of the study (pre) and again at the end of the study (post). The researcher also administered the student survey at the beginning of the study and at the end, and a parent survey was sent home during the middle of the study. Data was collected in an on-going manner. The students in the researcher's class graphed their individual timed math results and kept track of their progress on personal graphs, which were kept in their personal Data Notebooks. There were on-going discussions about how to increase automaticity and students shared what they did to help them memorize their facts.

The student survey was administered to the students in each class, at their seats, and read aloud by the researcher. The researcher thoroughly explained each question as it appeared in the survey and students marked their responses.

The timed math drills were administered three times a week and students graphed their results, keeping track of their progress and how many math problems they were able to complete correctly in two and a half minutes.

Parent surveys were sent home during Week 3 of the six-week study. Some came back immediately, and a few surveys were returned towards the end of the study period.

Data Analysis

The researcher analyzed growth made in each of the two math groups primarily by comparing pre and post test results. The researcher compared student study habits during the six week study, based on their responses from the student math survey. Parent responses were graphed and analyzed. The researcher then compared growth from

the first math group, which is the experimental group, to the second math group, which is the control math group, to determine if weekly timed math tests that included answers at the top were significant in helping students with automaticity of basic addition facts.

Limitations

Due to occasionally high absence rates, the instruction some children received were more sporadic than others. Because of the type of community the researcher taught in, students were frequently in and out of school. While typically students should be stagnant for the three-year tour of duty of their parent, some spouses choose to return to the States to visit family for a prolonged period of time. Not having a child in the classroom, or with breaks in their math fact drills, caused some student results to not show as much progress as others.

This study was geared towards mainstreamed, self-contained students. Children receiving instruction from a Special Education teacher in the math content area were not included in this study.

Although there are two math classes being used for the study, the number of students in each class was small.

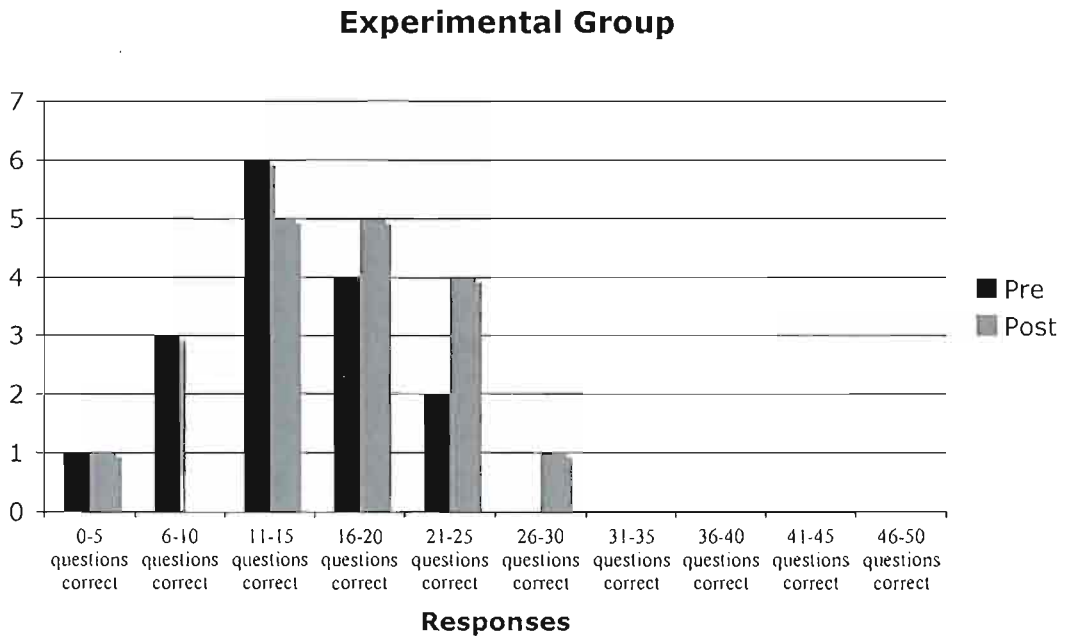
Chapter IV: Results

The purpose of this study was to determine if providing math fact answers at the top of the math drill sheet aids students in automaticity of recalled facts quickly or not. Two math groups were utilized; the experimental group had answers at the top of the paper that aided them when taking the timed test. The control math group did not have the answers given to them; they had to rely on mental math and strategies used at home to aid them in recall. A student survey was administered during the first and last weeks of the study to determine the strategies they employed to help them memorize facts while taking the timed test. A parent survey was also sent home during the study to find out student study habits at home, and to establish approximately how many days per week and how much time was devoted to practicing math facts.

Will providing math fact answers on the top of the page of math drill sheets improve student learning of math facts?

At the beginning of the study, the researcher noted that many students were struggling to recall the sums quickly, and several could only answer with a sum if they counted on their fingers. A couple of children seemed reluctant to attempt an answer at all. Students in the experimental math group did not seem to utilize the answers at the top of the paper as much as the researcher predicted they would. The researcher assumed that with the answers at the top of the page, children would be able to finish the 50 addition facts, or nearly finish, each time the test was administered. This was not the case. Very few students in the experimental math group were able to complete even half of the problems in the 2 ½ minute testing period with a correct sum.

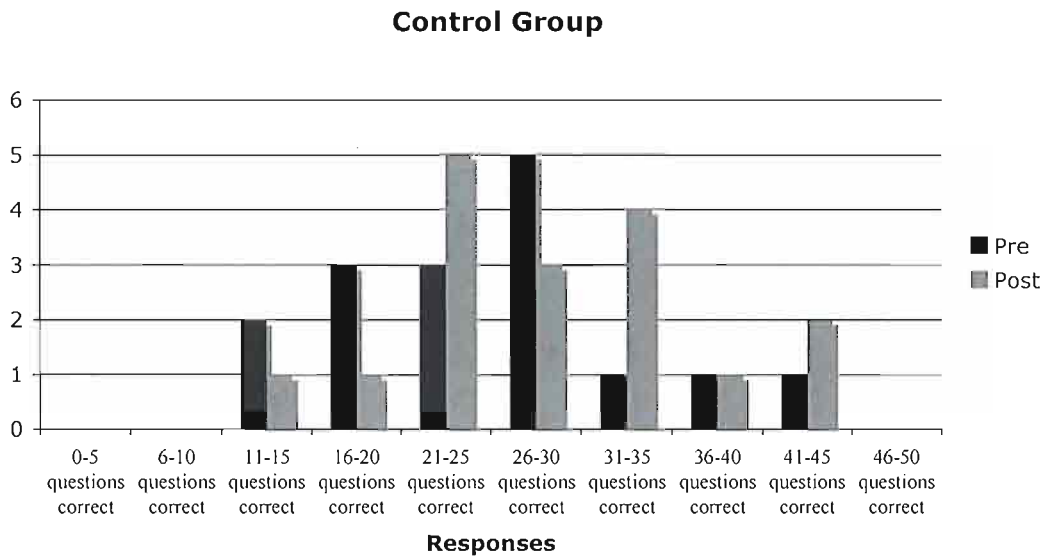
Figure 1. Student Responses for Pre and Post Mixed Drill Test - Experimental.



The data imply that, while students were not able to complete 50 addition facts in 2 ½ minutes accurately, they were showing improvement and making gains. On the pre test, 100% of the students answered correctly fewer than half of the test questions. When the test was administered at the end of the six week period, 0.06% of the students were able to answer at least 25 sums correctly. The data also show that on the pre test, 25% of the students were only able to correctly answer 10 problems or less, while on the post test, only 0.06% of the students answered 10 problems or less. Another finding is that the number of students who were able to answer correctly between 11 and 20 questions was 63%. All of the students in the experimental math group were able to answer 25 questions or less correctly on the mixed pre test. 0% of the students were able to answer

between 26 and 45 questions correctly on the pre test. Students in the experimental math group, on average, completed 13% correct in 2 ½ minutes on the pre test and on the post test completed 18% correct.

Figure 2. Student Responses for Pre and Post Mixed Drill Test – Control Group.



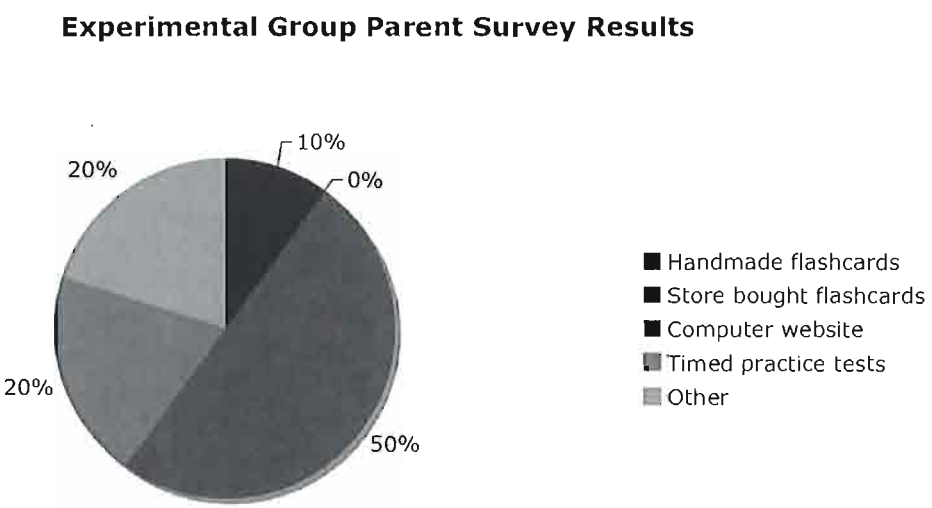
The data imply that on the pre test, 50% of the students answered correctly fewer than half of the test questions. When the test was administered at the end of the six week period, 44% of the students were able to answer at least 25 sums correctly. The data also show that on the pre test, all of the students were able to correctly answer more than10 problems. The number of students who were able to answer correctly between 11 and 20 questions was 31%. 41% of the students in the control group answered 25 questions or less correctly on the mixed pre test. Over 47% of the students were able to answer between 27 and 45 questions correctly. All students were able to answer at least

11 questions accurately. Students in the control math group, on average, completed 24% correct in 2 ½ minutes on the pre test and on the post test completed 31% correct.

What learning activities do students do at home that might help them learn their math facts?

For the experimental math group parent surveys, 75% were returned, compared to 94% of the control math group parent surveys. The experimental math group parent surveys noted that study strategies were completed by 33% of the students one to two times per week with an adult. 45% of the parents surveyed said their child practices their math facts three to four times per week with them, and 25% of the parents noted that their child is working independently on their math facts and did not help them study.

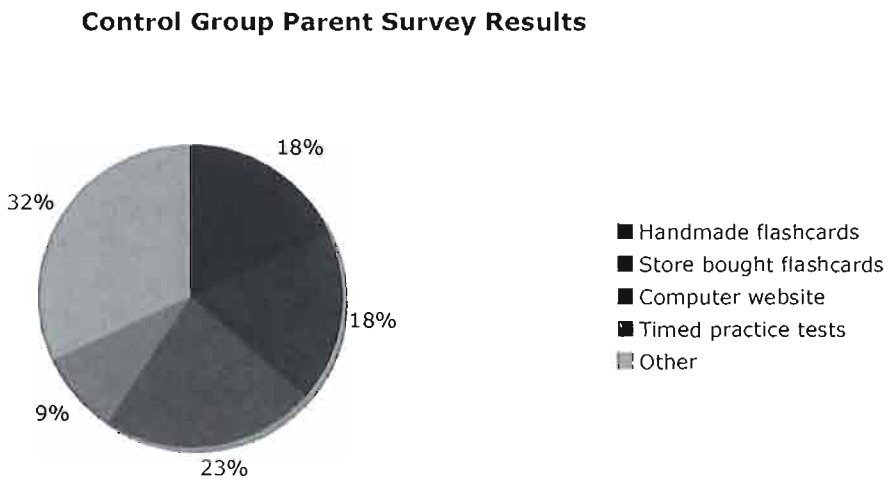
Figure 3. Experimental group Parent Survey Results.



The data reflect that 10% have made their own flashcards to quiz themselves at home and that no student has purchased store bought flashcards to study with. Half of the students, or 50%, whose parents returned their survey studied by means of a computer website. Three surveys noted that parents gave their child timed practice tests to help them memorize their sums. Three responses that fell into the "Other" category noted that the parent orally quizzed their child on math facts and one parent noted that she played board games with her child.

According to the returned control math group parent surveys, parents noted that study strategies were completed by 25% of the students one to two times per week with an adult. 31% of the parents surveyed said their child practices their math facts three to four times per week with them, 25% of the parents noted that their child is working independently on their math facts and did not help them study. 19% of the parents replied that their child studies their basic math facts daily.

Figure 4. Control math group Parent Survey Results.



The data reflect that 18% of the students have made their own flashcards to quiz themselves at home and that 18% purchased store bought flashcards to study with. Fewer students relied on computer websites in the control math group in order to study their facts; 50% of students in the experimental math group chose to study their math facts this way, compared with 23% from the control math group. 32% chose to study their math facts by "Other" means. Parents noted on the survey next to "Other" that they listened to Math Raps and music, orally quizzed their child, and helped their child learn tricks to learn their math facts. Three parents noted in their responses that they had purchased workbooks from the store to help their child learn their math facts. Interestingly, the data point to every strategy being utilized by the control math group, compared to the experimental math group, who did not employ store bought flashcards, listening to music, tricks, or store bought workbooks in their strategies.

Does weekly practice in school, coupled with practice at home, aid in retention?

The student survey was given to all children in both the experimental group and control group two at the beginning of the six-week study to assess what different types of strategies they employed during a timed test. It was given again at the end with the purpose being to gauge what strategies students were using or had employed in the past when solving addition problems, and as a means to compare from the beginning of the research period to the end, to see if strategies used during a timed test changed or not.

Figure 5. Experimental math group Pre Study Student Survey.

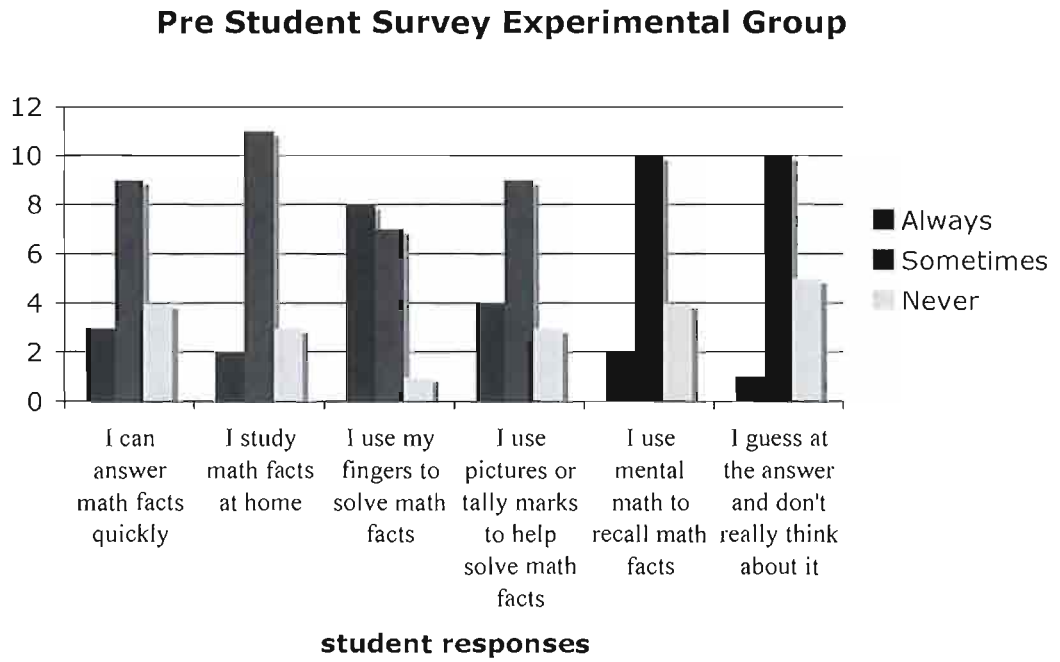
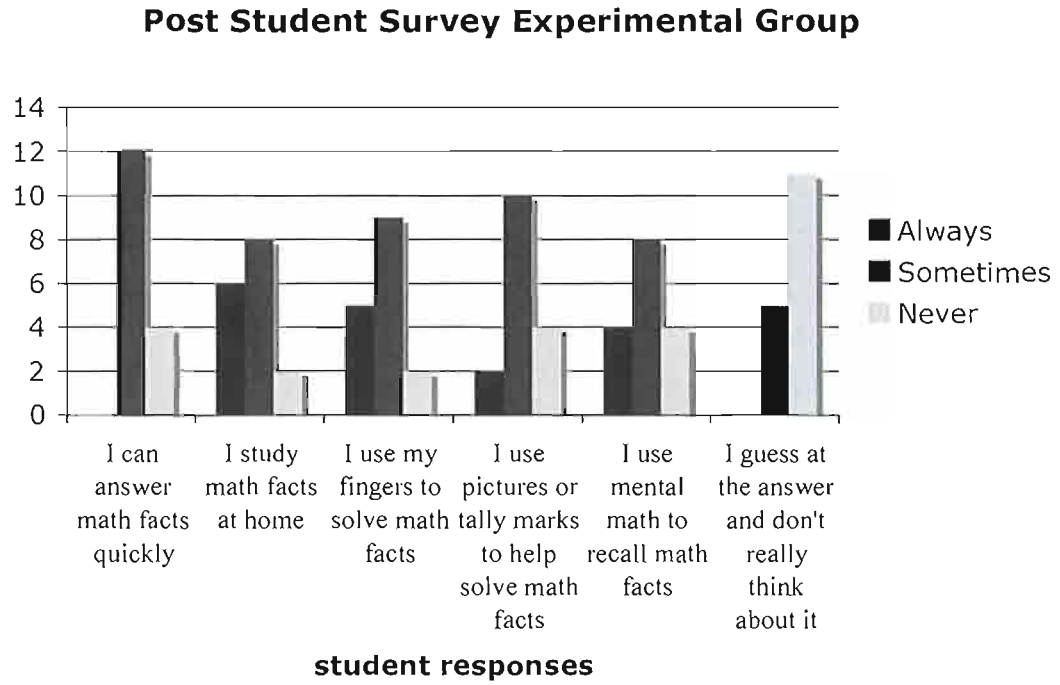


Figure 6. Experimental math group Post Study Student Survey.



I can answer math facts quickly

When comparing the pre student math survey for the experimental math group, the data revealed that student perceptions of their ability to know math facts quickly had stayed the same by the time they were asked the same question on the post survey. Twelve students said they could answer math facts quickly either 'always' or 'sometimes' on the pre survey. The same number of students, 12, felt they 'sometimes' answered math facts quickly on the post survey. In the pre survey, only nine students felt they could answer quickly 'sometimes'; in the post survey, the number rose to 12. However, three students answered 'always' to this question on the pre survey and zero answered 'always' on the post survey

I study math facts at home

Also, the data reveal that when comparing the pre and post survey, the number of children who said they studied their math facts at home is raised by one. Thirteen students answered 'always' or 'sometimes' on the pre survey, compared with 14 on the post survey. A positive noted is that the number of students who chose 'never' decreased by one.

I use my fingers to solve math facts

Fifteen students said they 'always' or 'sometimes' count on their fingers to help them solve math facts on the pre survey. Fourteen relied on this method by the post survey.

I use pictures or tally marks to help solve math facts

The data show that children in the experimental math group were fairly consistent with this strategy from the pre to post survey. Thirteen students said they 'always' or

'sometimes' draw pictures or tally marks to help them, compared with twelve students who still utilized this strategy by the post survey.

I use mental math to recall math facts

The researcher was pleased to note that the number of students who 'always' use mental math rose from two on the pre survey question to four on the post. However, the number of students who 'sometimes' use mental math went down from ten to eight. The same number said they 'never' use mental math on the pre and post survey.

I guess at the answer and don't really think about it

Finally, the research revealed for the experimental math group was promising and begins to show students were learning their math facts with automaticity and computational fluency over the course of the study period. Eleven students said they guess at the answer without thinking on the pre survey question either 'always' or 'sometimes', compared with five students answering 'always' or 'sometimes' on the post survey. The number of students taking wild guesses dropped by over 50% at the end of the research period.

Figure 7. Control math group Pre Study Student Survey

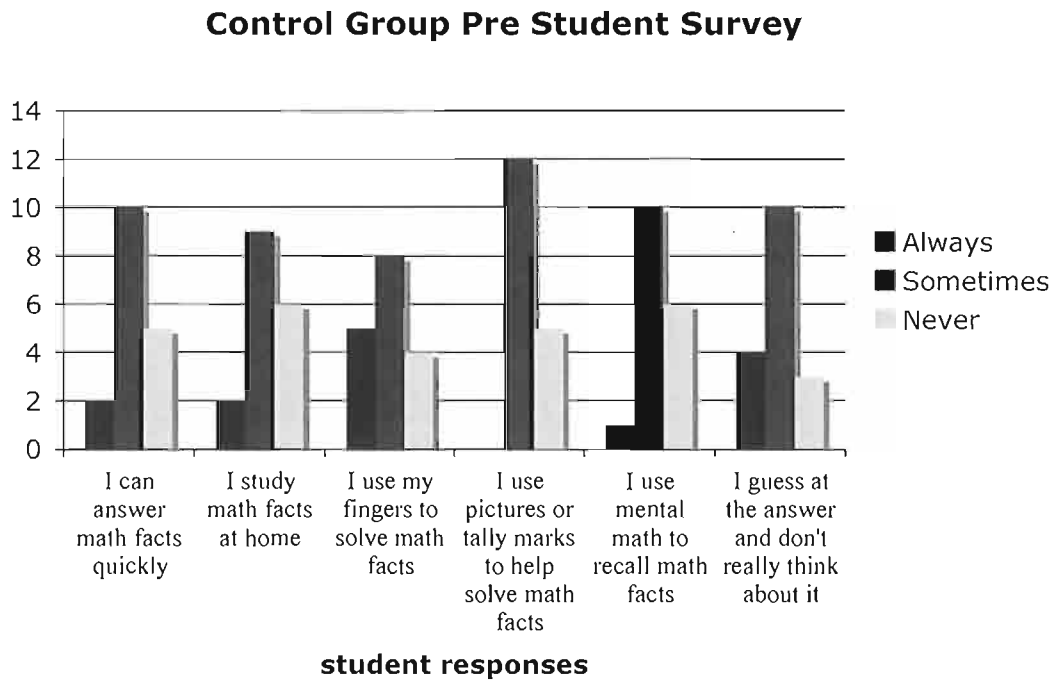
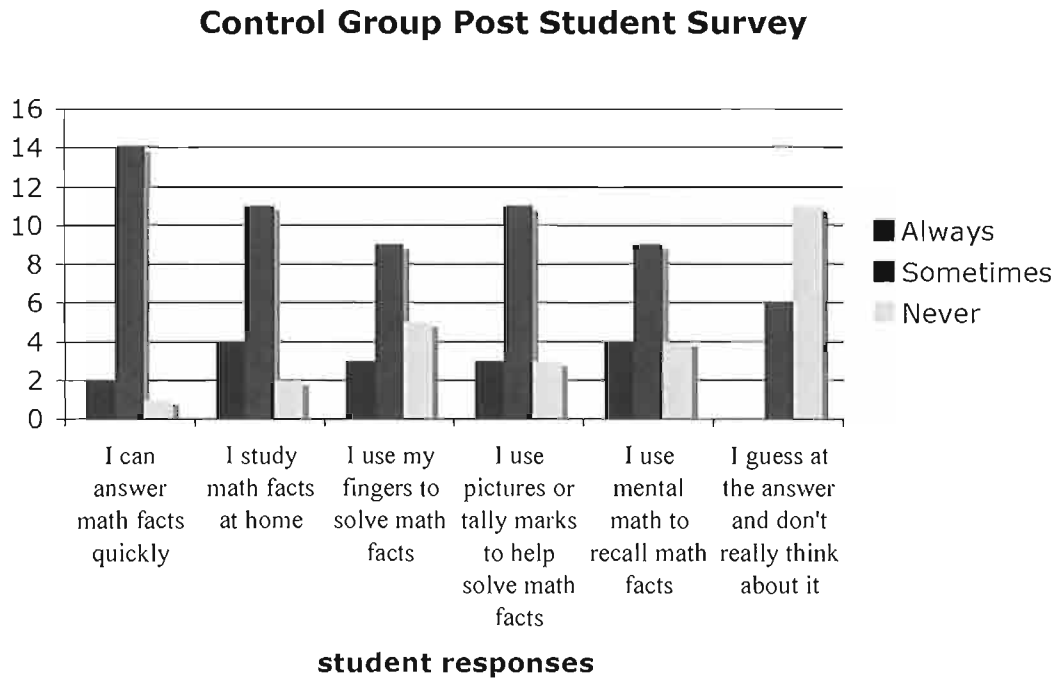


Figure 8. Control math group Post Study Student Survey.



I can answer math facts quickly

When comparing pre and post student survey data for the control math group, the data revealed that student perceptions of their ability to know math facts quickly had increased. On the pre survey, 12 students answered that they 'always' or 'sometimes' know facts quickly, versus sixteen on the post survey. The number of students who also felt they could answer math facts quickly 'never' decreased by four from the pre to post survey.

I study math facts at home

At the beginning of the research period, a total of 11 students answered with 'always' or 'sometimes' studying at home. Six weeks later on the post survey, 15 students employed this strategy to help them study and memorize their facts.

I use my fingers to solve math facts

Thirteen students used their fingers to help them count 'always' or 'sometimes' at the beginning of the study, compared with twelve at the end. This stayed pretty consistent from the pre to post survey.

I use pictures or tally marks to help solve math facts

The data show that children in the control math group relied more on tally marks and pictures at the end of the study versus at the beginning. Fourteen answered they 'always' or 'sometimes' used this strategy on the post survey compared to only twelve on the pre. Interestingly, five said they 'never' used pictures or tally marks on the pre survey but on the post survey, that number was three.

I use mental math to recall math facts

The researcher was pleased to note that the number of students who 'always'

used mental math rose from one on the pre survey question to four on the post. The number of students who 'sometimes' used mental math went down from ten to nine. Six students said they never used mental math on the pre survey compared with only four who never used mental math on the post survey.

I guess at the answer and don't really think about it

Finally, the research revealed for the control math group was also promising and reiterated that students were learning their math facts with automaticity and computational fluency over the course of the study period. Fourteen students said they guessed at the answer without thinking on the pre survey question either 'always' or' sometimes', compared with six students who answered 'always' or 'sometimes' on the post survey. The number of students taking wild guesses dropped by 47% at the end of the research period.

Will students show growth in basic addition facts from a Pre test at the beginning of the study to the Post test at the end?

Students in the experimental math group on average completed 13% correct in 2 ½ minutes on the pre test and on the post test completed 18% correct. The experimental math group had the answers at the top of the page for all of their timed tests.

Students in the control math group on average completed 24% addition sums correctly in 2 ½ minutes on the pre test and on the post test completed 31% of the sums correctly. The control math group was not given answers on their timed tests.

Both groups showed growth in memorization and automaticity of recalled sums after the six week research period.

Chapter V: Discussion

The ability for children to learn and maintain automaticity of basic math facts was the purpose for this research study. The research question was to determine if giving students the answers at the top of the paper was beneficial in helping students increase the number of problems they were able to get correct on a weekly timed math test. The research proved that gains were made in both the experimental math group and the control math group from the pre test to post test. However, giving the students in the experimental math group the answers at the top of their tests did not show a significant increase in computational fluency when compared with the control math group. Students in the experimental math group on average completed 13% on the pre test and 18% on the post test, netting a gain of 5%. The experimental math group had the answers at the top of the page for all of their timed tests. Students in the control math group on average completed 24% addition sums correctly on the pre test and on the post test completed 31% correctly. This shows a 7% gain.

A student survey was administered to children in both the experimental and control math classes to determine what kinds of studying and strategies they used to help them practice and learn their math facts. A survey was given at the beginning and end of the study to each group, so that differences could be noted. When comparing the pre student math survey for the experimental math group, the data revealed that student perceptions of their ability to know math facts quickly had stayed the same by the time they were asked the same question on the post survey. When asked if they studied math facts at home, thirteen said yes from the experimental group on the pre survey compared to 14 at the end, only a difference of one. Compared to the control group, 11 students

said they studied facts at home on the pre survey compared to 15 on the post, or an increase of four students.

A parent survey was sent home during the middle of the study, to establish what kinds of assistance parents were offering and giving their children, how many times per week their child studies math facts, and what their study methods were, whether computer games, flashcards, store bought workbooks or musical songs. For the experimental math group parent surveys, 75% were returned, compared to 94% of the control math group parent surveys. Based on answers and information provided from the parent surveys, it appeared that parents of students in the control math group spent more time interacting with their child in helping them acquire automaticity of basic math facts, as opposed to the parents of students in the experimental group, who seemed to rely heavily on students using the computers independently. The parents of students in the control math group also employed a wider variety of strategies to help their child study, such as listening to music, raps, buying workbooks from the store and flashcards.

A pre and post test of mixed addition facts was also administered to the students, to determine what their baseline of math fact recall was and to compare those to results at the end of the study, so that progress and gains could be noted. At the beginning of the study, the researcher noted that many students in the experimental group were struggling to recall the sums quickly, and several could only answer with a sum if they counted on their fingers. A couple of children seemed reluctant to attempt an answer at all. The students in the experimental group did not seem to utilize the answers at the top of the paper as much as the researcher predicted they would, however, they were showing improvement and making gains. Students in the experimental math group, on average,

completed 13% of the basic math facts correctly in 2 ½ minutes on the pre test and on the post test they were able to complete 18% with correct sums. For the control group, 50% of the students answered correctly fewer than half of the test questions on the pre test. When the test was administered at the end of the six-week period, 44% of the students were able to answer at least 25 sums correctly. Students in the control math group, on average, completed 24% correct in 2 ½ minutes on the pre test and on the post test completed 31% correct.

Limitations

Due to occasionally high absence rates, the instruction some children received was more sporadic than others. Prior to beginning this study, the researcher worried that attendance could have a very real effect on the data. The absences turned out to not be a problem, as once school got underway and students returned back from the States after summer vacation, attendance was quite normal. There were also no deployments or block leaves that are sometimes associated with a military community, and as such, no prolonged family time pulled students out that might have jeopardized data collection.

This study was geared to mainstreamed, self-contained students. All students that were used in this study were regular education, self-contained students. None received special education services in the area of math.

Although there were two math classes being used for the study, the number of students in each class was relatively small for data collection; 16 students made up the control group and 17 students were in experimental group.

Conclusions

The goal of the researcher was to determine if providing math fact answers on the top of the page of math drill sheets would show an improvement in student learning of math facts. Based on data collected and analyzed from the control math group, there was an increase in the amount of addition problems they were able to answer accurately in the 2 ½ minute timeframe. Students in the control math group on average completed 13% correct in 2 ½ minutes on the pre test and on the post test they completed 18% correct. Students in the experimental math group did not seem to utilize the answers at the top of the paper as much as the researcher predicted they would. The researcher assumed that with the answers at the top of the page, children would be able to finish the 50 addition facts, or nearly finish, each time the test was administered. This was not the case. Very few students in the experimental math group were able to complete even half of the problems in the 2 ½ minute testing period with a correct sum. Nevertheless, the students in the experimental group were showing improvement and making gains. The research revealed students were learning their math facts with automaticity and computational fluency over the course of the study period. The number of students taking wild guesses on the sums dropped by over 50% at the end of the research period. However, the gains the experimental group made during the course of the study were not significant when compared to the gains made by the control group. An increase in the number of math sums answered correctly showed a gain of 5% for the experimental group and 7% for the control group.

To aid in learning and memorizing addition facts at home, it seems that employing a variety of strategies, as well as parental involvement in the activities, is important in helping children master learning facts. Comparing the experimental math group parent surveys to the control group parent surveys, it seems that while some parents in the experimental math group were involved and would help their child study and master facts, 50% chose to let their child practice independently on the computer. Compared with the control group, which had a more balanced distribution of strategies used at home to help them study, only 23% chose to let their child practice their math facts independently on the computer.

Another question the researcher chose to answer was whether or not weekly practice in school, coupled with practice at home, would aid in retention. The fact that the researcher was committed to having her students take the timed drill tests on a regular schedule, three times per week, more than likely helped in the students know when to expect the tests. Also, discussing strategies with both groups and talking about what students could be doing at home, and what they were doing at home, more than likely aided in keeping the practice and commitment of reviewing and learning addition sums at the front of students' minds.

Finally, all students showed growth in basic addition facts from the pre test at the beginning of the study to the post test at the end. Students in the experimental math group, on average, completed 13% correct in 2 ½ minutes on the pre test and on the post test they were able to complete 18% accurately. Students in the control math group on average completed 24% correct in 2 ½ minutes on the pre test and on the post test they were able to complete 31% correct. Had the study period been longer, a more definite

increase or flat line of student test scores would have been more evident. As it was, over the six-week study, students in both math classes showed an increase in math fact retention. Their automaticity was increasing, as well as their speed. While the researcher predicted the students' scores from the control math group would go up substantially higher in a shorter period of time, this was not the case. However, progress was being made and scores were going up.

Recommendations

The researcher would recommend prolonging this study for a greater length of time in order for truer results to be noted.

Employing a variety of strategies to aid in automaticity of facts seems to be beneficial for memorization. A study based on the effectiveness of different math learning activities such as board games, computer games, workbooks or musical tunes might be a next step in order to discover what types of learning activities help aid children with memorization.

Also, the researcher began to realize that, although math timed tests were created for each fact, for example a test where at least one addend was three, one addend was four, one attended was five, and so on, it was difficult for the students to graph and realistically compare data against each other. The researcher realized that an addition facts of two test would not have all of the same problems as an addition facts test of eight. Therefore, the researcher recommends giving mixed tests of all basic facts, zero to nine, but varied.

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Appendices

Appendix A: Mixed Timed Test

Name_____ Mixed Timed Test Pre/Post

1 + 9 =	17+ 4=	14 + 3 =	16 + 2 =	2+0=
9+2=	4 + 11 =	7 + 19 =	9 + 5 =	1+3=
3 + 4 =	8 + 14 =	4 + 6 =	4 +15 =	7+6=
4 + 16 =	4+ 9 =	14 + 7 =	14 + 4 =	5+9=
5 + 4 =	5 + 8 =	9 + 11 =	5+ 4 =	8+3=
6 + 4 =	7 + 10 =	8 + 13 =	4 + 12 =	5+5=

4 + 15	11 + 4	4 + 14	4 + 4
4 + 13	4 + 16	4 + 1	4 + 0
4 + 9	7 + 4	4 + 3	4 + 18
4 + 10	1 + 4	16 + 4	6 + 4
4 + 13	4 + 17	4 + 18	4 + 0

Appendix B: Timed Test Sample

Name _____

Answers		
4+0=4	4+7=11	4+15=19
4+1=5	4+8=12	4+16=20
4+2=6	4+9=13	4+17=21
4+3=7	4+10=14	4+18=22
4+4=8	4+11=15	4+19=23
	4+12=16	

+4 Timed Test 2 ½ minutes

4 + 3 =	4 + 2 =			
9+4=	4 + 0 =			
3 + 4 =	8 + 4 =	4 + 19 =	4 + 6 =	4 + 5 =
4 + 16 =	4 + 0 =	4 + 5 =	4 + 7 =	14 + 4 =
8 + 4 =	5 + 4 =	4 + 11 =	5+ 4 =	4 + 3 =
2 + 4 =	4 + 10 =	4 + 13 =	4 + 12 =	4 + 14 =

4 + 15	11 + 4	4 + 14	4 + 4
4 + 13	4 + 16	4 + 1	4 + 0
4 + 9	7 + 4	4 + 3	4 + 18
4 + 10	1 + 4	16 + 4	6 + 4
4 + 13	4 + 17	4 + 18	4 + 0
14 + 4	4 + 19	18 + 4	4 + 7

Appendix C: Timed Test Sample

Name _____

+4 Timed Test 2 ½ minutes

7 + 4=	5 + 4 =		
4 + 9 =	17+ 4=	4 + 3 =	4 + 2 =
9+4=	4 + 0 =	4 + 19 =	4 + 5 =
3 + 4 =	8 + 4 =	4 + 6 =	4 + 5 =
4 + 16 =	4 + 0 =	4 + 7 =	14 + 4 =
8 + 4 =	5 + 4 =	4 + 11 =	5+ 4 =
2 + 4 =	4 + 10 =	4 + 13 =	4 + 12 =

4 + 15	11 + 4	4 + 14	4 + 4
4 + 13	4 + 16	4 + 1	4 + 0
4 + 9	7 + 4	4 + 3	4 + 18
4 + 10	1 + 4	16 + 4	6 + 4
4 + 13	4 + 17	4 + 18	4 + 0
14 + 4	4 + 19	18 + 4	4 + 7

Appendix D: Timed Test Sample

Answers		
5+0=5	5+7=12	5+15=20
5+1=6	5+8=13	5+16=21
5+2=7	5+9=14	5+17=22
5+3=8	5+10=15	5+18=23
5+4=9	5+11=16	5+19=24
5+5=10	5+12=17	
5+6=11	5+13=18	
	5+14=19	

Name _____

+5 Timed Test 2 ½ minutes

5 + 3 =	5 + 2 =
9+5=	5 + 0 =

3 + 5 =	8 + 5 =	5 + 19 =	5 + 6 =	5 + 5 =
5 + 16 =	5 + 0 =	5 + 5 =	5 + 7 =	15 + 5 =
8 + 5 =	5 + 19 =	5 + 11 =	5+ 18 =	5 + 3 =
2 + 5 =	5 + 10 =	5 + 13 =	5 + 12 =	5 + 15 =
5 + 9 =	17+5=			

5 + 15	11 + 5	5 + 15	15 + 5
5 + 13	5 + 16	5 + 1	5 + 0
5 + 9	7 + 5	5 + 3	5 + 18
5 + 10	1 + 5	16 + 5	6 + 5
5 + 13	5 + 17	5 + 18	5 + 0
15 + 5	5 + 19	18 + 5	5 + 7

Appendix E: Timed Test Sample

Name _____

+5 Timed Test 2 ½ minutes

7 + 5=	5 + 5 =	5 + 3 =	5 + 2 =
5 + 9 =	17+ 5=	5 + 19 =	5 + 5 =
9+5=	5 + 0 =	5 + 6 =	5 +15 =
3 + 5 =	8 + 5 =	5 + 7 =	15 + 5 =
5 + 16 =	5 + 0 =	5 + 11 =	5+ 5 =
8 + 5 =	5 + 5 =	5 + 13 =	5 + 12 =
2 + 5 =	5 + 10 =		

5 + 15	11 + 5	5 + 15	5 + 5
5 + 13	5 + 16	5 + 1	5 + 0
5 + 9	7 + 5	5 + 3	5 + 18
5 + 10	1 + 5	16 + 5	6 + 5
5 + 13	5 + 17	5 + 18	5 + 0
15 + 5	5 + 19	18 + 5	5 + 7

Appendix F: Student Math Survey

Student Math Survey

When you are taking a timed math test, whether in the classroom, in the library with a volunteer, or at home at the kitchen table, which of these strategies do you use to help you solve the math problems quickly?

For each strategy, choose "Always" if you always use that strategy.
Choose "Sometimes" if you use that strategy on occasion.
Choose "Never" if you have never used that strategy.

	Always	Sometimes	Never
I can answer math facts quickly			
I study math facts at home			
I use my fingers to solve math facts			
I use pictures or tally marks to help solve math facts			
I use mental math to recall math facts			
I guess at the answer and don't really think about it			

Appendix G: Parent Survey

Hello,

I am working on a research project in order to complete my Master's Degree. My topic is math and specifically, how kids retain math facts (are games that teach retention better than drills, are drills better than flashcards, etc...). To help me with some anecdotal information for my paper, would you please take a few minutes to answer the following?

If you have any questions, please feel free to contact me.

Shelley West
Shelley.west@eu.dodea.edu

1. How many **days** per week does your child practice math facts independently? Please choose one:
   - o 1-2 days
   - o 3-4 days
   - o 5+ days
   - o daily
   - o I am not aware that my child is practicing math facts at home

2. During one of your child's math fact practice sessions, **how long**, on average, would you say your child practices and/or reviews their facts?
   - o Around 5 minutes
   - o Around 10 minutes
   - o Around 15 minutes
   - o Longer than 15 minutes but under 20
   - o Other (please describe) _____

3. How many times **per week** do you or someone else in your house help your child practice their math facts?
   - o 1-2 days
   - o 3-4 days
   - o 5+ days
   - o daily
   - o My child is working independently on this

4. On average, **how long** would you say you help your child work to memorize their math facts?
   - o Around 5 minutes
   - o Around 10 minutes
   - o Around 15 minutes
   - o Longer than 15 minutes but under 20
   - o Other (please describe) _____

5. Please check the different ways your child practices their math facts:
   - o Hand made flashcards
   - o Store bought flashcards
   - o Computer website
   - o Timed practice tests
   - o Other (please explain) _____

This research has been approved by the UW-Stout IRB as required by the Code of Federal Regulations Title 45 Part 46.