A BRIEF ANALYSIS OF INTERVENTION STRATEGIES:
THE EFFECT OF CHORAL RESPONSE ON ACQUISITION OF
BASIC MATH FLUENCY WITH A SELECTED GROUP OF
STUDENTS WITH LEARNING DISABILITIES

by

Nicole Rochelle De Blasi

A Thesis

Presented to
The Faculty of Humboldt State University

In Partial Fulfillment
Of the Requirements for the Degree
Master of Arts
In Education
December, 2009
A BRIEF ANALYSIS OF INTERVENTION STRATEGIES:
THE EFFECT OF CHORAL RESPONSE ON ACQUISTION OF
BASIC MATH FLUENCY WITH A SELECTED GROUP OF
STUDENTS WITH LEARNING DISABILITIES

by

Nicole Rochelle De Blasi

Approved by the Master’s Thesis Committee:

David Ellerd, Committee Chair                  Date

Jayne McGuire, Committee Member                Date

Keri Gelenian, Graduate Coordinator            Date

John Lyon, Dean, Research and Graduate Studies Date
No Child Left Behind has caused increased demands on all students, but in particular those students in the special education classroom. These students are required to learn more with less time and teacher interaction. Many students with learning disabilities require different approaches to instruction than their general education peers. In a world where teachers are asked to meet minimum requirements within given amounts of time, many special education students are falling through the cracks and are not given an adequate baseline of knowledge to help them build on basic skills for advanced learning. Many students are now faced with learning new materials without fully understanding the basic concepts that are addressed in earlier grades. Once students enter middle school it is assumed that they have knowledge of all basic math facts and skills that will help them understand and complete an Algebra course. Unfortunately, many of these students do not have route memorization of their math facts (defined as simple addition, subtraction, multiplication and division of single digit by single digit numbers). Many students continue to count on their fingers, state they do not know the answer or use a calculator. Additionally, students are often not engaged in or find purpose when doing math facts individually and without teacher support. Studies have found that
when students are given opportunities to verbalize responses their effectiveness and efficiency in memorizing new facts improves (Wolery et. al. 1992). This study will investigate the effect of a group of middle school students’ ability to improve their math facts fluency by using a choral response method when completing a drill sheet. It is hypothesized that the students who participate in the choral response method will improve their fluency (and basic skill) knowledge as compared to a group of students who work on math facts with a repeated (silent and individual) method.
TABLE OF CONTENTS

ABSTRACT .......................................................................................................................... iii
DEDICATION ....................................................................................................................... viii
ACKNOWLEDGEMENTS ................................................................................................. ix
CHAPTER ONE: INTRODUCTION ...................................................................................1
CHAPTER TWO: LITERATURE REVIEW ........................................................................5
CHAPTER THREE: METHODS.......................................................................................16
CHAPTER FOUR: RESULTS............................................................................................28
CHAPTER FIVE: ANALYSIS...........................................................................................35
CHAPTER SIX: CONCLUSIONS ..................................................................................46
APPENDIX A: PARENT LETTER ..................................................................................51
APPENDIX B: SAMPLE MATH FLUENCY WORKSHEET .........................................53
APPENDIX C: SAMPLE STUDENT RECORD SHEET ..............................................54
REFERENCES ..................................................................................................................55
TABLES

TABLE 3.1: Participant Information .................................................................17
TABLE 3.2: Implementation Protocol – Drills and Practice ............................20
TABLE 3.3: Implementation Protocol – Flash Cards .....................................22
TABLE 3.4: Implementation Protocol – Choral Response .............................23
TABLE 4.1: Baseline Data for All Students Prior to Treatment ....................29
TABLE 4.2: Control/Drill and Practice Group ..............................................30
TABLE 4.3: Flash Card Group .................................................................30
TABLE 4.4: Choral Response Group ..........................................................31
FIGURES

FIGURE 4.1: Student Percent Increase .................................................................32

FIGURE 4.2: Average Percent Increase of Three Treatments .............................31
DEDICATION

I dedicate this research study to every one of my students who ever struggled with math. Not only do I appreciate their understanding and confidence in my ideas, but also their patience in allowing me to try new ways to make math more tangible and easier. Thank you all for letting me try new ideas in the classroom, as silly as they sounded when I first put them out there.
ACKNOWLEDGEMENTS

I could not have completed my research without the support and assistance of a number of important people. First, I would like to thank the educational staff at Humboldt State University, especially David Ellerd, Jayne McGuire, Peggy Kirkpatrick and Ann Diver-Stamnes. Without your support and guidance, this thesis could not have been possible. Thank you for the countless hours you have given me in your classrooms and with the editing process of this thesis.

Second, I would like to acknowledge my family including my husband, Mike, and my parents Scott and Susan. Without all of your support this thesis truly would not have been completed. Thank you for being my cheerleader when I felt I just couldn’t do any more, for inspiring me to get the work done even though I tried my hardest to “forget about it.” You all have been integral in my ability to finish this paper. Thank you from the bottom of my heart.
CHAPTER ONE
INTRODUCTION

*Concern and Purpose of Study*

Students are required to reach a level of mastery in advanced mathematical computations by the end of 8\textsuperscript{th} grade. Many of these students do not have a level of mastery on their basic math facts. They often rely on asking for help, counting or using manipulatives to solve for simple addition, subtraction, multiplication and division problems. Without a level of automaticity, mastery of more advanced mathematical problems is difficult if not impossible.

The purpose of this study was to examine the effects of choral responding on fluency and memorization of basic addition math facts, as opposed to standard practice methods of doing problems over and over or the flashcard method used in typical classrooms. After researching the current literature, a multiple-subject research design was developed that compared three different interventions with a special education math class in a public school. The goal of the research design was to determine which intervention was more successful in students’ ability to complete and retain basic math facts for this particular group of students. Chapter Two provides a review of the current literature in the field of choral response methods as well as the importance for students to learn and retain basic math facts. This chapter also addresses the need for students to gain automaticity in their knowledge of math facts. Finally, Chapter Two concludes with a discussion of the research question that
formed the basis of this current research study. Chapter Three is a discussion of the methodology used to implement the research design. This chapter includes a summary of the participants and a discussion of the setting and materials used to developed the study. Dependent and independent variables are also stated and discussed, as well as the treatment conditions. Chapter Three also includes the experimental design and procedures, and additionally a summary of how the social validity was treated.

The results of the research study are presented in Chapter Four in both tabular and graphical format. Participant scores for weekly math tests are included and compared based on the type of treatment that was received. Evidence is provided in the form of average number of problems completed with in the 2 minute weekly timed test. An overall comparison of gains (or loss) for each participant is also included.

The thesis concludes with Chapter Five, which is a discussion of the experimental design choice and a summary of the research findings. There is also an analysis of the limitations of the study and implications for future research and teacher practice.

Statement of Problem

There was three variables tested during the research study. The researcher determined if there was any difference between the choral responding, flashcards and the control group/drill and practice that used a traditional method of just practicing math facts in order to achieve fluency of addition math facts. The end result
determined if students obtain a level of automaticity in their math facts at a higher rate with the choral response method or the flash card method or finally, with those students who received no treatment.

*Definition of Terms*

*Addition facts.*

For the purpose of this study, addition facts are defined as specifically chosen random sets of math problems that range from 1+0 to 9+9.

*Drill and practice.*

For the purpose of this study the drill and practice refers to a set of addition facts in which the students just practice the computation without any treatment to aide in memorization other than individual practice.

*Flashcards.*

For the purpose of this study, flashcards are limited to random addition problems shown to a group for practice.

*Choral responding.*

For the purpose of this study, Choral Responding refers to the treatment of stating the math problem and the answer in a group, repetitive form (such as 2+2=4, 4+5+9 said out loud in a small group setting).

*Hypothesis*

By implementing a choral response method to a teacher’s instruction of basic math facts students’ abilities to correctly answer random addition facts will result in
a higher percentage of correct responses when compared to groups of students who participate in drill and practice instruction or flashcard instruction.
CHAPTER TWO
LITERATURE REVIEW

Introduction

With the implementation of No Child Left Behind (NCLB) teachers are required to teach more to all students with fewer resources and without regard to students’ current ability to grasp concepts. One problem with this law is that students are being pushed through material in all areas of the curriculum without actually mastering the basic skills. These basic skills are essential for moving forward in all academic areas as well as ensuring future independent success. In this study the researcher looked at how to improve basic math skills.

Automatic production of the basic mathematic facts (i.e., adding or subtracting two single-digit numbers) has assumed an important position in arithmetic teaching (Tournaki, 2003). In the past, mastery of math facts was considered fundamental to further mathematic study (Ashlock & Washbon, 1978). Currently, it is generally accepted that even if students are not automatic with basic facts, they should be engaged in activities that promote the development of number sense and mathematical reasoning (Gersten & Chard, 1999). Teachers today spend time and energy helping their students achieve automaticity in basic math facts (Tournaki, 2003). Students are taught how to become automatic either through the traditional drill and practice methods or through a direct teaching strategy (rules) (Tournaki, 2003).
Mathematics education has a long, ever changing history and future. In the 1940s there was a push for knowledge in more technological mathematical skills as there was a national need to pursue the technological age (Herra & Owens, 2001). During the 1960s students learned “new math” and then into the 1970s classrooms were back to the basics (Haught, Kunce, Pratt, Wernesks, & Zemel 2002). In the late 1980s the National Council of Teaching Mathematics (NCTM) created a set of math standards for grades K-12 (Haught et al., 2002). These standards encouraged the use of manipulatives and technology and decreased the focus on memorization of the basic skills (Haught et al., 2002). With the new NCLB requirements, the National Council of Teaching Mathematics (NCTM) has developed math standards based on the requirements of NCLB. Fluency in computation and math fact mastery are listed in the NCTM standards (Crawford, 2003).

**Learning the Basics**

Studies have shown that if basic facts are not learned and practiced in elementary school, it will become increasingly difficult for students to progress in their math skills in the secondary level (Steel & Funnell, 2001). There will always be some students who gain mastery through exploration and discovery, however there are many who need specific classroom interventions and program adjustments to gain the level of mastery needed to move onto more complex mathematical computations (Elkins, 2002). If students learn their basic math facts at an automated level, then it is believed that they will be more successful in their secondary and college level mathematic programs (Elkins, 2002).
Students who have learning disabilities have difficulties accessing standard classroom curriculum and more specifically those students who have a weakness in the area of recall of number facts are most vulnerable (Pegg, Graham & Bellert, 2005). There is only a limited capacity of cognitive ability and that one’s working memory has specific constraints in regard to the amount of information that can be processed (Zbrodoff & Logan, 1996). This ability is decreased in students with learning disabilities. By improving the processing speed of basic skills allows for a higher level of working memory to be available for more advanced tasks (Pegg, Graham, & Bellert, 2005). Research has shown that automaticity in recalling facts uses minimal cognitive capacity (McNamara & Scott, 2001). Automaticity is important for many reasons as stated above, but also within the classroom environment. When students are not automated in their thinking, lessons can stall as students look up facts or count on their fingers to figure out facts they should know from memory (Wong & Evans, 2007). In order to succeed at the high level mathematical skills, basic level skills must be mastered and effectively executed (Hasselbring, Goin, & Bransford, 1988). Without fluency and the ability to recall basic facts from memory at an automatic level students’ focus will be on those basic skills rather than more advanced problem solving skills which impedes advanced learning (Mercer & Miller, 1992). This being said, if students cannot perform basic math facts without the aid of a calculator, advanced level problem solving and mathematical functions will not be fully mastered (Westwood, 2003). Automaticity
is the level of mastery in which students can recall facts from memory without conscious effort (Hasselbring et al., 1988).

Research shows that academically low-achieving students and those with learning disabilities have the most difficulty learning math facts with automaticity (Woodward, 2006). Students with learning disabilities have been found to rely on counting strategies rather than automatic retrieval making the problem solving process slow (Geary & Brown, 1991). Student who rely on these strategies often make more retrieval and counting errors on basic math problems when compared to their non-learning disabled peers (Woodward, 2006).

When students are not able to retrieve facts automatically they are likely to experience a high cognitive load as they perform more advanced mathematical tasks (Woodward, 2006). Adding to the processing demand because of inefficient methods (such as counting) often leads to errors in mathematical calculations (Cumming & Elkins, 1999). Even if learning disabled students are delayed with their ability to recall facts automatically, studies have found that with systematic practice students can improve their abilities (Goldman et al. 1988).

Not fully and automatically knowing ones math facts can be frustrating for both student and teacher. Students who have mastered their math facts have been found to be more flexible and capable to reasoning (Waite-Stupiansky, 1998). Automaticity is the speed of processing (Mason, 2006). When students are presented with a basic math fact it should be an automatic retrieval, not a procedure to find the answer (Mason, 2006).
All students who experience a lack in knowledge of their basic math facts will continue to struggle and experience failure in mathematical concepts as they move forward in their learning of advanced level concepts (Miller, 1997). Although there is argument that too much time is spent on basic learning and not on the larger, more complex problem solving skills that NCLB requires students to master, the basic are building blocks for future application (Burns, 1999). State Standards and the National Council of Teachers of Mathematics both state that students must learn how to use mental math to solve applications involving estimation, problem solving and calculation (Haught et al., 2002).

Methods of Mastery

There are many different methods to teach students their basic math facts. Teaching students these facts through methods that use multiple modes of presentation are often advocated by experts. Traditional approaches include flashcards, worksheets, textbooks and timed tests. Current methods also include computer programs and calculators. Depending on student’s ability to recall information may determine how quickly the student will be able to learn the facts. Although the push over the years has been to go beyond the basic facts and into more complex thinking it is still imperative students have a basic grasp and ability to handle the simple before mastering the complex (Haught et al., 2002).

Drill and practice.

The drill and practice method teaches the basic facts by having students repeatedly practice their simple math facts in a practice and timed manner (how
many problems can the student complete in one minute). Studies have shown that frequent drill and timed tests have serious disadvantages (Isaacs & Carroll, 1999). Requiring students, especially those with learning disabilities, can cause anxiety and undermine a student’s understanding of the facts (Isaacs & Carroll, 1999). The drill and practice approach encourages students to believe that mathematics is more memorizing than thinking (Isaacs & Carroll, 1999). When the drill and practice method was used to teach students with and without a learning disability, it was found that students with the learning disability generally failed to automatize computational skills at an age-appropriate pace (Fleischner, Garnett, & Shepherd, 1982; Garnett & Fleischner, 1983; McKinney & Feagans, 1981).

*Flash cards.*

Using flash cards to practice and memorize math facts has been a strategy used in classrooms for years. Drilling students with flash cards on basic math facts and administering timed tests are often seen as archaic and uninspiring. In today’s test driven climate, teachers are encouraged to move to a math curriculum rich with problem solving, manipulatives, and active learning (Waite-Stupiansky & Stupiansky, 1999). In this study, flash cards will be used in a game like format. They will be used to encourage and compete against peers to remember math facts.

*Choral responding.*

Choral responding is a technique that allows all students to verbally respond to a question directed from the teacher (Heward, Courson, & Narayan, 1989). This form of responding allows for the teacher to hear accurate or in accurate responses
from a class or large group of students in a quick and efficient manner. Choral responding has been found to increase student participating during large group instruction (Gardner, Heward, & Grossi, 1994). By improving active student responses (student participation) student’s academic achievement also improves (Barbett, Heron, & Heward, 1993). Including choral responding into daily group lessons has been shown to improve active student responses as well as improved learning outcomes (Wood & Heward, 2004). Choral responding allows all students of all abilities to participate in active responding without fear of being on the spot. Teachers also get immediate feedback on which students are understanding the material or are not (Wood & Heward, 2004). Choral responding has been shown to improve student confidence in learning (Heward, Courson, & Narayan, 1989). Classroom off task behavior is also decreased during choral responding so that learning can take place without distractions (Heward, 1994).

Choral responding and active student responses work in a variety of settings and has been shown to improve students’ retention. One study found that students who participated in choral responding while learning health facts performed better on a daily basis, the health facts test, learned nearly twice as many facts and had a greater retention of materials when choral responding was used (Sterling, Barbetta, Heward & Heron, 1997). Research has shown that students who participate in direct instruction choral responding have greater academic, cognitive, and affective gains when compared to all other teaching models (Becker & Engelmann, 1996).
Benefits of Mastery

Statistics show that once math becomes an elective at the high school and college level students drop out at an average rate of 50% per year (Steen, 1989). This drop-out rate could be attributed to levels of frustration that teachers are challenged to reduce. Having knowledge of basic facts could help create a foundation that will reduce frustration, improve confidence and lead to mathematical mastery. Researchers have maintained that teaching children different strategies to learning can help them learn and retain new concepts of not only of higher order concepts and problems, but even of the basic math facts (e.g., Isaacs & Carroll, 1999; Steinberg, 1985).

Experts agree that students must first have and develop their thinking strategies before they can master memorization and automaticity (Leutzinger, 1999 & Waite-Stupiansky & Stupinsky, 1998). Repeated basic math fact activities create a repetition for students that leads to fluency, which leads to automaticity and memorization (Leutzinger, 1999).

According to Sprenger, “The brain has everything to do with learning, the more we know about brain science the easier it will be to make the hundreds of decisions each day that affect our students” (1999). It is imperative that teachers learn how the brain works and how students achieve memory on given items so that teaching can become more effective.

Even though national achievement has improved over the years, it is still clear that we lag behind our national counterparts in many areas, specifically in the
area of mathematics. As a nation it is important to continue to find ways to improve students’ knowledge and ability to compute and use problem-solving skills in math (Johnson, 1999).

In a world where technology is at every fingertip and information can be accessed at almost any time, teachers are faced with the question: What does every student need to learn before they leave my class. Thankfully, both at the state and federal level there are educational standards that build a framework that helps direct education. However, these standards are vast and often times complex, many students are not able to grasp the mastery of skills that are only taught for a short amount of time before teachers must move on to the next concept. Many times this information is not addressed again. Current research states that if students are not able to relate (access prior knowledge) to new concepts the likelihood of retention is diminished (Fogarty, 1997).

By repeating facts and activities (even in a short amount of time) students will become fluent in the use of taught strategies. Once this automaticity is created mastery is made much easier (Leutzinger, 1999).

*Research Study Justification*

There are a variety of instructional techniques that have been identified by which some students with learning disabilities may successfully practice and learn the basic math facts (Mattingly & Bott, 1990). These techniques include multisensory training (Lombardo & Drabmen, 1985), flash card drill (Schilling, 1985), instructional games (Beattie, 1981), manipulatives (Juliano, 1982), self-
monitoring (Coble, 1982), peer tutoring (Bullard & McGee, 1983), and computer-assisted instruction (Walkins & Webb, 1981). Although there is evidence to support the effectiveness of these procedures for mathematic instruction, most involve trial-and-error learning and not every method is effective for each student. Methods that teach students the right answer as they are learning the various procedures (addition, subtraction, multiplication and division) allow learners to promptly experience successful responding and avoid practicing errors. High levels of correct responding during initial instruction and practice (80% correct or higher) is one aspect of effective instruction (Rosenshine, 1983) and may be very important for learners with disabilities. This type of learning is present with the choral response method used in this research study.

Conclusion

The research reviewed clearly states that students need to learn their basic math skills so that they can be successful at more complex mathematical concepts. Additionally, it is not enough to just know one’s math facts, they must become automatic in their ability to retell the facts. With this knowledge, less time will be spent recalling or counting numbers and more time can be spent grasping the more complex equations that are taught in upper grades.

Through my review of the literature I was unable to find any research which examined the effects of choral responding on the acquisition of math facts. Although there is research stating that choral responding and active learning increases students’ abilities in various academic activities, there is no current research stating
the benefit of choral responding and math facts. Based on the lack of information on
the effects of choral responding and an increase in math facts retention I wanted to
specifically find out: 1) Will a student with learning disabilities improve their basic
math facts knowledge if they participate in a choral response practice session, rather
than drill and practice or flash cards method, prior to a timed test in a resource room
math class? And 2) will any other methods, when implemented prior to a timed test,
improve a student with a learning disability’s basic math facts knowledge?
CHAPTER THREE

METHODOLOGY

Participants

This study took place in a middle school in a small town in Southern Oregon. The students involved in this study were middle school students in grades 6-8 ranging in age from 12 - 14. There were 12 students who participated in the study, all of which had a diagnosed learning disability in math based on standardized test scores from the Woodcock Johnson III test. Table 3.1 includes scores for each student’s standardized score in Basic Math and Calculation (an average score is between 85 and 115).

Setting

The study was conducted in the students’ special education math class during the first trimester of the 2008/2009 school year. Students participated in the study during the first 15 minutes of their class period in their small groups based on treatments. Students were very familiar with the classroom and the staff members who were leading the treatment methods. During the treatment time the classroom was quiet, except for the choral response group who whispered their math facts out loud to the group.
Table 3.1.

**Participant Information**

<table>
<thead>
<tr>
<th>Student Name/age/grade</th>
<th>Basic Math Standard Score</th>
<th>Calculation Standard Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 (11, 6th grade)</td>
<td>79</td>
<td>81</td>
</tr>
<tr>
<td>A2 (13, 7th grade)</td>
<td>79</td>
<td>74</td>
</tr>
<tr>
<td>A3 (15, 8th grade)</td>
<td>69</td>
<td>60</td>
</tr>
<tr>
<td>A4 (12, 7th grade)</td>
<td>77</td>
<td>78</td>
</tr>
<tr>
<td>B1 (12, 7th grade)</td>
<td>68</td>
<td>66</td>
</tr>
<tr>
<td>B2 (10, 6th grade)</td>
<td>68</td>
<td>70</td>
</tr>
<tr>
<td>B3 (11, 6th grade)</td>
<td>68</td>
<td>79</td>
</tr>
<tr>
<td>B4 (13, 7th grade)</td>
<td>56</td>
<td>51</td>
</tr>
<tr>
<td>C1 (13, 8th grade)</td>
<td>79</td>
<td>81</td>
</tr>
<tr>
<td>C2 (13, 7th grade)</td>
<td>83</td>
<td>82</td>
</tr>
<tr>
<td>C3 (11, 6th grade)</td>
<td>85</td>
<td>89</td>
</tr>
<tr>
<td>C4 (14, 8th grade)</td>
<td>73</td>
<td>75</td>
</tr>
</tbody>
</table>

**Materials**

Warm-ups used for the treatment portion of the study consisted of a randomized set of 40 basic addition problems (ranging from 1+0 to 9+9) on the top half of a page, the bottom half had another set of 40 basic addition problems. In total there were 20 different warm-up pages for students to use. Each student used the
same warm-up sheet for the day regardless of their group. On the Friday post-test, students were given a worksheet with 80 random addition problems (ranging from 1+0 to 9+9). There were 4 different worksheets (a different one for each Friday post test). Each Friday all students were given the same worksheet. Students were given math folders that had a record-keeping grid on one side (so they could record their own scores) and had all their previously completed warm-ups, 1 minute tests and 2 minute tests.

The flash card group also had a set of 60 simple addition flash cards to practice prior to completing their warm up. Each group also had a stop watch to monitor the daily timings.

**Dependent Variable**

The effect of treatment conditions was assessed by a student’s ability to correctly answer simple math problems in a 2 minute time test. Student improvement was measured based on the percentage of problems answered correctly in a two minute timed test each Friday. Students did participate in daily post tests right after the treatment was implemented, but that test was only for recording purposes. Results were measured in percent correct.

**Independent Variables and Treatment Conditions**

Two interventions were implemented in this study to determine which of the two had a more significant impact on the percentage of correctly completed math facts in a two minute timed test. The control group participated in a drill and practice treatment (see Table 3.3) included practicing 40 random basic math problems
independently. The first intervention was the flash card method (see Table 3.4), which included participating in a flash card game as a group and then practicing basic math problems independently. The last intervention was the choral response method (see Table 3.5) included orally reciting basic math facts as a group, students then practiced 40 random math facts independently. After each group participated in their treatment method they practiced daily with a 1 minute post test. Each Friday during the study students completed a two-minute timed test to determine the overall percentage of problems answered correctly.

**Control Group (Drill and Practice)**

The control method was lead by an educational assistant. This group practiced the addition facts by doing 40 random facts from 0-9 silently with a pencil (top half of 1 full page of 80 practice problems) untimed. Once they completed the practice set they waited for the timed one-minute test, which was an additional 40 problems, listed on the bottom of the practice page. This group did the same methods for the entire time of the study. Once the timed test was administered these students completed as many of the remaining 40 problems that they could in one-minute. The educational assistant then corrected the total number correct and students recorded their score on a scoring sheet. Table 3.2 discusses the implementation protocol for the drill and practice group.
Table 3.2.

*Implementation Protocol – Drill and Practice*

<table>
<thead>
<tr>
<th>Drill and Practice Group Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students go to their assigned seat at the table.</td>
</tr>
<tr>
<td>Students begin working on their 40 minute warm up problems.</td>
</tr>
<tr>
<td>When completed with the 40 problems, students have staff member correct.</td>
</tr>
<tr>
<td>Students review any incorrect problems.</td>
</tr>
<tr>
<td><strong>Students wait for group to finish warm up.</strong></td>
</tr>
<tr>
<td>Students do a one minute timed post test to see how many problems they can complete.</td>
</tr>
<tr>
<td>Students have staff member correct post test.</td>
</tr>
<tr>
<td>Students record their score on a record keeping grid.</td>
</tr>
</tbody>
</table>

*Flashcard Group*

This method was also lead by an educational assistant. Prior to completing their practice sheet of 40 problems the educational assistant had students go through a set of 30 addition flashcards. The aide would show the cards to the group, students would say the answer, the first student to get the correct card would earn that card, the student who collected the most cards would win (if there was a tie, the cards would go into a pile and the next clear winner would earn all cards in the pile). Once the students completed the set they would then go through and complete their practice problems independently untimed. After finishing and correcting their
practice problems they would complete their timed test in one minute. The educational assistant would correct the final test and then students would record their final score. Table 3.3 shows the implementation protocol for the flash card group.

Table 3.3.

*Implementation Protocol – Flash Cards*

<table>
<thead>
<tr>
<th>Flash Card Group Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students go to their assigned seat at the table.</td>
</tr>
<tr>
<td>Staff member holds up a flash card.</td>
</tr>
<tr>
<td>First student to correctly answer the card gets to keep it.</td>
</tr>
<tr>
<td>Group goes through 60 basic flash cards, student with the most cards wins.</td>
</tr>
<tr>
<td>Students complete their 40 problem warm up.</td>
</tr>
<tr>
<td>When completed with the 40 problems, students have staff member correct.</td>
</tr>
<tr>
<td>Students review any incorrect problems.</td>
</tr>
<tr>
<td>Students wait for group to finish warm up.</td>
</tr>
<tr>
<td>Students do a one minute timed post test to see how many problems they can complete.</td>
</tr>
<tr>
<td>Students have staff member correct post test.</td>
</tr>
<tr>
<td>Students record their score on a record keeping grid.</td>
</tr>
</tbody>
</table>

*Choral Response Group*

This method was lead by the researcher as it was the method being tested for the study. Students were given the same practice sheet as the other two methods. In
this treatment students, lead by the researcher, would say out loud the problem and the answer before writing it down (2+2=4, then write 4 down, 5+9=14, then write down). The students would all state the problem and the answer in unison, if a problem was said incorrectly the researcher would correct the problem and then the group would restate the problem 2 times prior to continuing. Once all 40 problems were stated the students would participate in the one-minute timing. After completion the researcher would correct the timed test and the students would record their scores. Table 3.4 shows the implementation protocol for the choral response group.
Implementation Protocol – Choral Response

<table>
<thead>
<tr>
<th>Choral Response Group Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students go to their assigned seat at the table.</td>
</tr>
<tr>
<td>Staff member hands out 40 problem warm up page.</td>
</tr>
<tr>
<td>Staff member begins reading the first math problem with the answer (i.e. 1 + 2 = 3). No answer is provided, staff member recites the answer with the problem. Students do not write down answers at this point.</td>
</tr>
<tr>
<td>Students repeat the problem and answer after staff member.</td>
</tr>
<tr>
<td>Students and staff member chorally respond to all 40 problems.</td>
</tr>
<tr>
<td>After the choral response is done, students go back to the beginning and write down the answers 40 problem warm up.</td>
</tr>
<tr>
<td>When completed with the 40 problems, students have staff member correct.</td>
</tr>
<tr>
<td>Students review any incorrect problems.</td>
</tr>
<tr>
<td>Students wait for group to finish warm up.</td>
</tr>
<tr>
<td>Students do a one minute timed post test to see how many problems they can complete.</td>
</tr>
<tr>
<td>Students have staff member correct post test.</td>
</tr>
<tr>
<td>Students record their score on a record keeping grid.</td>
</tr>
</tbody>
</table>
**Experimental Design and Procedures**

A single-subject research design was used to compare choral response, flash cards and drill and practice methods and determine their efficiency to achieving math fact automaticity and retention. This designed used a control group (drill and practice) and two experimental groups (flash cards and choral response). Participants were placed in groups by a randomized control trial. Students were put into 3 groups of 4 based on a numbered list. Each student was counted off 1, 2, 3 or 4 and placed in a group accordingly. All three groups were assigned a staff member to administer the treatment. I worked with the Choral Response group as it was the method I was testing for my research question and was looking to see if this method produced the highest percentage of growth.

The study was conducted during a four-week period which started in October of 2008. Prior to the study, students participated in district approved curriculum that covered basic skills such as addition, subtraction, multiplication and critical thinking. During the four-week study, the treatment was conducted 4 times per week for 15 minutes per session. During the first 15 minutes of the math class, each staff member had the students work in their small groups and participate in their assigned treatment prior to doing their one-minute quick timing. After the treatments were administered students continued to work on their regular curriculum based on their IEP goals and objectives as well as basic skills that they struggled with.

Students were tested daily as a standard measure. During the daily tests students were given their treatment based on their groups. The drill and practice
group just practiced the problems, one group participated in a flash card game (staff showed card, first student to say card got the card, at the end the one with the most won the game) and the final group did choral response to 30 practice problems (led by teacher). All students then do a one-minute practice test independently. They record their scores on that given 40 problem practice page on a grid in their math folder. They are able to see what they did before and how many problems they got correct.

A final weekly test was done every Friday for the entire study. The Friday tests were done for 2 minutes and no treatment was done prior to the test. These tests contained a random group of 80 problems ranging from 0+0 – 9+9. Multiple tests were used to insure that students did not memorize problems or order of problems. Tests were then scored and a percentage correct was found to compare to prior weekly tests. Daily tests were only used for student record keeping.

*Baseline*

An initial performance level or baseline (see Table 4.2) on each student was completed at the beginning of the study prior to implementing any treatment. Students were given 80 problems and were given 2 minutes to complete as many problems as they could in the time given. The baseline was developed by finding the percentage correct each student completed during the 2 minute timed test.

*Treatment*

Students participated in treatment sessions based on their group (control group/drill and practice, flash cards or choral response). There were 16 total
treatment sessions and 4 post-test sessions all of which were conducted in the student’s resource room math class. Each treatment session lasted a total of 15 minutes, and each post-test session lasted 5 minutes. Students were subjected to the treatments Mondays – Thursdays for the entire 4 week period and post tests were conducted on Fridays.

Students were randomly put into treatment groups based on a numbering system. Each treatment session required the use of a different worksheet that had 40 warm up problems and 40 post-test problems. The flash card group also needed a set of 60 basic addition flash cards. Staff members implementing each treatment followed a specific protocol for each treatment to ensure validity.

*Inter-observer Agreement*

For one week of the study (week 3), each staff member switched the group they were working with (I went to the control/drill and practice group, the control group assistant went to the flash card group and the flash card assistant went to the choral response group). During this phase, each staff member continued to implement the treatment based on the protocol developed. Interobserver agreement was computed by monitoring the average number of problems correct and compared with the previous week’s work. For this phase 25% of the worksheets were assessed for interobserver agreement. Students’ averages for problems correct ranged from -2% to +3%. Which was similar to weeks 1 and 2.
**Social Validity**

Students were given a pre-test prior to participating in any treatment. As the treatments were implemented, students recorded their daily post-test scores and were able to see if they were answering more or less problems correctly. In their groups they were able to discuss how they were doing and how that made them feel about math. Additionally, an informal survey of elementary teachers was conducted. The researcher found that in elementary school, many students participated in an “Everyday Math” program that focused on skills rather than remedial facts. At the end of the treatment, students were given a final post-test. Students were then shown their overall growth of the study, this information was also shared with their parents when the study was completed.

**Assumptions**

The groups were randomly assigned using a random table of numbers. Therefore, the research that any difference between the groups is based on the different treatment used in each group, not to other factors.
CHAPTER FOUR

RESULTS

Analysis of the Data

Students were given a baseline timed two-minute test (T1) prior to implementation of any treatments. This test consisted of a random grouping of simple addition facts ranging from 0+0 to 9+9. Students independently completed the test in two minutes; their score was recorded in percent correct form (PC).

As shown in Table 4.1 students listed with an A prior to their number participated in the control/drill and practice treatment. Students with the B in front of their number participated in the treatment with flash cards and the students with a C in front of their number participated in choral response group. Table 4.2 indicates the baseline for all participants prior to the implementation of the treatments.

At the end of the 4 week study, all of the Friday post-test scores were added up and averaged then was compared to the students’ baseline percentage. Once the figure was calculated, a percent increase (in number of problems answered correctly) or a percent decrease (in number of problems answered correctly) as determined by subtracting the baseline number with the percent correct average for the study. Tables 6, 7 and 8 indicate the percentage increase or decrease for each student in the specific group.
Table 4.1.

*Baseline Data for all Students Prior to Treatment*

<table>
<thead>
<tr>
<th>Student</th>
<th>Percentage Correct (PC) Out of 80</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>43</td>
</tr>
<tr>
<td>A2</td>
<td>40</td>
</tr>
<tr>
<td>A3</td>
<td>55</td>
</tr>
<tr>
<td>A4</td>
<td>49</td>
</tr>
<tr>
<td>B1</td>
<td>31</td>
</tr>
<tr>
<td>B2</td>
<td>28</td>
</tr>
<tr>
<td>B3</td>
<td>25</td>
</tr>
<tr>
<td>B4</td>
<td>50</td>
</tr>
<tr>
<td>C1</td>
<td>23</td>
</tr>
<tr>
<td>C2</td>
<td>37</td>
</tr>
<tr>
<td>C3</td>
<td>41</td>
</tr>
<tr>
<td>C4</td>
<td>58</td>
</tr>
</tbody>
</table>

Note: Percentages are based on the total number of problems answered correctly in 2 minutes out of 80 problems.
Table 4.2.

*Control/Drill and Practice Group*

<table>
<thead>
<tr>
<th>Student</th>
<th>PC Average for study</th>
<th>Percent increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>43</td>
<td>+4%</td>
</tr>
<tr>
<td>A2</td>
<td>52</td>
<td>+17%</td>
</tr>
<tr>
<td>A3</td>
<td>71</td>
<td>+16%</td>
</tr>
<tr>
<td>A4</td>
<td>72</td>
<td>+12%</td>
</tr>
</tbody>
</table>

The average number of correct problems for this group was 49 correct problems.

Table 4.3.

*Flash Card Group*

<table>
<thead>
<tr>
<th>Student</th>
<th>PC Average for study</th>
<th>Percent increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>39</td>
<td>+8%</td>
</tr>
<tr>
<td>B2</td>
<td>28</td>
<td>+7%</td>
</tr>
<tr>
<td>B3</td>
<td>25</td>
<td>+17%</td>
</tr>
<tr>
<td>B4</td>
<td>54</td>
<td>+4%</td>
</tr>
</tbody>
</table>

The average number of correct problems for this group was 36 correct problems.
Table 4.4.

Choral Response Group

<table>
<thead>
<tr>
<th>Student</th>
<th>PC Average for study</th>
<th>Percent increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>31</td>
<td>+6%</td>
</tr>
<tr>
<td>C2</td>
<td>71</td>
<td>+21%</td>
</tr>
<tr>
<td>C3</td>
<td>62</td>
<td>+22%</td>
</tr>
<tr>
<td>C4</td>
<td>67</td>
<td>+2%</td>
</tr>
</tbody>
</table>

The average number of correct problems for this group was 51 correct problems.

*Note.* For Tables 4.2, 4.3 and 4.4 percent increase/decrease is determined by a comparison between the baseline figures for each student as compared by the average of the 4 Friday post tests each student completed.

As shown in Figure 4.1, all students were compared to each other. Student C3 had the largest increase in percentage of problems answered correctly. Figure 4.1 also shows that student C4 had the lowest increase in problems answered correctly.
There was growth for all students during the treatment phase. When looking at the data it is interesting to note that the group that received the flashcard treatment was significantly lower in their growth as compared to the other 2 groups. One other conclusion that could be drawn is since these are all students who have learning disabilities specifically associated with math, they could be working at their peak performance and regardless of treatment, they could be completing as much work as they possibly can. Group C saw the highest increase in average percentage which was the group receiving the choral response treatment.

Figure 4.2 shows the overall average percent increase for each of the groups.
Although all groups had an average increase in the percent of problems completed in the 2 minute timing, control/drill and practice group and the choral response group had the highest average increase. The control/drill and practice group averaged an 11% increase over the course of the treatment and the choral response group averaged a 13% increase. The flash card group on the other had only averaged a 1% increase despite having a flashcard treatment implemented prior to doing their timings.
Acceptance or Rejection of the Hypothesis

Based on the study’s data, there was a minimal increase in students’ ability to complete and retain their math facts within the given study time. Although students who participated in the choral response treatment averaged a 13% increase in their ability to complete 80 math problems in 2 minutes, the students with no treatment also improved their average increase by 12%. The difference between the 2 treatments was 1%. The students who used a flashcard treatment improved by the smallest margin, only 9%. Thus, any practice of math facts does improve automaticity, regardless if the practice is choral or independent.
CHAPTER FIVE

ANALYSIS

Choice of Experimental Design

Single subject research designs (also referred to as single-case experimental designs) are designs that can be applied when the sample size is small or when a number of individuals are considered as one group. These designs are typically used to study the behavioral change an individual exhibits as a result of some treatment (Gay & Airasian, 2003). Although I did not measure a behavioral change, I was looking for one specific change within the individual groups. In these types of research designs, the researcher is able to control the variables being implemented in the study. In my research design methods (single-subject randomized time-series design), I tested frequently both right after a treatment and at the end of each week of the study. This allowed me to detect any variables that might influence my data (such as regression, history, and maturation).

Because I was using my groups as single subjects and those groups were random my validity was accurate. If the dependent variable changes at the same time as the independent variable treatment, it is unlikely to be due to anything other than the treatment itself (Graziano & Raulin, 2000).

Advantages of this treatment are 1) selection of dependent variables that have a high social importance, 2) demonstration that the independent variables can be applied with fidelity by typical intervention agents (i.e. teachers, educational
assistants) in context across a meaningful period of time and 3) intervention is acceptable, feasible within available resources, effective and there is an ability to continue the use of the intervention methods after the formal support is removed (Horner, et. al., 2005).

Summary and Findings

Two research questions were explored during this study. The first research question addressed was: Will a learning disabled student improve their basic math facts knowledge if they participate in a choral response practice session prior to a timed test in a resource room math class?

Of the 4 students who participated in the choral response treatment, all students improved their basic math fact knowledge. C1 improved his math fact knowledge by 6%, C2 improved by 21%, C3 improved by 22% and C4 improved by 2%. Students participating in this treatment method had the highest average gain in numbers of math facts answered correctly during the 2 minute weekly post tests. When looking at all three response methods the control/drill and practice group averaged an 11% increase over the course of the treatment. The flash card method only averaged a 1% total increase. The choral response method showed an overall average increase of 13%. Students participating in this method had the highest individual increase of math facts fluency and retention during the course of the study.
The second research question answered was: Will any other methods, when implemented prior to a timed test, improve a learning disabled student’s basic math facts knowledge?

Of the 8 remaining students who participated, 5 students showed gains in their math fact accuracy. Two students decreased their math fact accuracy and one had no change. Of the students who participated in the control/drill and practice group only one student decreased their math fact accuracy, A1 increased their fluency by 4%. A2 improved his math fact accuracy by 17%, A3 improved by 16% and A4 improved by 12%. In the flash card group all students had a increase in their average percent correct on the weekly math post test. Additionally, B3 had a significant increase in the number of problems answered correctly (an increase of 17%). B1 had an increase of 8% math fact accuracy and B4 had an increase of 4% accuracy during the 4 week study.

Students were put into groups randomly at the beginning of the school year, prior to study implementation. These groups were created based on numbering off students based on their classroom seating chart. Each group was comprised of 4 students and one staff member. Each staff member was trained in the treatment method. Prior to the implementation of the study all students took a baseline 2 minute test. All students scored between 23 and 58 correct problems on the 2 minute timed test. During the initial baseline gathering period, students were given a worksheet with 80 random basic addition math problems. Students then were
instructed to begin working on the problems for 2 minutes. All students worked
diligently and did not appear to play around.

Once the study was implemented, students became very familiar with the
structure of the study. Students in the control/drill and practice group would go to
their group and begin their 40 problem warm up. After they completed their warm
up, students took a 1 minute timed post test to determine their daily score. This score
was recorded in their folders. Students then were able to see their growth or decline
daily which often lead to self motivation to do better.

Students in the flash card group started their method by competing in a game
using a set of 60 basic addition problems. The educational aide in the group held up
one card at a time and students competed to say the answer to the card first. When it
was said correctly, the aide would say, “Yes, 3+3 is 6 (or what ever the flash card
was)” and then would give the student the card. At the end of the session the student
with the most cards won (they didn’t receive any prize, but students were motivated
to win). Once the game was completed, the students would complete a 40 problem
warm up sheet. Upon group completion, the students would participate in a 1 minute
timed post test. Students would record their scores in their folders.

In the choral response group students would begin their treatment by chorally
responding to the basic addition facts on their warm up sheet. I lead this group. I
would begin by saying the problem and answer out loud for the students (i.e. 4+9 =
13), students would then restate the problem and answer in unison. If not all the
students responded to the choral response, I instructed the group to state the problem
again. Once all 40 problems were completed, the students would then go back to the beginning and complete the warm up by writing down the answers. After the group completed the warm up they would complete a 1 minute post test. Students would then record their scores in their folders.

On Friday’s students participated in a 2 minute timed test. Students were all given the same test and given 2 minutes to complete as many of the 80 problems they could in the given time. These worksheets were collected and the percent correct was recorded. Student scores increased on average for each of the three groups. The flash card group had the lowest increase of only an average of 1%, where as the control/drill and practice group increased by 11% and the choral response group increased by 13%.

This study compared three treatments to help middle school students become fluent and automatic in their ability to remember math facts. The study examined whether the implementation of a choral response method improved the students’ ability to retain and become fluent in their math facts as compared to the other treatments. In the first treatment, students practiced their math facts with paper and pencil while sitting in a small group before completing a timed math test. The second treatment required students to participate in a game involving flash cards prior to doing a timed math test. The final group students participated in a choral response method of stating the math facts ad answers out loud in a group and then doing a timed math test. By implementing a choral response method to a teacher’s instruction of basic math facts students’ abilities to correctly answer random addition facts will
result in a higher percentage of correct responses when compared to groups of students who participate in drill and practice instruction or flash card instruction.

Students were given a pre-test prior to participating in any treatment. As the treatments were implemented, students recorded their daily post-test scores and were able to see if they were answering more or less problems correctly. In their groups they were able to discuss how they were doing and how that made them feel about math. At the end of the treatment, students were given a final post-test. Students were then shown their overall growth of the study; this information was also shared with their parents when the study was completed.

Overall students all the students improved their ability to correctly complete basic math facts on their weekly post test. After the study was completed students continued to work on their basic math facts and continued to see improvements no only with addition problems, but also with subtraction problems.

Discussion

Studies have shown that if basic facts are not learned and practiced in elementary school, it will become increasingly difficult for students to progress in their math skills in the secondary level (Steel & Funnell, 2001). Students with learning disabilities in math lag significantly behind their cognitively normal peers; they need consistent interventions to improve their ability to master math facts. If students learn their basic math facts at an automated level, then it is believed that they will be more successful in their secondary and college level mathematic programs (Elkins, 2002). In order to succeed at the high level mathematical skills,
basic level skills must be mastered and effectively executed (Hasselbring, Goin, & Bransford, 1988). Based on this information I created my research questions and developed my research study.

The first question asked was whether a student with learning disabilities would improve their basic math facts knowledge if they participate in a choral response practice session prior to a timed test in a resource room math class. The conclusion from my research was positive. Students who participated in this treatment all improved the number of math facts answered correctly within a 2 minute timed test. Two of the students who participated in this treatment improved by the greatest average percent increase (21% and 22%).

By improving active student responses (student participation) student’s academic achievement also improves (Barbett, Heron, & Heward, 1993). Including choral responding into daily group lessons has been shown to improve active student responses as well as improved learning outcomes (Wood & Heward, 2004). By introducing the choral response students were able to actively participate in their learning, making them accountable for their learning and keeping them engaged in the learning process as well.

The results for the students who participated in the choral response method showed a significant gain in problems answered correctly. By including choral responding into daily the daily math fact lessons, student responses and correct answers both increased (Wood & Heward, 2004). Students who participated in this treatment were prompted to recite correct answers, which in turn gave them
confidence to state the problems out loud without fear of being wrong. As a teacher, I was able to know immediately if a student was hearing and stating the correct answers (Wood & Heward, 2004). Choral responding has been shown to improve student confidence in learning (Heward, Courson, & Narayan, 1989).

Although there are no data on how choral responding improves students’ ability to retain and become automatic in their math facts, there are data that show that choral responding does improve general retention. One study found that students who participated in choral responding while learning health facts performed better on a daily basis, the health facts test, learned nearly twice as many facts and had a greater retention of materials when choral responding was used (Sterling, Barbetta, Heward & Heron, 1997). Research has shown that students who participate in direct instruction choral responding have greater academic, cognitive, and affective gains when compared to all other teaching models (Becker & Engelmann, 1996). These studies’ outcomes are similar to the results of my research. Each of the students who participated in the choral response treatment did retain a higher percentage of correctly answered math problems.

All the students who participated in my research study were identified as having a learning disability in math based on standardized assessments. All students have an active IEP in place. These students are unable to participate in the general education curriculum because they are performing below grade level and do not have a handle on their basic math skills. Without fluency and the ability to recall basic facts from memory at an automatic level students’ focus will be on those basic skills
rather than more advanced problem solving skills which impedes advanced learning (Mercer & Miller, 1992). By the end of the study, these students all showed a significant improvement in their basic math fact retention.

The second question I asked in my study was: Will any other methods, such as drill and practice and flash cards also improve a learning disabled student’s retention and rate of automaticity of basic math facts on timed tests in a resource room math class? The answer to this question was yes, but not with percentages as large as those that I found with the choral response method.

Students who participated in the control/drill and practice group showed a consistent improvement over their baseline scores. The overall average for all the post tests was an increase of 11%. Despite not receiving a specific treatment, this group had the second highest average increase. This could be attributed to consistent daily practice or student motivation. Although studies have shown that frequent drill and timed tests have serious disadvantages (Isaacs & Carroll, 1999), such as requiring students (especially those with learning disabilities) to believe that math is just a series of repetitive memorization activities (Isaacs & Carroll, 1999). In my study, students did increase their basic fact knowledge, but also when asked to do multi-digit addition problems these students continued to use the basic skills to master this advanced level of mathematics as well. These students are able to complete these problems without the aid of a calculator and as a result advanced level problem solving and mathematical functions can be fully mastered (Westwood, 2003).
In the flash card group, the average increase for percent of questions answered correctly was 9%. These students improved by the lowest average increase, however student B3 improved 17% as compared to the original baseline data. B3 was very involved with the flash card game and often would get excited and would yell out the answers, even if another student stated the answer first. Even though the remaining group numbers had a smaller percentage increase, there was a significant increase in general.

The hypothesis of the study was to find out if implementing a choral response method to a teacher’s instruction of basic math facts would improve a student’s ability to correctly answer random addition facts at a higher percentage of correct responses when compared to groups of students who participate in drill and practice instruction or flashcard instruction. All students in the choral response group increased their average percent increase. Student C3 and C2 (choral response treatment) both improved over 20% in their ability to correctly answer basic math facts on the 2 minute test. Students A1, A2, A3 and A4 (control/drill and practice group) all improved their average numbers by 4%, 12%, 16% and 17% respectively. In the flash card group students improved their overall percentages by B1 8%, B2 7%, B3 17% and B4 4%. Repeated basic math fact activities create a repetition for students that leads to fluency, which leads to automaticity and memorization (Leutzinger, 1999). Students who are able to gain knowledge of their basic math facts will improve their mathematical concepts as they move forward in their
learning of advanced level concepts (Miller, 1997). By mastering the basic facts, these students are poised to continue to master more advanced methods of math.
CHAPTER 6
CONCLUSIONS

Limitations of Study

This study does not accurately reflect all middle school students. This study is limited to one special education classroom of middle school students (6th – 8th grades) with 12 students all having mathematical learning disabilities. Students who did not participate in the choral response method often would yell out answers when the choral group was practicing. Selection bias is a major concern for this study. As all of the students were in a special education class, it is not possible to generalize the results to all students.

Additionally, all students participated in each method in the same room. Although students worked with different problems at different times, the choral response method tended to be louder than the other groups and as a result could cause distractions. Moving forward it might be beneficial to implement the choral response method in a second room.

Students had been working on their math facts for 8 weeks prior to the study (with basic math curriculum and worksheets), their baseline could have been off because of their prior knowledge, and the daily testings could be a more accurate picture on their abilities. The baseline was one test, one day. The use of the choral response method only made a 2% increased difference as compared to the paper and pencil method of practicing math facts. The study was conducted over the course of
a 4 week period as opposed to the original 12 week period. This decrease in timing might have affected the overall lower increase in math facts retention. Additionally, the test phase did not start until late October as opposed to the beginning of the school year. This could have had 2 possible effects: 1) students had had 8 weeks of math instruction that could have increased their original baseline, and/or 2) 4 total students either moved into or out of my classroom during this time, bringing new levels to the groups or causing a need to rearrange the groups just prior to the test phase. This could have caused a change in comfort level within the group or behavior dynamics that could have also changed the groups. Creating a longer study process might yield higher (or possibly lower) percentages and would need to be addressed to ensure social validity.

If a student was absent during the Friday 2 minute test day, they made up that test the following Monday. However, the 4 one minute practice sessions were not done consecutively if this occurred. Student B1 missed several days of school during this period (although increased their average percent correct by 8%) and C1 went to speech 1 day a week during this time period, and although I asked him to stay and then go to speech, often times he was unfocused on the task at hand, he completed very little in the practice phase of the study. Since there was an issue of absences and interruptions due to other commitments, for a longer investigation, these issues would need to be addressed to ensure internal validity.

Because the research was done in a special education classroom the results do not generalize across other subjects and settings. This study only examined the
treatment methods on a small class setting of students with learning disability. As a result the conclusions made based on this study can only be made to this specific single group of students. Replication of this study with more students would give a better idea of how to generalize the results to a larger group of students that have different ability levels and learning styles.

Since there was a time limit on this test, it is difficult to state how long the information will be retained for each student. Additionally, it would be important in a longer study to test the different methods with other mathematical functions (subtraction, multiplication and division). There wasn’t much time to remove the treatment to test the success of the treatment methods. In a longer study, it would be important to try an ABAB experimental design. An extended maintenance phase would be helpful with a longer study.

Implications for Future Research

Overall the outcomes of this study were successful for all students. However, students were tested in a small group environment, with a familiar instructor. This would be a difficult set up to implement in a general education classroom, as there is usually only one teacher and no instructional assistants. In a general education classroom future research would have to focus on a multiple treatment design study that would allow for 1 or more of the treatments to be conducted in the larger class setting.
Lengthening this study over a period of more weeks and multiple settings would allow for a more diversified student base. This would allow for greater generalization than the current study’s single subject research design.

**Implications for Educators**

Students with learning disabilities face challenges in school everyday. Teachers are being asked to do more will less due to bills such as NCLB. All teachers need to know strategies that can help all students in their classrooms. Based on the literature review students who have learning disabilities have difficulties accessing standard classroom curriculum and more specifically those students who have a weakness in the area of recall of number facts are most vulnerable (Pegg, Graham & Bellert, 2005). Teachers need quick, easy ways to help students access the general curriculum if efficient manners. The results of this study show that any type of intervention, including drill and practice, flash cards and choral responding is an efficient, effective way to help students build their base knowledge of basic math facts.

By teaching students these basic skills will help them in the long run. If students learn their basic math facts at an automated level early in their schooling, then it is believed that they will be more successful in their secondary mathematic programs (Elkins, 2002). By taking time upfront to teach basic skills, students will become more successful as they continue on with their academic career.
**Final Thoughts**

Further study is recommended on best practices for students to retain math facts. It would be beneficial to try other facts such as subtraction and multiplication to see if the results would be replicated with more difficult operations. Additionally, it would be beneficial to try the test in a general education classroom with more students of varying abilities. Since there was limited growth for some students, it would be best to obtain 3 baseline timings, and then average those numbers. As stated previously, the baseline test for this study was on one day and one test. A multi-baseline approach might yield a better and more accurate baseline. That being said it is essential that the study cover the course of a quarter or a semester to best see the improvements of the students.

Although the students were agreeable to do the treatments, it wasn’t until the researcher showed them the data (showing their progress) that they became excited about the work. Once the students saw their growth, they began to become competitive against themselves as well as against their peers in the group. During the final week of the study, all students were asking what their last score was and were racing to beat themselves. Many students wanted to practice in the same method as the C group. It would be helpful to allow the students to track their own improvements on a graph so that they could see how they are doing. Additionally, when the study is over, it might be helpful for the class to graph their overall progress so that students can see how much they have learned.
10/1/08
Hi Parents,

As the year is well under way I would like to inform you of a project I am planning on doing in my math class. As you know, basic math facts are the building blocks to advanced mathematical computations. Without a firm grasp on these simple problems, advanced methods become difficult and frustrating. I am planning on implementing a test in your child’s math class during the next month to test strategies to try and find the best way for students to become fluent with their basic math facts.

The project will entail breaking the class into 3 groups. One will be practicing math facts daily with paper and pencil, a second group will be practicing with paper and pencil, but will also practice using flash cards as a group and the final group will be practicing their math facts using a choral response method. After each practice set, students will be timed for one minute to see how many correct problems they can complete. Once the test is done, the method that shows the greatest improvement in overall fluency of math facts will be implemented as a class. Every Friday students will have a timed test to find the percentage of correct answers they can complete in 2 minutes. Since we are testing regularly, students might become frustrated at their progress or feel embarrassed by having to recite math facts out loud. We will keep all data confidential; student will be able to individually see how they are doing, but not their peers. We will also be working in small groups so the embarrassment factor will be limited to 4 other students.

Although this project will go on for 4 weeks, students will only be spending 7 minutes total each day on learning their facts. After their math facts timed test they will continue to work in small groups on IEP goals as well as basic skills that they are currently struggling with. Participation in this test is strictly voluntary. If you would like to have your student participate please sign and return the second page of this letter. If you would rather they not participate, do not return this form. Students’ grades will not be impacted by participating or not participating in this test. All information will be gathered and recorded in an anonymous manner. Students will only be identified by numbers in my records. If at any point you would like your student to stop participating in the test, please give me a call or email me. All test results will remain in a locked file cabinet until next year and then will be destroyed.

If you have any questions or concerns, please feel free to contact me at any time at North Middle School (ndeblasi@grantspass.k12.or.us or 474-5740). Thank you for your time and support.
Sincerely,

Nicole De Blasi
My child, _____________________________, has permission to participate in this project as a part of their math instruction for this year. This test will help determine the most efficient way for students to learn basic math facts. Participation in this test is strictly voluntary. I understand that if at any time I do not want my child to participate they can withdraw (by contacting Mrs. De Blasi) at any time without any penalty at any time.

The testing will take place between November 1 and December 15, 2008 and will be conducted 4 times per week for approximately 7 minutes per day.

My child’s name will not be linked to any reports or records. I understand that all information will be kept anonymous and locked for one school year.

If I have any questions I can contact Mrs. De Blasi at North Middle School by phone, letter or email. (541.474.5740 or ndeblasi@grantspass.k12.or.us).

___________________________________   Parent Signature
___________________________________   Date
APPENDIX B: SAMPLE MATH FLUENCY WORKSHEET

#1 - Math Fluency (0+0 to 9+1)

<table>
<thead>
<tr>
<th>Practice (1 Minute)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>2</th>
<th>9</th>
<th>6</th>
<th>0</th>
<th>5</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>+0</td>
<td>+0</td>
<td>+1</td>
<td>+0</td>
<td>+1</td>
<td>+0</td>
<td>+1</td>
<td>+9</td>
<td>+1</td>
<td>+2</td>
<td>+8</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>+0</td>
<td>+1</td>
<td>+5</td>
<td>+0</td>
<td>+1</td>
<td>+3</td>
<td>+0</td>
<td>+4</td>
<td>+7</td>
<td>+3</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>+5</td>
<td>+7</td>
<td>+1</td>
<td>+9</td>
<td>+7</td>
<td>+0</td>
<td>+0</td>
<td>+0</td>
<td>+8</td>
<td>+0</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>8</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>+1</td>
<td>+3</td>
<td>+0</td>
<td>+0</td>
<td>+0</td>
<td>+7</td>
<td>+1</td>
<td>+1</td>
<td>+0</td>
<td>+6</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>0</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>+7</td>
<td>+1</td>
<td>+9</td>
<td>+0</td>
<td>+0</td>
<td>+0</td>
<td>+7</td>
<td>+0</td>
<td>+8</td>
<td>+5</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>+7</td>
<td>+0</td>
<td>+3</td>
<td>+0</td>
<td>+0</td>
<td>+1</td>
<td>+1</td>
<td>+4</td>
<td>+9</td>
<td>+3</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>+5</td>
<td>+6</td>
<td>+1</td>
<td>+0</td>
<td>+1</td>
<td>+0</td>
<td>+2</td>
<td>+0</td>
<td>+8</td>
<td>+0</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>+1</td>
<td>+7</td>
<td>+0</td>
<td>+0</td>
<td>+3</td>
<td>+1</td>
<td>+1</td>
<td>+4</td>
<td>+9</td>
<td>+1</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
</tbody>
</table>

Total Correct (1 minute) ________________
## Appendix C: Sample Student Graph

### Fluency Graph

<table>
<thead>
<tr>
<th>WSHT #</th>
<th>Date/Total Correct</th>
<th>Date/Total Correct</th>
<th>Date/Total Correct</th>
<th>Date/Total Correct</th>
<th>Date/Total Correct</th>
<th>Date/Total Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10/6 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10/7 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10/8 39, 10/9 38, 10/13 40</td>
<td>10/9 38, 10/13 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>10/14 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>10/15 31, 10/16 30, 10/20 27, 10/21 34, 10/22 38, 10/23 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>10/27 27, 10/28 34, 10/29 39</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>10/30 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>11/3 28, 11/4 27, 11/5 29, 11/6 34, 11/10 34, 11/12 38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>11/25 35, 11/26 38, 11/27 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>12/1 30, 12/2 35, 12/3 38, 12/4 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>12/8 32, 12/9 35, 12/10 36, 12/11 36, 12/15 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>12/16 38, 12/17 40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


Available: ESBSCO/Academic Search Elite [2008, September 13].


