

MODIFIED COPY, COVER, AND COMPARE USING MULTIPLICATION FACT  
TRIANGLES: THE EFFECTS ON MATH FACT ACCURACY AND FLUENCY

By

JENETTE FOSSUM

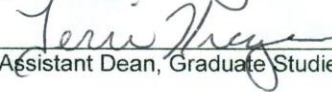
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Thesis Advisor



Program/Department Chair



Assistant Dean, Graduate Studies

University of Wisconsin – Superior

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Running head: MODIFIED COPY, COVER, AND COMPARE USING FACT TRIANGLES

Modified Copy, Cover, and Compare Using Multiplication Fact Triangles:

The Effects on Math Fact Accuracy and Fluency

Jenette Fossum

University of Wisconsin - Superior

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## **Chapter 1: Introduction**

### **Introduction**

Math is an integral component in all we do in our lives each and every day. It is also an academic area that builds on previous skills in order to learn more complex processes; each skill is not an independent entity. If students struggle to master the basic, fundamental skills in mathematics they will be set up for frustration and possible failure in their future educational career.

According to Bryant (2005) 5% - 8% of school-aged children display some form of a disability in the area of math, which often leads to long term struggles with math. In order for students to be productive members of society and to be independent in their work, home life, and hobbies students need to understand mathematical processes, and educators need to provide them with the basis for those skills at a young age. Although not all students learn math at the same rate, it is never too late to go back and re-teach students what they may have missed the first time it was taught.

Schools have demanding schedules in regards to scope and sequence of the required curriculum and attainment of state standards. For students who are struggling in math, there needs to be an effective and efficient way to catch up on their skills in order to gain the confidence and knowledge needed to learn the next sequential concepts. The concern is that if students are not identified early and provided with early intervention services they will begin to experience exponential loss in their math abilities which may become irreparable as they enter middle and high school.

## **Problem Statement**

The premise of Response to Intervention (RtI) revolves around providing students who are struggling, academically and/or behaviorally, with additional time, intensity, and focus through research-based interventions. A common misconception is that providing students with additional homework help for several weeks would be considered a valid research-based RtI intervention (Bryant, 2005). However, best practice in regards to RtI suggests that interventionists should first conduct two six-week Tier 1 interventions to try and remediate the student's specific academic or behavioral struggles within the classroom setting. If the large group Tier 1 intervention does not prove to be effective in addressing the student's needs, then the intensity of the intervention is moved to Tier 2, where the student is provided with more specific and focused interventions in a small group setting (Bryant, Bryant, Gersten, Scammacca, Funk et al., 2008).

Heiman (2010) noted that through the government's emphasis on school reform in recent years, many districts have reported making gains in student math achievement at the elementary level, but some middle and high school students, especially in high poverty districts, remain behind in their math skills due to a decreased emphasis. This study explored how student achievement levels in middle and high school are affected by the implementation of a categorical intervention in two areas of math (ex. math fluency and calculation).

## **Purpose for the Study**

The purpose of this study was to examine the effects of a specific, carefully research-based intervention on the math performance of middle school students identified as students in need of Tier 2 RtI interventions, and high school special education students identified as requiring a pull-

out math curriculum. This study was designed to help reorganize RtI service plans for students currently assigned to Tier 2 interventions for an extended period of time. If students spend less time receiving these services it would leave RtI personnel available to provide other necessary interventions. Most school districts have limited staff available to provide RtI services; therefore, at times students may not receive the high quality interventions they need due to personnel limitations. Also, in relation to the special education component it is the ultimate goal for teachers to be able to effectively and efficiently help students who are behind their same aged peers to remediate lost skills as quickly as possible. This study sought a more effective and efficient intervention and service delivery process, so that the students who require interventions are more likely to have that help made available to them.

This study also aimed to examine whether focusing on specific math areas would be more effective than providing students with support on their independent work through the current math curriculum. Students who continue to receive RtI services for extended periods of time are apparently not learning skills that are helping them to transition back to academic independence. Special education students who do not gain automaticity with math facts are not able to complete their designated work efficiently, creating an impediment in their academic progress (Axtell, McCallum, Bell & Poncy, 2009). During previous interventions which provided such students with consistent assistance on their math work, students may have adopted some aspects of learned helplessness, which has not encouraged academic independence. This study sought information about a technique that could be used to decrease student work time on math assignments and increase their accuracy with math facts to decrease the amount of time the student is reliant on supplementary assistance.

## **Research Questions**

This study examined whether or not students' math skills/abilities changed due to a new, specific, methodical, research-based intervention, called modified Copy, Cover, and Compare. Not only did this study aim to measure the effects of the intervention on overall math skills, but it also examined the effects of the intervention on students' accuracy and fluency levels related to multiplication facts.

The author strived to answer the following questions through this study:

1. Does the use of a modified Copy, Cover, and Compare intervention result in a change in student math achievement scores based on the STAR Math test?
2. Will students' digits incorrect per minute (DIPM) decrease following a six-week modified Copy, Cover, and Compare intervention?

## **Assumptions**

For the purpose of this study, it was assumed that the intervention would be delivered with fidelity by highly qualified interventionists, and that the students involved in the study were struggling in the area of math and not experiencing significant reading or attention deficits which could affect the effectiveness of the interventions. It is also assumed that a six week intervention period along with the allotted time in this study is sufficient to be considered an efficient and effective intervention. An additional assumption was that neither students nor teachers were invested in one outcome over another but that both were focused on effective teaching, learning, and support of student learning. Lastly, it is assumed that the research on the CCC strategy is solid, sound and reliable.



**Limitations of the Study**

A limitation of this study was the sample size of students and that the study was only conducted in one middle school and one high school setting for a six week period. The sample that was selected was a sample of convenience. The sample size reflected the small size of the local population. This local population may not be representative of the larger population of students who struggle with math studies. Also, the researcher is the math teacher for seven of the sample subjects which may lead to an unknown bias in the research data. Lastly, there was not a control group established to compare the research results to in order to determine the true effectiveness of the study.

The modified Copy, Cover, and Compare materials used in this study also provided a limitation because they were developed by the author and were not normed or standardized with other populations. The materials did follow the guidelines of the Copy, Cover, and Compare program with regard to the number and types of problems. Another limitation was that this study provided no follow-up to see if the expected gains made could be maintained and over what time period.

**Delimitations of the Study**

It was beyond the scope of this study to account for curriculum changes and potential changes in qualifications for Tier 2 RtI services. A delimitation of this study was that some of the research subjects were students who had been identified as requiring a Tier 2 intervention under the RtI model, but the RtI qualification process is rather subjective and does not provide concrete reasoning for who is qualified. For this reason it was not realistic to include the process for

selection of students for RtI services as a component of this study as it was up to the teachers to identify students with needs for Tier 2 RtI services.

The new math curriculum in the middle school during the year of this study included higher standards for each grade level which may have affected students' performance and involvement in or qualification for Tier 2 RtI interventions. This study did not aim to evaluate the effectiveness of the new math curriculum, but rather the effectiveness of the intervention administered through the RtI and special education programs specifically related to multiplication math fact accuracy and fluency.

The study did not intend to evaluate the effects of previous interventions students may have been a part of due to their special education or RtI participation. It did not intend to take into account the length of time the student had attended the school or the consistency of their attendance. These were not considered because the author focused on the effects of the specific intervention for the specified period of time on students of different backgrounds and abilities in order to assess the generalizability when using the intervention with diverse populations.

### **Referenced Definition of Terms**

RtI: RtI stands for Response to Intervention, and is a process that aims to help students who struggle academically or behaviorally through a tiered system of individualized, research-based interventions (Douglas & Horstman, 2011).

Tier 2 intervention: Tier 2 interventions are additional time, intensity, and focus geared toward the specific math needs of the student outside of regular instruction time. These interventions are provided in a small group setting (Douglas & Horstman, 2011).

RtI and special education intervention time: For this study, middle school students and high school students received 15 minutes of intervention time two days a week. Both samples participated in the intervention for a six week period.

STAR Math assessment: This assessment is computer based and includes 25 multiple choice questions. The progress through the test is determined by student response to pinpoint their current math achievement level (STAR Math: Technical Manual, 2012).

Cover, Copy, and Compare – This method is a simple, efficient, self-managed academic intervention aimed to improve accuracy, fluency and maintenance for students of various abilities and skills related to different subject areas. This method requires students to study a piece of information, cover up the stimulus, copy down the information and compare their answer in order to ensure a matching answer (Skinner, McLaughlin & Logan, 1997).

Modified Copy, Cover, and Compare – This intervention method adds an additional step when compared to Cover, Copy, and Compare. This method was created by the author of this study and expects students to view a fact triangle (academic stimulus), copy the stimulus, cover the original stimulus and generate the information from memory to produce the learned information on their own. After writing the practiced information the student compares their answers to the original fact triangles to ensure correct completion.

## Chapter 2: Literature Review

### Introduction

This study set out to examine the effects of specific, carefully research-based interventions on the math performance of middle school students identified as students in need of Tier 2 RtI interventions, and high school special education students identified as requiring a pull-out math curriculum. It is noted by Douglass and Horstman (2011) that research-based strategies can help students to fill gaps they may experience due to their difficulties in math. These strategies can supply meaning to students and may help them generate connections they otherwise fail to make. Bryant (2005) also argued that without early identification tools and interventions, students with math disabilities may not be able to attain mastery levels necessary for success on the high stakes assessments which have become such integral parts of the educational system today.

This study assessed the use of a research-based intervention meant to fill gaps in children's math experiences. It examined what the research has found to date. While not extensive, this literature review is organized into three areas. First, the review highlights the need for increased time, intensity, and focus for students receiving interventions, the strategic presentation of those interventions, and effective progress monitoring assessments required to gauge student growth as a result of these interventions. These components define the Response to Intervention (RtI) process as it has been proven effective for students in the area of academics and behavior. The second section of the literature review focuses on specific interventions which identified areas of need for students struggling in the area of math. The research highlights the need for specific interventions in each area of math to help students bridge the gap between their abilities and those of their age-appropriate peers, including interventions focusing on areas such

as quantitative reasoning, number operations, place value, and basic facts. In the third section of the literature review, previous research studies which used the Cover, Copy, and Compare method to remediate students' basic fact deficits are discussed. The review notes the benefits and limitations of the intervention in relation to multiple ages of students and method of implementation. A modified version of Copy, Cover, and Compare is the intervention implemented in this study in order to attempt to remediate middle and high school students' math fact difficulties.

### **Components of an Effective RtI Intervention**

Response to Intervention (RtI) is a program to promote student academic and behavioral growth, requiring methodical strategies implemented to maximize student growth. The essential service components of RtI include time, intensity, and focus. The following studies highlight the need for increased intensity of interventions, strategic presentation of skills in sequence, and effective assessments to gauge progress in the area of math.

Duhon, Mesmer, Atkins, Greguson, and Olinger (2009) explored the impact of increasing intervention frequency on student performance, specifically in the area of math. The study examined whether or not an increase in intervention intensity would affect students' academic performance on single digit addition facts. The authors hypothesized that the student's math fact accuracy and completion would increase as the intensity of the intervention increased.

Duhon et al. (2009) implemented their intervention with 35 students from a Midwest rural elementary school. The participants in the study consisted of the members of two of the five second grade classrooms. All students were involved in the first phase of the intervention which involved administering the addition fact probes one time per day for one month. The responses

of the students during the first phase were used as baseline data to compare with in the later phases of the intervention. When students were able to meet the designated criterion for three consecutive days they were dismissed from the intervention. Duhon et al. explained that the second phase of the intervention included administering probes that had the same format as the original probes, but had different problems in various orders, and the probe was administered five times a day. If students were not responsive to that intervention they were then moved to phase three where they received the probe ten times a day. After the initial data was collected, the researchers also considered skill maintenance and administered follow-up probes to analyze student retention of the skill taught during the intervention.

Duhon et al. (2009) found that the interventions increased student scores on the addition probes, with an average increase from 11 correct answers to 62 correct answers. It was noted that all students in the study made improvements. After all of the phases were administered, all students in the intervention group were considered to have reached the mastery level of functioning related to the specific skill of adding one digit numbers. With regard to maintenance of the skill, two of the three students who reached the third phase maintained the skills they mastered during the intervention period. The authors noted the importance of school officials recognizing the necessity of students not only learning skills, but also retaining them for later application.

Duhon et al. (2009) did note some limitations in relation to their study. They stated that using a benchmark criterion at times may be misleading due to various students' growth over time and their initial scores in relation to the benchmark. For future studies they recommended charting growth slopes of each student and then assessing specific student growth compared to an aim line or a group norm. The authors also noted the small sample size as a limitation, and

questioned the reproducibility of the study because it would be difficult to administer this type of intervention with the same procedure in a large school-wide group of students. Duhon et al. concluded that it was valuable for them to consider the option of increasing the intensity of an intervention; rather than discounting it at the first signs of failure, since they did see gains with certain students.

In an article which explored the benefits of RtI in relation to the sequence of skill-building rather than increasing intensity, VanDerHeyden and Burns (2009) examined whether or not the mastery of early skills affects the ability of students to learn and master future related skills. They also explored the relationship between fluency scores and predicted retention rates of the intervention skills over several months. The authors hypothesized that if students master early skills they will be more capable of mastering future related skills. They also conjectured that intervention scores could predict future performance on retention probes.

VanDerHeyden and Burns (2009) conducted their study in a suburban elementary school in the Southwestern region of the United States. The sample was selected from the second through fifth grade classrooms and included 432 students. The intervention consisted of an intervention probe which was used on a class-wide basis. The students worked in peer groups to practice, verbally and in written format, a set number of problems from a selected skill. The probe was used to track student progress and to alert the instructor when to move on to the next skill. VanDerHeyden and Burns determined that once the class median reached the mastery range it was permissible to move on to the next skill in the sequence. The retention skill probe was used weekly to track retention of previously learned skills during the intervention stage. Lastly, the authors used a progress monitoring probe once a month that included mixed skill

problems selected from the grade appropriate skill sequence previously determined by the school.

In the data analysis, VanDerHeyden and Burns (2009) used individual student data to compare academic growth related to the selected intervention skills. The authors concluded that the students who failed to reach a mastery level during the intervention stage also failed to reach mastery in assessment of subsequent related skills, which were more complex in nature.

VanDerHeyden and Burns noted that there was a fairly strong agreement between the performance of students on the intervention probe and identification of low-performing children. The authors then concluded that intervention probe scores could subsequently be used to assist with early identification of students in need of additional academic assistance.

VanDerHeyden and Burns (2009) noted that learning a basic math skill is directly related to students' success in learning the more complex subsequent skills. The authors cautioned that it was important to evaluate student success or failure based on their participation in an intervention directly related to their area of concern. The authors also highlighted the need for explicit teaching of how to solve computation and applied math problems so that students are able to generalize those skills when asked to perform more complex tasks in the future. Lastly, the authors illustrated that fluency scores, which are obtained through class-wide interventions, could be a possible tool used to identify children in need of more significant interventions.

Not only is the implementation of effective interventions essential for student success, but students also need effective progress monitoring to assess their gains in the specific intervention area. In a related study conducted by Anderson, Lai, Alonzo and Tindal (2011) the use and effectiveness of a Curriculum Based Measurement (CBM) tool to examine student



progress in relation to RtI interventions was explored. The authors hypothesized that the use of the CBM tool would help with identification and monitoring of students who are persistently low performing in the area of math.

Anderson et al. (2011) selected their study participants from two mid-sized school districts in the Pacific Northwest. All of the participants were from fifth grade classrooms. The authors used the easyCBM® online benchmark and progress monitoring system. The easyCBM® tool was based on the National Council of Teachers of Mathematics (NCTM) standards. The focal points in fifth grade mathematics were number and operations, geometry, measurement, and algebra. The authors reported that this tool had a high reliability rating and that the validity was also high because the CBM was generated from the NCTM standards.

Anderson et al. (2011) found that the easyCBM® measure was effective because the creators of the tool developed it based on grade level content standards while making those standard assessments accessible to all levels of learners. The authors reported that this tool would be potentially useful in informing educational decisions dependent on student performance. Anderson et al. also noted the usefulness of this tool on a large scale and for RtI identification for typically-achieving students and low performing students. The authors did note, however, that the easyCBM® measure was most effectively used in conjunction with other measures to get a concrete idea of where students were functioning academically in the area of math.

Anderson et al. (2011) identified limitations in relation to their study of the easyCBM® tool. The authors note that they used only one progress monitoring measure with students and that there are many other forms that could be used but were not assessed in the study. They also noted that their sample came from only two school districts and that if they were to repeat the

study they would include a broader population. Lastly, they suggested future researchers segregate various groups of students, such as students with specific learning disabilities and lower performing students, in relation to their same aged peers performing at grade level to note varying performance levels on the same measurement tool.

These three articles note the benefits of RtI in relation to the intensity of an intervention, the sequencing of instruction, and the assessment of student progress. Whether the intervention is in relation to math, behavior, or reading these three components are important to providing effective interventions that promote growth of student skills. Without these factors, as the studies indicated, the efficiency and effectiveness of interventions may not constitute the best use of students' educational time.

### **RtI Math Intervention Focus Areas**

There are documented benefits of increasing the frequency of interventions, strategic presentation of material, and monitoring progress in relation to interventions, but when providing math interventions, the research also showed it is important to look at the subsections of math to explore specific areas of student needs. There have been studies that have explored the benefits of focusing specifically on areas of math when administering interventions to students. Some of the areas include place value, magnitude comparison, addition and subtraction of digits, and number sequences. The following research studies illustrate the benefits of providing students with skill-specific interventions in the area of math to assist them with decreasing the achievement gap between them and their same-aged peers.

Fuchs et al. (2005) noted the importance of targeting specific skills for students struggling in math, and early identification of needs to facilitate the proper assistance and

intervention. The authors' goal was to assess the preventative effects of tutoring and to estimate the existence of math disabilities in the presence and absence of tutoring.

Fuchs et al. (2005) conducted their study with first graders from 41 classrooms in 10 different schools at the beginning of the school year. They began the study by identifying students who were at-risk for math difficulties and then assigning those students randomly to tutoring groups for intervention. The tutoring sessions happened three times a week for a 16 week period. The authors used a curriculum based measurement tool and administered it weekly to note progress.

The intervention process in the study conducted by Fuchs et al. (2005) consisted of a 30 minute tutoring session with groups of two to three students. The last 10 minutes of each session was devoted to student practice on a software program (Math FLASH) that promoted automaticity of math facts. The authors assessed students at the end of each session using a worksheet that the students completed independently to assess if they had reached a mastery level.

Fuchs et al. (2005) reported that there was a greater improvement in the at-risk tutored students when compared to the at-risk control group. The authors noted that the prevention practices of intervening through tutoring decreased the math disability prevalence. The authors also promoted the idea that RtI can be a useful tool in helping to decrease the number of students identified as having a math disability. Practice in the area of math computation, concepts/application skills, and story problems were identified by the authors as essential components that can lead to higher achievement in students. The practice used in the study

provided participants with about 24 hours of small-group tutoring coupled with eight hours of work on a specified math computer software.

Another study that focused on specific math interventions was conducted by Bryant, Bryant, Gersten, Scammacca and Chavez (2008). The authors explored the benefits of Tier 2 interventions for students who are at risk for demonstrating a math disability. The purpose of their study was to assess the effects of a Tier 2 intervention which focused on the areas of number operations and quantitative reasoning for students in first and second grade who were identified as having difficulties with math.

Bryant, Bryant, Gersten, Scammacca and Chavez (2008) conducted a study in an elementary school in a suburban Texas school district with 126 first grade students and 140 second grade students. The study was a quasi-experimental design that used the regression-discontinuity measure. The participants were administered four sub-tests from the Texas Early Mathematics Inventory – Progress Monitoring tool in a pre-test/post-test design. The scores from the Magnitude Comparison, Number Sequences, Place Value, and Addition/Subtraction Combinations sub-tests were all added together for the Total Score for each student.

Bryant, Bryant, Gersten, Scammacca and Chavez (2008) implemented interventions in addition to the regular core curricular instruction. The interventions were strategic and focused on specific skill sets that students commonly struggle with in mathematics. Skills addressed included number concepts, base ten, place value, and addition and subtraction combinations. The authors concentrated particularly on number concepts such as identifying teen numbers and zeros holding place values, since these skills have been identified as challenges for many students with

math difficulties. As a part of the intervention, students received an average of 63 fifteen minute tutoring sessions over an 18 week period.

Bryant, Bryant, Gersten, Scammacca and Chavez (2008) reported different results between the first grade group and the second grade group. There was no significant effect ( $b=.04$ ) observed with the group of first grade students but there was a significant main effect ( $b=.19$ ) observed with the second grade group of students. The authors also noted that although there was a significant improvement in the scores of the second grade students they were still considered to be below the level of their same-aged peers. The authors suggested that there was evidence from their study indicating that Tier 2 interventions should focus on mathematical skills such as number operations and quantitative reasoning because they could provide a predictive indicator of math struggles for students. The authors conjectured that it is possible the first grade group did not make as many gains because they needed more intervention intensity to learn number-sense tasks due to developmental differences.

Bryant, Bryant, Gersten, Scammacca and Chavez (2008) reported that there were limitations to their study. They stated that the study would have been stronger with a larger sample size and with instructional content that included word problem solving, considering the significant struggles students with math difficulties have in this area.

In a similar study by some of the same authors, Bryant, Bryant, Gersten, Scammacca, Funk et al. (2008) provided evidence that supported focusing on specific math areas for students who are identified as having difficulties in the area of math. A difference between the two studies was that Bryant, Bryant, Gersten, Scammacca, Funk et al. (2008) was run for a longer

period of time. Both studies, however, aimed to decrease the gap between students who struggle in the area of math compared with their same aged peers through Tier 2 math interventions.

In a study that highlights math interventions specific to certain math subtopics, Bryant, Bryant, Gersten, Scammacca, Funk et al. (2008) explored the effects of booster lessons as a Tier 2 intervention on the math performance of students identified with math difficulties. The goal was to decrease the gap between students struggling with math and their grade-appropriate peers. The authors hypothesized that the experimental group receiving the Tier 2 intervention would make greater gains than the group of students who did not receive the specific math intervention.

Bryant, Bryant, Gersten, Scammacca, Funk et al. (2008) chose to focus on four specific math areas when developing their interventions. Magnitude comparison, number sense, place value, and addition/subtraction combinations were all assessed on a pre-test/post-test system to gauge improvement for each participant. The authors noted that systematic teaching approaches need to be employed to provide students with enough instruction to increase their skills in each area. The study focused on providing students with a brisk pace of instruction, participation opportunities, immediate feedback for correction, and strategies for learning skills in the four content areas listed above.

Bryant, Bryant, Gersten, Scammacca, Funk et al. (2008) developed a Tier 2 intervention that was 23 weeks in length, with the intervention administered to students four times a week for 20 minutes. There were 161 total first grade participants; 42 of which received the booster math lessons intervention and 119 students who did not receive the intervention. The intervention consisted of explicit, strategic instruction in lessons concentrating on number concepts, base ten concepts, and addition and subtraction problems.

In the results of their study, Bryant, Bryant, Gersten, Scammacca, Funk et al. (2008) showed a significant main effect which indicated a positive result from the intervention program according to the regression discontinuity (RD) analysis. The authors credited the success of the intervention to additional instructional time in each area and the extended length of the intervention period. As pointed out by the authors, it is usually difficult for struggling math students to understand arithmetic combinations, but they demonstrated that work with fact families and fluency building math activities assisted in student growth in this area. The Tier 2 students who had the lowest pre-test scores made the greatest gains in magnitude comparison. The authors noted that the tutors who administered the interventions were people who had experience tutoring students and who adhered to the requirements of how the interventions were to be carried out.

Bryant, Bryant, Gersten, Scammacca, Funk et al. (2008) noted limitations of this study which included the small sample size from which they drew their participants, and uncertainty about whether struggling students were having difficulty with reading word problems along with carrying out the mathematical processes. Lastly, the authors stated that in future practice, teachers could work on numeracy skills and use curriculum-based measures in their classrooms in order to employ a preventative intervention with primary students rather than employing the pull-out sessions.

As illustrated by the authors of these articles it is essential that educators identify the appropriate areas of need along with the most effective means for intervening to decrease the number of students at risk for experiencing math difficulties. The studies reviewed in this section used various methods, but the common thread for an effective intervention was that it must be

specific, individualized, and administered by a qualified person to a small group of students rather than as whole class instruction.

### **Cover, Copy, and Compare Program**

Not only is it important to concentrate on the specific areas of math when planning interventions for students who are identified as needing Tier 2 RtI services, but educators also need to choose effective, research-based interventions. When identifying students in need of math interventions, it is important to focus on the areas of need so that time and energy can be dedicated towards the true need of each student. Often, slow math fluency timing and weak accuracy of math facts impede students' abilities to complete math tasks effectively. Cover, Copy, and Compare has been used in multiple studies over the years. It was described by Skinner, McLaughlin and Logan (1997) as a simple, efficient, self-managed academic intervention that can improve accuracy, fluency and maintenance with various students and in different academic areas. The basic premise behind the program is to have a student view a stimulus, cover the stimulus, copy it without looking at the original item and compare their answer to the original stimulus to ensure accurate learning of the concept. This technique has been used in the areas of math, spelling and vocabulary development. The Cover, Copy, and Compare program has been shown in the research presented below, to provide efficient and effective practice to help students increase their math fact abilities.

Axtell, McCallum, Bell and Poncy (2009) explored the effect of fluency training on middle school students' ability to gain automaticity with their division facts. The goal of their research was to increase fluency rates of math facts using two programs, Drill, Practice, Repair (DPR) and Cover, Copy, and Compare (CCC), while evaluating the performance of an



experimental group compared to a control group. The authors hypothesized that the group which underwent the interventions of math fluency training would experience a greater increase in the automaticity of their division facts.

The literature review compiled by Axtell et al. (2009) summarizes the positive outcomes of DPR and CCC, including (1) strong basic math skills which lead to the ability to complete complex math tasks, (2) higher scores on achievement tests, and (3) higher levels of skill maintenance. The authors conducted a preliminary study and drew conclusions from a pre-test and post-test measurement before they designed their intervention, which included the following procedure. The DPR process, which was used as the main intervention in this experiment, first asked students to use a tap-a-problem technique to complete problems quickly; then it moved to the CCC component where the students gained practice completing math problems quickly but accurately. Students then completed a timed assessment session to evaluate the effectiveness of the CCC practice, and finally, students created a graph noting their progress, which provided them with immediate feedback.

Axtell et al. (2009) included experimental and control groups composed of students ranging in age from 12-15 years old who were chosen by educators to participate in a four week summer program due to noted academic struggles, according to the authors. The experimental group consisted of students attending summer school for additional instruction in math and the control group for additional reading instruction. Axtell et al. explained that the students in the control group did not receive any math fluency training. The pre and post tests were CBM (Curriculum Based Measurement) probes to detect improvements in automaticity and fluency.

Overall, Axtell et al. (2009) found that the math fluency intervention increased the automaticity of division facts for students in the experimental groups. A proposed reason for increased automaticity was imposing time limitations that did not allow students to use strategies such as finger counting when solving math problems. The authors recommended that this intervention would be helpful in a multi-tiered instructional or RtI model. They also suggested that it could be effective in large group or small group settings as well.

Axtell et al. (2009) noted a few limitations of this research. The size of the experimental group (n=23) and the size of the control group (n=13) were relatively small for experimental research. Also, the original experimental design included three post-tests to allow for taking a mean score for over all comparison, but due to limited time at the end of the experiment, only one post-test was given during the research timeline. Axtell et al. noted that this may have affected the validity of the results. Lastly, the selection of subjects in this experiment was not random, nor representative, but rather a sample of convenience from middle to low SES schools in one school district of the United States.

In contrast to the study completed by Axtell et al. (2009), Grafman and Cates (2010) carried out a study that examined the benefits of Cover, Copy, and Compare in comparison with the modified Copy, Cover, and Compare (MCCC) method. The purpose of their study was to extend the use of CCC and MCCC using subtraction problems and to evaluate the effectiveness of both programs. They also included a component in their study that assessed which method was preferred by the teachers and students for teaching/learning subtraction math facts.

Grafman and Cates (2010) conducted their study with 47 second grade students from two classrooms in an elementary school located in a suburb in the Midwest. Their intervention

spanned three class periods and took a total of 50 minutes to complete. Students were administered a pre-test and a post-test that each contained 40 two-digit by one-digit subtraction problems to measure growth. As a part of the intervention, students were provided with both the CCC and MCCC worksheets each day. These pages consisted of 25 subtraction problems which were similar in format and nature to those presented in the pre-test and post-test forms.

On the first day of the study, Grafman and Cates (2010) provided students with only the pre-test measure and they were asked to complete as many problems as possible in two minutes. On the second day the authors administered the CCC and MCCC procedures to the students. During the CCC method, students looked at the problem with the correct solution, covered the problem, wrote the problem and solution on the right hand side of the page, and then compared their responses to the correct response provided in the first column. During the MCCC method, students first studied the problem and solution, then copied the problem and solution from the written model, covered the problem up, and then copied the same problem again. Lastly, they uncovered the correct solution to ensure their final answer was correct. If students did not get all of the problems correct on either procedure, they were required to complete an error-correction procedure which consisted of copying the problem they got wrong one more time in order to write the correct answer. On the third day, students were administered a post-test to note progress and to gather information on which method the students preferred.

Grafman and Cates (2010) reported that the data indicated that students demonstrated better fluency when working with the CCC model over the MCCC model. There was not a significant difference in the error rates reported for students using the CCC model versus the MCCC model. The participants noted that they preferred the CCC method over the MCCC

method due to the ease of the procedure. A positive aspect noted by the authors was that both of these methods required minimal time to teach the skill and to administer the worksheets.

Grafman and Cates (2010) did identify a few limitations to their research which included not truly being able to identify which method had a more positive effect on the post-test scores since all students completed both methods. Closer monitoring was required to ensure that students were following directions and to note whether students were looking at the answers as they completed the worksheets, and this could be a limitation. Grafman and Cates gave the students equal amounts of time to complete both the CCC procedure and the MCCC procedure, which may have been misleading because the MCCC procedure requires an additional step which would assume a need for additional time.

A third study which focused on the benefits of the Cover, Copy, and Compare method was conducted by Poncy, McCallum and Schmitt (2010). The authors of this study paired the Cover, Copy, and Compare (CCC) method with the constructivist-oriented method entitled Facts That Last (FTL). In contrast to the Grafman and Cates study assessing which method would be more effective or was preferred, Poncy et al. focused on the benefits that resulted from using both methods in an alternating treatment design.

Poncy et al. (2010) conducted their study with 19 second grade students from a rural elementary school in the Midwest. None of the students included in the study were receiving special education services. The purpose of the study was to compare the effects of two theoretically different interventions on the levels of math fact fluency. Specifically, Poncy et al. focused on the impact of these interventions on students' digits correct per minute (DCPM) when

completing basic subtraction facts. The intervention was applied for 10 consecutive school days and skill maintenance data was collected 2 months after the intervention had concluded.

As a part of the study Poncy et al. (2010) asked students to complete the CCC portion of the program by looking at a fact triangle, covering it up, writing the problem and answer that could be generated from the fact triangle, uncovering the model, and checking for accuracy. Corrective feedback was provided to students who made procedural errors. The second intervention used by Poncy et al. was FTL which revolves around the teacher asking students critical thinking questions related to fact families and how the numbers correlate with one another. According to the authors, students were provided with a two page worksheet that emphasized the skills they learned about fact families and then they were asked to complete a stack of flashcards related to the skills taught in the fact family portion. Poncy et al. explained the FTL portion of the study focused more on the interaction between students and teachers, how the students came to the correct answer, and the reasoning behind their answer.

Poncy et al. (2010) reported that the CCC method led to immediate improvement in accuracy and maintained knowledge of math facts when compared to FTL. The FTL procedure yielded similar results in Digits Correct Per Minute (DCPM) when compared to students in a control group who did not receive the additional instruction. Poncy et al. noted limitations associated with their study which included selection and modification of methods and diversity of the study sample. The authors suggested that there may have been inconsistencies in the data because the authors modified the CCC method by including fact triangles. They also noted that the FTL program provides seven techniques to improve math fact accuracy and fluency, and the teacher in this study chose only the two methods they felt would be most effective. Poncy et al.

noted that it would be beneficial in future research to include students in various grades with various target skills such as addition, multiplication, or division.

Overall, the studies reviewed here demonstrate that there are benefits of the CCC program when used independently and when coupled with other math intervention strategies such as FTL, DPR, and MCCC. The majority of previous research reviewed used these interventions with small samples and young participants, ranging from first grade through fifth grade. The current study aimed to focus on the effects of math fluency interventions with a middle school and high school population where it is unclear if similar methods would have the same outcomes.

### **Summary of the Literature Reviewed**

In summary, the literature presented here provides evidence of the importance of helping students reach mastery with their math facts. The current literature review supports the argument that simply helping students increase their accuracy and fluency with math facts can have a measureable impact on their overall math performance. The success derived from helping students reach mastery has been demonstrated in multiple research studies.

From the studies highlighted in this literature review (Bryant, Gersten, Scammacca & Chavez, 2008; VanDerHeyden & Burns, 2009) the success of the program is dependent on the students involved and the method that is chosen for their individual or group needs. In the first section, the studies (Duhon et al., 2009; Anderson et al., 2011) supported the benefits of providing students with increased time, intensity, and focus when trying to help them improve on an identified area of academic need. These studies noted that increasing the amount of time spent

focusing on a specific skill set can increase skill levels to the mastery level within a reasonable amount of time.

The second section focused more specifically on the area of math and how skills are interrelated within that subject matter. Fuchs et al. (2005) and Bryant, Bryant, Gersten, Scammacca, Funk, et al. (2008) suggest that math facts are the building blocks behind much of what students do in math, and that by increasing these skills, students will find more success in the area of math overall. In the third section, Axtell et al. (2009), Grafman and Cates (2010), and Poncy et al. (2010) concentrated on the use of the Cover, Copy, and Compare method coupled with other methods, and modified the procedure to find the most effective way to help students increase their Digits Correct Per Minute when completing math facts. The CCC method was shown to be effective and efficient due to the rather simple implementation, the limited resources needed, and the positive results shown in relatively short periods of time.

The literature reviewed in this section provides a strong basis for continued research using the Cover, Copy, and Compare method, or a modified version, with various samples of students with the potential to assist them in increasing their accuracy and fluency when it comes to basic math facts. However, the available research has left a gap in the area of middle and high school students and the effectiveness of these interventions with older students who have definite delays in math facts and computation. This study attempted to look more closely at the needs of middle and high school students.

As shown in the literature reviewed, research has been conducted to examine the use of CCC with younger students, but little research has concentrated on the effects of implementation at the middle school and high school levels with a sample of Tier 2 RtI students and special

education participants. Much of the existing research was also completed by pairing CCC with other intervention strategies. This study was designed to examine the benefits of using modified Copy, Cover, and Compare (MCCC), a version of CCC, independently for a six week period to note benefits on math calculation skills and overall math achievement.



## Chapter 3: Methodology

### Introduction

The length of time students spend in a Tier 2 intervention through the RtI process is dependent on the improvement of base math skills, such as math facts, increased through methodical and specific interventions provided to the students. Also, when students with special education needs plateau due to struggles with a basic math skill, their progress towards attaining the skill level of their same-aged peers is halted. If these specific interventions are delivered with fidelity and accuracy, students may experience heightened success in the area of math facts which could help them towards achieving success in the area of more complex math skills. The purpose of this study was to examine the effects of a specific, carefully research-based intervention on the math performance of middle school students identified as students in need of Tier 2 RtI interventions and high school special education students identified as requiring a pull-out math curriculum. For the purpose of this study, which was based on the regression-discontinuity design, the independent variable was considered to be the modified Copy, Cover, and Compare model and the dependent variables were the Mastering Math Facts two minute math fact timings administered for progress monitoring purposes and the STAR Math test administered to show growth over time.

The author strived to answer the following questions through this study:

1. Does the use of a modified Copy, Cover, and Compare intervention result in a change in student math achievement scores based on the STAR Math test?
2. Will students' digits incorrect per minute (DIPM) decrease following a six-week modified Copy, Cover, and Compare intervention?

## **Participants**

The participants in the younger group of this study were students in sixth, seventh, and eighth grade who have been identified by teachers to be in need of Tier 2 RtI interventions in the area of math at a small Midwestern middle school. The older group of students was from the high school special education program from the same district. For the 2012-2013 school year there were six middle school students who were receiving Tier 2 interventions in the area of math two times a week for a 45 minute class period. These students made up the younger group, and the intervention was implemented for part of the 45 minute class period, with the remainder of the 45 minutes continuing to be dedicated to supplemental curricular support. All of these students were mainstreamed for the rest of their school day. The high school group consisted of seven students with special education needs who were receiving pull-out services in math, and who received the intervention to increase their accuracy and fluency of math facts. They participated in the intervention for 15 minutes two times a week during the time that they were scheduled to be in the special education room.

The small Midwestern middle school had 81 students, six of which received math RtI services. This sample accounted for 7% of the total population of students in the middle school. In the high school, there were 23 special education students out of the total population of 105 students; seven of those students were receiving pull-out services in math. This sample accounted for 6.7% of the total high school population. The school district from which the sample was taken was located in a rural community. According to district demographic reports, the school population was mainly comprised of white students. There was a small percentage of students from diverse backgrounds including 2.5% of students who were Asian and 2.5% of

students who were African American. In addition, 53% of the student population was eligible for the free or reduced lunch program.

Table 1

**Demographics of the High School Pull Out Math Group**

<b>Student</b>	<b>Age</b>	<b>Years in Pull Out Math</b>	<b>Gender</b>	<b>Other areas of academic concern</b>
PO #1	16	10	Male	Abstract thinking, reading comprehension
PO #2	14	6	Female	Reading comprehension
PO #3	15	1	Male	None
PO #4	15	2	Female	None
PO #5	15	2	Male	None
PO #6	17	4	Male	Reading comprehension, decoding
PO #7	17	7	Male	Reading comprehension, decoding, dyslexic tendencies

Table 2

**Demographics of the Tier 2 RtI Group**

<b>Student</b>	<b>Age</b>	<b>Years in Tier 2 RtI</b>	<b>Gender</b>	<b>Other areas of academic concern</b>
RtI #1	13	2	Female	Organization, assignment completion
RtI #2	13	2	Female	None
RtI #3	13	2	Female	Assignment completion
RtI #4	13	1.5	Female	Reading comprehension, processing difficulties
RtI #5	12	.5	Female	Reading comprehension, processing difficulties
RtI #6	11	.25	Male	Organization

### **Procedure**

Teacher One administered the intervention to the middle school students during the Tier 2 intervention time and the general education math teacher administered the STAR Math test for

the pre-test component. Teacher One administered the STAR Math test for the post-test due to the increased frequency of administration compared to students not participating in the study. The teacher administering the RtI intervention, Teacher One, had seven years of teaching experience in regular education and had been the RtI interventionist for the past two years. Teacher Two delivered the intervention to the students identified as having special education needs. Teacher Two had been a special education teacher and had been delivering alternate math curricula for eight years. Both teachers were active participants in the RtI leadership team and the RtI interventions team within the district. For the implementation of this study Teacher One was trained by Teacher Two to ensure consistency in the delivery of the intervention. Teacher One and Teacher Two collaborated throughout the study to ensure that the procedures were aligned. Teacher Two observed Teacher One for the first week of intervention delivery to ensure consistency in the procedure. The general education math teacher was not involved in the administration of the intervention, but was aware of the intervention timeline and tools. All subjects were permitted to participate in this study through a permission form that was reviewed by the author's institutional review board (See Appendix A).

### **Instrumentation**

To obtain a baseline for this study, students were assessed using the STAR Math test prior to the administration of the intervention. The STAR Math test is a standardized test which provides a grade equivalent and percentile rank for each student based on a 25 question test administered by computer. According to Renaissance Learning, the publishers of the STAR Math test, it is a reliable, valid test which correlates highly with high-stakes standardized math tests. It was normed nationally using a sample of 25,800 students from 256 schools in 42 states. Renaissance Learning reported a test-retest reliability ( $n=1,541$ ) and a generic reliability ( $n=25,795$ ). The

grade level reliability estimates averaged greater than 0.84. There is also a high correlation between scores on the STAR Math test to other standardized tests ( $>0.70$ ) (STAR Math: Technical Manual, 2012).

The progress monitoring tool used in this study came from the Mastering Math Facts program. Mastering Math Facts was a program created by the Otter Creek Institute and contains different levels of difficulty with addition, subtraction, multiplication and division facts. The program consists of one minute timings for daily practice that contain specific facts. It also has two minute timings used for progress monitoring the students' success week after week that contain all of the multiplication facts in random order (Crawford, n.d.). The interventionists used the Mastering Math Facts two minute multiplication timings to assess progress weekly between STAR Math tests.

The students participating in the study participated in the modified Copy, Cover, and Compare (MCCC) intervention twelve times. The flashcards and practice worksheets used by the interventionist contained all multiplication facts that included single digit numbers multiplied by single digit numbers. The MCCC measures contained all multiplication fact families divided out among five worksheets. Each measure consisted of six fact triangles with two columns for copying the problems generated from the fact triangle and two additional columns for students to write the problems after they have covered up the correct answers from the first three columns (See Appendix B). Due to the fact that the author developed these specific MCCC materials there is no information evaluating the tool's validity or reliability.

## Implementation

The students were administered the STAR Math test prior to the initiation of the intervention and once at the end of the six week intervention. Students were also administered a Mastering Math Facts two minute multiplication timing as a pre-test to get an accuracy and fluency rate for each student prior to the intervention. Students participated in weekly assessments to gauge an increase or decrease in their digits incorrect per minute.

The implementation of the MCCC program in this intervention consisted of administering the intervention twice a week. Students were provided with a MCCC worksheet, starting with set one and moving through the sets on a rotating basis. For example, the students received set one the first week and complete that set both days. Then they moved on to set two for the second week, and so on.

In order to complete the MCCC worksheet they generated two multiplication problems from the fact triangle in the left column. For perfect squares such as  $3 \times 3$  or  $4 \times 4$ , they only generated one problem; the second box was blacked out to communicate that there was only one possible problem due to the repetition of numbers. After the students generated both problems they covered the first three columns with a piece of paper and went on to the fourth column where they viewed the incomplete fact triangle and generated the math facts independently for the last two columns. When they finished the "Cover" portion of the MCCC worksheet, they uncovered their first two columns to check their answers. If they had any incorrect answers, they circled the incorrect problem and wrote the correct solution below the incorrect problem.

After they completed their MCCC worksheet each day, they were administered a stack of sixteen to seventeen flashcards, depending on the set, which incorporated the problems included

in the fact triangles for that day. They completed these flashcards with the teacher first for accuracy and a second time for fluency. The teacher then documented on their intervention log any of the flashcards that were incorrect or that the student was not able to complete with automaticity. Automaticity was determined by whether or not the student could produce the correct answer within two seconds of being presented with the flashcard stimulus. Only on the second day of the week, they completed a Mastering Math Facts two minute multiplication timing as a progress monitoring tool to note possible growth throughout the intervention. Each student's progress was noted through growth slopes represented on a line graph (See Figures 4 & 5).

As noted above, at the end of the six week period students completed one last Mastering Math Facts two minute multiplication timing which was treated as a post-test to note accuracy and fluency growth along with a final STAR Math test to gauge overall math achievement growth throughout the intervention (See Figures 1 & 2).

Throughout the six week time period the interventionists informally observed student motivation towards the intervention and the activities involved. If there was a noted lack of motivation towards the intervention the teachers wrote this down for later comparison to student progress. Considering this was an informal observation there was not a specific measurement tool used.

### **Data Analysis**

In order to analyze the data the author compared individual student data on the STAR Math test and on the progress monitoring tool to note growth. Percentile ranks and averages were used for comparison of progress. Individual student results remained confidential by not sharing student

demographic data along with their progress scores. After the growth of each student was measured, an average for the students who participated in the RtI program was calculated and the same was done for the students from the special education population for comparison purposes. The author then combined individual student data to analyze the growth or decline of each group in fluency and accuracy of multiplication math facts over the time period of the intervention (See Figures 3 & 6).

After the data was collected, the district RtI intervention team analyzed the effectiveness of the MCCC program and the specific procedure that was used, in order to make informed decisions about how to most effectively serve students in the Tier 2 math intervention group. The RtI team planned to use this data to inform the decisions made in regards to the intervention programming for each student immediately when they were referred to the Tier 2 intervention stage. The special education case managers used the data to make informed decisions about IEP goals and student progress related to mastering their basic math facts. Student progress also informed the special education case manager's decisions regarding the need for isolated math fact practice.



## Chapter 4: Results

The purpose of this study was to examine the effects of a specific, carefully research-based intervention on the math performance of middle school students identified as students in need of Tier 2 RTI interventions, and high school special education students identified as requiring a pull-out math curriculum.

The author strived to answer the following questions through this study:

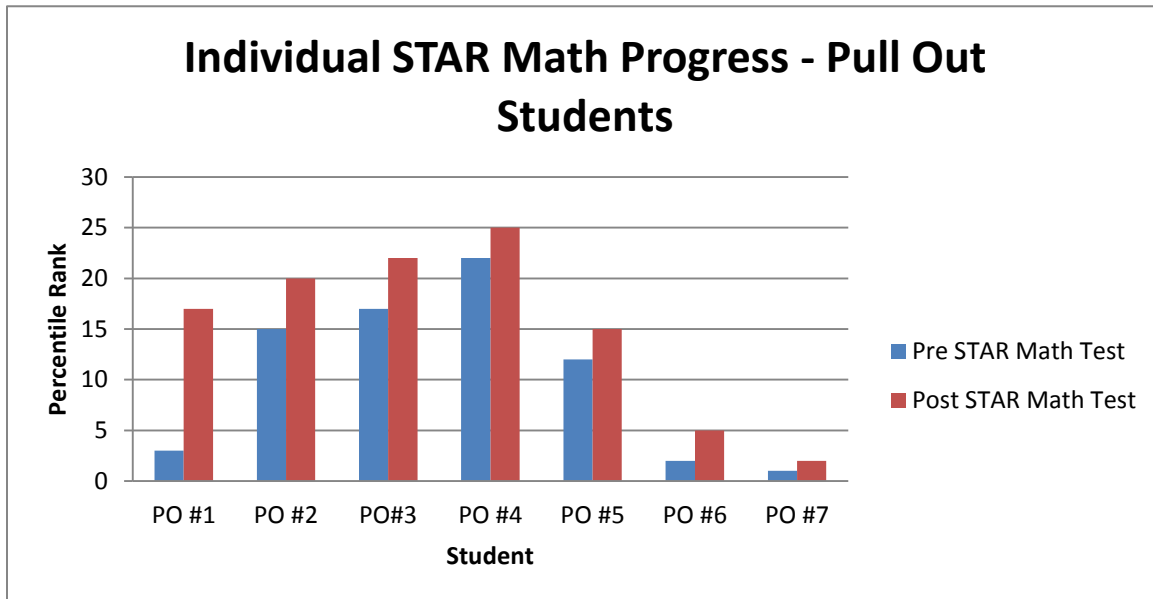
1. Does the use of a modified Copy, Cover, and Compare intervention result in a change in student math achievement scores based on the STAR Math test?
2. Will students' digits incorrect per minute (DIPM) decrease following a six-week modified Copy, Cover, and Compare intervention?

This chapter will highlight the progress noted from the students who participated in the study. The results from the STAR Math test along with the Mastering Math Facts two minute multiplication progress monitoring tool were compared on an individual level and with group averages to note the overall group performance. The two groups were kept separate in group reporting due to the variance in their age level and general education classification.

### **Dependent Variable 1: STAR Math Test**

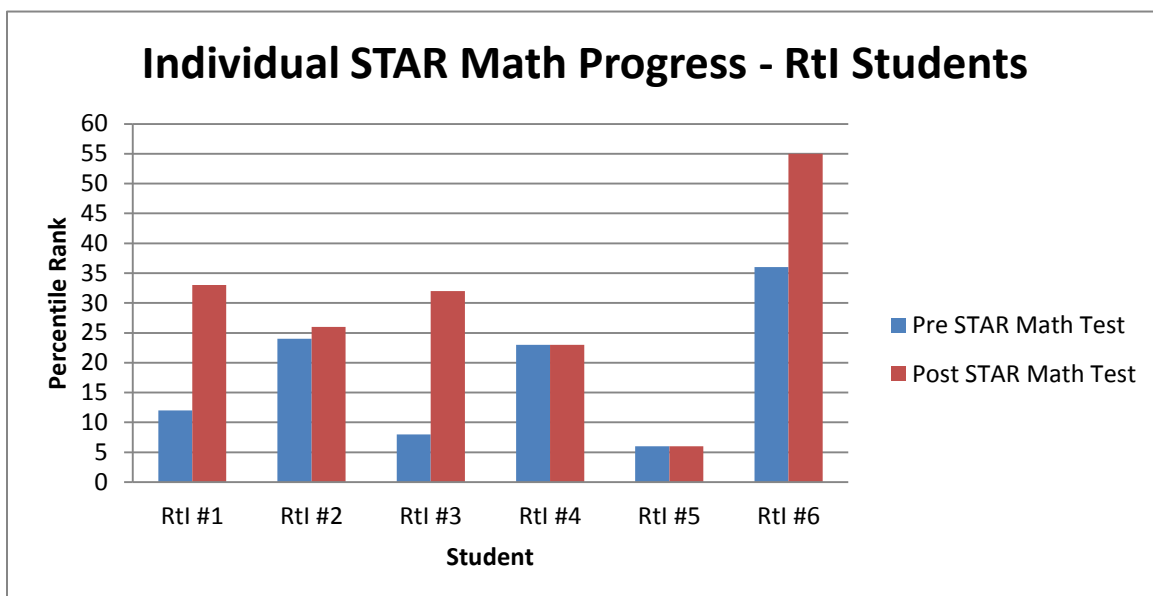
Figure 1 represents each individual student's growth or regression on the Pre-STAR Math test compared to the Post-STAR Math test. The percentile rank measurement was chosen to represent student progress rather than using their grade equivalency for more accurate reporting.

Figure 1



It is noted that all students who were a part of the pull out math group made progress on their STAR Math scores. The maximum growth made by an individual student was 14 percentile points (PO #1) while the minimum growth made by an individual student was one percentile point (PO #7). On average the group grew 4.5 percentile points over the six week period.

Figure 2

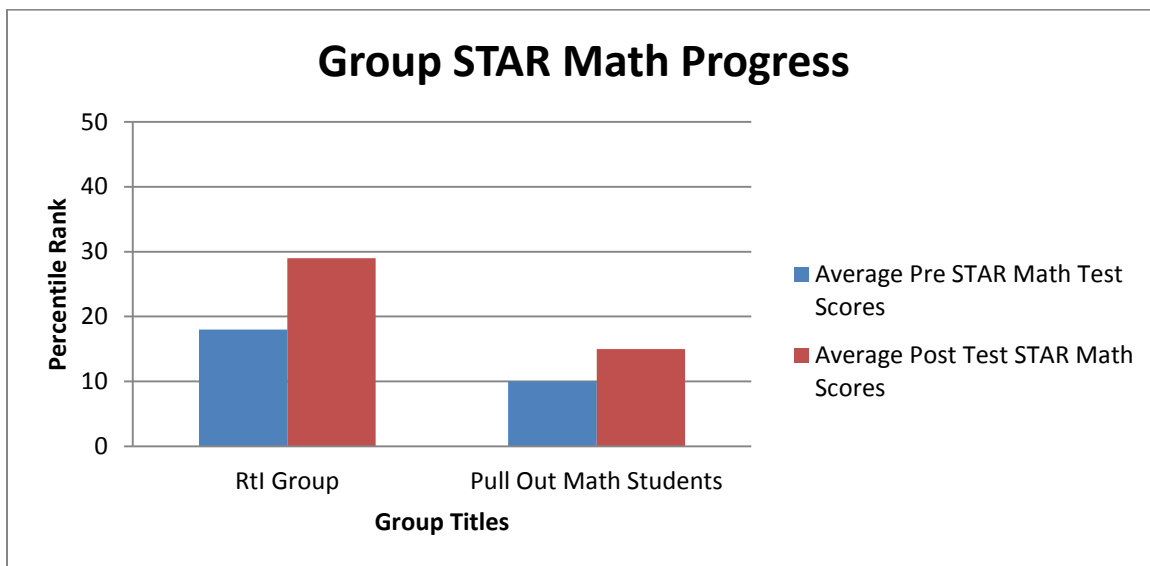


As displayed in Figure 2, it was observed that four out of six students who were a part of the Tier 2 RtI group made progress on their STAR Math scores. The maximum growth made by an individual student was 24 percentile points (RtI #6) while the minimum growth made by individual students was 0 percentile points (RtI #4 & RtI #5). On average, the group grew 14 percentile points over the six week period.

**Combined data analysis.**

Figure 3 represents the average of the middle school RtI group and the high school math pull out group to show comparable growth among the two groups. Again, percentile rank was chosen as the measurement to represent the group growth.

Figure 3

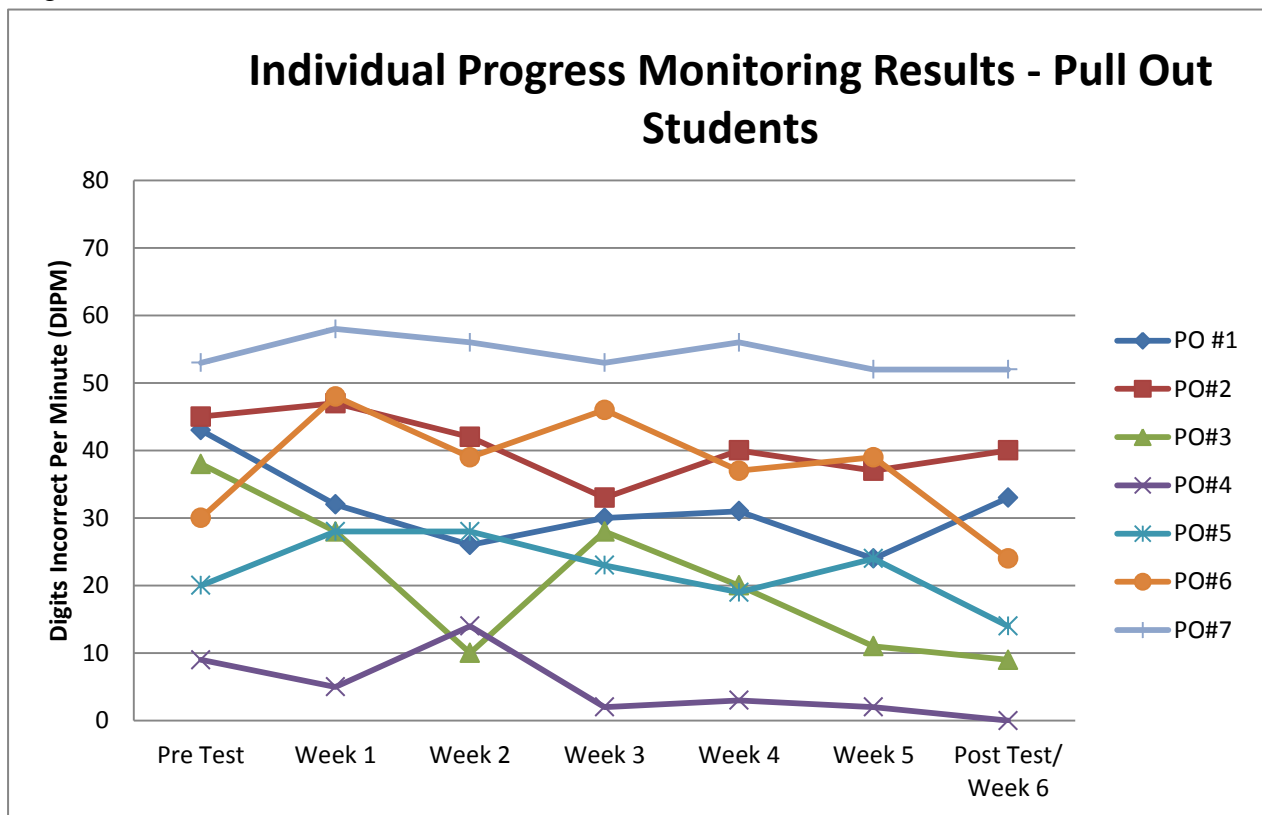


Overall, it is noted that the RtI Group as a whole made rather impressive growth over the six week period according to the STAR Math test. The students who participated in the pull out math program also made slight growth in regards to their STAR Math test results.

**Dependent Variable 2: Digits Incorrect Per Minute**

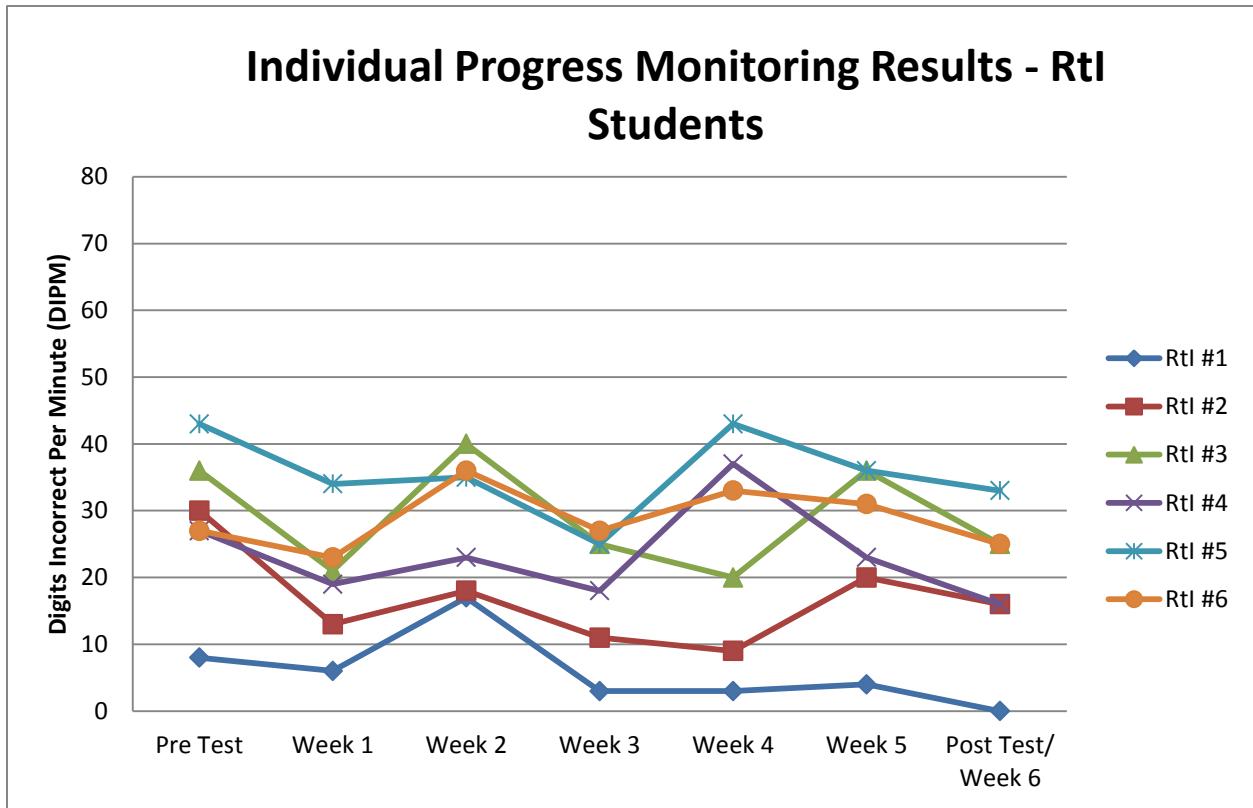
Figures 4, 5 and 6 display the progress of students on the Mastering Math Facts two minute multiplication progress monitoring tool. The results are reported according to Digits Incorrect Per Minute (DIPM). The goal was to note a decrease in the overall DIPM per student when considering their progress from the beginning of the study to the end of the study.

Figure 4



When examining the progress monitoring results for the students in the high school pull out math group in Figure 4 the greatest decrease in DIPM for an individual student was 29 (PO #3). The smallest decrease was one DIPM (PO #7) and the average decrease for the group was 9.4 DIPM.

Figure 5

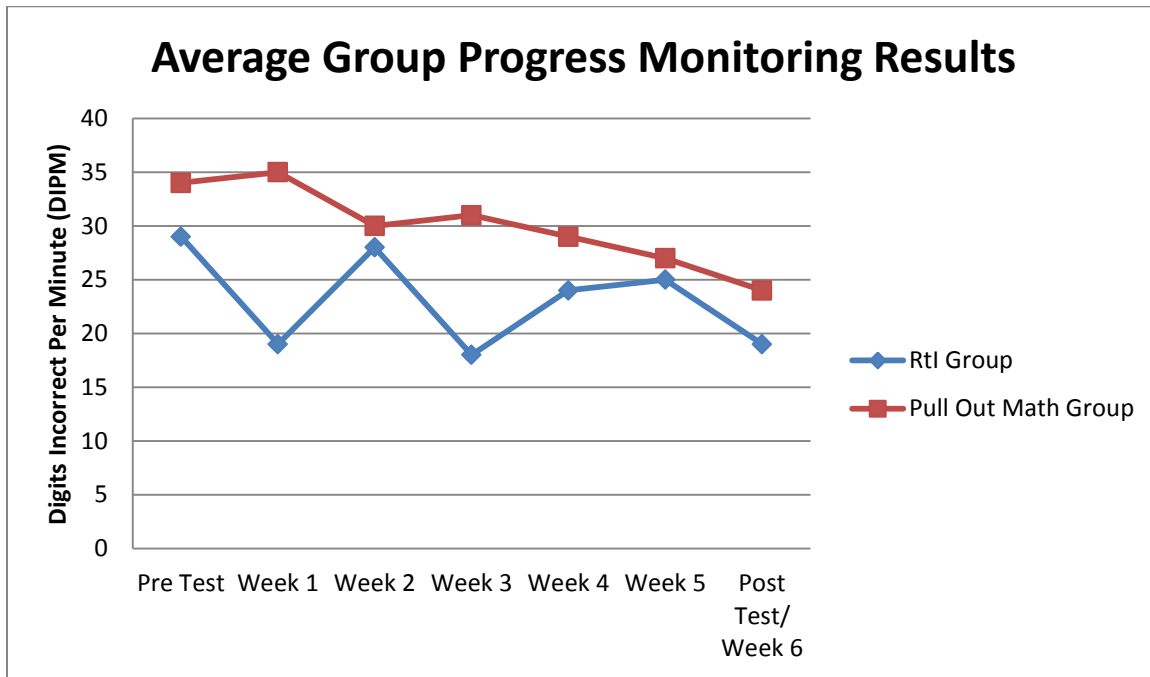


When examining the progress monitoring results for the students in the RtI math group in Figure 5 the greatest decrease in DIPM for an individual student was 14 points (RtI #2). The smallest decrease was two DIPM (RtI #6) and the average decrease for the group was 9 DIPM over the six week period.

**Combined data analysis.**

Figure 6 shows the progress of the two groups as they progressed through the Mastering Math Facts progress monitoring exercises as a part of the intervention.

Figure 6



The noted progress on the Mastering Math Facts two minute multiplication tests suggests that students were able to make slight gains through the process of completing the math intervention. The RtI group as a compiled set of data decreased their DIPM by ten points and the math pull out group decreased their DIPM by ten points as well.

## **Chapter 5: Discussion**

### **Summary of the Study**

The purpose of this study was to determine whether the use of a six week modified Copy, Cover, and Compare intervention would be able to improve the overall math achievement scores of the students who participated in the study according to the STAR Math test. It also aimed to examine whether the intervention would help students decrease the number of digits incorrect per minute (DIPM) on a Mastering Math Facts two minute multiplication timed test.

There were two groups that participated in the study, one was a middle school group who received a Tier 2 RtI intervention for math help and the other group was composed of high school students who all had special education diagnoses and were pulled out of the general education classroom to receive their math curriculum. The study consisted of a pre-test/post-test model with the STAR Math test and also included Mastering Math Facts two minute multiplication fact timings. For six weeks each student completed a modified Copy, Cover, and Compare (CCC) sheet with designated math facts. Following the second administration of the modified CCC review sheet for the week students completed a Mastering Math Facts two minute timed multiplication progress monitoring sheet in order to note progress made from the math intervention. Each day the participants were also asked to complete sixteen or seventeen flashcards, depending on the set, to reinforce the math facts included on their modified CCC worksheet to encourage accuracy and fluency.

### **Conclusions**

The results of this study indicate that the students benefited from the math intervention to a slight degree. For the high school students in the pull out math group student achievement growth

according to the STAR Math test showed improvement for all participants. For those same students there was an overall decrease in their digits incorrect per minute according to the two minute multiplication progress monitoring tool. For the students in the middle school Tier 2 RtI group there were similar results of slight growth for the group as a whole with both the math achievement score according to the STAR Math achievement test and the Mastering Math Facts two minute multiplication progress monitoring tool. The only exception was that there were two students from the RtI group who did not make progress in the positive or negative direction from the pre-STAR Math test to the post-STAR Math test. For both of the groups it was noted that there were frequent peaks and dips in their digits incorrect per minute on the progress monitoring tool. No student in either group regressed from pretest to posttest or on either dependent variable measurement. Overall, both groups did decrease their DIPM over the six week intervention period and they increased their percentile rank on the STAR Math assessment.

In relation to individual student progress it was noted that there was little relationship between students who improved their STAR Math assessment scores the greatest with students who decreased their DIPM the most over the course of the study. For example, PO#1 increased his score on the STAR Math assessment by the greatest amount compared to other students in the pull out group but he did not make great gains in decreasing his DIPM over the course of the study. This was also the case in the RtI Math student group. RtI#6 increased his STAR Math assessment score by the greatest degree in comparison with the RtI Math group; however, he made the smallest gains when decreasing his DIPM on the progress monitoring tool.

A consistency that was noted when examining individual student data, however, was that PO#7 made the smallest gains both in increasing his STAR assessment scores and in decreasing his DIPM on the progress monitoring tool. PO#7 has been receiving pull out math services for



seven years and continues to consistently struggle with automaticity of certain components in the area of math. He displays some dyslexic tendencies which at times may impact his ability to automatically recall information such as multiplication math facts. PO#3 has been receiving pull out math services for the shortest amount of time which may correlate to his success in the area of fluency and accuracy with his math facts. When in the special education referral process his main struggle was identified in the area of math reasoning rather than calculation; however, when noting his initial performance on the progress monitoring tool he struggled to complete the facts correctly. After some practice and maintenance of the skill he showed great growth in regards to his multiplication facts.

The two students who maintained their percentile scores on the STAR Math assessment but did not make noted progress were RtI#4 and RtI#5. Both of these students have been identified as struggling in math, but there have also been teacher concerns in other areas such as reading comprehension and processing difficulties. These factors may have affected their ability to make gains on an assessment of overall math ability and concepts.

As was noted by Poncy et al. (2010), there was improvement in the accuracy of math facts practice with the CCC method. This study however, did not assess the maintenance of those facts over a period of time as Poncy et al. (2010) did with their study. In contrast to Grafman and Cates (2010) and Poncy et al. (2010), this study did not compare or couple the intervention strategy with another intervention with the exception of flashcard practice; therefore, not producing data that could be compared in a similar way. This study focused more on the impact of the intervention on individual and group progress in relation to the intervention's effects.

For students who struggle with their math facts this may be a good intervention to use with both the general education and special education population to show improvement over a rather short period of time. However, when examining where students initial fact skills lie, it is important to evaluate whether this intervention as demonstrated in this study would be sufficient to bridge the achievement gap between them and their same aged peers.

### **Implications from the Data**

When examining the data it was noted that there was an increase in the math achievement scores according to the STAR Math assessment and there was an overall decrease in the DIPM for all students from the pre-test to the post-test of the Mastering Math Facts two minute multiplication timings. The frequent dips and valleys noted in the progress monitoring are hypothesized to be an effect of daily life events or school events that occurred leading to outside distractions which took away from the students' ability to perform as consistently on the progress monitoring tests. The author examined the schedule of students on days when most students experienced an increase in DIPM on the progress monitoring tool and found that there were either snow days or field trips the day of, before or after the day where the data was observed to have a spike.

Also, student motivation toward the study was observed to have a slight impact on the level of their improvement. At times students from the RtI math group were more motivated to complete the task in order to get homework help so that they did not have to take their work home with them. This may have led to them rushing through the intervention and not putting forth their greatest effort.

When reflecting on the study the author noted the stark connection between students' abilities to complete math facts with fluency while they were still struggling with the accuracy

component. Many students were able to complete the facts familiar to them with great fluency but when provided with one fact that they were uncertain of their fluency decreased greatly because they became flustered and were not able to continue working at the same rate. It was also noted by both teachers who administered the intervention that it was important to observe the students during the cover stage of the intervention in order to avoid the temptation of them looking at the correct answer in the first column if they were unsure.

### **Implications for Future Research**

Overall, the intervention proved to have a positive effect on the student's abilities to learn math facts and to produce them with increased accuracy and fluency throughout the six week time period. In future studies it may be helpful to extend the intervention period to see if continued growth could be observed. It may also be beneficial to add a component to the study that could assess the maintenance of this skill to see if continued practice was necessary or if the students retain the math facts from the initial intervention. Increasing intensity of the study would also be an important component to include in future research. Increasing the amount of time students spend with this intervention may help to demonstrate a greater increase in math achievement levels and decreased DIPM which could help students in seeing success with their multiplication facts. Lastly, it would be helpful to include a control group to see if the intervention was having the positive impact on student's success or if their success was a secondary result of the curriculum they were being taught already in their math class.

In summary, the use of a six week modified Copy, Cover, and Compare intervention proved to have a slight positive impact on students' overall math achievement and their ability to decrease their DIPM. The implementation of this study included two groups of students but

showed an overall positive effect with both groups. There are multiple options for future research using this method in order to determine whether different variables such as math instruction, time allotted and effective maintenance procedures of the skill could be manipulated in order to maximize student success.

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## APPENDIX A

December 17, 2012

Dear Parent/Guardian,

My name is Jeni Fossum, I am the high school special education teacher and am also involved in the Response to Intervention (RtI) team for the [\*\*\*\*] School District. These opportunities allow me to work either directly or indirectly with your son or daughter already helping them to improve their math skills. Recently, I have been taking some time to research an approach to teaching basic math facts that I believe will be a better fit and more successful for the students in the RtI and special education programs. In order to use this method in our school with a larger population of students I need to collect some information by using it with a select group of students. I have chosen your son or daughter because the RtI team or special education staff has identified him or her as a student who would benefit from extra assistance building math skills in the area of basic facts. In order to start this program I need to explain the program to you and get your permission to include your son or daughter in this new intervention.

**What your student will do:**

If you allow your student to participate in this study they will be asked to complete three STAR math test sessions to show if the program is benefiting them or not. They will use new math worksheets when they regularly meet with [\*\*\*\*\*] or me for their math intervention time. These new worksheets will replace the method we are currently using and will not take more time away from their regular class time or study hall time. The program will last for six weeks and we will report the information about your son or daughter's progress to you.

**Risks, Discomforts, and Cost:**

I do not anticipate there being any risks or discomforts brought on by this program. Your student will not be asked to participate in any rigorous activities and the program will take less than fifteen minutes each of the days that they meet for their math intervention. There is no cost to your son or daughter for participating in this program. Your child will not lose any additional class time and will not be singled out. This program will not hold your child back or weaken any of his or her skills.

**Benefits:**

Through this study, I hope to document an effective method for helping students improve their math facts to their grade level. This program is designed to provide students with practice and repetition for math facts, which research shows is a very beneficial tool for teaching math.

**Confidentiality:**

The results of this study are entirely confidential. As the person collecting information, I will know your child's progress, but when it is reported, your child's name will be removed from the results on the test and he or she will remain anonymous.



**Right to Refuse or Withdraw:**

At any time during the program you or your student has the right to inform me that participation in the program will stop. There is no penalty for stopping their participation at any time.

**Contact Information:**

If you have any questions before during or after the program please feel free to contact me. My phone number is [\*\*\*\*\*] or you can e-mail me at [\*\*\*\*\*]. If you have further questions or concerns please feel free to contact [\*\*\*\*\*] at the University of Wisconsin – Superior at [\*\*\*\*\*] or by e-mail at [\*\*\*\*\*]. You may also contact [\*\*\*\*\*], IRB Coordinator at [\*\*\*\*\*] or by e-mail at [\*\*\*\*\*].

**Your Consent:**

If you agree to allow your student to participate in this study please check the first box below and return the signature portion to the school. If you do not want your student to participate in the program please check the second box but still return the form to the school so I understand your decision.

I want to thank you for taking the time to review this information and for considering allowing your student to participate in this program. If you have any questions please do not hesitate to contact me.

Parent Consent Form

I have read this permission form. All of my questions were answered and all parts of the program are clear to me.

Please check one:

\_\_\_\_\_ I **give my consent** for my son or daughter to be part of the program. I have received a copy of this consent form.

\_\_\_\_\_ I **do not give my consent** for my son or daughter to be part of the program.

Student's Name – Please Print

Parent/Guardian Name – Please Print

Parent/Guardian Signature

Date

APPENDIX B

Copy, Cover and Compare Directions

1. Students will be provided with a MCCC worksheet that contains 9 fact families in the left hand column. They will be expected to generate the two multiplication problems from the designated fact family. Note: There will only be one problem generated from perfect squares such as 3x3 or 4x4.
2. After they have completed the first two columns they will use the 4<sup>th</sup> column with the partially completed fact triangle to finish the final two columns by rewriting the two math facts along with the answer generated from fact recall. After they complete all of the rows, the student will then go back and check to make sure that they answered each set of problems correctly.
3. If they provided an incorrect answer for any of the problems, they will be asked to circle the incorrect problem and rewrite it below their original problem with the correct answer.
4. After completing the MCCC worksheet the student will complete a stack of 16 to 17 flashcards, depending on the set, to review the problems they just practiced. Students will go through the first time and demonstrate accuracy to ensure that they know the answers to the problems. Any problems that the student struggles with should be documented on the intervention log in the accuracy column. The second time they will be expected to complete the stack of cards with automaticity. The interventionist will note any cards they are not able to complete with automatic recall in the fluency column of the intervention log.
5. The student will complete each set for a week, which consists of two intervention days. The problems noted as difficult for the student throughout the first five weeks will be used on their final week set. The interventionist will create the final week set using the blank MCCC template.
6. If there are not any noted struggles throughout the first five weeks, the interventionist will complete all 90 flashcards with the student and any cards which are not completed with automaticity and perfect accuracy, meaning there is immediate recall with no errors, will be added to their week six MCCC worksheet template.
7. After the second intervention session each week, the interventionist will administer a Mastering Math Facts Two Minute Timing Tool to assess progress with overall automaticity and fluency.

Multiplication Fact Family Sets

Set #1

1x1 = 1	1x6 = 6	2x3 = 6	2x8 = 16	6x3 = 18	4x5 = 20	5x5 = 25	5x6 = 30	7x8 = 56
	6x1 = 6	3x2 = 6	8x2 = 16	3x6 = 18	5x4 = 20		6x5 = 30	8x7 = 56

Set #2

2x1 = 2	7x1 = 7	2x4 = 8	9x2 = 18	3x7 = 21	4x6 = 24	6x6 = 36	6x7 = 42	7x9 = 63
1x2 = 2	1x7 = 7	4x2 = 8	2x9 = 18	7x3 = 21	6x4 = 24		7x6 = 42	9x7 = 63

Set #3

1x3 = 3	8x1 = 8	2x5 = 10	3x3 = 9	3x8 = 24	4x7 = 28	5x7 = 35	6x8 = 48	8x8 = 64
3x1 = 3	1x8 = 8	5x2 = 10		8x3 = 24	7x4 = 28	7x5 = 35	8x6 = 48	

Set #4

1x4 = 4	2x2 = 4	2x6 = 12	3x4 = 12	3x9 = 27	4x8 = 32	5x8 = 40	9x9 = 81	6x9 = 54
4x1 = 4		6x2 = 12	4x3 = 12	9x3 = 27	8x4 = 32	8x5 = 40		9x6 = 54

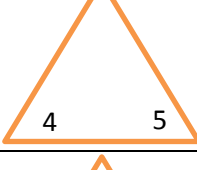
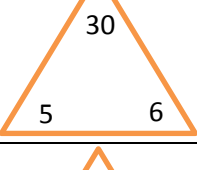
Set #5

1x5 = 5	1x9 = 9	2x7 = 14	3x5 = 15	4x4 = 16	4x9 = 36	5x9 = 45	7x7 = 49	8x9 = 72
5x1 = 5	9x1 = 9	7x2 = 14	5x3 = 15		9x4 = 36	9x5 = 45		9x8 = 72

Copy, Cover, and Compare: Multiplication Set #1

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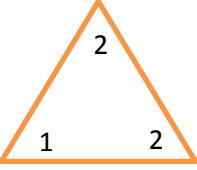
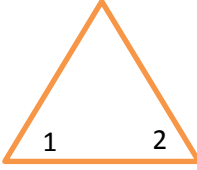
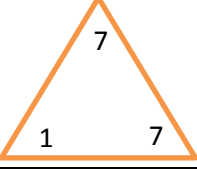
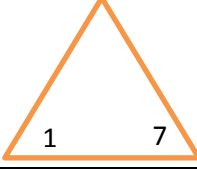
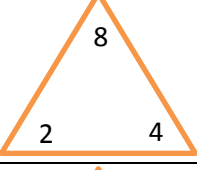
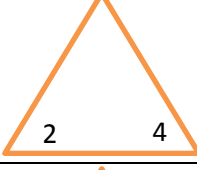
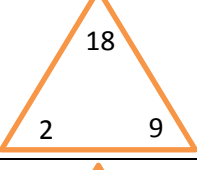
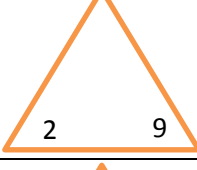
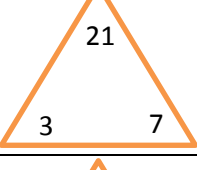
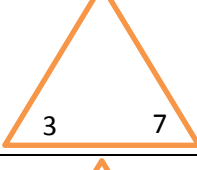
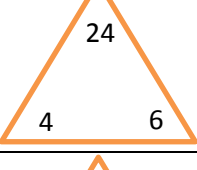
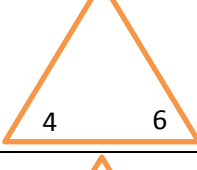
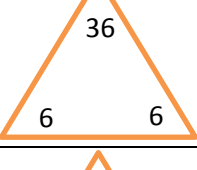
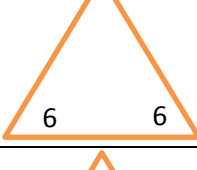
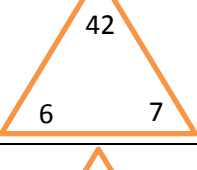
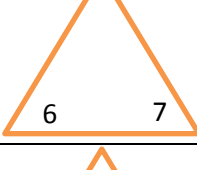
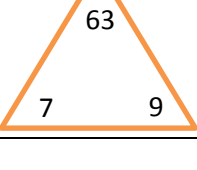
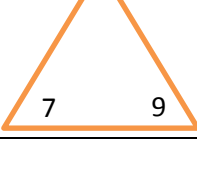
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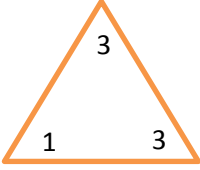
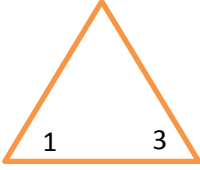
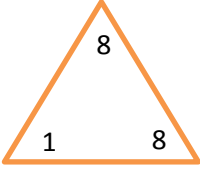
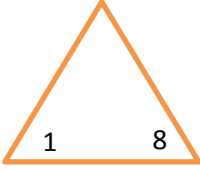
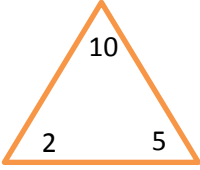
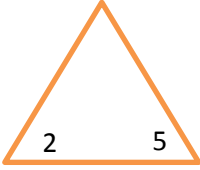
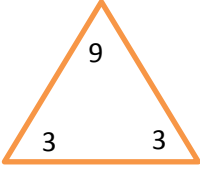
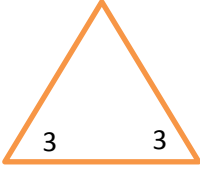
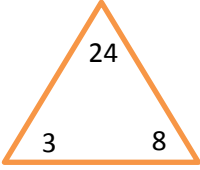
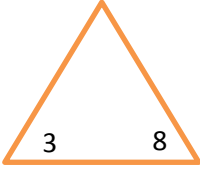
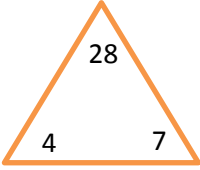
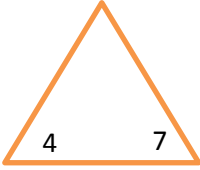
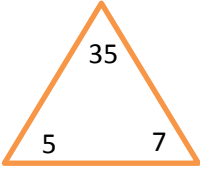
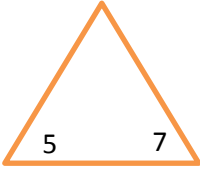
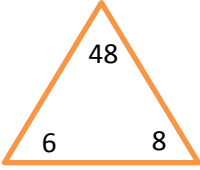
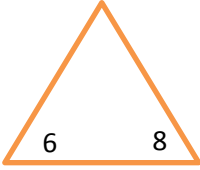
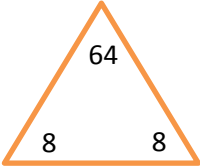
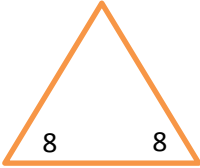
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Fact Triangle	Copy		Fact Triangle	Cover	
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Copy, Cover, and Compare: Multiplication Set #3

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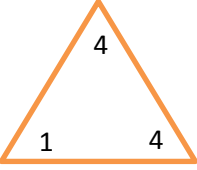
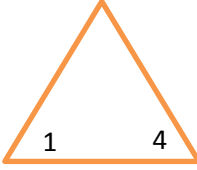
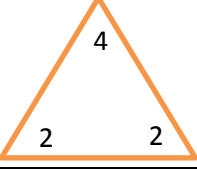
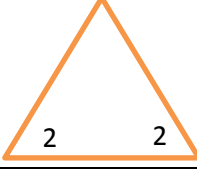
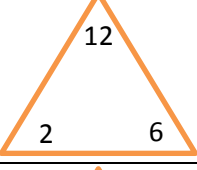
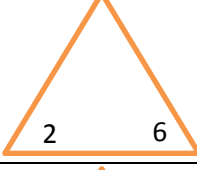
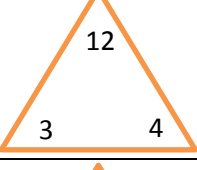
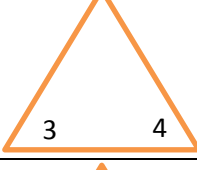
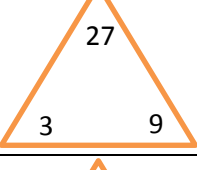
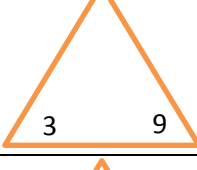
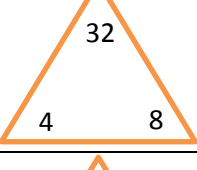
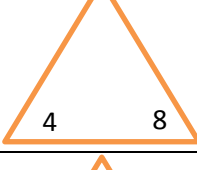
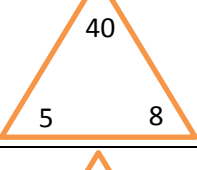
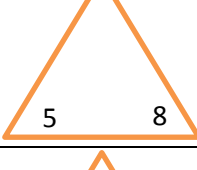
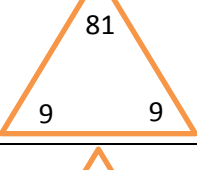
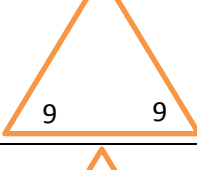
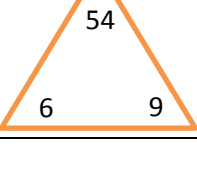
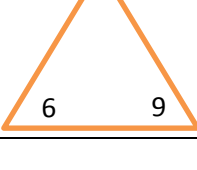
Date: \_\_\_\_\_

	Copy			Cover	
Fact Triangle	Problem 1	Problem 2	Fact Triangle	Problem 1	Problem 2
					
					
					
					
					
					
					
					
					

Copy, Cover, and Compare: Multiplication Set #4

Name: \_\_\_\_\_

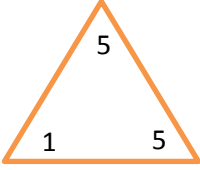
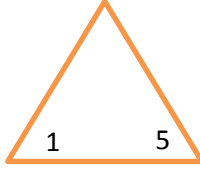
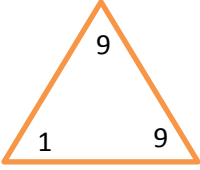
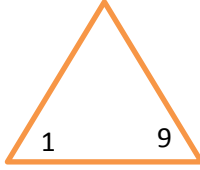
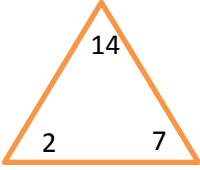
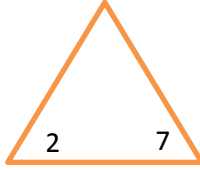
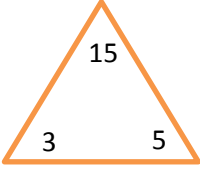
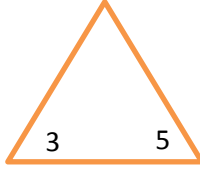
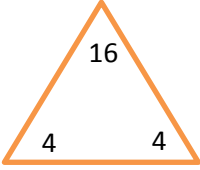
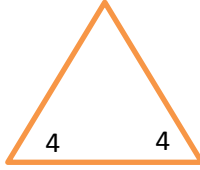
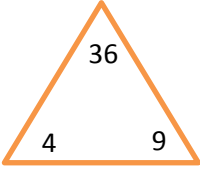
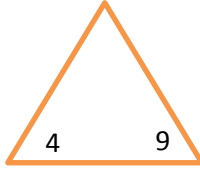
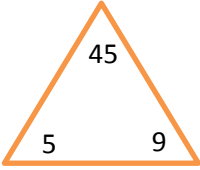
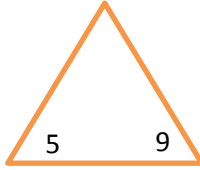
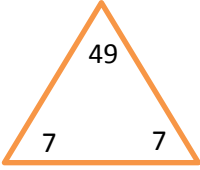
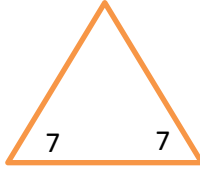
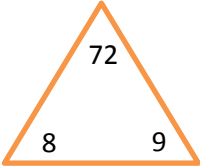
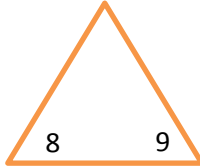
Date: \_\_\_\_\_

	Copy			Cover	
Fact Triangle	Problem 1	Problem 2	Fact Triangle	Problem 1	Problem 2
					
					
					
					
					
					
					
					
					

Copy, Cover, and Compare: Multiplication Set #5

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Fact Triangle	Copy		Fact Triangle	Cover	
	Problem 1	Problem 2		Problem 1	Problem 2
					
					
					
					
					
					
					
					
					

Copy, Cover, and Compare: Multiplication Set #6

Name: \_\_\_\_\_

Date: \_\_\_\_\_

	Copy			Cover	
Fact Triangle	Problem 1	Problem 2	Fact Triangle	Problem 1	Problem 2
