EFFECTIVE MATHEMATICS INTERVENTION PROGRAMS FOR STUDENTS IN GRADES THREE THROUGH FIVE

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Abstract

Although 80% of all learning disabilities are reading related, increasing attention is now being given to mathematics. Many effective instructional techniques and interventions have resulted from research aimed at reading needs, but schools lack sufficient recommendations for students who struggle in mathematics. Teachers can implement quality instructional strategies and solid interventions based upon reading to remediate mathematics difficulties for students in upper elementary school. Collecting data and using that data to make decisions about instruction and student support servicing can offset student mathematics deficits. This paper will explore characteristics of an effective mathematics Response to Intervention program and offer some resources for educators to use to remediate mathematics deficits.
Chapter I: Introduction

Statement of Problem

In 2001, with the passing of the No Child Left Behind (NCLB) act schools were forced to incorporate data driven models of instruction to all students based on their individual needs and show student growth as measured by state assessments (Lembke, Hampton, and Beyers, 2012). Shortly after NCLB, the Individuals with Disabilities Act of 2004 connected and described how NCLB applied to students with special needs. The Response to Intervention model (RTI) was introduced within the 2004 IDEA act. Practitioners previously used IQ-achievement discrepancy testing and began the shift to a more comprehensive data based model of decision making. Though RTI is a method for identifying children with learning disabilities, this method is also a means for early identification to all children at risk for school failure (Fuchs & Fuchs, 2006).

NCLB required strict guidelines regarding student achievement in multiple content areas including mathematics (Elliot, 2008). Schools needed to prove student achievement and measure student growth for each and every student. Eligibility for special education changed via IDEA 2004 and permitted districts to use up to 15% of their special education monies to fund intervention activities. RTI was a substitute for IQ-achievement discrepancy, a means of identifying learning disabled students, and an effective early intervention method of teaching students with learning difficulties (Fuchs & Fuchs, 2006).

In less than ten years since IDEA, Moors, Weisenburgh-Snyder & Robbins (2010) found that 71% of districts surveyed implemented an RTI framework or were in the process of implementation. The same districts had reported only 60% in 2008 and 44% in 2007. The shift from IQ-achievement discrepancy to RTI comes because over identification of students with
learning disabilities was happening when the students were really victims of poor instruction (Fuchs, Compton, Fuchs, Paulsen, Bryant, & Hamlett, 2005).

According to Fuchs & Fuchs (2006), due to 80% of all learning disabilities being reading related, schools focused on implementing effective RTI reading programs. However, increasing attention is now being paid to the area of mathematics because students who struggle with reading generally struggle with mathematics as well. In recent years, identification of students with learning disabilities in mathematics is similar to the number of students being identified with learning disabilities in reading. An estimated 5-8% of school aged children have a mathematics disability (Moors et al., 2010). High-stakes tests are showing learning difficulties with grade-level mathematics skills. The 2005 National Assessment of Educational Progress (NAEP) revealed 64% of 4th grade students and 70% of 8th grade students were below grade level expectations in mathematics (Poncy, Skinner, & Jaspers, 2007). The National Center for Educational Statistics (NCES) reported 39% of U.S. 4th grade students and 32% of U.S. 8th grade students were considered at or above proficient level in mathematics in 2007 (Poncy, McCallum, & Schmitt, 2010).

According to Hulac, Dejong, & Benson (2012) recent research has provided many effective interventions and instructional techniques addressing students’ reading needs through the RTI process, but educators are struggling with having solid recommendations for students who struggle in the area of mathematics. Teachers are also struggling with identifying the individual student’s areas of weakness in mathematics. In addition, fewer research-based options for mathematics interventions exist and teachers’ time is already taxed due to identifying and conducting interventions in reading.
Assessments are a crucial part of a teacher’s job and are a telling sign of how a student is progressing. Though teachers can see the individual struggles of students in their class, teachers need a concrete way of identifying and tracking the progress or lack of progress of individual students. Although teacher recommendation is taken into consideration, test data is necessary to track and monitor the progress of all students (Lembke et al., 2012). If a student is having difficulties in mathematics, assessments should be done to help identify the problems and the reasons behind the problems (Burns, Codding, Boice, & Lukito, 2010). Assessments are only one component to applying an RTI model to mathematics interventions. This review of literature will analyze the characteristics of effective mathematics RTI programs for students in 3rd through 5th grade.

**Research Question**

What are the characteristics of an effective mathematics RTI program for students in grades three through five?

**Definition of Terms**

The following terms are used throughout this review discussing the characteristics of effective mathematics RTI programs in 3rd through 5th grade. Familiarity with these terms will facilitate understanding of this study and clarify some basic concepts.

**Cover, Copy, Compare (CCC).** A three step, self-managed intervention where the student looks at an academic stimulus, covers the stimulus, copies the stimulus, and evaluates the responses checking for accuracy (Skinner, McLaughlin, & Logan, 1997).

**Curriculum Based Measurement (CBM).** A standardized assessment used to track student progress (Fuchs et al., 2005).
Differentiated Instruction. Core instruction that incorporates flexible groupings and peer tutoring (Lembke et al., 2012).

High-Stakes Tests. State’s assessments that impact the school and the students (Poncy et al., 2010).

Interventions. Focused lessons based on the individual students’ needs (Samuels, 2011).

Mathematics Fluency. True mastery of the concept demonstrated when the individual performs the task smoothly, accurately, and without hesitation (Moors et al., 2010).

No Child Left Behind (NCLB). Standards set by government requiring states to show adequate yearly growth of all students (Moors et al., 2010).

Progress Monitoring. Additional tests given to students to make sure the extra lessons are working (Samuels, 2008).

Response to Intervention (RTI). A multi-tiered service delivery model of identifying students who are struggling and providing interventions for students with learning difficulties (Moors et al., 2010).

Self-Administered Folding-In Technique (SAFI). A self-administered intervention combining the Cover, Copy, and Compare intervention with deliberate manipulation of known to unknown facts and corrective feedback (Hulac et al., 2012).

Taped Problems. An intervention using a tape recording with a problem followed by a long pause. During the pause, the student writes down the answer and then compares the answer to a correct answer from the tape (McCallum, Skinner, Turner, & Saecker, 2006).
Chapter II: Review of Literature

Quality mathematics instruction and effective mathematics interventions are essential elements in a RTI program. Teachers can implement instructional strategies and help remediate deficits with their students when an effective mathematics intervention program is in place. Described in this literature review is a brief overview of the RTI model including the three tiers of support, the critical role of assessments, and data collection. Effective mathematics teaching strategies, mathematics interventions and techniques that help increase mathematics performance are also reviewed.

RTI Model

The Response to Intervention model represents a systematic method for evaluating the needs of all students and through carefully selected and implemented interventions. This model may also be used to assist schools in identifying students who may require more intensive instructional services and/or be eligible for an exceptional student education program (National Center on Response to Intervention, 2010). The Response to Intervention model provides a tiered approach to academic intervention. RTI uses three tiers of academic interventions including universal (tier 1), strategic (tier 2), and intensive (tier 3). Students are placed in one of the tiers of intervention based on their current academic needs. If the student does not respond to the research-based interventions at any of the levels, the student may be placed in another tier to receive more additional support (Lembke et al., 2012).

Tier 1 Universal Support. Tier 1 is the main level of support which begins with a research-based core curriculum to address all students’ needs. Mathematics instruction at this tier should incorporate differentiated instruction, groupings, and peer tutoring at the individual students’ needs. Instruction should be high quality and incorporate fidelity checks to monitor the
quality. A universal screening tool should be used to assess each student’s level of performance and determine whether each student is performing to grade level expectations (Lembke et al., 2012).

**Tier 2 Strategic Support.** Tier 2 is another level of support for students who fall below benchmark scores on universal screening. Students who are performing below expectations or students who are not making adequate progress with core curriculum will be referred for Tier 2 instruction. Tier 2 students are not progressing as expected through Tier 1 instruction and need smaller group, more individualized instruction. Interventions at this level provide the student with the high quality core programming all students receive and additional support several times per week for about 30 minutes per session in a small group setting (Lembke et al., 2012).

**Tier 3 Intensive Support.** Tier 3 intervention is the level for students who are far below grade level expectations in mathematics and performing the lowest in the class. Tier 3 is the most intensive support provided to students who regardless of the quality core and smaller group instruction from Tier 1 and Tier 2 intervention efforts are not progressing and achieving at the level expected. Tier 3 interventions are generally provided as individual sessions every day of the week (Moors et al., 2010).

Though the RTI process is a tool for identifying students with learning disabilities, RTI is a way of providing learning support to children before referral for special education services. The National Research Center on Learning Disabilities defines RTI as: “…an assessment and intervention process for systematically monitoring student progress and making decisions about the need for instructional modifications or increasingly intensified services using progress monitoring data” (Elliot, 2008). RTI has changed the way people look at educating each student.
Though schools can provide extra supports to students without using the RTI model, most research on mathematics intervention centers around this model.

**Assessments**

A necessity exists and is now required for assessments to drive instructional decisions. Educators need a system of identifying struggling mathematics students through data-based decision making regarding each individual students’ academic needs. Valid, reliable, curriculum-based assessments are critical components of the intervention process (National Center on Response to Intervention, 2010). A system of tracking student performance and guiding educational instruction towards grade-level expectations is needed for all students from the highest performing students in the class to the lowest performing students (Michigan Department of Education, 2006).

**Universal Screening.** A measurement system for collecting student achievement data is an important piece to all mathematics intervention programs. Accountability for student growth and academic progress is placed on local schools, and extends to individual classrooms and teachers. All students are entitled to receive high-quality, research based instruction in the core academic areas. This high quality instruction should align to the state and/or federal standards system. To ensure that all students are receiving research based, quality instruction, all students should be screened with a universal screening assessment system to pretest, monitor, and posttest against grade-level benchmarks and standards no less than three times per school year (National Center on Response to Intervention, 2010).

The results of the universal screening system give the schools data to make decisions regarding group and/or individual needs of all students. When a universal screening tool is used, schools collect data to ensure the appropriate curriculum and instructional processes are in place.
in their school. In addition, universal screening systems tell the educators which students may need different instructional approaches and/or more intensive interventions. Universal screeners measure both the quality of instruction delivered from the teachers and whether each individual student is learning the grade level material as intended (Michigan Department of Education, 2006).

Schools are turning to assessments with certain features to collect academic achievement for students. The most common assessments used in the studies researched include Curriculum-Based Measurements (CBM). CBMs were developed because a need became more apparent for educators to have performance data for academic foundational skills. The criterion-referenced tests measure student progress to standards and individual student growth (Moors et al., 2010). CBMs generally last from 1 to 8 minutes and are usually group administered. CBMs were used as a primary assessment tool in the majority of the research on this topic (i.e., Fuchs et al., 2005; Lembke et al., 2012; Hulac et al., 2012). CBMs are frequently used as an assessment tool because they are both a universal screening tool and a progress monitoring tool which align to the standards. Tests are administered individually for students in pre-K to 1st grade and group administered for students in grades 2-8 (Lembke et al., 2012). Though which universal screening assessment used is important, making sure that universal screening is taking place is one of the most important parts of an intervention program.

**Diagnostic Assessments and Progress Monitoring.** After universal screenings have been conducted on every student and students are identified as performing below grade-level expectations, diagnostic screenings should be conducted. Diagnostic screenings provide educators with additional information about what the student’s strengths and weaknesses are and what skills and concepts need remediation (Lembke et al., 2012).
Progress monitoring assessments are necessary to monitor student progress to determine intervention and instructional effectiveness (Burns et al., 2010). Progress monitoring provides a tool to easily monitor a student’s progress and make changes to the student’s intervention program as necessary. Progress towards grade-level expectations is monitored and all instructional decisions are data-based and easily measured (Michigan Department of Education, 2006). Progress is being monitored to evaluate the general education instruction delivered to the student. If sufficient progress is not being made towards grade level expectations, all parts of the student’s instruction need to be assessed to determine where the problem exists. Educators use the information gathered through progress monitoring to determine if changes need to be made and what changes need to be made to curriculum, materials, or instructional procedures. Progress monitoring is also used to make student placement decisions regarding the level of instructional intensity (Fuchs et al., 2006).

Progress is monitored frequently and usually conducted between one and four weeks apart, depending on the instructional needs of the student. Tests are closely aligned to curricular content. CBMs are one of the most widely used progress monitoring tools. Student scores are used to analyze progress and determine servicing needs (Moors et al., 2010).

**Strategies**

Once a universal screening assessment has been completed for each student, educators have the daunting task of instructing each individual based on his or her individual needs. The universal screening assessment informs teachers of the students’ areas of strengths and weaknesses and leaves the teacher with making data-based instructional decisions on what each individual student needs to progress and academically grow. Classroom instruction is driven by
the standards set for each grade level. Several strategies have emerged as key components to quality mathematics instruction.

**Quality Core.** Mathematics instruction needs to start with a quality core mathematics program accessible to all students. The core program is also referred to as Tier I instruction. The core program should be research based. The National Center on RTI (2010) defines the core mathematics program as the “course of study usually mandated by the local school board that is provided for all students”. Core instruction should include differentiated instruction to teach mathematics to the individual child’s academic needs. After a universal screener has been conducted, the teacher can make groupings of students with similar academic needs for instruction (Lembke et al., 2012).

When universal screening assessments indicate that 60% or more of students score below the cut point on the assessment, the core instruction should be assessed. Problems may exist with the curriculum being taught, the differentiated activities or materials, or the teacher’s abilities to adequately teach the subject (National Center on Response to Intervention, 2010). When academic deficits are observed through the universal screener, the problem is initially assumed to be the instructional environment and not the student. If the data suggests only a small percentage of students are struggling, then core instruction is eliminated as the problem and more intensive, smaller group instruction is utilized to remediate the problems (Moors et al., 2010). Quality core instruction can eliminate the possibility that students are the victims of poor instruction and provide evidence of a mathematics disability (Fuchs et al., 2005).

Part of a quality core mathematics program is differentiated instruction. When the universal screening tool indicates a need exists for a different instructional approach, the teacher is responsible for differentiating the instruction to meet the individual needs of the student. There
is no longer a “one lesson fits all” approach in mathematics education. A teacher’s experience and/or other diagnostic assessments are needed to determine what instructional strategies, interventions, and services are needed to help each student reach their highest academic potential (Ketterlin-Geller et al., 2008).

Educators offer each student the teaching and learning strategies that best meet the student’s individual learning needs. Flexible groupings, team teaching, centers, peer tutoring, and accommodations are all components of a classroom that differentiates. Differentiated instruction is not spending more time teaching the lesson to the students who struggled with the assignment. Differentiation is providing the lesson at the academic level in which each student is performing (National Center on Response to Intervention, 2010).

**Instructional Strategies.** Most of math instructional time in elementary school is devoted to learning basic mathematics computation facts. Basic mathematics computation facts include solving simple addition, subtraction, multiplication, and division problems. If a student lacks the ability to accurately solve basic fact problems, the student will likely have difficulty completing more complex mathematics tasks. Early research on mathematics difficulties (Goldman, Pellegrino, & Mertz, 1988; Hasselbring, Goin, & Bransford, 1988) shows a correlation between students who struggle in mathematics and automatic retrieval of basic mathematics facts in elementary school.

Though acquiring the ability to solve basic problems accurately is important, accuracy alone is not sufficient. Students also need to solve problems rapidly (McCallum et al., 2006). Evidence suggests students who can complete basic facts automatically may have more cognitive resources available for learning more complex computation concepts. The more rapidly students can complete basic mathematics facts, the more quickly the students can complete newly
acquired complex tasks. In addition, students who do not master basic mathematics skills are likely to continue to struggle and perhaps fail in later learning of other mathematics concepts (Grafman & Cates, 2010).

Six core principles from reading research establish the foundation for the mathematics RTI model. The core principles are:

- **Principle 1:** The school employee’s belief system that all students can learn when there is effective instruction.
- **Principle 2:** Universal screenings are conducted at least three times per year to measure student proficiency.
- **Principle 3:** A progress monitoring system is in place to gauge the effectiveness of teacher instruction and facilitate decision making.
- **Principle 4:** Research-based instruction is used for core instruction and interventions.
- **Principle 5:** Tiers or levels of instructional supports are in place and quality instruction and qualified personnel implement support.
- **Principle 6:** Program effectiveness is monitored to ensure the effective implementation of the RTI system in the school (Lembke et al., 2012).

Teaching effective instructional strategies to teachers, psychologists, and other school educational professionals will help guard against skill-deficit failures (Grafman & Cates, 2010). Some meta-analyses have been conducted on the features of mathematics instruction that most benefit low-achieving students (Baker, Gersten, & Lee, 2002) and students with learning disabilities (Gersten, Chard, Jayanthi, Baker, & Lee, 2006). Six instructional strategies appeared to be consistently effective in teaching mathematics to students with difficulties. The strategies
include visual and graphic depictions, systematic and explicit instruction, student think-alouds, peer-assisted learning, formative assessment data provided to teachers, and formative assessment data provided directly to students. Using a graduated instructional sequence that proceeds from the concrete to representational to abstract (CRA) is recommended. Concrete instruction is learning through hands-on manipulation using concepts or procedures. After students learn concretely, learning happens with pictorial representations. Eventually, students learn and instruction should focus on abstract symbols. These scaffolding techniques are components of effective mathematics instruction (Ketterlin-Geller et al., 2008). The instructional strategies listed above are effective because the strategies each increase active student engagement. The more a student responds, the more likely the student is to increase learning.

Interventions and Techniques in Upper Elementary School

Fuchs et al. (2005) argued adequate resources are not being put into mathematics instruction and the consequences are being noticed on high-stakes testing. On average, 20% of all elementary students need additional instructional support beyond the quality core instruction (Burns et al., 2010). Teachers need simple resources to correct the deficits in mathematics education and not further strain the delicate system facing our schools today. Mathematics difficulties and mathematics disabilities generally appear in the basic skills including number sense, number and operations, and word problem solving (Moors et al., 2010). Therefore, much of the mathematics interventions researched are based on learning the basics of mathematics. Several researched interventions and techniques are discussed in the literature that would be easily managed in a general education setting.

**Cover, Copy, and Compare.** One specific intervention widely used throughout the research studies that warrants discussion is Cover, Copy, and Compare (CCC). CCC was
mentioned in several of the research articles and is widely used and recommended throughout mathematics intervention (i.e., Grafman & Cates, 2009; Poncy et al., 2007; Codding, Eckert, Fanning, Shiyko, & Solomon, 2006; Codding Chan-Iannetta, Palmer, & Lukito, 2009; Hulac et al., 2012). Cover, Copy, and Compare is a self-regulated, simple intervention used to improve accuracy and fluency. The steps of this intervention include looking at a stimulus, covering the stimulus and writing the response, and checking the response for accuracy. When used as a mathematics intervention, the student reads the mathematics problems written on the left side of the paper, covers the problem and answer with an index card or similar item, copies the problem and answer from memory on the right side of the paper, and then checks the answer to see if their response is accurate. If the answer is incorrect, the student will correct the problem by writing the answer correctly next to the incorrect answer (Skinner et al., 1997).

Poncy et al. (2007) conducted a quasi-experimental study to explore intervention effectiveness for students with mild learning problems. The CCC method was utilized to increase accuracy and fluency in basic addition facts. One 10-year old female participant with a full-scale IQ of 44 with a diagnosis of moderate mental retardation was used in the study. The participant attended school in the mid-Western United States. Baseline testing was completed with one minute to complete as many problems as possible. Testing was completed once a week for four weeks for use as a baseline measure and a control set.

Each intervention session consisted of the participant completing a packet of three pages which included the intervention, a practice sheet, and a progress monitoring assessment probe. When the participant worked on the CCC sheet, she read the problem and answer, covered the problem and answer, wrote the problem and answer, checked for accuracy, and then verbalized the correct problem and answer three times. If the answer was incorrect, the participant was
instructed to correct the problem and answer. Four problems were administered during each session and she worked on the problems until all the answers were correct. When completing the practice sheet, the participant worked on the problems until all problems were answered correctly. The assessment consisted of the participant having one minute to complete as many facts as possible and an accuracy score found using the number of digits correct per minute (DC/minute) (Poncy et al., 2007).

The accuracy of the control set of problems ranged from 27-44% of DC/minute. The CCC intervention showed immediate accuracy increases to 90% and remained at high averages ranging from 89-100% throughout the entire intervention process. An assessment was conducted 14 days after the intervention ended, and the participant’s accuracy level was maintained with 100% of DC/minute for the CCC intervention and 27% for the control set. Poncy et al. (2007) concluded the CCC intervention is effective for increasing student’s accuracy and automaticity of basic mathematics facts.

Coddington et al. (2009) extended Skinner’s (1997) study on the CCC intervention by adding goal setting. The descriptive study examined the effects of the CCC intervention with the combined effects of goal setting with subtraction problems. Two goal setting strategies were examined including Goal Setting Problems Correct (CCC+GSC) and Goal Setting Errors (CCC+GSE). The participants of this study included 10 third grade classrooms with 8 teachers across three elementary schools in two districts in the northeast part of the United States. One hundred seventy three students participated including approximately 57% female students and 43% male students.

from 60 to 90 minutes daily and the intervention was conducted from one to three times weekly for 10 to 15 minutes per session. The teacher’s classes were randomly assigned to one of four groups. The four groups included: CCC intervention only, a control group, CCC+GSC, and CCC+GSE (Codding et al., 2009).

A survey level assessment was conducted to baseline the participants prior to the intervention starting. Results between 28 and 62 correct digits indicate students in the instructional range and results less than 28 indicate students in the frustration level. Two researchers implemented the intervention for 6 weeks and set individual student goals. Two times a week, participants took a 2-minute progress monitoring assessment. Following the assessment, a worksheet packet was provided with the CCC intervention problems and answers on the left hand side of the page and the same problem without the answer on the right hand side of the page. The participants followed the CCC procedure and were given 3 minutes for this procedure. A control group was administered the progress monitoring assessment identical to the experimental groups, but did not participate in the CCC intervention (Codding et al., 2009).

The results were separated by students who performed below the 25th percentile (frustration level) on the survey level assessment. The results of this study showed students below the 25th percentile gaining an average of 1.21 correct digits per session. Students in the control group made 0.49 correct digits gain, students in the CCC+GSE group made 0.60 correct digits gain, students in the CCC group 0.89 correct digits gain, and students in the CCC+GSC group 1.27 correct digits gain. Students performing above the 25th percentile who were in the control group had a 0.93 correct digits gain per session and students in the CCC+GSC intervention group gained 1.71 correct digits per session. Three separate one-way analyses of variance (ANOVAs) examined pretest differences among the four treatment groups (subtraction
correct digits (subtraction CD), general outcome measure (GOM), and 2 x 1 digit subtraction). $P$ value of .02 was used to determine significance. No significant differences were found for subtraction CD, $F(3, 164) = 0.29, p > .05$; GOM, $F(3, 146) = 0.56, p > .05$; and 2 x 1 subtraction, $F(3, 143) = 1.16, p > .05$. Codding et al. (2009) describe results as show using goal setting in conjunction with the CCC intervention produces higher scores at the end of the intervention.

Copy, Cover, and Compare. Another variation of the CCC intervention is the Modified Copy, Cover, and Compare intervention (MCCC). Grafman and Cates (2010) conducted a study using a modification of CCC which includes an additional step of copying the problem and correcting the answer before completing the original steps of CCC. The participants of the study included forty-seven second grade students between the ages of 7 and 8. Two middle class suburban schools in the Midwest participated with two teachers administering the study. The study consisted of three sessions lasting 50 minutes each where two different types of worksheets were administered. One set of worksheets served as a pretest/posttest and the other set was self-instructed worksheets similar to the pretest/posttest set. Each student took a pretest, a CCC worksheet, a MCCC worksheet, and a posttest. Students were given two minutes to complete each worksheet. Correction procedures took place when students answered questions incorrectly. Each student was scored by error rate and fluency on each worksheet. Scoring was done by giving points per problem depending on the number of digits in the correct place. A ratio was calculated by taking the number of digits correct and dividing by 120 seconds or the total amount of time taken to complete the worksheet if they finished sooner. An informal assessment was taken of the student and teacher preference of the intervention.

Grafman and Cates (2010) verified all problems on the worksheets to ensure the directions were accurately followed and verified 91.69% of the CCC problems and 92.18% of
the MCCC problems were completed accurately. Dependent $t$ tests were conducted to assess the differential effects of the two procedures and a chi-square test assessed student preference for the two procedures. Significant increases were found in the number of digits correct per minute from pretest to posttest with the $p$ value at .00. No significant differences were found between the error rates on the pretest and posttest with a $p$ value of .33. The $p$ value of .00 indicates a significant increase in fluency and more digits correct per minute with the Cover, Copy, and Compare (CCC) intervention compared to the Copy, Cover, and Compare (MCCC) intervention. The chi-square test also showed a significant difference between the student’s preference to the CCC and the MCCC intervention. The $p$ value was .000 for the CCC intervention over the MCCC intervention. The Cover, Copy and Compare intervention has potential to be a useful tool to increase fact fluency in mathematics.

**Self-Administered Folding-In Technique.** The self-administered folding-in technique (SAFI) is an intervention which uses a deliberate manipulation of known to unknown mathematics facts and corrective feedback. Hulac et al. (2012) conducted a quantitative study to determine the effectiveness of the SAFI intervention on math fluency performance of fourth-grade students. Participants included 11 fourth grade students from one school in a small town in the Upper Midwest identified by their teachers as having difficulty mastering multiplication facts. Participants included 3 male and 8 female students including 8 Caucasian, 1 African American, and 2 American Indian students. A control group included the entire fourth-grade class who were administered a maze CBM test to verify that the results of the intervention were not due to differential treatment of the participants. Nine of the 11 participants received Title I instruction in addition to the core instruction and the SAFI intervention. Two graduate assistants led the intervention and monitored the intervention process and four additional graduate
assistants helped with data collection. Baseline testing was conducted using a mathematics CBM subskill mastery test administered once a week for three weeks. Participants were placed into one of four groups through a two step process. The participants were ranked from highest to lowest achieving based on their baseline mathematics CBM score. Next, the highest four and the lowest four were placed into two separate groups. The remaining participants were placed in the groups so equal performance was spread amongst the other two groups.

After three weeks of baseline testing, a modified multiple baseline design was used to evaluate the effectiveness of the SAFI. Staggered introduction of the intervention was used. One hundred twenty-one flashcards with multiplication facts from 0 x 0 to 10 x 10 were divided into known and unknown stacks. The intervention consisted of the participants taking seven multiplication facts from the “known” pile and three multiplication facts from the “unknown” pile. Students write the answer to the flashcards on a dry erase board within 3 seconds. If the student’s answer is correct, the flashcard is placed into the “known” stack. If the answer is incorrect, the card is placed into the “unknown” stack and the student needs to write the fact and the correct answer three times on the dry erase board. The intervention is completed when all cards have been attempted (Hulac et al., 2012).

Once interventions started, the experimental group was tested three times per week using the mathematics CBM for progress monitoring. The control group was administered the maze CBMs at the same schedule as the experimental group. The median of three assessment scores per week were used to track participant progress. Students were scored by the number of correct digits per 2 minute assessment on the mathematics CBM. Additional progress monitoring consisted of using a flash-card technique to assess the known multiplication facts each week. All interventions and progress monitoring concluded after six weeks. After the intervention
concluded, the participants then had a three week latency period and were tested again to see if their scores maintained. For the experimental group, average mathematics CBM scores increased from 49.9 digits correct per 2 minutes to 74.2 digits correct per 2 minutes during the intervention stage. Scores reflected a 48.7% increase from baseline to intervention phase. The control group increased from 16.0 answers correct to 17.6 answers correct during the intervention stage. The percentage of all nonoverlapping data (PAND) statistic was used to compare the intervention effect on reading and mathematics scores, and to gauge the effectiveness of the SAFI on improving mathematics fact fluency. The PAND for the mathematics CBM was 2.65 and the PAND for the maze CBM was 0.9. The mathematics CBM PAND of 2.65 suggests group performance during the intervention was stronger than performance during the baseline phase of the intervention. The effect size of the SAFI was roughly three times as big as the effect size of the control group. Student administered interventions show increase in mathematics fact fluency and free up educator’s time to work on other areas (Hulac et al., 2012).

**Preventive Tutoring.** Preventive tutoring is a technique used to alleviate the gap with students’ mathematics difficulties. When screening assessments indicate a deficit with mathematics ability, individual or small-group tutoring sessions can be administered. Fuchs et al. (2005) conducted a quantitative study to examine the effects of preventive tutoring when added to core classroom instruction. Fuchs et al. study used 41 first-grade classrooms in 10 schools in a large southeastern metropolitan school district. Class sizes averaged 18 students and the teachers involved in the study had taught an average of 17.80 years. Eighteen teachers held a bachelor’s degree, 22 teachers had a master’s degree, and 1 teacher had a doctorate degree. One teacher was male and 40 teachers were female.
Students deemed not at risk (NAR) and students deemed at risk (AR) were identified by testing the 667 students who returned parent permission to participate. CBM computation measures, addition fact fluency measures, subtraction fact fluency measures, and CBM concept/applications measures were used to pretest and posttest the participants. All baseline tests consisted of 25 questions per test, except the story problems test which had 14 questions. The participants were given 5 minutes to complete as many problems as they could and their score was the number of problems correct. The 319 lowest performing students were identified for individual testing. The lowest performing 139 students were identified as AR and were randomly assigned to control or tutoring conditions. Four pools of students were formed including 69 students in the AR control group, 70 students in the AR tutored group, 180 individually tested students placed in the NAR group, and 348 group tested NAR students. Intelligence and academic measures showed NAR students performed higher than AR students and the control and tutored AR groups performed about the same (Fuchs et al., 2005).

Fuchs et al. (2005) study placed two or three students into a tutoring group of two or three students with each session that consisted of 30 minutes of small-group tutoring and 10 minutes of student Mathematics Flash software. Tutors used the CRA model to instruct and followed 17 scripted topics. Each topic included manipulative activities and a worksheet covered over 48 tutoring sessions. Progress Monitoring was performed each day checking for mastery of the topic where a score of 90% or higher was needed to master the topic. Mathematics Flash was used to increase fact retrieval.

One-way analyses of variance (ANOVAs) were applied to pretest, posttest, and improvement scores using NAR vs. AR control vs. AR tutored as the factor. Results for the CBM computation test showed effect sizes (ES) for AR tutored group exceeded the AR control
group (ES = 0.40) for weekly rate of improvement and was comparable to the NAR ES of 0.11. On the CBM story problems test, the AR tutored group exceeded the AR control group (ES = 0.70) but was lower than the NAR of -0.38. On the CBM concepts and applications test AR tutored group exceeded the AR control group (ES = 0.67) and the NAR (ES = 0.45). Preventive tutoring can be utilized in the classroom to facilitate learning on computation, concepts and applications, and story problems. Though this research was conducted with 1st grade students, tutoring can be utilized at any grade level and applicable to a later elementary setting. Preventive tutoring appears to be a viable supplement to general education instruction though not necessarily a replacement for general education instruction (Fuchs et al., 2005).

**Taped Problems.** McCallum et al. (2006) conducted a study using the Taped Problems (TP) intervention. The quasi-experimental study was conducted to replicate and extend previous research on the TP intervention. The TP intervention was adapted to a classwide experiment and consisted of a multiple-probes-across-tasks design to monitor the intervention effects on multiplication fact fluency. All 18 third-grade students from one classroom including 11 Caucasian, 5 African American, and 2 Hispanic students participated in the study. All participants were 8 or 9 years old with 10 students male and 8 being female. All students were general education students with varying achievement and ability levels.

Baseline testing indicated 15 students were performing below grade level, 3 students were performing at grade level, and no students were at mastery level of multiplication fact fluency. Three baseline tests were administered each day using the three sets of 12 multiplication facts and lasted 4-5 minutes. Intervention sessions were conducted in the general education classroom and lasted approximately 20 minutes for 4 consecutive school days. Twelve audio tapes were made using a varying time-delay format. Each of 12 problems was read a total of four
times on each tape. The first 12 problems were read through the first time with no time delay between the problem and the answer. The next set was read with a 4 second time delay between the problem and the answer. The third and fourth sets were read with a 2 second delay. The problems were numbered 1-48. Intervention sheets were made and correlated to each of the twelve audio tapes. The sheets correlated with the problems spoke in the audio tape and a space for the participant to write the answer was next to each problem (McCallum et al., 2006).

Progress monitoring probes were administered on each of the intervention days and consisted of 48 problems and spaces for answers. One minute was given to complete as many problems as possible. A score of 0, 1 or 2 digits correct would be awarded per answer depending on the number of digits correct the student answered. In the problem 9 x 5 = _____, an answer of 45 would get a 2 point score because both the 4 and 5 are in the correct place. A score of 1 was given for one digit in the correct place and a 0 was given when no digits were in the correct place. After progress monitoring, the student conducted the TP intervention with the same set of items as they were assessed on. Participants used one tape and set of problems for four intervention sessions (McCallum et al., 2006).

Digits correct per minute (DCM) during baseline testing for problem set A averaged 6.5 DCM for the 18 participants and increased to 13.6 DCM during the intervention phase. Effect sizes comparing baseline and immediate assessment showed an effect size of 1.09. During the maintenance phase, participants average 12.9 DCM. Set B baseline scores included 7.5 DCM and increased to 14.9 DCM on the immediate assessment during the intervention phase. The effect size was 0.99 and the maintenance average was 14.7 DCM. Set C baseline scores showed 9.1 DCM and increased to 16.4 DCM on the immediate assessment during the intervention phase. The effect size was 1.6 and no maintenance phase was completed on this set of
multiplication facts. Sixty-seven percent of students who were working at the frustration level during baseline testing increased to the instructional level following the TP intervention and 67% of students working at the instructional level during baseline testing increased to the mastery level. The TP intervention appears to be an effective technique for increasing mathematics fact fluency with multiplication problems (McCallum et al., 2006).
Chapter III: Results and Analysis Relative to the Problem

Introduction

When No Child Left Behind (2001) was passed, overwhelming efforts and lots of attention went into teaching children how to read. Instructional focus turned to correcting reading deficits and mathematics instruction was not the focus. Recent research has indicated many students who have deficits in reading also have deficits in mathematics as well (Moors et al., 2010). Solid recommendations for correcting these deficits are at a premium and mathematics interventions are few in number. With high-stakes tests indicating declining mathematics scores, recent attention has shifted to mathematics instruction and correcting mathematics deficits (Poncy et al., 2007). Studies indicate similarities exist between reading Response to Intervention programs and mathematics RTI programs.

Common Characteristics

RTI is the intervention model generally used and followed for any intervention program. Schools need a solid core mathematics program including differentiated instruction, groupings, and peer tutoring to truly teach to each individual child’s needs. When the quality core instruction is not sufficient to meet the needs of all students, smaller groups and more individualized instruction are needed to remediate (National Center on Response to Intervention, 2010; Lembke et al., 2012; Moors et al., 2010; Elliot, 2008).

A common component to all intervention programs is the need for assessments. Intervention programs using assessments give educators the data necessary to make data-based decisions and track progress for individual students. Assessments help teachers scaffold instruction and monitor their instruction. Curriculum Based Measurement assessments are widely used because of their alignment to the standards and ability to quickly access criterion-
referenced information (National Center on Response to Intervention, 2010; Michigan Department of Education, 2006; Moors et al., 2010; Fuchs et al., 2005; Lembke et al., 2012; Hulac et al., 2012). All studies reviewed included baseline testing and progress monitoring to help educators gather academic information.

Quality core mathematics instruction is the single most important component of a mathematics RTI program. Differentiating the lessons and teaching to the individual students’ needs is critical and part of every mathematics RTI program (Moors et al., 2010; Fuchs et al., 2005; Ketterlin-Geller et al., 2008; Lembke et al., 2012). Teacher’s experience and problem solving abilities are needed to ensure quality instruction is being delivered and poor instruction is not the reason for mathematics difficulties. Determining what specific instructional strategies, interventions, and services each individual students needs is essential.

The Concrete Representational Abstract instructional approach is used throughout the research (Ketterlin-Geller et al., 2008; Fuchs et al., 2005). Student learning flows from learning through concrete instruction to representational instruction to abstract instruction. Scaffolding of learning increases student engagement and students respond more efficiently to mathematics instruction. Visual and graphic depictions, systematic and explicit instruction, student think-alouds, peer-assisted learning, and formative assessment data are considered good teaching practices and encourage student learning.

A common theme presented throughout the studies is that students need to have automaticity in their basic mathematics facts in order to be fluent and not struggle in mathematics instruction (Grafman & Cates, 2009; Poncy et al., 2007; Codding et al., 2006; Codding et al., 2009; Hulac et al., 2012; Skinner et al., 1997; McCallum et al., 2006). Most of mathematics difficulties and mathematics disabilities appear when students are completing basic
skills including number sense, number and operations, and word problem solving (Moors et al., 2010). Repetition and practice of the basic facts are needed to achieve automaticity. This fact reinforces the idea that students need to learn their basic facts by written memory and not rely on other sources to find the answer. With less effort used to determine the answers to basic problems, more cognitive space is available to learn higher skill mathematics concepts.

**Limitations**

Though many good mathematics interventions are used and suggested throughout this study, mathematics intervention programs are in their infancy stage in research. Most mathematics studies researched centered on mathematics fluency (McCallum et al., 2006; Hulac et al., 2012; Grafman and Cates, 2010; Coddington et al., 2009; Poncy et al., 2007; Coddington et al., 2006). Mathematics fluency is a critical component to mathematics instruction, but other mathematics skills are necessary to be successful in mathematics. Conceptual understanding is a more isolated problem and is harder to correct with a template intervention. One intervention studied (Fuchs et al., 2005) could be used as a conceptual intervention, but studies on conceptual understanding interventions appear to be limited.

Some studies were conducted on a specific age group of students and/or a small group of students, but are most likely applicable to different age groups and larger groups of students. Fuchs et al. (2005) conducted a study on first grade students using the preventive tutoring technique. The study indicated preventive tutoring appeared to be a viable supplement to general education instruction. Studies were not researched in this review indicating preventive tutoring could be used with students in older grades, but there are no suggestions indicating this technique should be used only with early elementary school students. Hulac et al. (2012) conducted a study on the Self-Administered Folding-In Technique with 11 fourth grade students. Although only 11
students were used in this study, no indications were found that this intervention could not be used with larger groups of students.

Summary

Schools are held accountable for student achievement. Though reading instruction and intervention was the primary push two decades ago, mathematics achievement is gaining momentum as a problem area. Changes need to be made to mathematics instruction to address the problem of mathematics achievement across the nation. Through quality mathematics instruction and research-based interventions, gains can be made and test scores will validate those gains. Using the three-tiered approach of Response to Intervention, students can be taught based on their academic need and receive additional support when assessments indicate that need.
Chapter IV: Recommendations and Conclusions

Recommendations

Schools have an obligation to provide all students with high-quality mathematics instruction. Each student learns differently and has different strengths and weaknesses in regards to their learning needs. Collecting data on all mathematics students helps educators make solid, data-based decisions. Universal screening and progress monitoring assessments can help guide educator’s mathematics instruction and student servicing. When individual student needs have been identified, quality core mathematics instruction using differentiated instruction, flexible student groupings, and team teaching needs to take place.

Teaching the basic mathematics facts to a mastery level is a crucial part of any mathematics program. Increasing active student engagement and incorporating scaffolding techniques helps increase student learning. Using an instructional sequence that moves from concrete instruction to representational instruction to abstract instruction is effective and highly recommended. When students are not making adequate progress with the core curriculum, individual and small group interventions should be used to provide additional, individualized instruction. Using good instructional techniques and individualized intervention while monitoring student progress helps educators make future instructional decisions, correct deficit areas, and produce growth in mathematics learning.

Areas for Further Research

A recommendation for a future study on mathematics intervention programs would include comparing the effects of a conceptual intervention versus a basic mathematics fact intervention on students in upper elementary school. The conceptual intervention would monitor story problem skills and the basic mathematics fact intervention would monitor mathematics
fluency. After conducting a universal screening in a school district using all 5th grade students either during the fall or winter test cycles, students would be identified as either below or above grade level expectations. Along with teacher recommendations, all students below grade level would be included in the study.

Students would be grouped into either the conceptual intervention group, the basic mathematics fact intervention group, or a control group based on individual ability levels in an attempt to make each group as equal in abilities as possible. Progress monitoring assessments would take place on a consistent schedule to check for increases in student learning. Limited interruptions to the students’ core instruction and conducting the intervention at a consistent time each session would be ideal. Intervention personnel would be fully trained prior to the study until they are conducting the intervention with close to 100% accuracy. One of the researchers conducting the study would oversee the teacher trainings and monitor intervention fidelity. Interventions would take place for no less than six weeks and no more than one school year.

Data collected would relay whether or not the intervention conducted produced higher achievement scores than the control groups results showed. Correlations between the intervention and student growth could then be analyzed and decisions made about the effect size of the intervention. Hypotheses could be drawn from the results as to whether or not the intervention shows merit and could be used for larger sample sizes or different groups of students.

**Summary and Conclusion**

Mathematics instruction is gaining momentum as an academic concern since growing numbers of students are being identified as below grade level in their mathematics skills. Teachers need to identify individual students’ areas of need and implement individualized
quality instruction based on those needs. Having resources and strategies to implement makes this daunting task manageable. Collecting data to make decisions and show student growth is more imperative and necessary than ever before. Education has drastically changed in the last couple decades and resources are limited to address these changes. Implementing an effective mathematics Response to Intervention program can alleviate these problems and make this task manageable.
References


