CHARACTERISTICS OF EFFECTIVE MATH INTERVENTIONS SPECIFICALLY DESIGNED TO INCREASE THE PERFORMANCE OF MIDDLE SCHOOL STUDENTS WITH LEARNING DISABILITIES ON HIGH-STAKES TESTS

by:
Amanda Batten

Northern Michigan University
November 18, 2011

APPROVED BY: Derek L. Anderson, Ed.D.
DATE: November 11, 2011
Table of Contents

Abstract ......................................................................................................................... 3

Chapter 1: Introduction ................................................................................................. 4

  Background of Problem ............................................................................................... 4
  Purpose of Study ........................................................................................................ 6
  Research Questions ..................................................................................................... 6
  Definition of Terms .................................................................................................... 7

Chapter 2: Literature Review ....................................................................................... 9

  High Stakes Tests ....................................................................................................... 9
  Strategies, Interventions, and Programs ..................................................................... 14

Chapter 3: Synthesis ..................................................................................................... 30

  Common Characteristics ............................................................................................. 30
  Connecting Interventions to Performances on Tests .................................................. 33

Chapter 4: Conclusion ................................................................................................. 34

  Suggestions for Further Research .............................................................................. 34

References ................................................................................................................... 37
Abstract

Even with the demands and pressure of high-stakes tests, students with learning disabilities are required to complete and perform as well as students without disabilities. Teachers can facilitate student learning and increase math performance through accommodations within individualized educational programs, intensive strategies and interventions, and progress monitoring. Providing strategies – whether in whole group, peer group, or independently – will help each student grow as a learner. Monitoring progress of each learner enables teachers to teach to student strengths and remediate weaknesses. In this paper, progress monitoring and strategies to increase the performance of students with learning disabilities are described, along with recommendations for future research.
Chapter I: Introduction

Background of Problem

Students often have difficulties taking assessments, especially tests mandated at the state or district level. Participation required by all students, including students with learning disabilities, place accountability on schools and districts as well as access to the general education curriculum. Students with learning disabilities often struggle in the “acquisition and use of listening, speaking, reading, writing, reasoning, and mathematical skills” (Rosebraugh, 2000, p. 994). Students with learning disabilities take high-stakes tests for the same reasons as students without disabilities. High-stakes tests allow access to curriculum for future graduation requirements, academic standards, and scholarships for students with and without disabilities (Gartland & Strosnider, 2004).

No Child Left Behind has required states to hold student achievement accountable by giving assessments to measure growth. When schools fail to show growth on high-stakes tests, the state may intervene on a variety of levels, and the process can be very stressful and discouraging for individuals taking or administering tests (Judson, 2007). Although the Individuals with Disabilities Education Act requires students with disabilities to receive accommodations for completing high stakes tests (Thurlow, Lazarus, Thompson, & Bount Morse, 2005), scores often reflect poor performances because of low ability levels. Many other factors influencing student performance on assessments include test anxiety and disabilities. Research supports the notion of teachers teaching to the test because teachers have narrowed their teaching prepare for state tests (Boyd, 2008).
The Curriculum and Evaluation Standards for School Mathematics also places accountability on school districts to demonstrate student progress on mathematic performance. The Curriculum and Evaluation Standards for School Mathematics was created by the National Council of Teachers of Mathematics involving teachers, supervisors, mathematics, and more. The process of reviewing, creating, and selecting standards of what is needed to improve mathematics was funded by U.S. Department of Education (Romberg, 1993). Throughout all grade levels there are four standards that need to be incorporated into the math curriculum. These four standards are math as problem solving, math as communication, math as reasoning, and math connections. Five goals for the outcome of student performance in mathematics were pulled from the four standards from the evaluations and standards statements. The five goals consist of students becoming better as problem solvers, learning to reason mathematically, learning to value mathematics, becoming more confident with their math skills, and learning to communicate mathematically. For the secondary level math classroom, the focus on mathematical reasoning and problem solving are more prominent (Gagnon & Maccini, 2000).

Many students have difficulties learning and completely understanding mathematics because of rote learning (Wiggins, 2010). The number of level-one recall questions on high-stakes tests contributes to the limit of in-depth understanding students have with mathematics. Level-one recall questions do not require students to comprehend or apply learning to the question (Boyd, 2008). Vocabulary in word-related math problems are also a struggle for students with learning disabilities because language difficulties. How a student understands a math concept or how he or she communicates with their peers about math problems can be directly related difficulties with math vocabulary. Math vocabulary is also largely present within
mathematic assessments given at the state and district level. Deficits in math vocabulary can also influence student performances on these assessments (Montague, Krawec, & Sweeney, 2008).

In the past couple of years, Response to Intervention has made a huge impact in schools across the nation. Response to Intervention is a three-tiered structure put in place for schools to implement a variety of researched-based strategies and interventions depending on students’ level of need. Students in Tier 1, 2, and 3 receive curriculum along with their peers, while Tier 2 and 3 receive additional intensive small group explicit instruction (Byrant & Byrant, 2008). Response to Intervention can help bridge the gap of learning catch students displaying behaviors that indicate math weaknesses. These math behaviors displayed by students with learning disabilities include word problems, multi-step problems, misaligns numbers, counts on fingers, takes a long time with calculation and more (Bryant, Bryant, & Hammill, 2000).

**Purpose of Problem**

Students often have difficulties taking high-stakes tests and their results can display lower scores than their actual ability. Students with special needs have many factors that can contribute to a decrease in test scores. These factors may include anxiety, low academic ability, lack of enthusiasm for the test. Students with learning disabilities have poor performance and in math and need intensive instruction to help remediate their skills. Teachers need to observe behaviors and characteristics of skill deficits in math can help provide math instructional objectives (Bryant, Bryant, & Hammill, 2000). Teachers often resort to teaching to the test and pack in large amounts of information prior to the test. This method of preparation can overwhelm, confuse, and stress students, resulting in lower test performance. Standardized assessment scores can also be impacted through the lack of progress monitoring in student growth (Ysseldyke &
Bolt, 2007). Teachers need to focus on effective interventions and instruction to increase math performance of students with learning disabilities. Students need to be taught skills and strategies that allow them to become independent learners (Miller & Mercer, 1997) in the classroom and on high-stakes tests.

**Research Questions**

What are the most effective math interventions schools can put in place to decrease the probability of being placed on a list of low-performing schools based off test scores?

**Definition of Terms**

The terms listed below will be presented throughout this review to discuss the characteristics of effective math interventions specifically designed to increase the performance of middle school students with learning disabilities on high-stakes tests.

**Cognitive Strategy Instruction.** Instruction that teaches students which strategies or mental activities while learning to increase performance (Montague & Dietz, 2009)

**Cover, Copy, Compare.** A three step procedure of looking at a stimulus, covering up the stimulus and copying it from memory, and then checking for accuracy (Skinner, McLaughlin, & Logan, 1997)

**Curriculum Based Measurement (CBM).** A standardized and systematic process of recording student progress on academic curriculum (Fuchs, Fuchs, Hamlett, & Stecker, 1991)

**Direct Instruction.** Includes both “what to teach” and “how to teach,” and includes explicit instruction, mastery learning, error corrections, scaffolding instruction until
student is responsible for learning, examples and nonexamples for generalization,
cumulative review of previously learned skills (Gagnon & Maccini, 2000)

**Guided Instruction.** Student input, discussion, and questioning of material with teacher
guidance and support (Kroesbergen & Van Luit, 2002)

**High Stakes Testing.** A state’s system of assessments that have consequences on
students (Ysseldyke, et al., 2004)

**Modification/Accommodation.** A change to an assessment procedure or its material
(Thurlow, Lazarus, Thompson, & Bount Morse, 2005)

**Peer-Assisted Learning.** A strategy with scripted dialogue between a student and their
peer (Kroeger & Kouche, 2006)

**Progress Monitoring.** Reviewing student performance to determine if a validated
treatment is effectively working for each individual student (Fuchs, Powell, Seethaler,
Cirino, & Fletcher, 2008)

**Response to Intervention.** A three-tiered structure that places students on levels to
receive a variety of supports depending on their level of need (Byrant & Byrant, 2008)

**Self Talk: Say-Ask-Check.** An independent self-directed strategy to break down word
problems through script (Montague, Krawec, & Sweeney, 2008)

**Structured Instruction.** Teacher directed instruction with very little student questions or
discussion (Kroesbergen & Van Luit, 2002)
Chapter II: Literature Review

Students with and without disabilities in the nation are required to take high-stakes tests. High-stakes tests place accountability and are stressful for all individuals involved. Teachers can implement strategies that will increase high-stakes test scores and performance within the classroom for students with and without disabilities. Described in this section are the effects high-stakes tests have on the level type of questions in assessments given by teachers. The effects of performances students with learning disabilities have on high-stakes testing are also discussed. Along with effects of progressing monitoring on student performance, strategies and interventions that help increase the math performance of students with learning disabilities are reviewed. These strategies and interventions include the Cover, Copy, Compare intervention, peer-assisted learning, schema strategy, and Solve It! Many different formats of instructing, guided instruction, structured instruction, strategy instruction are included. The common characteristics of these strategies and instruction formats are described and a recommendation for future research is expressed.

High-Stakes Tests

High-stakes tests can have a large impact on school districts around the nation. Schools everywhere are being held accountable for student success and progress in academics. Boyd (2008) examined the effects of these state tests in relation to the types of questions teachers were using on classroom tests. The participant group consisted of nine teachers, in all stages of their teaching careers, who taught math grades four through twelve in different districts. The teachers were required to provide classroom tests administered for two years, before and after the new Ohio state test was required.
Boyd (2008) compared the tests with the state standards and each individual item was coded with Webb’s framework for analyzing item knowledge. Webb’s framework has four levels of item knowledge: recall, skill/concept, strategic thinking, and extended thinking. Neither the teacher’s tests nor the state test presented questions at the extended thinking level. After tests were submitted, the researcher and one of the nine teachers involved reached a 90% agreement on how to benchmark each item. Items were coded individually, with the teacher not coding her own test, and if there was a discrepancy in coding a particular item, the item was discussed, noted, and a decision was made. An interview was also conducted with each teacher involved.

Results show that recall, the lowest depth of knowledge, with an average of 87% was the largest percentage of questions asked by teachers. The state’s test items also included 62% of test items coded at the recall level. The recall-leveled items on the two tests from both years did not change significantly, but over half of the teachers decreased the amount of recall questions. Skill/concept leveled questions increased only by an average of 11% to 13% and strategic thinking questions increased only by an average of 1% to 2% between the two years. The state’s test items included skill/concept and strategic thinking leveled questions, but this did not influence the teachers to assess the students at these levels. During the interview process, two out of eight teachers reported a dislike for using multiple-choice type questions to make the tests more challenging for students. When coding the test items used by teachers, results and those interviewed concluded that seven of the teachers used curriculum created tests, which use over 85% of recall level questions. Two of the teachers began aligning their tests the second year to parallel the state’s tests and this resulted in an increase of lower-level-type questions (Boyd, 2008).
The recognition of high-stakes tests and teacher-made assessments using low-level questions is quite alarming. Students require more in-depth thinking to make skills and concepts more concrete. Although it is beneficial for students to become familiar with the types of questions seen on high-stakes tests, higher level thinking and questioning needs to take place. Teachers need to be cautious and not narrow down assessments and curriculum to align directly to high-stakes tests. Curriculum and knowledge assessment needs to be more in-depth and require the students to think beyond the rote and recall information that they will not generalize or maintain in the future (Boyd, 2008).

Consequences for students with and without learning disabilities can result in failure to perform on high stakes tests. Christenson, Decker, Triezenberg, Ysseldyke, and Reschly (2007) handed out The Perspectives of Testing and Grade Promotion Survey to 249 teachers and school psychologists from 99 schools in 19 states. The survey was created using nine themes that were based on similarity of high-stakes testing articles read in a comprehensive literature review. These themes included high expectations, the procedure of how to measure student progress, responsibility for accountability of results, understanding the outcomes of high-stakes tests, guidelines for retention or promotion decisions, the prevention of early school failure, earlier identification of students with learning disabilities, advancement of a student’s instructional environment, and the availability of resources. In creating the survey items, factors for grade advancement, observable events of high-stakes tests, availability of instructional choices, and the overall effects of a high-stakes test were analyzed.

Teachers and school psychologists answered survey items with a four or five-point scale on each section. When distributing surveys the principal from each school was asked to have a general and special education teacher, as well as a school psychologist to complete the survey.
Low rates of 11.6% of the surveys were returned, which places a major limitation for the study as a whole (Christenson et al., 2007).

A small negative effect on students was found due to high-stakes testing. About 25% of the participants answered that high-stakes testing had a negative effect on what and how the students were taught. When answering the section on observable events, teachers saw an increase in many areas due to the accountability system and the implementation of high-stakes tests. These areas included the improvement of instructional performance, progress monitoring of student performance, advancing low achieving students’ progress, and a more concrete set of instructional goals. Forty-six percent of the survey’s respondents observed a decrease in the teaching of curriculum not tested on high-stakes tests (Christenson et al., 2007).

When looking at the difference between students with and without disabilities, the authors determined that answers between the special education and general education teachers had to have a ten-point difference in order to be considered a significant result. Some areas that met this requirement and showed an increase were the monitoring of quality instruction, referrals for special education, knowledge and skills of the teachers working with diverse learners, communication between home and school, testing procedures, and parent’s request to end the implementation of high-stakes testing. One item that showed a decrease was the inclusion of students with disabilities in the general education setting (Christenson et al., 2007).

Christenson et al. (2007) established five themes that emerged from the written portion of teacher’s impressions of grade advancement. These themes included the notion that students with and without disabilities have different standards for advancement, it is uncommon for students with disabilities to be retained, students with disabilities are advanced to the next grade level
because of addition support, decisions for advancement are made case-by-case, and differences in grade promotion are not observed. Forty-five percent of the general education and 51% of the special education teachers stated that grade advancement decisions were “occasionally” or “never made” the same way for students with and without disabilities. Overall, general and special education teachers felt that high-stakes tests did not influence the decision of grade advancement for students with disabilities.

A small percentage of 25% teachers observed negative effects from high-stakes testing for students with learning disabilities. The small percentage is not a result that an individual that is involved in the education of students with disabilities would expect. The result may have been affected by the low rate of surveys that were returned, but is supported by the notion that decisions about advancement or retention for students with disabilities are not dependent on high-stakes tests. Teachers have also increased effective instruction and the curriculum they teach because of high-stakes test accountability (Christenson et al., 2007).

Ysseldyke et al. (2004) found similar results in their research of high-stakes testing with the involvement of grade advancement for students with learning disabilities. Some other areas tracked for information included the participation and improved performance of students, higher standards for students, instructional changes, and the alignment of individualized educational plans to high-stakes tests. Also researched was the increased use of accommodations on high-stakes tests, linking standards, assessment, and the curriculum together, teaching to the test and narrowing of the curriculum. Lastly, test stress, and parental awareness and understanding were also examined.
Multiple methodologies and media analyses were used to track and search for anecdotal and evidence-based reports on these areas of concern. Ysseldyke et al. (2004) located information by using the Lexis-Nexis database to search for newspaper articles discussing these important themes relating to education, daily monitoring of headlines in the educational organizations magazines and publications, and databases were used to find empirical-based literature. Ratings of surveys, monitoring of headlines pertaining to high-stakes tests, and focus group comparisons of individualized educational plans information were also researched for information. Transcripts of literature were coded in the QSR N5 computer software and the focus groups transcripts were indexed using a computer program called Atlas Ti. Emerging themes from the coding softwares and the rating of the surveys produced many a variety of results.

Results indicated more students with learning disabilities scoring well on high-stakes tests. An increase in awareness by parents about accommodations that can be provided to their child and an increase in performance of students with disabilities due to raised expectations were also found in the results gathered. Teachers may inadvertently teach to the test by focusing on skills that were assessed in previous years. Preparing students for the content and format of tests seen on high-stakes tests also has increased due to raised expectations. Schools have also implemented supplemental curricula to increase performance of low-achieving students. It is unclear of how a student’s individualized educational program connects to or effects statewide assessments. An individual educational program can be influenced by state assessments, especially when a teacher is writing in accommodations for particular students. One result of surveys reviewed and summarized indicated that teachers did not feel or observe a change in curriculum due to the pressure of high-stakes tests (Ysseldyke et al., 2004).
The awareness by parents and teachers of the effects of high-stakes tests has steadily increased. Narrowing of the curriculum, supplemental curricula, and exposure to test like material has been a result of high-stakes tests, but many teachers feel that curriculum is not affected. Accommodations and parent awareness has increased due to high-stakes tests, which can be facilitated by teachers during the individualized education program meeting.

**Strategies and Interventions**

Gagnon and Maccini, (2002) suggested that the most effective instructional approaches or methods of teaching students with learning disabilities are to incorporate effective instructional techniques, the use of manipulatives, and real-life application. Also included were the accommodations most frequently used, which included calculator use, modification of assignments, behavior management, and extended time for assignments and test. In addition to effective instructional techniques, Fuchs et al. (2008) also reviewed four large-scale studies relating to two programs, Math Flash and Pirate Math, for computation and problem solving. Through these two interventions, Fuchs et al. described, recommended, and concluded with seven principles of math interventions were described and recommended to increase the performance for students with mathematics disabilities. These principles included teacher instruction being explicit, the instructional design decreases the learning challenges, the concept of learning is strong, repeated practice, cumulative review, a motivation factor to centralize student attention, and progress monitoring.

**Progress Monitoring.** Progress monitoring is an effective tool that can be used to increase performance scores. Progress monitoring, including curriculum-based measurements/assessments are administered by the teachers and staff of the building. Progress
monitoring includes five steps: selecting appropriate measurement tools, ensuring the reliability and validity of the material being measured, administering and scoring of measures being assessed, setting goals based off data collected, and determine if instruction is effect for improving student performance (Stecker, Lembke, & Foegen, 2008). Ysseldyke and Bolt (2007) conducted a study including 80 classrooms, 41 participating as the treatment group and 39 as the control group, participated in a randomly assigned experiment for progress monitoring. All grade levels, elementary and secondary participated and included all content areas of mathematics. All students took a pre- and post-test of the STAR Math, a mathematics achievement test, and the Terra Nova subtest of mathematics. The experimental group of teachers were trained and required to use progress monitoring in addition to their regular math curriculum. Also present was a wide range of math abilities in the students participating.

Ysseldyke and Bolt (2007) used accelerated Math as a constant tool to electronically assess and monitor student progress with math objectives. Accelerated Math is a quick tool to have students practice the objective with an end result of satisfactory or mastery. When the student finishes the practice portion with a satisfactory score, the teacher can immediately print out a test, or if the student receives a mastery score, the computer will print a practice page for the next skill. If the student is having difficulties, the computer will inform the teacher, who can then intervene. The Accelerate Math program was implemented all year round.

Students were sorted into three groups, based off how many objectives each student mastered. Students mastering less than nine objectives were placed in the non-implementers group, completing ten to 36 objectives placed students in the low implementers group, and students mastering more than 36 objectives were placed in the high implementers group. In the experimental group, teachers did not use Accelerated Math with all students in their classrooms
and no apparent pattern was used to determine which students were excluded. One-way analyses were used on all three of the groups’ scores of the post-tests, which displayed significant differences between grades two through five and grades six through eight. Groups of students involved in the high implementation group of interventions displayed significantly increased scores on the post-tests in all grade levels, with a $p$ value less than .001 for the STAR Math and less than .019 for the Terra Nova test. The low and no implementation group of students did not have a significant increase on the two post-tests (Ysseldyke & Bolt, 2007).

One limitation of this study was 39.5% of students from the experimental group did not receive implementation of Accelerated Math. There was not a particular pattern or criteria that excluded these students from participating in the program. The implementation of this program was high for integrity because of the training of staff, goals set by students, and the data provided to monitor student performance. Data show an increase in student achievement when staff progress monitor student performance. Progress monitoring of student performance influences student achievement by creating expectations to reach goals and to rely on research-based interventions and strategies (Ysseldyke & Bolt, 2007).

Progress monitoring can also give teachers an insight to how students will perform on high-stakes tests. Keller-Margulis, Shapiro, and Hintze (2008) conducted a study including 1,477 elementary students, varying in ethnicity, participated from six elementary schools. Data were collected for curriculum-based measurements on mathematics three times during the year. Only 59% of 75% of the original participants were used in the normative data because of attribution. Reading curriculum-based measures were also collected and researched, but for the content of this literature review, only the mathematics portion will be discussed. Math computation probes, consisting of 25 problems were assessed, as well as math concepts and applications probes,
Math Interventions and High-Stakes Test

consisting of 18 problems. Terra Nova also resulted in high validity for the curriculum-based measurements. Administration procedures were used to collect data in a ten- to fifteen-day period, but did not have guidelines on how to use data for making instructional decisions. The high-stakes tests administered to students was the PSSA, Pennsylvania System of school Assessment, which places students in a level of Below Basic, Basic, Proficient (passing), and Advanced.

After data were collected, outliers, distributional properties, and parametric assumptions were observed and factored out of the results. Correlations were also observed between each of the curriculum-based measurements, as well as the high-stakes test. To analyze the relationship between the curriculum-based measurements and the high-stakes test, receiver operator characteristics were identified to create a cut score. A positive correlation between spring scores on the curriculum-based measurements in mathematics data and the slope of improvement was found. The correlation between the spring curriculum-based measurements and the high-stakes tests score also displayed a positive correlation, with a p value less than .01 two years later. The measures concluded a range of around 65% to 69% prediction accuracy of students passing or failing high-stakes test from curriculum-based measurements. Curriculum-based measurements have a positive correlation with determining whether a student passes or fails a high-stakes test. The value of p was less than .01 on high-stakes tests two years later and a mixture of p values less than .05 and .01 for one year later (Keller-Margulis et al., 2008).

Although this study was conducted in an elementary school, curriculum-based measurement may be applied to a middle school setting. Results displayed positive correlations between the two measures assessed, but the correlation slightly decreased as the students progressed into higher grades. Participants ranged from first grade to fifth grade, so generalizing
this data to middle and secondary student performance may be done, but with caution. Using curriculum-based measurements to determine what student’s have mastered is beneficial for planning instruction and can be used as a base for predicting the outcome of high-stakes tests (Keller-Margulis et al., 2008).

**Strategy Instruction.** Strategy instruction is another intervention and tool that can increase student performance for students with and without learning disabilities. Strategy instruction is a tool for students to guide their own learning through mental activities and strategies (Montague & Dietz, 2009). Strategic instruction breaks down concepts into sub-skills through mnemonic cues, rules, memory, and retention (Byrant & Byrant, 2008). Teaching test-taking skills prior to a test can be taught as an example of strategy instruction. Implementing test-taking skills before a high-stakes test can have a positive effect on students with disabilities.

Thirty-eight high school students with disabilities were separated into two groups consisting of similar age, ethnicity, and gender to participate in a study conducted by Carter et al (2005). The students completed the Simulated Tennessee Competency Achievement Program-Mathematics designed for graduation, and the Test Anxiety Inventory. The Test Anxiety Inventory consisted of 20 questions assessing the frequency of anxiety before, during, and after tests. Students were given both assessments right before and after a series of six test-taking strategy sessions. Strategy sessions involved bubble sheet completion, sorting problems, estimation, substituting, checking answers, recopying problems, underlining, reading all the possible answers, and elimination.

On the Competency Test Math Simulations, a paired-sample of t tests was used to find the differences between the two groups and found a significant increase of correct responses for
the first group. The second group only had a slight increase, but displayed a significant increase in correct responses after the delayed intervention. When instruction was delayed, the first group had a slight increase. A review of the Test Anxiety Inventory scores indicated a significant decrease in emotionality and total anxiety score for the second group. No significant difference on the inventory was reported for the first group. Students were separated by gender, ethnicity, and disability, but not specifically based off their current anxiety state with tests and school in general. All significant findings displayed a $p$ value less than .05 (Carter, et al., 2005).

Although the participants were high school level students, results can be generalized to middle school students based off the closeness in age. Incorporating test-taking strategies in the earlier grades can help prepare students for high-stakes testing and decrease anxiety sooner. Many students, especially those with learning disabilities, can increase scores on high-stakes testing when receiving test-taking strategies and curriculum based interventions (Carter, et al., 2005). Strategy instruction gives a toolbox of learning strategies that will help the students solve different types of problems on high-stakes tests. Another beneficial outcome of implementing test-taking strategies and curriculum-based interventions for students is the possibility of decreasing test anxiety. Students feel more confident with their toolbox on information and strategies and feel better prepared when taking a high-stakes test.

**Guided Versus Structured.** Engaging students and creating independent learners through intervention can be effective when it is time to administer high-stakes tests. Constructivist principles suggest that students need to be involved in their learning, which can be facilitated with questions by the teacher. These principles can be applied to students with and without disabilities. Kroesbergen and Van Luit (2002) studied 58 students with and without disabilities. Participants completed a quasi-experiment involving guided and structured
instruction. Students came from seven schools holding an average age of nine years old, with univariate and multivariate analyses showing no differences in age, gender, IQ, or instruction in multiplication. Students participated in a pre- and post-test for multiplication, with 20 questions testing ability and 40 items testing fluency. The MASTER Training Program the researchers used was adjusted for multiplication teaching 25 lessons of different tasks with small steps between lessons. Structured instruction, guided instruction, and control or general teaching was used within groups of students. For the purpose and observation of the study, the group of students that received structured instruction answered teacher questions and did not contribute much to the learning process. The guided instruction group of students was more active in the learning process by asking questions and taking charge of their own learning.

No significant difference was found between the control group and the guided or structured group on the pre-test. Students in the guided instruction group had a significantly higher outcome, value of $p$ equaling 0.00, on the post-test for automaticity in comparison to the structured instruction group. This was also apparent with the post-test given to the group with guided instruction compared to the control or structured instruction group. Students with disabilities displayed a greater improvement of transfer knowledge compared to students without disabilities. When tested three months, students with disabilities had declined while students without disabilities improved in knowledge. Also evident from the data was that students without disabilities performed better with guided instruction, whereas students with disabilities performed better with structured instruction (Kroesbergen & Van Luit, 2002).

Schools were randomly assigned to the study conditions but the groups within the building were not randomly chosen for the different types of instruction presented. Although instruction was not chosen at random, the increase in performance from students is a highlight of
effectiveness when looking at the types of instruction to use. Based off the results of this study, teachers of students with disabilities should search for interventions that lean more towards a student input and teacher supported learning format, rather than student driven learning (Kroesbergen & Van Luit, 2002). While a more in-depth look at the learning struggles of the low-achieving and students with disabilities in relation to the different instruction-types could be done, the results of this study guides teachers on what instruction-type benefits different groups of students. Structured instruction appears to be most effective when looking at instruction that would most benefit students with learning disabilities.

**Schema Strategy Instruction.** Schema strategy instruction is also another effective intervention for students with learning disabilities to learn mathematics, especially word problems. Schema strategy is the procedure of conceptually organizing information in your mind to solve problems. Four eighth-grade students with learning disabilities and severe language difficulties participated in a multiple-probe-across-participants design to find the effects of schema strategy instruction with mathematical word problems. Students completed a series of tests that were modified to include the names of their peers. The tests had 12 one-step and multi-stepped multiplication and division word problems. Participants and the teacher at the end of the study also completed a strategy questionnaire, using the Likert-type and open-ended questions. Pre- and posttreatment scores for each student were calculated for each type of problem that was taught. When collecting data for strategy use, Jitendra, DiPipi, and Perron-Jones (2002), computed the number of times each student used each strategy. This was calculated over the number of possible times the student could use each strategy.

Jitendra et al. (2002) trained the teachers on how to use the scripted lessons and the procedure of assessing the students. Each student received one-on-one instruction from a special
education teacher. Each participant was introduced to the strategy spread out over a length of time. Baseline data were gathered before each skill and 35 to 40-minute lessons were taught with schemata diagrams. A score of 100% correct was needed before a student could proceed to the next skill, and after interventions were conducted, a generalization probe was administered. During the instruction phase students were trained to identify problem schemata, modeled through explicit instruction, participated in discussions with the teacher, provided teacher-supported practice, practiced, progress monitored, and given corrective feedback for each skill introduced. Note sheets with key features were given and faded out until mastery of each skill was accomplished.

Results indicated a mean score of 38% of correct word problems before the implementation of intervention and increased to a mean score of 100% after intervention was conducted. A significant increase of strategy use, drawing diagrams, and writing number sentences to help solve word problems occurred after the intervention. Two students demonstrated the same amount of strategy use in the maintenance phase after intervention. One student decreased 25% and one student did not have a score for the maintenance phase. The student questionnaire given resulted in positive and negative comments about word problems. The teacher rated the intervention high across the areas of efficiency, effectiveness, flexibility, application, the ability to general, and how easy it was use (Jitendra et al, 2002).

Although this study had a very limited population, results displayed an influence of schema-based instruction on the performances in mathematical strategy use for all four of these students with learning disabilities. Applying schema-based instruction to solving word problems may be beneficial for a large population of students if generalized. A student being able to collect one more self-implementing strategy for their toolbox is positive for future tests and
assignments. Students need more strategies that they can use to guide their own learning to be successful academically (Jitendra et al., 2002).

**Peer-Assisted Learning.** Peer-assisted learning strategy is one intervention that can remediate math skills for struggling middle school students. The peer-assisted learning strategies program was implemented as a remedial service to students struggling with mathematics from a group of 150 seventh graders. Students who struggled with mathematics included students with learning disabilities, behavior plans, and Asperger’s syndrome. Students were paired using a split list procedure and were trained five days with scripted lessons (Kroeger & Kouche, 2006).

The peer-assisted learning strategy program was implemented three out of five days of the week and students were assigned the role of coach or player. The coaches used scripts to support the player and answered questions when the player was struggling. Players and coaches switched roles during the peer-assisted learning strategy program depending on the skills taught. Scaffolding was built in and slowly the students gained independence with the program (Kroeger & Kouche, 2006).

Kroeger and Kouche (2006) described the peer-assisted learning strategy as having all students engaged, increased confidence, and an increase in quiz scores for struggling students. Although one student’s comment of how the peer-assisted learning strategy was annoying to read the script repeatedly, student reactions to the intervention were in general recorded as positive. Students enjoyed the help of their partner, having scripts to assist with helping their partner figure out the problem, and feeling more confident in asking questions instead of feeling embarrassed. Not all students had a positive view on the peer-assisted learning strategy. Another positive outcome from the peer-assisted learning strategy was students had a tool, the scripted
role-playing, which he or she could repeat in their mind when taking a test. Peer-assisted learning can be applied to classrooms with students with learning disabilities so that pair work can be implemented. Students are also enabled with a script of walking through math story problems while implementing the peer-assisted learning strategy.

**Self-Talk & Solve It!** Another strategy that has that is beneficial when students repeat steps and phrases in their mind are self-talk for problem solving. Montague, Krawec, and Sweeney (2008) gave their recommendation of incorporating the Solve It! Say-Ask-Check Model for students with low vocabulary and concepts. The Say-Ask-Check Model is a self-regulatory strategy that guides students through math word-problems with thinking aloud through questions and steps.

Rosenzweig, Krawec, and Montague (2011) gathered talk aloud data were from a larger study, conducted by Montague. Seventy-three middle school students, mainly White or Hispanic were grouped into three categories based on performance on the criterion-referenced Florida’s Comprehensive Assessment Test. The groups consisted of students with learning disabilities, low performing learners, and average learners. Data was collected during individualized audiotaped sessions of students solving one-, two-, and three-step problems using a think-aloud strategy model. Students were taught through a script in advanced how to think-aloud through problems and why it was useful to increasing math performance. Students were also modeled the think-aloud steps, allowed time to practice, and then solved three word problems. The instructor would prompt the student to think aloud if they were quiet longer than five seconds.

Transcripts were created with the audiotaped sessions and entered into a computer program called Atlas Ti that coded responses for metacognitive thinking. Seven cognitive and
seven metacognitive codes were calculated and categorized into cognitive verbalizations, productive cognitive verbalizations, and nonproductive metacognitive verbalizations. Productive verbalizations include the process of self-monitoring, self-questioning, and self-instruction, whereas nonproductive verbalizations tend not directly contribute to solving word problems. Frequency of each category was collected through tally marks and was calculated into percentages. Interrater agreement of categories and coding was 92% (Rosenzweig, Krawec, & Montague, 2011).

Factorial ANOVA was used to determine the differences between each student group, type of problem, and metacognitive verbalizations. Results indicated in comparison to average performing peers, students with learning disabilities overall used metacognitive verbalizations significantly more, with a p value equaling .018. Students displayed a significant increase, with a p value less than 0.001 of metacognitive verbalizations on three-step problems compared to one-step problems. An increase in metacognition use by all three groups was found for two- and three-step problems. Productive metacognitive verbalizations were significantly higher than nonproductive verbalization with a p value equaling 0.046. Another finding indicated students with learning disabilities and low achieving students had an increase of nonproductive verbalizations of one-step problems in comparison to three-step problems (Rosenzweig, Krawec, & Montague, 2011).

The think aloud process used in the Rosenzweig et al (2011) study is closely related to the Solve It! Say-Ask-Check method for the math problem solving process. This process includes reading for understanding, say in your own words, visualize, hypothesize how to solve the problem, estimate the answer, compute the answer, and go back and check your answer in the problem (Montague, Krawec, & Sweeney, 2008). To enable students with a script and to break
down the process of learning when solving word problems adds another tool and strategy to their toolbox. This is exceptionally useful for students when the word problems are multi-step problems (Rosenzweig, Krawec, & Montague, 2011). Enabling students with a tool to break down word problems and solve independently with a script is positive and can increase mathematics performance.

**Cover, Copy, and Compare.** Cover, copy, and compare is another self-regulated intervention that students can use to increase their fluency in math. Cover, Copy, and Compare has three steps that are self-managed by the student. The steps include looking at a stimulus, covering the stimulus and marking a response, and then checking for an accurate answer. For mathematics Cover, Copy, Compare is mostly used with math facts and the student would look at the math fact, cover and copy down the math fact, and then check to see if they were accurate. If the student were to copy the problem incorrectly, they will complete the error correction step by copying the problem down correctly (Skinner, McLaughlin, & Logan, 1997).

Grafman and Cates (2010) conducted a study for find the difference between the Cover, Copy, Compare method and a modified copy, cover, and compare method during three sessions lasting 50 minutes each. Forty-seven general education students of different ethnicities in a second grade classroom completed two types of worksheets. The first set of worksheets was used as pre- and post-tests and each consisted of 40 subtraction problems. The second set of worksheets had 25 subtraction questions similar to the pre-and posttest.

Each student completed a pre-test, two worksheets using the two interventions, and a post-test. Students were timed for two minutes on the pre- and post-test, and during the intervention days, students were trained on how to use both interventions. If students answered
the problem incorrectly, the error-correction procedure was to be done, which has the students copy and answer the problem correctly once. To collect data for both tests, the number of errors and the number of correct digits per minute was calculated. Students scored one point for every correct digit in the correct place and no points were counted if the students used the error correction procedure. These numbers created a ratio between correct responses and 120 seconds. After each test, students were immediately asked which intervention they preferred and the teacher documented the total of raised hands (Grafman & Cates, 2010).

To ensure that students were following the directions and interventions correctly, Grafman and Cates (2010) reviewed all problems on every worksheet completed. Students followed directions around 92% of the time for both interventions. Dependent t tests were conducted to assess the effects of errors per minute and digits correct per minute. A chi-square test was used to figure results for student preference between the two interventions used. A significant increase, with a p value less than 0.05, was found for digits correct per minute from the pre- to the post-test. When comparing the errors per minute on the pre- and posttest, no significant difference, with a p value of .33 was found. Students had a significant difference, p value of 0.00, of correct digits per minute on the Cover, Copy, Compare intervention than the copy, cover, and compare intervention. No significant difference was found between both interventions on the errors per minute results. Students preferred the Cover, Copy, Compare intervention with a p value of .00 in comparison to the Cover, Compare, Copy intervention. Students can increase math fact fluency with the implementation of the Cover, Copy, Compare intervention. The error-correction step of this intervention helps students recognize mistakes. Students will learn to fix their thinking the next time they answer math facts.
Grafman and Cates’ (2010) research ended with remarkable results on the effects of using the Cover, Copy, Compare intervention for increase student fluency. One limitation of this study was the amount of time, although effective, a longer range of time would increase validity and outcomes for results. Although students with disabilities were not directly identified within the study, results can be generalized. Many students are not identified as having a learning disability and struggle daily in mathematics and other curricular areas. Results cannot be guaranteed but a positive outcome of increased scores can be predicted for many students with and without disabilities while using the cover, copy, compare intervention.

Many interventions and strategies may help to increase the math performance of students with learning disabilities. It is important for teachers to look at the common characteristics displayed by interventions and strategies and to apply them in their everyday curriculum. Judson (2007) suggested that when an entire school or district’s staff can discuss, agree, and implement certain math interventions, the students would often shortly follow suit. Teachers start to see the value of the intervention being used and have enthusiasm for the intervention, resulting in an increase of student engagement for participation.

Schools and districts can implement many different strategies and interventions to improve the academic performance of students at all grade levels. Taking the time to pinpoint each student’s strengths and weaknesses will help to choose which intervention or strategy to implement. Implementing the most effective strategy will enable students to be independent and successful learners. Students with learning disabilities can participate in many interventions to increase their math skills. Incorporating strategic instruction, Cover, Copy, Compare intervention, peer-assisted learning, Solve It!, or schema strategy with the math curriculum will help to increase the math fluency and word problem skills.
Chapter III: Synthesis

Common Characteristics

A common result of each study indicated that not all students displayed a positive increase in performance (Grafman & Cates; 2010; Jitendra, DiPipi, & Perron-Jones, 2002, Kroeger & Kouche, 2006; Kroesbergen & Van Luit, 2002; Mong & Mong, 2010; Montague, Krawec, & Sweeney, 2008). These results reinforce the mindset that each individual child learns differently and may need more or less support compared to their peers. Students with learning disabilities may have a difficult time learning a variety of skills. Even though a strategy or intervention may not benefit all students, many strategies can benefit different styles of learning. Teachers need to implement the most appropriate strategies and interventions to increase each student’s learning difficulties and styles.

Explicit instruction is a common occurrence for increasing student mastery and retention. Using interventions with explicit teaching bridges the gap of deficiency for students with and without disabilities. Explicit instruction scaffolds learning for students until they are able to perform the skill independently. The student is able to see how the skill is done correctly by the teacher, work with the teacher until he or she increases their performance on the skill, works independently on the skill, and then given time to practice the skill until mastery is achieved. Interventions can encompass explicit instruction with very structured and detailed dialogue to enhance student learning (Grafman & Cates, 2010; Jitendra, DiPipi, & Perron-Jones, 2002; Kroeger & Kouche, 2006; Kroesbergen & Van Luit, 2002; Mong & Mong, 2010, Montague, Krawec, & Sweeney, 2008).
Explicitly taught instruction is a component of many interventions that increase student performance and relies on students taking ownership of their own learning. Students can be taught many inventions that can be included in their repertoire of self-implemented strategies. Strategies such as the Cover, Copy, Compare and the say-ask-check model can help increase student performance on many areas of learning (Grafman & Cates, 2010; Jitendra et al, 2002; Montague et al., 2008). Peer-assisted learning strategy is another intervention that includes components of students having on steps or scripts to help increase their performance in math. Although the peer-assisted learning strategy requires students to work with their peers, the dialogue component can be used to guide them on questions in an independent setting on a tests or assignments (Kroeger & Kouche, 2006).

Studies have also shown a variety of interventions and strategies that include students using their toolbox of strategies to solve problems encountered in the everyday classroom instruction and on high-stakes tests. Increasing the size of students’ toolbox of strategies is beneficial if he or she is able to choose the correct one. Students need to be taught the strategy and process of choosing the best strategy to help them solve their problem (Grafman & Cates, 2010; Jitendra, DiPipi, & Perron-Jones, 2002; Kroeger & Kouche, 2006; Montague, Krawec, & Sweeney, 2008).

Another component of strategies is the constant review of student performance and mastery (Grafman & Cates, 2010; Jitendra et al, 2002; Kroesbergen & Van Luit, 2002). A teacher can review mastery during a guided session practice, student’s independent practice, or on a curriculum-based measurement. Observations and data collected regularly can help determine how a student performs academically. Through constant data collecting, teachers can plan for future curriculum to teach and a guide to what kind of instruction to use. Data and
observations are also a good indicator of how a student will perform on a high-stakes test (Carter et al, 2005; Keller-Margulis, Shapiro, & Hintze, 2008).

A final commonality between strategies and interventions found to increase the math performance of students with learning disabilities is the use of the error correction procedure. Many of these interventions include the peer-assisted learning strategy, cover, copy, and compare intervention, and the Say-Ask-Check Model (Kroeger & Kouche, 2006; Grafman & Cates, 2010; Montague, Krawec, & Sweeney, 2008). If students continue to pass over errors made, he or she will not recognize or recall the accurate answer. The process of incorrect thinking and solving will continue and the students fail that skill or problem in the future. Having the students recognize the errors made and then correct their thinking is beneficial to increase performance for future challenges with similar problems or questions.

**Connecting Interventions to Performance on High Stakes Testing**

Students with and without disabilities are held accountable to perform on tests that can determine their path in academics. Tests scores can result in high anxiety for students, pressure for school districts, failure, and success (Carter et al, 2005; Christenson et al, 2007; Judson, 2007; Ysseldyke et al, 2004). Through the implementation of researched-based interventions, an increase of skill mastery will occur, which can directly influence high-stakes test scores. Given the tools and strategies, students with and without disabilities will generalize their learning and successes of skill performance to high-stakes test, benefiting their academic paths (Carter et al, 2005; Christenson et al, 2007; Ysseldyke, 2004). Providing students with strategies to improve performance on mathematic skills can be generalized to performances on high-stakes tests (Carter et al, 2005). These strategies and interventions can be provided through the three-tiered
structure of Response to Interventions. Through small group and intensive explicit instruction, students with learning disabilities will increase mathematics performance and high-stakes tests (Byrant & Byrant, 2008).
Chapter IV: Conclusion

Recommendation

Teachers and staff should provide students with researched-based instruction interventions to increase performance in math. Pinpointing students’ strengths and weaknesses will provide teachers with an idea of what interventions to implement in the classroom. Instruction in the classroom that encompasses structure, teacher guidance, practice, and error correction helps increase student performance of mathematics. Incorporating opportunities for peer work and strategies that include scripts allows students to become independent learners. Monitoring the progress of student mastery also helps to guide future instruction, remediate skills, and predicts students’ performance on high-stakes tests. Student performance on high-stakes tests can improve when effective instruction and interventions are integrated into the daily routines of middle school math classes. Providing students with tools and strategies that allow them to be independent learners will translate into higher performance in the classroom and on high-stakes tests.

Recommendations for a future study would include researching and comparing the different effects each intervention or strategy with progress monitoring has on increasing middle school student performance in mathematics. Interventions and strategies that have benefited student growth in mathematics skills would need to be located and documented. After collecting a list of interventions and strategies, a grouping each intervention by skill needs to take place. For example, one group of interventions could be based on math fluency and creating another group of interventions for the increase of word problem skills.
After grouping each intervention, data would be collected with middle school students ranging in age, ethnicity, and levels of learning difficulties. Progress monitoring in the form of curriculum-based measurements would also need to be in place and the frequency exact in all groups. The choice of the progress monitoring materials used would need to be flexible to student change in performance, limited interruptions to instructional time, and meaningful in relation to education (Stecker, Lembke, & Foegen, 2008). Baseline measures along with data and end results would need to be documented throughout the study.

Training teachers on how to conduct the intervention would need to take place prior to the implementation of research occurs. Conducting the intervention would include knowledge of implementing the instruction and assessments. An administrator to monitor how interventions and strategies are being implemented would increase the validity and integrity of the study. Assessing students with a pre- and post-assessment to show growth would also need to take place. As for how long the interventions should take place will depend on the intervention, but for reliable and accurate results, approximately two months to a full year should be done. Conducting the interventions for a maximum length of time allows students to adjust to the procedures of the intervention and results will start to show valid knowledge of student mastery. Administering two interventions at the same time, to a similar group of students in age, ethnicity, and learning level will allow for sooner results and comparisons.

Correlations between interventions and student growth will need to be analyzed. Also analyzed would be the correlations between each intervention and the levels of all students in the study. Results of this hypothetical study would narrow down interventions and strategies that would best help different types of learners. Based off results, teachers can gauge the level their learners perform and pair a successful intervention and strategy with those groups. With
grouping the interventions, teachers may start with the skill needing to be increased. The search for the intervention would best benefit a specific type of learner within that skill group could then be performed.

Conclusion

The successes of all students are not positively influenced by one or two mathematics interventions. As teachers, we need to determine how each student learns mathematics to determine which effective tools and strategies they need to help her or him learn. Even though students with learning disabilities may have more struggles when learning, teachers can provide strategies and support their learning so that mastery of skills can occur. High-stakes tests have many components including anxiety, the option of accommodations, and more, but with interventions on how to conquer these obstacles allows students to demonstrate their knowledge of mathematics. Monitoring student growth and struggles will allow teachers to address students’ weakness and enhance their strengths. Observing students behaviors and math performance will indicate strengths and weaknesses that can be monitored and skills implemented to improve performance. Implementing specific interventions and monitoring student performance on math skills helps to increase the performance and relieve stress and anxiety on high-stakes assessments for students with learning disabilities.
References


curriculum-based measures in reading and mathematics. *School Psychology Review*,


doi:10.1007/s10864-010-9114-5

instruction and mathematical problem solving. *Council for Exceptional Children, 75*(3),
285-302.

students' mathematical problem solving. *Perspectives on Language and Literacy, 34*(2),
13-17.

Leadership, 50*(5), 36.

994-1000. doi:10.1046/j.1365-2923.2000.00689.x

students with and without learning disabilities during mathematical problem solving: A


