Effects of an Intervention on Math Achievement for Students with Learning Disabilities

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Abstract

Students with learning disabilities score lower than other at-risk groups on state standardized assessment tests. Educators are searching for intervention strategies to improve math achievement for students with learning disabilities. The study examined the effects of a mathematics intervention known as Cover, Copy, and Compare for learning basic math computation skills. Fifteen students diagnosed with learning disabilities participated in this study using Curriculum Based Assessment probes to collect the data. There was a significant difference in math achievement from pre- to post-test scores for students with learning disabilities who participated in the Cover, Copy, and Compare treatment, $t\ (14) = -15.09$, $p < .001$. An analysis of covariance determined the efficacy of a Cover, Copy, and Compare intervention was not related to gender or ethnicity. One recommendation for future research is to conduct studies regarding Cover, Copy, and Compare instruction's impact on student achievement for younger and older students with learning disabilities.

Effects of an Intervention on Math Achievement for Students with Learning Disabilities

Students with learning disabilities are more at risk of falling behind in their grades and, as a result, are at risk of dropping out of school (Glago, Mastropieri, & Scruggs, 2009; Milsom & Glanville, 2010). According to the National Assessment of Educational Progress (2007), only 6% of students with learning disabilities passed the math component on a standardized mathematics assessment. Because No Child Left Behind (NCLB, 2002) mandates for all students perform at mastery levels by 2014, it was important to study the effectiveness of researched-based interventions for students with learning disabilities (DeSimone & Palmer, 2006). Common Core State Standards (CCSS) assessments are aligned with the accountability provisions of NCLB and are used as the new measuring tool for achievement (Jennings & Sohn, 2014).

An analysis of NCLB and the CCSS was conducted in a study to determine if NCLB and the CCSS could help educators and policy makers understand what they can expect in the future as the CCSS-aligned assessments become the new measuring tool for the accountability provisions of NCLB. Some principals are instructing their teachers to focus their efforts on average performing students. Jennings and Sohn (2014) predicted that high proficiency standards produce increases in average achievement and increases in inequality on high stakes tests such as the CCSS between higher and lower performing students because lower performing students are neglected to the extent that teachers use more time to prepare higher achieving students to meet or exceed standards. One example of the commitment to computation skills is found in the fourth-grade standards in Number Operations and Base Ten (CCSM.4.NBT.4) requiring that students demonstrate fluency in adding and subtracting multi-digit whole numbers (National Governors Association Center for Best Practices et al., 2010). Jennings and Sohn suggested that a greater emphasis is placed on math at the expense of reading and therefore, more educators are searching for researched based interventions strategies in math and the primary target of the CCSS is the elementary grades. Elementary students with learning disabilities experience many challenges when making the transition to middle school (Glago et al., 2009). Students making this transition may experience a drop in their grades, and this often results in low self-esteem and social and peer exclusion. Glago et al. revealed evidence of the benefit of improving calculation skills for elementary students in determining future success in other math subjects as well as in other subjects such as science. Poor academic performance in early elementary grades correlates with future drop-out rates for students with learning disabilities (Glago et al., 2009; Joseph & Schisler, 2009).

The Common Core reduces the breadth of mathematics topics in elementary grades, which provides students with more time to focus on basic computation skills to be better prepared for a successful transition to middle school. Jordan, Kaplan, and Hanich (2002) found that basic calculation skills were a significant factor in math achievement in higher-level mathematics. The National Mathematics Advisory Panel (2008) reported on the importance of students developing fluency skills in mathematics. A significant link was found to exist between fluency in basic calculation skills and overall mathematics performance (Codding, Eckert, Fanning, Shiyko, & Solomon, 2006; Poncy, Skinner, & Jaspers, 2007).

Students with learning disabilities are more likely to show symptoms, such as problems with accuracy and fluency in basic calculation skills in early grades (Jordan et al., 2002). There are various reasons for students' difficulties in mathematics, including deficits in intelligence, motivation, and vocabulary (Kroesbergen & Van Luit, 2003). The type of instruction influence the ability to learn. Difficulties in mathematics result from inappropriate instruction for the learning styles of students with learning disabilities and directly influence their ability to learn math (Carnine, 1976). Students with learning disabilities are more likely to show signs of weaknesses in basic calculation skills when they enter kindergarten by needing props (e.g., counting their fingers), problems in memorizing, and inaccurate computations for grade-level competency (Jordan et al., 2002).

Research Questions

Question 1. What is the effect of a Cover, Copy, and Compare treatment on academic achievement in math for student with learning disabilities?.

Question 2. What is the difference in math achievement by gender for students with learning disabilities?.

Question 3. What is the difference in math achievement by ethnicity for students with learning disabilities?

Method

Participant Protection

Prior to conducting this research, IRB approval was obtained. The following precautions were made to protect each participant. First, the data collection procedures employed in this research were part of standard procedures at the elementary school under study; therefore, parent consent and student assent were not required. Second, it was possible to conduct the study without recording any names or other identifiers of individual students. Third, students were identified by number, which protected participants' rights, and the researcher received no information regarding their identity and individual performance.

Research Participants

The participants came from a population of 125 fifth-grade students at an elementary school in northeast Georgia. The school, with a population of approximately 700 students, is one of six elementary schools in this district. The teacher assigned students with learning disabilities who scored below the cutoff criterion and who needed the treatment most to the treatment group. Fifteen students with learning disabilities participated in the study. These students scored at or below 50. The majority of the participants were Black (n = 8, 53.3%). Most of the participants were male (n = 9, 60.7%). Frequencies and percentages for participant demographics are shown in Table 1.

Table 1
Frequencies and Percentages for Participant Demographics

Demographic	*N*	%
Group		
Treatment	15	100.0
Ethnicity		
Black	8	53.3
Hispanic	4	26.6
White	3	20.1
Gender		
Female	6	40.0
Male	9	60.0

Design and Instrumentation

A one-group pre- and post-test design was used for this study. This design required data to be collected on study participants' levels of academic performance before and after the intervention took place (Shadish, Cook, & Campbell, 2001). This study design only looks at one group of individuals: those who receive the intervention (treatment group). The pre- and post-test design allows for inferences on the effect of the treatment (Shadish et al., 2001). Descriptive information is used to explain the context of the study. Quasi-experimental studies rely primarily on simple statistical tests like t tests and attempts to examine the effects of an intervention on a specific population (Shadish et al., 2001).

The teacher used AIMSWeb Mathematics CBMs to assess math achievement in division skills for fifth-grade students with learning disabilities (Pearson, 2008). The pre-assessment and post-assessment CBMs measured performance and the CBM assessment probes measured progress. The CBM pre- and post-assessment instruments and the math probes yielded information on accuracy (percentage of digits correct) and fluency (digits correct per minute). The following section addresses teacher training, the specific testing instruments, and scoring processes.

Teacher Training

Teachers received training in CCC instructional strategies. CCC procedures require the teacher to follow a five step process. First, the teacher gives the student a sheet of target problems. Second, the student is taught to study the problems and answers provided on the left side of the page. Third, the teacher instructs the student to cover the problems and answers on the left side of the page. Fourth, the student is taught to write the problems on the right side of the page. Fifth, the student uncovers and evaluates the response (Skinner, Belfiore, Mace, Williams, & Johns, 1997).

Testing Instruments

The AIMSWeb CBM math probes determined if students with learning disabilities improved performance in mathematics skills. School professionals have used the results of CBM math probes to improve instruction and monitor students' progress. Researchers usually give students a commercial broad-based achievement test to assess their skills in mathematics. These tests contain samples of a wide range of types of computation problems, but very few problems of any particular type. Combined with the fact that these types of math tests usually have only one form, it is difficult to reliably identify which types of problems students can do correctly and more importantly, to monitor the effectiveness of math interventions by measuring progress frequently. Math CBMs resolve these problems by providing educators instruments that tests across grade levels or types of math computation problems such as difficulties in math fact accuracy (Marston, 1989; Shinn, 2002). Math CBMs are reliable and appropriate instruments to measure the effectiveness of CCSS.

The CBM assessment probes contained 20-25 division problems with one and two digit divisors. The probes consisted of four different sheets of division problems over the 8-week treatment period. CBM assessment probes are reliable instruments that are sensitive to changes of students' performance over time (Shapiro, 2004). Educators and states sanction CBM assessment intervention materials because of their high rates of predictive success in helping students achieve higher scores on standardized tests.

Treatment

The teacher administered the AIMSweb CBM Mathematics to the treatment group. Students practiced division skills to assess accuracy and fluency in math. Students in the treatment group practiced division skills with one- and two-digit divisors for 15-minute sessions twice weekly over the 8-week intervention period. Following this instruction, students used 4 minutes to complete the division probes to determine if students' accuracy and fluency improved.

Testing and Scoring Process

The AIMSweb CBMs provided current functioning information of students' skills in division at the beginning of the study, determined academic changes during an 8-week study, and provided information on students' skills in division at the end of the study. The teacher assigned

AIMSWeb CBM probes, gave students 4 minutes to record solutions on paper, divided the total number of correct problems by the total of problems attempted, and multiplied by 100 to calculate percent accuracy. The teacher measured achievement by calculating scores from the pretest and the posttest using data provided from AIMSWeb CBMs.

Results

For the treatment group, pretest scores ranged from eight to 20 (M = 13.93, SD = 4.11). At posttest, the treatment group had scores from 30 to 50 (M = 42.07, SD = 6.62). Means and standard deviations for pretest and posttest for students with learning disabilities are in Table 2. A test of the hypothesis determined the efficacy of a CCC treatment for students with learning disabilities and academic achievement. A dependent sample t test compared pretest scores to posttest scores. The results of the dependent sample t test indicated there was a significant difference, t (14) = -15.09, $p < .001$. This suggests that there was a significant increase from pretest scores to posttest scores. Therefore, null hypothesis 1 was rejected. See results of the dependent sample t test in Table 3.

Table 2
Means and Standard Deviations for Pretest and Posttest

	Treatment	
Test	*M*	*SD*
Pretest	13.93	4.11
Posttest	42.07	6.62

Table 3
Dependent Samples t-test Results for Pretest Versus Posttest Scores

	Pretest		Posttest			
	M	*SD*	*M*	*SD*	*t* (14)	*P*
Scores	13.93	4.11	42.07	6.62	-15.09	.001

An ANCOVA was used to assess if there were differences in the posttest scores by gender after controlling for pretest. In this analysis, posttest scores were the continuous dependent variable, gender was the independent dichotomous variable, and pretest scores were the continuous covariate. In preliminary analysis, the assumptions of normality and equality of variances were assessed with the Kolmogorov-Smirnov (KS) test and Levene's test, respectively. Both tests yielded non-significant results, supporting the assumptions. The results of the ANCOVA were not significant, F (1, 12) = 1.33, p = .272, suggesting that gender was not related to the CCC instructional strategy. Therefore, Null Hypothesis 2 could not be rejected (see Table 4). Means and standard deviations for pretest and posttest by gender are in Table 5. An ANCOVA was used to assess if there were differences in the posttest scores by ethnicity after controlling for pretest. In this analysis, posttest scores were the continuous dependent variable, ethnicity was the independent nominal variable, and pretest scores were the continuous covariate. In preliminary analysis, the assumptions of normality and equality of variances were assess with Kolmogorov-Smirnov (KS) test and Levene's test, respectively. Both tests yielded no significant results, supporting the assumptions. The results of the ANCOVA were not significant, F (2, 11) =1.99, p

=.183, suggesting that ethnicity was not related to the CCC instructional strategy. Therefore, Null Hypothesis 3 could not be rejected. Results of the ANCOVA are in Table 6. Means and standard deviations are in Table 7.

Table 4
Results for ANCOVA for Posttest by Gender

Source	*SS*	*MS*	*F*(1, 12)	*p*	η^2
Pretest	15.23	15.23	0.34	.571	.03
Gender	59.50	59.50	1.33	.272	.10
Error	538.20	44.85			

Table 5
Means and Standard Deviations for Pretest and Posttest by Gender

	Female		Male	
Test	*M*	*SD*	*M*	*SD*
Pretest	11.67	1.97	15.44	4.56
Posttest	39.33	7.76	43.89	6.62

Table 6
Results for ANCOVA for Posttest by Ethnicity

Source	*SS*	*MS*	*F*	*p*	η^2
Pretest	15.23	15.23	0.38	.549	.03
Ethnicity	158.89	79.45	1.99	.183	.27
Error	438.81	39.89			

Table 7
Means and Standard Deviations for Pretest and Posttest by Ethnicity

	Black		Hispanic		White	
Test	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pretest	12.88	4.05	13.50	3.42	17.33	4.62
Posttest	39.88	5.51	4150	8.70	48.67	1.15

Discussion

A test of hypothesis determined the efficacy of a CCC treatment for students with learning disabilities and academic achievement. The purpose was to determine if student achievement in math computation skills (division) increased from pre to posttest when the instructional strategy was CCC. The results of a dependent sample *t* test indicated a significant difference in scores. Students with learning disabilities scores increased significantly from pretest to posttest in math.

An ANCOVA was used to assess if there were differences in the posttest scores after controlling for the pretest. ANCOVA assessed the differences in the posttest by gender. The results of the posttests determined that a CCC intervention was not related to gender. ANCOVA assessed if there were differences in the posttest scores by ethnicity after controlling for the pretest. The results of the posttests determined that a CCC intervention was not related to ethnicity. Students with learning disabilities were instructed in division skills using CCC strategies. These results support findings of other researchers regarding CCC when compared to other intervention strategies (Belfiore, Lee, Scheeler, & Klein, 2002; Codding, Shiyko, Russo, Birch, Fanning, & Jaspen, 2007; Poncy, Skinner, & Axtell, 2010; Skinner et al., 1997). Poncy et al. (2007) evaluated and compared the effects of a CCC intervention and Taped Problems (TP). The results reported by Poncy et al. demonstrated improvement in math fact accuracy and fluency for elementary students diagnosed with a mild form of retardation. The dependent measures included the number of digits correct and the number of digits completed per minute on assessment probes. The study extended the research on math fact accuracy and speed by determining that both TP and CCC could enhance math performance for students with low cognitive functioning skills in math and who often counted their fingers in order to compute the correct answer. Students with learning disabilities made progress toward the cutoff criterion in this study and therefore extended the research by supporting the findings of previous research. Belfiore et al. (2002) compared elementary students' rates of growth in percent accuracy and fluency on two empirically-validated instructional interventions. This study assessed whether Behavior Momentum (BM) and CCC instructional strategies in combination increase academic gains of elementary students. The results of the study did not show significant differences between the CCC intervention and the BM intervention on rates of growth. However, previous research documents that these interventions increased academic gains in accuracy and fluency when used separately (Codding et al., 2007; Skinner et al., 1997; Skinner, Turco, Beatty, & Rasavage, 1989).

Cover, Copy, and Compare interventions have been found to be more effective than a traditional approach for students with learning disabilities (Cieslar, McLaughlin, & Derby, 2008; Codding, Channetta, Palmer, & Lukita, 2009; Poncy et al., 2010). Students with learning disabilities have demonstrated an increase in accuracy and fluency after an intervention in CCC procedures. CCC instructional strategies are effective because they require students to continue practicing a skill until mastery is achieved, which is not always part of the traditional instructional plan (Poncy et al., 2007, 2010). Researchers have previously documented that CCC strategies used in conjunction with other intervention strategies did not result in significant differences between the models; however, when CCC is implemented alone, there have been significant increases in accuracy (Belfiore et al., 2002; Codding et al., 2007).

The findings from this study support the need for more research-based intervention strategies in math for students to achieve proficiency and meet the standards put forth by government agencies. The most important benchmark is for elementary students to achieve a solid foundation in math computation skills.

Implications for Practice

Lee and Tingstrom (1994) modified CCC procedures in order to increase students' accuracy and speed in a small group setting. The study's results indicated that the instruction was effective because students' accuracy and speed improved significantly in division skills. Lee and

Tingstrom found that teachers reported that CCC used in a group setting was an effective instructional strategy and that they would use it again.

Cover, Copy, and Compare is a repetitive process. Although there was no significant difference in math achievement by gender, students did make improvement. By giving students opportunities to make responses until they make a correct choice; results indicated increased accuracy and fluency for girls and boys. Boys showed the greatest amount of growth. According to Carr and Davis (2001), gender gaps exist between boys and girls in achievement and this has attracted the attention of educators. Researchers attribute this to stereotyping girls in the classroom by asserting that girls enjoy math less than boys do (Carr & Jessup, 1997). Expectations of parents and teachers account for differences in achievement by gender (Carr & Jessup, 1997; Carr & Davis, 2001).

In the present study, there were no significant differences in math achievement by gender. Girls and boys advanced to a higher level of achievement and also experienced increases in their self-confidence to achieve grade-level competence (Shapiro, 2004). At pretest, females in each racial category scored lower than males in each racial category. The results of this study indicated that female students with learning disabilities showed improvement although they were not significant. White females scored higher than Black and Hispanic females. White males and Hispanic males continued to perform higher than Black males and females in math. Because of the belief that females perform lower in math than their male counterparts, it was important to include gender in this study because the differences in math achievement between males and females is a growing concern for educators and researchers (Carr & Davis, 2001; Carr & Jessup, 1997).

Students with learning disabilities exhibit a variety of characteristics that distinguish them from their peers. In order for older elementary students with learning disabilities to improve in math, instruction designed to remedy students' math deficiencies in basic skills will give students more opportunities to succeed (Kroesbergen & Van Luit, 2003). The Common Core State Standards require that students focus on fewer topics in the elementary grades and use more time to comprehend basic math facts (computation). Students from different ethnic backgrounds are at a disadvantage in that they often have language barriers, low parental support, and low expectations from teachers. The Common Core helps make up for deficits by providing more time for students to learn math facts. Cover, Copy, and Compare instructional strategies provide more opportunities to for students with learning disabilities and cultural differences to achieve higher math scores by providing a foundation that will lead to solving higher-level math skills. Cultural difference is a primary cause of academic difficulties and contributes to students' learning difficulties (Kroesbergen & Van Luit, 2003). This study provides teachers with an intervention that has a research foundation for improving students' academic achievement.

Recommendations for Future Research

Because of the statistically significant academic improvement fifth-grade students with learning disabilities demonstrated from pre to posttest due the implementation of the CCC instructional strategy, one recommendation is for principals, administrators, and teachers to explore the benefits of this strategy for students with learning disabilities and cultural differences.

This study focused on one group of students at an elementary school in northeast Georgia, so it is recommended that a larger study be conducted with a larger sample of students from different states and different cultural backgrounds. Future studies examining the impact of CCC across earlier grades would add to the knowledge -base on this intervention and provide information on how this strategy affects achievement of younger elementary students with learning disabilities. Gathering student perceptions of CCC instructional strategies through interviews or open-ended surveys may be beneficial in determining how students feel about the repetitive process of CCC instructional strategies.

Educators should focus on implementing instructional strategies in reading and math that provide higher and lower achieving students the same opportunity to achieve higher grades (Jennings & Sohn, 2014). It is recommended that educators and policy makers focus on the achievement rates of students in states that implement the CCSS and states that have not adopted CCSS to determine if CCSS should be the accountability tool of NCLB. The goal of CCSS is to ensure that all students are achieving the same skills in all states and that the standards are not lowered in order to allow more students to pass the state tests.

Summary

This study examined whether CCC instructional strategies affect academic achievement in math computation skills for fifth-grade students with learning disabilities. Although conclusions from past studies on CCC instructional strategies vary when using CCC instructional strategies alone and when comparing them to other interventions, multiple researchers recommend implementing CCC procedures (Belfiore et al., 2002; Codding et al., 2007; Poncy et al., 2010). Quantitative statistical analyses of differences in scores between pre- and post-test data determined that CCC instructional strategies appear to improve student achievement in math for students with learning disabilities.

Results from this study provide positive evidence that CCC instructional strategies increased student achievement for this sample of students. CCC instructional strategies could provide the confidence that students with learning disabilities need to succeed in math. Additionally, data from this study could encourage teachers to realize how important it is for students to be proficient in math computation skills, which are foundational for success in higher-level math skills and are supported by the Common Core. A good foundation in math may lead to a greater number of students with learning disabilities graduating from high school and may gain the mathematical skills needed to enter rewarding careers.

All teaching and learning strategies need to be investigated if they promise any potential benefits for learners to overcome mathematics. Cover, Copy, and Compare appears to be an effective strategy, especially for students with special needs. This study contributes to positive social change by providing practical classroom strategies that can improve mathematics. By improving basic math skills, more students may elect to take math-related courses and enter rewarding careers.

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