2005

Cover, copy and compare method versus copy, cover, and compare method for teaching mathematics: A comparative analysis

Joel Grafman

Eastern Illinois University

This research is a product of the graduate program in School Psychology at Eastern Illinois University. Find out more about the program.

Recommended Citation

https://thekeep.eiu.edu/theses/1064
No further reproduction or distribution of this copy is permitted by electronic transmission or any other means.

The user should review the copyright notice on the following scanned image(s) contained in the original work from which this electronic copy was made.

Section 108: United States Copyright Law

The copyright law of the United States [Title 17, United States Code] governs the making of photocopies or other reproductions of copyrighted materials.

Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the reproduction is not to be used for any purpose other than private study, scholarship, or research. If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that use may be liable for copyright infringement.

This institution reserves the right to refuse to accept a copying order if, in its judgment, fulfillment of the order would involve violation of copyright law. No further reproduction and distribution of this copy is permitted by transmission or any other means.
THESIS REPRODUCTION CERTIFICATE

TO: Graduate Degree Candidates (who have written formal theses)

SUBJECT: Permission to Reproduce Theses

The University Library is receiving a number of requests from other institutions asking permission to reproduce dissertations for inclusion in their library holdings. Although no copyright laws are involved, we feel that professional courtesy demands that permission be obtained from the author before we allow these to be copied.

PLEASE SIGN ONE OF THE FOLLOWING STATEMENTS:

Booth Library of Eastern Illinois University has my permission to lend my thesis to a reputable college or university for the purpose of copying it for inclusion in that institution's library or research holdings.

[Author's Signature]  [Date]  [4-15-05]

I respectfully request Booth Library of Eastern Illinois University NOT allow my thesis to be reproduced because:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

[Author's Signature]  [Date]

This form must be submitted in duplicate.

http://www.eiu.edu/~graduate/thesisreproduce.htm  4/2/2005
Cover, Copy and Compare Method Versus Copy, Cover, and Compare Method for Teaching Mathematics: A Comparative Analysis

BY

Joel M. Grafman

THESIS
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Specialist in School Psychology

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY CHARLESTON, ILLINOIS

2005
YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING THIS PART OF THE GRADUATE DEGREE CITED ABOVE

Date

Department/School Head
Cover, Copy, and Compare Method versus Copy, Cover, and Compare Method for Teaching Mathematics: A Comparative Analysis

Joel M. Grafman

Eastern Illinois University
Abstract
This study compared the fluency and accuracy rates produced when using the Cover, Copy, and Compare and Copy, Cover, and Compare interventions to complete subtraction math problems. Two second grade classrooms consisting of 20 or more students participated in the study. Participants were administered a pretest, Cover, Copy, and Compare worksheet, Copy, Cover, and Compare worksheet, and a posttest. Results revealed significantly higher digits correct per second (i.e. fluency) scores on the posttest and Cover, Copy, and Compare worksheets when compared to the pretest and Copy, Cover, and Compare worksheets with no difference in the errors per second (i.e. accuracy) scores. Cover, Copy, and Compare is a more efficient math intervention and students completed more problems after the intervention.
Mathematics is one of many subjects taught to children in the public school system. Literature suggests that there is a link between mathematics performance and the general academic performance of children (Stading, Williams, & McLaughlin, 1996). Specifically, students who can not add and subtract are likely to encounter difficulty in school and life as mastery of these skills are needed in many situations (Miller & Heward, 1992). In addition, children who do not master basic math facts will likely continue to struggle and perhaps fail in later learning of other math concepts (Miller & Mercer, 1997; Pellegrino & Goldman, 1987). Moreover, fluency (i.e. speed) and accuracy are generally targeted by educators because both have been linked to social and academic success (Stading et al., 1996). To guard against such skill deficit failure, several different instructional methods are employed by teachers. A couple of general instructional methodologies that are commonly used to increase both fluency and accuracy is drill and practice through the use of flashcards and worksheets.

Math Difficulties

There are a number of hypotheses as to why children do not become proficient in basic math skills. Some of these hypotheses focus on internal structures. For instance, children who do not become proficient in basic mathematical concepts are often identified as having a disability. Some children may suffer from primary math disability, also known as dyscalculia. Fleischner and Manheimer (1997) point out that primary math disability might be related to dysfunction of the right hemisphere of the brain and is usually associated with visual-spatial disturbances as well as disturbances in social
perception and the development of social skills. An internal hypothesis developed by Russell and Ginsburg (1984) points out that a child with a mathematics difficulty (MD) might perform poorly on math tasks because of deficiencies or differences in general intelligence, logical reasoning, memory capacity, or other general cognitive deficits. However, regardless of the causal mechanisms for such MDs, children often make similar mistakes such as subtracting the smaller number from the larger number when borrowing and may experience trouble particularly when borrowing from zero (Russell & Ginsburg, 1984; Pellegrino & Goldman, 1987). In a study by Russell and Ginsburg (1984), students classified as having math difficulties made more errors than their same grade peers and students in the grade below them. Children classified as having math difficulties performed significantly worse than their same grade peers in the categories of: mental addition, counting large numbers, multiples of large numbers, accuracy in written addition and subtraction, and monitoring errors.

Rivera and Bryant (1992) refer to these systematic procedural errors as bugs and suggest that they are consistently made by students with MD when problem solving. Researchers have attempted to categorize mathematics problem solving. For example, Russell and Ginsburg (1984) categorized error strategies into the following groups: writing numbers as they sound, misalignment, wrong operation, addition bug, subtraction bug, and simple miscalculation. Students classified as having a math difficulty performed significantly worse than the other third and fourth grade students on complex subtraction problems and subtraction problems with irrelevant information. When referring to children with math difficulties, Russell and Ginsburg (1984) conclude that these children experience a minor difficulty in that they do not use adequate strategies
and experience major difficulties in applying basic concepts and skills to problems involving large numbers. According to Russell and Ginsburg (1984), students with MD usually result from making errors typical of younger children, inattention, poorly executing adequate strategies, or an inability to work with large numbers. In a more general sense, students with MD appear to be at an earlier stage of learning than their non-MD counterparts.

**Learning Hierarchy**

Haring and Eaton (1978) developed a learning hierarchy that is useful in understanding mathematics performance from a developmental stage perspective. The first stage is the acquisition stage. In this stage, the emphasis is on making accurate responses. This is often achieved through demonstration and modeling. In the acquisition stage of learning, the student learns how to perform the skill and immediate performance feedback is considered ideal (Miller & Heward, 1992).

In the learning hierarchy developed by Haring and Eaton (1978), once accuracy is achieved, the focus is shifted to building fluency (i.e. proficiency). It is important to build fluency so that the skill can be used in a meaningful way. Student’s academic success and social success could be linked to building proficiency (Ozaki, Williams, & McLaughlin, 1996). Fluency is a critical component of fact mastery and should be focused on when a student enters the practice stage of learning (Miller & Heward, 1992).

In this stage, the emphasis is on improving speed. Proficiency is often obtained through the use of drill procedures. Maintenance or retention of learned skills is another component of this stage. Retention can be achieved through overlearning or the use of meaningful material (Haring & Eaton, 1978). Fluency is generally measured as the
number of correct responses per minute. This measure is obtained by providing a 1 minute time trial where students are given more problems to complete than they could possibly finish in 1 minute. The educator then counts up the total number of digits correct per minute and records this as the fluency measure. Skinner and Smith (1992) suggest that increases in problems or digits correct per minute lead to increases in learning. According to Miller and Heward (1992), fluency should be used to assess children's progress in math because (1) it provides a complete picture of learning and performance; (2) it is sensitive to changes in performance; and (3) it has critical functional implications both in school and out of school. According to Miller and Heward (1992), students should be able to complete at least 30 to 40 problems per minute. However, they did not specify the age at which this rate of fluency should occur. Miller and Heward (1992) point out that time trials provide students with many opportunities to respond, are easy to implement, and are enjoyed by students. Increases in fluency and accuracy can result from repeated assessments (Skinner & Shapiro, 1989). Giving students performance feedback and multiple assessments will allow them to see the progress they have made over time (McLaughlin & Skinner, 1996).

In addition, becoming fluent in basic math skills is the precursor to learning how to solve more complex problems. Usually, students complete math assignments by making written responses. In order for students to be able to move onto more complex multi-digit multi-step problems, they must first master and be able to quickly recall their basic single-digit addition, subtraction, multiplication, and division problems (Pellegrino & Goldman, 1987, Russell & Ginsburg, 1984). Therefore, there is a belief among educators that certain math facts must be memorized. When children master basic
addition facts, they store their knowledge in memory. Retrieval of this knowledge should be achieved quickly and automatically (Pellegrino & Goldman, 1987). Children who have MD often struggle to memorize their basic facts (Russell & Ginsburg, 1984). It appears that learning disabled children struggle with basic facts because they must compute them using a counting strategy rather than just recalling the facts from memory (Pellegrino & Goldman, 1987). However, it should be noted that mental growth does not occur from just memorizing facts (Wakefield, 1998).

The next stage in the learning hierarchy is the generalization stage. In this stage, the emphasis is on using the learned skill in the presence of a novel stimulus. Generalization can be learned through practice procedures such as discrimination training and differentiation (Haring & Eaton, 1978).

The final stage in the learning hierarchy is the adaption stage. In this stage, the emphasis is on adapting the response to the unique situation and stimuli presented. Adaption can be learned through problem solving and simulations. Problems in this learning hierarchy can arise when students do not maintain or apply the knowledge they have gained. At this time, there are no systematic procedures that are used to instruct children at each individual level of the learning hierarchy (Haring & Eaton, 1978).

**Strategies for Teaching Basic Math Facts**

Children who have mathematics difficulties often have a strategy for solving basic math problems and this strategy usually involves counting (Russell & Ginsburg, 1984). For instance, when solving basic math problems, students diagnosed with LD often use finger counting (Skinner, Turco, Beatty, & Rasavage, 1989). Students with LD are more likely to rely on counting strategies whereas normal students rely on recall when
computing basic facts (Fleischner & Manheimer, 1997). Four strategies that are used to count numbers include: the counting-fingers strategy, fingers strategy, the counting strategy, and the retrieval strategy (Siegler & Shrager, 1984). According to Isaacs and Carroll (1999), some of the counting strategies that children can use to solve basic addition and subtraction problems include: (1) counting forward and backward (i.e. counting by one’s), (2) skip counting (i.e. counting by 5’s), (3) counting forward and backward a specified number of numbers (i.e. start at 7 and count forward 5), (4) counting by tens (i.e. 8+5=8+2=10 and 10+3=13 so 8+(2+3)=13), and (5) doubles facts (i.e. 4+4=8 so 4+6 must be 2 more than 8). Siegler and Shrager (1984) point out that children use a variety of strategies to add and subtract. They count up from one, count on up from the first number or the higher number, count their fingers, tap their feet in a rhythmic fashion, and break down complex problems into simpler ones. In a study by Jolivette, Lassman, and Wehby (1998), a counting-up strategy was found to be the most effective in improving a student’s accuracy when solving math problems. The counting-up strategy was superior when compared to a visual advance organizer and a manipulative organizer (Jolivette et al., 1998). The use of counting strategies is appropriate for kindergarten and first grade students, however, second grade students should have mastered the most basic addition facts and not have to count by one’s. Moreover, children in the third or fourth grade should be able to quickly recall the answer to basic addition facts (Isaacs & Carroll, 1999). One problem with counting procedures is that outside of school, children often use counting to solve addition and subtraction problems that add up to no more than ten (Wakefield, 1998). In addition, finger counting would not be an adequate strategy to use for multiplication and division problems (Ozaki
et al., 1996) because, it would be too hard and time consuming for a person to count numbers when multiplying and dividing. Finally, Van Luit (2000) suggests that counting is not an adequate strategy for solving math problems because (a) the decimal system is ignored, (b) it does not promote fact memorization, and (c) errors are often made in counting.

Two other strategies found in the literature appear to be useful for teaching basic math. One program that can be utilized in teaching basic math skills is the Strategic Math Series (Miller & Mercer, 1997). A mnemonic math strategy called DRAW can be used to help students solve problems. The acronym DRAW stands for: (1) Discover the sign; (2) Read the problem; (3) Answer, or draw and check; and (4) Write the answer (Miller & Mercer, 1997). Sometimes, the computational strategy used to solve basic skills can be generalized and used with more complex strategies. Rivera and Bryant (1992) suggest that instructional practice should be tailored to the individual student rather than a group of students. According to Rivera and Bryant (1992), manipulatives such as bean sticks or rods can be used to solve help children add and subtract whole numbers at the concrete level. An advantage to using manipulatives is that immediate feedback from the teacher can be provided, which can lead to an increase in fluency.

It appears that a common characteristic among the most effective instructional procedures is practice. Because of this, it is not surprising that methods that increase acquisition in mathematics focus on increasing the number of opportunities to respond and practice those responses. One such method involves students tutoring classmates by orally reading problems to them and having them respond verbally with an answer. Another method is a drill procedure using flash cards. A math fact is flashed in front of
the child's eyes and then the child has to quickly respond with a verbal answer. If the child gets the problem wrong or does not respond within two seconds, the problem is read again with the answer and then placed only a few cards back (Stading et al., 1996).

Rather than simply increasing student response rates by providing multiple learning trials on an individual basis, teachers can increase the number of students who respond by increasing the wait time or amount of time between when they ask a question and then call on a child for an answer. In addition, reducing the inter-trial interval time (i.e. the amount of time between trials) may also be effective for increasing acquisition of basic mathematics facts. This can be accomplished by more rapidly presenting the next item (i.e. go to the next flash card) after the previous learning trial is complete (Skinner, 1998).

It is clear that drill and practice procedures are effective methods for students to become proficient in performing an academic skill, such as mathematics (Haring & Eaton, 1978; Pellegrino & Goldman, 1987). However, a potential limitation of drill and practice procedures is that they can be cumbersome for teacher implementation as they generally require increased levels of one to one contact. Therefore, teachers may prefer to use procedures that do not require as much one to one instruction, but still results in increased levels of opportunities to practice and be provided feedback. One such class of procedures is referred to as self-managed interventions.

**Self-Managed Intervention/Correction Feedback**

When conducting self-managed interventions, Skinner and Smith (1992) point out that students, rather than their teachers, observe, record, and evaluate their own academic behaviors. Thus, they are provided with immediate feedback, which will lead to more
opportunities to respond correctly and to students becoming more fluent in academic skills. Teachers often prefer that students use self-managed interventions (Skinner & Smith, 1992). When students record their own behavior in academics, the recording should be simple and efficient enough as to not disrupt rate of responding. Self-managed interventions can be used with both general and specific academic skills (Skinner & Smith, 1992), and learning is inferred when responses do not require much effort and can be produced rapidly.

A major advantage of using self-managed interventions is that they focus on using accurate and immediate corrective feedback that prevents students from learning incorrect responses because these incorrect responses are corrected right away and the correct responses are reinforced (Siegler & Shrager, 1984; Skinner, Shapiro, Turco, Cole, & Brown, 1992; Skinner & Smith, 1992). Because self-managed interventions do not require that immediate corrective feedback to be provided by teachers or peers, these procedures are seen as more efficient.

Providing students with immediate corrective feedback is essential when they are in the acquisition stage of learning (Skinner, 1998). For instance, Hansen (1978) used an overcorrection procedure in his Cover, Copy, and Compare intervention when words were spelled incorrectly. In Cover, Copy, and Compare, students immediately evaluate their responses by comparing their responses to the correct response which is provided on their worksheet (Skinner & Smith, 1992). Self-delivered immediate corrective feedback is a more desirable intervention because it can be used in any setting and does not require another person’s time or cooperation. Immediate corrective feedback can also be used to increase accuracy when doing academic work and it can help maintain a high rate of
opportunities to respond (Skinner, Shapiro, et al., 1992). Skinner and Shapiro (1989) point out that a direct relationship between the number of opportunities to respond and a child's performance may exist. Children may learn at a faster rate if they are given more opportunities to respond to questions (Skinner, 1998). Unfortunately, immediate corrective feedback does not always produce academic performance gains (Skinner & Smith, 1992).

*Add-A-Word Spelling Program.* Cover, Copy, and Compare and Copy, Cover, and Compare procedures were developed from the Add-A-Word spelling program (McGuigan, 1975). Pratt-Struthers, Struthers, and Williams (1983) point out that the Add-A-Word spelling program consists of spelling lists adapted for each individual, daily practice, and daily testing. It also employs a Copy, Cover, and Compare procedure in its daily practice procedure (McAuley & McLaughlin, 1992). In the Add-A-Word spelling program, a spelling word is removed from the list when it has been spelled correctly over two consecutive days. Maintenance of correct spelling is achieved by reintroducing the word five days later and then once a month. If the word is spelled incorrectly during maintenance, it is then added back into the word list (Pratt-Struthers et al., 1983; Pratt-Struthers, Bartalamay, Williams, & McLaughlin 1989; McAuley & McLaughlin, 1992). The Add-A-Word program requires little time and cost to employ (Pratt-Struthers et al., 1989) and time was reported to be less than the typical time needed for traditional spelling instruction (Pratt-Struthers et al., 1983).

In the study by McAuley and McLaughlin (1992), all of the subjects who struggled in spelling made significant gains in correct spelling, even to the point of surpassing the average of all students in their class. In the study by Pratt-Struthers et al.
the Add-A-Word spelling program increased students' correct spelling from a mean of 0% at baseline to a mean of 90% during treatment. The Add-A-Word spelling program increased the number of words spelled correctly on a creative writing assignment (Pratt-Struthers et al., 1989). According to Pratt-Struthers et al. (1983), another advantage of the Add-A-Word program is that students can progress at their own rate. This means that each student is provided with the maximum amount of opportunities to respond, which can lead to an increase in fluency.

**Cover, Copy, and Compare.** As discussed previously, Cover, Copy, and Compare (CCC) was originally used by Hansen (1978) as an intervention to increase spelling accuracy. Cover, Copy, and Compare can be used to increase performance in children with behavioral disorders, learning disabilities, or normal children (McLaughlin & Skinner, 1996). Cover, Copy, and Compare, can be effective for a variety of students across settings and curriculum objectives. Skinner, McLaughlin, & Logan (1997) point out that the Cover, Copy, and Compare intervention requires an academic stimulus, a response, an evaluation procedure, and an error correction procedure. It is also pointed out that the effectiveness of the Cover, Copy, and Compare procedure may be impacted by time limitations, goal setting, feedback given, and the assessment procedures.

According to McLaughlin and Skinner (1996), training students on the Cover, Copy, and Compare procedure can be done by verbalizing the steps as the procedure is modeled. Students then perform the procedure and feedback is given by the instructor when errors are made. In the study by Skinner et al. (1989), five steps were included in the Cover, Copy, and Compare procedure. According to Skinner et al. (1989), “The experimenter: (a) looked at the first problem and its solution, (b) covered them with an
index card, (c) wrote the problem and solution on the right side of the page, (d)
uncovered the problem and solution, and (e) evaluated his/her response” (p. 414). The CCC worksheets should contain the problems and answers down one side of the page so that students can write with one hand and cover the completed problems and answers with the other (Skinner et al., 1997). If a problem persists with the child using an index card (i.e. the child loses the card or rips it), Wright (2001) and Pratt-Struthers et al. (1983) suggest folding the CCC worksheet in half so that the completed problem is on one fold and the open space to write the problem and answer is on the other side of the fold.

Slightly different materials were used for the Cover, Copy, and Compare procedure used in the study by Skinner, Shapiro, et al. (1992). This study used single digit by single digit multiplication. Instead of having the correct problem and answer written on the left hand side of the page, flashcards were employed. In the procedure in this study, the students were asked to “... (a) turn over the top card and look at the problem and solution, (b) turn the index card back over so that it is face down, (c) write the problem and solution on the left side of the paper, and (d) turn the index card over and evaluate what has been written” (Skinner, Shapiro, et al., 1992, p.107).

Another form of Cover, Copy, and Compare is Verbal Cover, Copy, and Compare (V-CCC). This procedure is the same as the written form except for changes in the third and fourth step. Instead of writing the problem and answer on the third step, the student states the problem and answer out loud. On the fourth step, instead of comparing the written responses, the child evaluates their response from memory of what they said in the previous step. Another form of CCC is Cognitive Cover, Copy, and Compare (C-
This procedure is identical to V-CCC only that the student says the problem and answer to themselves instead of out loud (Skinner, Bamberg, Smith, & Powell, 1993).

Two advantages of using the Cover, Copy, and Compare intervention is that it provides many opportunities for children to respond and it gives them immediate feedback as to their performance on the task (McLaughlin & Skinner, 1996; Skinner et al., 1989). An interesting finding from the Skinner et al. (1989) study was that there were both increases in rates of accuracy and correct responding. Increases in responding rates can also lead to increases in learning rates (Skinner, 1998). As discussed previously, an error correction procedure (or immediate corrective feedback) decreases the chance of a child repeatedly responding incorrectly to academic problems. Immediate corrective feedback is completed by the child when following the Cover, Copy, and Compare procedures (Skinner et al., 1989; Skinner et al., 1997). One reason that student responses are often accurate when using the Cover, Copy, and Compare procedure is because they see the correct responses immediately before they have to make their response (McLaughlin & Skinner, 1996). Also, by allowing students to evaluate their responses themselves, it avoids the possibility of negative evaluations from peers (Skinner & Smith, 1992). Skinner et al. (1997) suggest that positive practice overcorrection may be a useful overcorrection procedure because it “…may increase students’ accuracy levels during CCC by; (a) punishing incorrect responses, (b) increasing the number of active accurate academic responses, and (c) requiring that the last several academic responses made be accurate” (p.301). Another advantage of the CCC procedure is that it is self-managed, therefore allowing for frequent responses because of the short amount of time between stimulus presentation, response, and feedback (Skinner et al., 1993).
The Cover, Copy, and Compare intervention has been shown to improve students' academic skills across the skill domains of the learning hierarchy (Skinner et al., 1997; McLaughlin & Skinner, 1996). When employing a Cover, Copy, and Compare intervention, children should be reinforced not only for their accuracy, but also for their rate of responding (i.e. fluency) or the number of correct problems per minute (McLaughlin & Skinner, 1996; Skinner et al., 1997).

There are three reasons why the CCC intervention may result in increases in performance. First, it provides immediate corrective feedback. Second, because feedback is given immediately, it may increase the rate of responding. Third, the types of responses that need to be made during the CCC intervention are similar to those made in assessments (Skinner, Ford, & Yunker, 1991).

According to Skinner et al. (1993), the short amount of time between when the student sees the sample of the problem and correct answer and then is asked to write the correct problem and answer increases the probability of correct responding. When the child compares their response to the model and their response is correct, the child is reinforced, which means that their response will also be strengthened. This is known as the principle of contingency. Immediate correction of errors in calculation is important due to the principle of recency (it is more likely that the most recent response will be remembered). While sub-vocal responses to arithmetic problems would be ideal because they would decrease noise and increase rate of responding, they can not be utilized in the classroom because they do not create permanent products.

Skinner, Shapiro, et al. (1992) measured the students' fluency and accuracy. The study included six participants from a regular education second grade classroom.
Researchers used three mutually exclusive sets of one-digit by one-digit multiplication problems for this study. Treatment integrity data were collected during four sessions across all conditions for each of the participants. Responses were scored on 41% of the sessions by a second independent observer. Subjects were given 60 seconds to work on the CCC worksheets instead of given as much time as they needed to complete the CCC worksheets. All of the subjects in the study increased their fluency and all but one increased their accuracy in both of the immediate corrective feedback conditions compared to baseline. Although higher levels of fluency differed across subjects for the self-delivered and peer-delivered immediate corrective feedback, the self-delivered immediate corrective feedback took much less time.

Skinner et al. (1991), used addition problems to train the CCC procedure to participants. Participants included two male students between the ages of 9 and 11 that were attending a school for behaviorally disordered children. Three mutually exclusive sets of one-digit by one-digit multiplication problems were provided to the subjects in this study. Every third assessment was scored by an independent observer for all participants. Subjects were provided non-contingent reinforcement for participating in the study. The Verbal Cover, Copy, and Compare (V-CCC) procedure used in the study was similar to the CCC procedure used in the study by Skinner et al. (1989), with the only difference being that the subjects said the problem and solution aloud instead of writing the problem and solution. Digits correct per minute (i.e. fluency) and percentage of problems correct (i.e. accuracy) served as dependent variables in the study by Skinner et al. (1991). Results of the study showed that students were more fluent and accurate when using the V-CCC procedure compared to Written Cover, Copy, and Compare (W-
CCC) and a no treatment condition. The V-CCC condition provided more opportunities to respond. When queried, students indicated that they would rather respond to a question verbally than to write out the answer. This study supported previous research (Skinner & Shapiro, 1989), which showed that interventions that provide the opportunity for higher rates of academic responding are more effective. However, the advantage of using W-CCC in the classroom when compared with V-CCC is that W-CCC is a response form that does not require a verbal response from the student that could create noise and disrupt other students who are working on other problems (Skinner et al., 1991; Skinner et al., 1997). Verbal responding also creates a problem because the students can not refer back to a permanent product left by a written response when evaluating their response to a problem (Skinner et al., 1997).

Skinner et al. (1993) investigated interspersing procedures with three male students between the ages of 9 and 12 in a private school for children with behavioral disorders. Materials used in the study included three mutually exclusive sets of division problems. The experimenter observed the students performing the C-CCC procedure on three different occasions. Every third assessment across problem sets was scored by a second observer. When given a choice between W-CCC and C-CCC, the students chose C-CCC. Rates of accurate responding increased to higher levels for all of the participants after the C-CCC intervention was implemented. Intervention and maintenance assessments after C-CCC implementation revealed accuracy levels of near 100% across all students in the study. Although there are advantages to using C-CCC (e.g. more opportunities to respond, prevention of verbal disruption of the classroom), correct and
incorrect responses can not be verified and no permanent products remain after the student has gone through the procedure (Skinner et al., 1993).

Lee and Tingstrom (1994) were able to improve the fluency of answering division problems across subjects without sacrificing accuracy. They suggest that CCC may be effective with larger groups of students. However, it could be more beneficial to modify the intervention for the individual student’s presenting problem. All students experience different difficulties and respond to interventions in different ways. Participants in the study by Lee and Tingstrom (1994) included 5 fifth grade students (3 females and 2 males) ages 10 and 11 from a Chapter 1 class in a middle school. Materials for the study included three different sets of division problems. Every tenth assignment across all groups of division facts were scored by an independent observer. After completion of the study, the teacher reported that she thought the CCC intervention was simple to implement and that she would like to implement it with a different class in the future. Lee and Tingstrom (1994) report that school psychologists might suggest using the CCC intervention when engaging in consultation cases.

When using the Cover, Copy, and Compare procedure, the number of times the student is required to write the accurate response after an error should be limited so that the student does not become discouraged from working on the assignment (Skinner et al., 1997). Also, McLaughlin and Skinner (1996) caution the user of an error correction procedure to not make this procedure overly aversive as this might lead to students cheating so that they can complete the process in a timelier manner. To prevent fatigue, it is recommended that CCC worksheets be brief and spaced out through the day. McLaughlin and Skinner (1996) recommend that educators monitor students’ use of the
Cover, Copy, and Compare procedures to be sure that they are following directions. They also recommend that praise for their effort be provided.

**Copy, Cover, and Compare.** A similar but slightly different intervention to Cover, Copy, and Compare was described by Stading et al. (1996). This intervention, called Copy, Cover, and Compare, can be adapted to most situations and can produce performance gains for students of all ages (Larsen & McLaughlin, 1997; McAuley & McLaughlin, 1992). Just like the Cover, Copy, and Compare intervention, it provides the student with immediate corrective feedback and increases the opportunities that the child has to respond to math problems. This often leads to an increase in fluency.

According to Stading et al. (1996), the Copy, Cover, and Compare procedure for math requires the student to copy the problem and answer from a written model, cover the problem and answer, write the problem and answer from memory, and then compare the written response to the original model. If the child’s answer is correct, they move onto the next problem, if the child’s answer is incorrect, they repeat the problem until it is written correctly from memory. Therefore, the Copy, Cover, and Compare procedure can be completed at the rate the student desires and success can also be evaluated by the student (Hubbert, Weber, and McLaughlin, 2000). A similar but different Copy, Cover, and Compare procedure was used by Ozaki et al. (1996). The procedure employed was as follows: “The child was instructed to 1) Look at the first completed math fact (e.g. “5 x 3 = 15”), 2) Read aloud the problem (e.g. “five times three equals”) and Copy the answer (e.g., “15”), 3) Cover the problem, (4) read the problem aloud (e.g., “five times three equals”) and Write the answer from memory (e.g., “5”), and then 5) Compare his answer to the original modeled problem to verify if the answer is correct or not” (p.68).
This procedure differed slightly from other Copy, Cover, and Compare procedures in that the problem did not need to be placed in short-term memory by the child. The problem was written out for them in advance, which might have confounded the results as this procedure was different from previous studies.

The advantages of using the Copy, Cover, and Compare procedure are similar to the advantages of using the Cover, Copy, and Compare procedure. Research indicates that the Copy, Cover, and Compare procedure could be successfully administered in the home by a child’s parent (Larsen & McLaughlin, 1997; Stading et al., 1996). Stading et al. (1996) found that the Copy, Cover, and Compare procedure is effective at teaching and increasing mastery of basic multiplication facts for students’ diagnosed with a learning disability. Ozaki et al. (1996) reported that the advantage to using the Copy, Cover, and Compare procedure is that it forces the student to attend to the problem. Just like Cover, Copy, and Compare, the Copy, Cover, and Compare procedure can produce a fast rate of responding and give immediate corrective feedback. The Copy, Cover, and Compare procedure was also found to be effective and efficient in terms of time, effort, and money (Stading et al., 1996; Ozaki et al., 1996). It appears from the results of the Stading et al. (1996) study that the child maintained the facts learned in the Copy, Cover, and Compare procedure over time.

A Copy, Cover, and Compare study was conducted by Ozaki et al. (1996). The subject of this study was an 11 year old male diagnosed with a learning disability. Materials included worksheets containing one-digit by one-digit multiplication problems. An independent observer assessed the student’s accuracy twice during baseline and eight times during the intervention. Results of the study showed the Copy, Cover, and
Compare intervention to be effective in teaching and helping a child master basic multiplication facts as there was an increase in correct responding.

Bolich, Kavon, McLaughlin, Williams, and Urlacher (1995) combined the Copy, Cover, and Compare intervention with a token economy to evaluate the retention of basic multiplication facts in students diagnosed with an attention disorder. Participants in the study included two teenage males in middle school with a type of ADHD. Materials for the study included a worksheet that consisted of one-digit by one-digit multiplication problems. Two different researchers independently scored the probe sheets. The Copy, Cover, and Compare procedure used by Bolich et al. (1995) combined a written and verbal form of responding as the participants were asked to say the problems and answers aloud and also provide a written response. Results of the study indicated that the Copy, Cover, and Compare procedure helped students improve their accuracy and improve their maintenance of basic multiplication facts. The use of the token reinforcement and praise resulted in a slight improvement in performance, but this improvement was not significant. The study also gave preliminary evidence that the Copy, Cover, and Compare procedure can be effective in improving the math performance of students diagnosed with ADD and ADHD.

Components of the CCC intervention. Cover, Copy, and Compare and Copy, Cover, and Compare are self-managed interventions that provides instructional cues and are designed in a drill and practice format where students can follow the drill and practice procedures on their own (Skinner et al., 1997; Larsen & McLaughlin, 1997). Skinner, Belfiore, and Pierce (1992) point out that the Cover, Copy, and Compare intervention is self-instructional because students work at their own pace, deliver their own prompts,
evaluate their responses immediately after the responses are made, and correct their own errors. Students can work and learn at their own pace and independently, which means that it can be used in the classroom setting (McLaughlin & Skinner, 1996; Skinner et al., 1997). After students have been trained in the CCC procedures and provided materials, a large number of correct responses can be made over a brief time period and without teacher assistance, making the intervention efficient and effective (Skinner, Belfiore, et al., 1992; Skinner et al., 1989). By managing the intervention themselves, students might be more motivated to do the work (Skinner et al., 1997). The Copy, Cover, and Compare procedure is easy to administer, not costly, and requires little time and effort to complete (Larsen & McLaughlin, 1997; Murphy, Hern, Williams, & McLaughlin, 1990; McLaughlin & Skinner, 1996; Skinner et al., 1989). By requiring very little time and effort, it makes more time available for teaching instruction and student learning (Skinner et al., 1991), learning rates may increase, and students may find the intervention to be more acceptable (McLaughlin & Skinner, 1996).

Hansen (1978) developed the Cover, Copy, and Compare intervention to increase accuracy in spelling and results of the study found the intervention to be effective. According to Hansen (1978) there are four steps in the Cover, Copy, and Compare procedure for spelling: (1) the student looks at the word; (2) the student copies the word while silently reading the letters as he or she spells it; (3) the student covers the word and writes it again from memory; and (4) the student compares the word they wrote to the original.

A similar procedure was used in the study by Murphy et al. (1990) for Copy, Cover, and Compare. If students do not spell a word correct on a maintenance check,
then this word should be added back into the unknown word list (Hansen, 1978). In the study by Murphy et al. (1990), students simply repeated the Copy, Cover, and Compare procedure when they spelled a word wrong. A slightly different procedure was used in the study by Hubbert et al. (2000) in which the researchers utilized 4 columns during the Copy, Cover, and Compare procedure. There was a “Word” column, “Copy” column, “Cover/Check” column, and “Correct” column. Errors in copying were immediately corrected by the instructor. The worksheet was folded in half to cover the words (Pratt-Struthers et al., 1983) and subjects did not evaluate their responses until the worksheet, which contained six words, was complete (Hubbert et al., 2000). Spelling words are removed from the list once they have been mastered (i.e. spelled correctly over a period of three straight days) and they are later brought back for a maintenance check (Larsen & McLaughlin, 1997). Results of the study by Larsen and McLaughlin (1997) showed the Copy, Cover, and Compare procedure to be both effective and practical for spelling instruction.

In addition to these procedures increasing student performance, they have also been shown to be more acceptable by students. As part of the evaluation of the CCC intervention, Skinner, Belfiore, et al. (1992) gave students a questionnaire using a Likert scale to rate the CCC intervention. Unlike suggestions that the CCC intervention might be boring to students (Skinner et al., 1989), results of the questionnaire indicated that the students found the CCC intervention to be highly acceptable. The results of the Skinner, Belfiore, et al. (1992) study indicated that the CCC intervention improved the academic performance of the students. However, it is unclear as to why students’ acceptability of the procedure increased.
In addition to the positive gains that are made using the CCC procedure, Smith, Dittmer, and Skinner (2002) suggest that knowledge gained through the CCC procedure could maintain over time or at least be able to be relearned in short period of time. Smith et al. (2002) suggest that the CCC intervention is most beneficial when the student is allowed to progress at their own pace. In addition, treatment integrity was maintained as students followed the self-evaluation and error correction procedures well. Hansen (1978) found that self-correction is an economical and educational learning tactic. Self-correction provides the student with immediate corrective feedback and will give the student the opportunity to increase the number of responses they make.

Cover, Copy, and Compare with other subjects. Research has shown that CCC can be used for a variety of subjects including math (Skinner et al., 1989), geography (Skinner, Belfiore, et al., 1992), reading (Skinner & Shapiro, 1989), and spelling (Murphy et al., 1990). Wright (2001) suggests that the Cover, Copy, and Compare intervention can be used for math, spelling, and vocabulary lessons. Hubbert et al. (2000) and McLaughlin and Skinner (1996) point out that the Cover, Copy, and Compare procedure is a simple and efficient self-managed procedure that can lead to increases in accuracy, fluency, and comprehension in the areas of spelling, mathematics, and geography for all types of children across all settings.

Most of the research on Cover, Copy, and Compare, has focused on spelling. There were several important findings reported in the study by Murphy et al. (1990). Results of the study indicated that using the Copy, Cover, and Compare approach resulted in high spelling test scores. Accuracy was higher and more stable in the Copy, Cover, and Compare condition than the traditional spelling condition. When asked about
the Copy, Cover, and Compare procedure, all of the students preferred this method over other methods of spelling instruction and they felt that their test scores were higher with the Copy, Cover, and Compare approach. The teacher felt that it gave students' confidence that they could direct their own learning. The Copy, Cover, and Compare procedure also allowed the teacher to devote more attention and time to those students who needed additional help (Murphy et al., 1990).

In the study by Hubbert et al. (2000), the Copy, Cover, and Compare method resulted in greater accuracy than the tradition method. Students were also able to use a method that allowed them to work at their own pace and correct their own errors. The procedure not only taught students skills, but it also allowed them to do their work in a more independent fashion. However, Hubbert et al. (2000) warn that the Copy, Cover, and Compare procedure may be useful for memorization, but may not cause the behavior to generalize to other spelling skills. According to the learning hierarchy developed by Haring and Eaton (1978), it is important that the learned skill generalize to other skills (i.e. other spelling words) and this is more likely to happen if the student has become fluent in the learned skill.

Skinner, Belfiore, et al. (1992) suggest that the results of their study would have been strengthened had the effects of CCC been compared with another intervention. Two areas of future research suggested by Ozaki et al. (1996) that are to be covered in the current study include comparing the Copy, Cover, and Compare procedure to other practice procedures and using the procedures with an entire classroom. Since there is only a minimal difference in procedure, it is believed that the limitations of the Copy, Cover, and Compare intervention are the same as the Cover, Copy, and Compare intervention.
Previous studies have not looked at the effectiveness or possible confounds associated with using Cover, Copy, and Compare or Copy, Cover, and Compare for addition and subtraction problems. However, Wright (2001) has included addition and subtraction Cover, Copy, and Compare problems on his website http://www.interventioncentral.org.

Summary

It is crucial that children acquire basic mathematical knowledge as this is a life skill and it will lead to better academic performance. Children with MD often struggle with math because they make erroneous errors. Hansen (1978) has identified a learning hierarchy which explains how academic skills develop. The stages of the learning hierarchy include the acquisition, fluency, generalization, and adaption stages. Children use many different strategies (i.e. finger counting) when computing answers to basic math problems. Drill and practice appears to be the best strategy to use to help children become proficient in an academic skill. The most desirable intervention to teachers is a self-managed intervention because it provides the student with immediate corrective feedback and many opportunities to respond. One such self-managed intervention is Cover, Copy, and Compare. This intervention requires the student to look at the problem and answer, cover up the problem and answer, write the problem and answer on the right hand side of the page, uncover the model, and evaluate their response. The Copy, Cover, and Compare intervention is the same intervention with a slightly different procedure. It requires the student to copy the problem and answer before covering up the original model. Both interventions require an error correction procedure when the student makes a mistake. In addition, both interventions have been described as efficient and effective.
Cover, Copy, and Compare produce increases in performance and has been rated highly by students. The intervention has also been used with a variety of academic subjects.

Statement of Purpose

The purpose of this study is two fold. First, the author will attempt to extend earlier research on Cover, Copy, and Compare and Copy, Cover, and Compare procedures by comparing their respective effectiveness and efficacy to one another. The second purpose of this study will be to attempt to extend earlier research on the Cover, Copy, and Compare and the Copy, Cover, and Compare procedures by assessing the effects of these procedures on subtraction.

Research Questions

An attempt to answer the following questions will be made over the course of this study. Which procedure (Cover, Copy, and Compare or Copy, Cover, and Compare) will produce lower error rates? It is predicted that the Copy, Cover, and Compare procedure will produce lower error rates since the student has the opportunity to copy the problem directly from a model before covering up the model. Which procedure (Cover, Copy, and Compare or Copy, Cover, and Compare) is more efficient in terms of digits correct per second? Based on the review of previous studies, it is hypothesized that the Cover, Copy, and Compare intervention will be more efficient than the Copy, Cover, and Compare intervention because it requires one less step in the procedure. The Copy, Cover, and Compare procedure requires the student to copy the problem twice instead of just once. Which procedure (Cover, Copy, and Compare or Copy, Cover, and Compare) is preferred by students and teachers? It is predicted that students will prefer the Cover, Copy, and Compare intervention because it requires less work, while teachers will prefer
the Copy, Cover, and Compare intervention because it provides more practice for the students. Will exposure to the Copy, Cover, and Compare and Copy, Cover, and Compare procedures produce an increase in accuracy scores from the pretest to the posttest? It is predicted that both procedures will be effective in increasing the students’ fluency. That is, it is predicted that the students will obtain a higher accuracy score and digits correct per second score on the posttest than on the pretest.

Method

Participants and Setting

Two regular education classrooms consisting of 20 or more second grade students were sought out to participate in the current study. The study took place at two suburban schools in the Midwest. Three class periods and a total of approximately 50 minutes were needed to complete the study.

Materials

A math skill computation probe (traditional) worksheet was given to each student as a pretest and posttest measure. Cover, Copy, and Compare, and Copy, Cover, and Compare worksheets were also assigned to the participants. Each student participated in each condition, but were given the worksheets in a random order to account for sequencing effects. The worksheets were adapted from those presented on Jim Wright’s website: http://www.interventioncentral.org (Wright, 2001). Traditional worksheets contained 40 subtraction review problems, while the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets contained 25 subtraction review problems. Problem types were determined based on each teacher’s recommendation of which types of problems their students’ needed to practice in order to increase their fluency. The
math problems presented on the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets contained the same type of problems, but used different numbers. For instance, on the Cover, Copy, and Compare worksheet, the students were presented with a two-digit by one-digit subtraction problem up to eighteen without regrouping (i.e. 18 - 6). Therefore, on the Copy, Cover, and Compare worksheet, the students were presented with a two-digit by one-digit subtraction problem up to eighteen without regrouping that used different numbers (i.e. 15 - 4).

**Experimental Design and Procedures**

A within subjects design was employed in the current study to evaluate the effects of the Cover, Copy, and Compare and Copy, Cover, and Compare interventions. Each student was exposed to Cover, Copy, and Compare worksheets, Copy, Cover, and Compare worksheets, and administered a pretest and posttest.

Before the intervention condition began, students were taught how to work the problems contained on the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets. A sample problem containing a simple one-digit by one-digit subtraction problem was used to teach the students how to complete each worksheet. In the Cover, Copy, and Compare procedure, students were asked to: (1) look at the problem and solution, (2) cover the problem, (3) write the problem and solution on the right side of the page, (4) uncover the problem and solution, and (5) evaluate their response (Skinner et al., 1989). In the Copy, Cover, and Compare procedure, students were asked to: (1) look at the problem and solution, (2) copy the problem and solution from the written model, (3) cover the problem, (4) write the problem and solution on the right side of the page, (5) uncover the problem and solution, and (6) evaluate their response (Stading et al., 1996).
The “Traditional” approach involved subtracting the numbers in the problems to arrive at a solution. Worksheets were evaluated for error rate (i.e. the number of errors made per second) and accurate response rate or fluency (i.e. the number of digits correct per second).

If students did not complete a problem correctly on the Cover, Copy, and Compare or Copy, Cover, and Compare worksheets, they were instructed to complete an error correction procedure. For the error correction procedure, students were asked to copy down the problem and correct answer one time. This error correction procedure was used to prevent the children from practicing incorrect responses (Skinner et al., 1989).

The study was conducted on three class days; however, the study was divided up across one week. The first day of the study took place on a Monday, the second day on a Wednesday, and the third day on a Friday. This was done in an attempt to control for practice effects (i.e. having the same problem appear multiple times) and recency effects (i.e. having the same problem appear multiple times in a short period of time). A pretest was given on the first day (i.e. Monday), while a posttest was given on the third day of the study (i.e. Friday). One comparison was done on the second day (i.e. Wednesday). On the day of the intervention, students were given two math worksheets (one Cover, Copy, and Compare, and the other Copy, Cover, and Compare) in counterbalanced order to guard against practice effects.

Each worksheet was clearly labeled with a title that told the students which intervention procedures to follow (See Appendix A and B). The Cover, Copy, and Compare worksheets were labeled with the word “Cover” at the top, the Copy, Cover,
and Compare worksheets were labeled with the word “Copy” at the top, the pretest was labeled with the word “Traditional (Pretest)” at the top, and the posttest worksheet was labeled with the word “Traditional (Posttest)” at the top. In addition, a square box surrounded each problem on the “Cover” worksheets, while a circle shape surrounded each problem on the “Copy” worksheets in order to further distinguish the two types of worksheets. As stated earlier, each of the traditional worksheets consisted of 40 subtraction problems, while the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets consisted of 25 subtraction problems. Timing was accomplished by using a stopwatch. Time was started when the experimenter said “Begin” and ended once time had elapsed and the experimenter said “Stop”. Students were given exactly 2 minutes to complete the pretest and later the posttest. Students were also given exactly 2 minutes to work on each Cover, Copy, and Compare and Copy, Cover, and Compare worksheet. The math problems presented on the pretest and posttest worksheets were counterbalanced for presentation. For instance, on the pretest worksheet, the student was presented with the problem 16 - 6. Therefore, on the posttest worksheet, the student was presented with the same problem 16 - 6, but it was located at a different place on the worksheet. Cover, Copy, and Compare and Copy, Cover, and Compare worksheets could not be compared to the traditional worksheets due to instructional time interference (ITI). That is, it takes the students longer to complete each problem due to all of the extra steps that need to be taken in order to complete the problems.

Dependent Variables

There were two dependent variables used in this study: (1) the number of digits correct per second (i.e. a measure of fluency) and (2) the number of errors made per
second (i.e. a measure of accuracy). Each student was given 2 minutes or 120 seconds to complete each Cover, Copy, and Compare and Copy, Cover, and Compare worksheet and 2 minutes or 120 seconds to complete each traditional worksheet. The researcher used seconds for a more sensitive recording of rate of responding. Previous studies used digits correct per minute (Lee & Tingstrom, 1994; Skinner et al., 1989; Skinner et al., 1991; Skinner et al., 1993; Skinner, Shapiro, et al., 1992). Digits correct were determined by the number of digits that were in the correct place. For example, the problem 13 - 2 could be scored as a 0, 1, or 2 on the traditional worksheets. Zero points would be awarded for an answer of 27. One point would be awarded for an answer of 12. It would be scored this way because the number in the tens column is correct. Two points would be awarded for an answer of 11 since both the ones and tens columns contain the correct numbers (Skinner et al., 1989). The problem 14 - 5 = 9 could be scored as a 0, 1, 2, 3, or 4 on the Cover, Copy, and Compare or Copy, Cover, and Compare worksheets. Zero points would be awarded for an answer of 9 - 3 = 6. One point would be awarded for an answer of 13 - 8 = 5. It would be scored this way because the number in the tens column is correct. Two points would be awarded for an answer of 14 - 4 = 10 since both the ones and tens columns contain the correct numbers. Three points would be awarded for an answer of 14 - 5 = 8 since the subtraction problem is correct. Finally, four points would be awarded for an answer of 14 - 5 = 9. The time interval and number of digits correct helped produce a digits correct per second ratio for the two intervention and control conditions. To calculate this ratio, the number of digits correct was divided by 120 seconds or the total amount of time used to complete the worksheets if a student happens to finish prior to the allotted time limit of 120 seconds. However, students did
not earn credit for digits correct on the initial copy portion of the Copy, Cover, and Compare procedure. Student’s answers were also evaluated by the number of errors made. The number of errors they made was divided by the amount of time they were provided to complete the worksheets. This provided an error rate measure that was used to assess student accuracy. When students made error corrections, the error corrections were not factored into their percentage of problems correct scores. Although error corrections will affect student’s fluency scores, the error corrections will not be factored into their digits correct scores. For example, if the student responded with the answer 18 - 3 = 14 for the problem 18 - 3, the student would be awarded three digits correct even when the student responded with the answer 15 after completing the error correction procedure. Error corrections will affect students’ rates of responding for the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets because this error correction procedure will require extra time.

*Student/Teacher Survey*

Immediately after the students completed the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets, they were asked to rate which method they preferred. Specifically, students were asked, “Which problems did you like solving more, the ones with a square (“Cover”) or the ones with a circle (“Copy”)?” A total preference figure was calculated by adding up the number of hands raised for the square problems and the number of hands raised for the circle problems. The teacher was also asked to rate the two intervention procedures (See Appendix C).

*Interobserver Agreement*
A second observer was asked to score the number of digits correct for half of the problems contained in the Cover, Copy, and Compare, Copy, Cover, and Compare, and pre and posttest worksheets completed in this study. The percentage of agreement between the two observers was calculated by dividing the agreements per digit by the number of agreements plus disagreements per digit and multiplying by 100. This was done on a problem by problem basis. Interobserver agreement was 100% for the pretest, posttest, and Copy, Cover, and Compare worksheets. Agreement was reached on 99.5% of the problems on the Cover, Copy, and Compare worksheets.

_Treatment Integrity_

The experimenter observed the students performing the Cover, Copy, and Compare and Copy, Cover, and Compare procedures to make sure that they were following the directions. Instructions for the procedure were read by the experimenter. Since a time limit had been set, the experimenter made sure that each student had the same amount of time to complete the worksheets.

_Data Analysis_

Statistical tests were conducted to compare each student on the number of errors made and digits correct per second. The error rates obtained by each student on the Cover, Copy, and Compare and Copy, Cover, and Compare procedures were compared using a dependent t-test. Digits correct per second scores for each student were also compared on the Cover, Copy, and Compare and Copy, Cover, and Compare procedures using a dependent t-test. A chi squared goodness of fit test was conducted on student preference. A statistical test was not run on the teacher survey due to the small number of questions asked by the examiner. The purpose of these questions was to measure
student and teacher preferences for the procedures. Finally, a dependent t-test was conducted to compare the scores obtained by the students on the pretest and posttest. All of the statistical tests run on the data collected used an alpha level of .05 as the cut off point for statistical significance.

Results

Table 1 displays the means and standard deviations for the pre-test and post-test conditions for digits correct per second (DCPS) and errors correct per second (EPS). A dependent t-test was conducted on the digits correct per second and errors per second scores for the pretest and posttest across all participants. These data are displayed in Figure 1. Overall, the participants showed a significant increase in the number of digits correct per second from pretest to posttest $t(43) = -7.562$, $SE = 0.007$, $p = .000$, $d = 1.14$. Only five of the forty-four students did not improve their digits correct per second performance from pretest to posttest. A significant difference was not found between the number of errors made on the pretest and posttest worksheets $t(43) = -0.932$, $SE = 0.003$, $p = .357$ (two-tailed), $d = 0.140$.

Table 2 displays the means and standard deviations for the Cover, Copy, and Compare and Copy, Cover, and Compare conditions for digits correct per second (DCPS) and errors correct per second (EPS). A dependent t-test was also conducted on the digits correct per second and errors per second scores for the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets across all participants. These data are displayed in Figure 2. Participants had significantly higher digits correct per second performance on the Cover, Copy, and Compare worksheets compared to the Copy, Cover, and Compare worksheets $t(43) = 8.592$, $SE = 0.015$, $p = .000$, $d = 1.295$. Thirty-nine of the
forty-four students completed more digits correct per second on the Cover, Copy, and Compare worksheet. In addition, no significant difference was found between the number of errors made on the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets $t(43) = 1.706, \ SE = 0.002, \ p = .095 \ (\text{two-tailed}), \ d = 0.257$.

These results indicate that students did not make a significantly different number of errors when comparing the pretest and posttest worksheets and the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets. Results also indicate that more problems were completed on the Cover, Copy, and Compare worksheets and that an improvement was made in the participant’s ability to answer two-digit minus one-digit subtraction problems after implementation of the interventions. Increases in rates of responding (i.e. increases in digits correct per second) for the posttest and Cover, Copy, and Compare worksheets did not result in decreases in accuracy (i.e. increases in errors per second).

A chi squared goodness of fit test was conducted on student preference. Table 3 displays the means and standard deviations for the proportion of students who chose the Cover, Copy, and Compare or Copy, Cover, and Compare method as their preferred intervention worksheet. Results show that significantly more students preferred the Cover, Copy, and Compare worksheets over the Copy, Cover, and Compare worksheets $\chi^2 (1, \ n = 44) = 13.091, \ p=.000, \ d = 0.54$. Teachers were also asked to rate the two intervention procedures using the questions contained in Appendix C. Both teachers surveyed said that they would prefer using the Copy, Cover, and Compare intervention for teaching their students’ basic math facts and building their students’ fluency in basic math facts.
A treatment integrity check was made by the experimenter in an attempt to ensure that the students followed the directions given to complete the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets. The experimenter reviewed all intervention worksheet problems completed and attempted to determine if the directions were followed correctly. For instance, if the students copied the problem on the left hand side of the page on the Cover, Copy, and Compare worksheets, then it was clear that directions were not followed. In addition, if students did not complete the overcorrection procedure when answering an item incorrectly, they clearly did not follow directions. The percentage of problems on which directions were followed was calculated by dividing the number of intervention worksheet problems completed where directions were followed by the number of intervention worksheet problems completed where directions were followed plus the number of intervention worksheet problems completed where directions were not followed and multiplying by 100. Students followed the directions given on 91.88% of the intervention worksheet problems. Students followed directions on 91.69% of the Cover, Copy, and Compare worksheet problems, while they followed directions on 92.18% of the Copy, Cover, and Compare worksheet problems.

Discussion
This study investigated the accuracy and fluency rates of students using the Cover, Copy, and Compare and Copy, Cover, and Compare intervention worksheets. This study also investigated students' accuracy and fluency rates on traditional math problem worksheets before and after implementation of the interventions. Participants in the current study demonstrated an increase in digits correct per second from pretest to posttest suggesting that the interventions were effective, when combined, in producing
gains in student performance. The interventions also produced more digits correct per second when using the Cover, Copy, and Compare intervention when compared to the Copy, Cover, and Compare intervention. No significant difference was found in the error rates produced across the two conditions. These results support earlier findings on Cover, Copy, and Compare and Copy, Cover, and Compare research that investigated rates of accurate responding (Bolich et al., 1995; Lee & Tingstrom, 1994; Ozaki et al., 1996; Skinner et al., 1989; Skinner et al., 1991; Skinner et al., 1993; Skinner, Shapiro, et al., 1992; Stading et al., 1996).

In addition to supporting earlier research, the current study extended previous research in three ways. First, this is the first study that directly compared the differential effects of the two procedures. When comparing the two intervention procedures, the Cover, Copy, and Compare procedure is recommended for use over the Copy, Cover, and Compare procedure. This is based on the fact that participants' rate of correct responding was higher on the Cover, Copy, and Compare intervention, leading to an increase in the number of opportunities to respond when compared to the Copy, Cover, and Compare procedure. Providing more opportunities to respond, with no difference in the number of errors, suggests that the Cover, Copy, and Compare procedure is more effective (Skinner et al., 1991; Skinner & Shapiro, 1989).

Second, the Cover, Copy, and Compare and Copy, Cover, and Compare procedures were used with two large, diverse, regular education classes which contained non-disabled students. Ozaki et al. (1996) had suggested that future research use a large class of non-disabled students to expand on the utility of the Copy, Cover, and Compare intervention, while Skinner et al. (1989) suggested that the use of the Cover, Copy, and
Compare procedures could be used in a whole class setting. Previous studies looked at
the use of the Cover, Copy, and Compare and Copy, Cover, and Compare procedures for
multiplication (Bolich et al., 1995; Ozaki et al., 1996; Skinner et al., 1989; Skinner et al.,
1991; Skinner, Shapiro et al., 1992; Stading et al., 1996) and division facts (Lee &
Tingstrom, 1994; Skinner et al., 1993). The current results suggest that the Cover, Copy,
and Compare and Copy, Cover, and Compare procedures can be used with younger
students to build fluency in their basic subtraction facts. Third, this study investigated
these procedures in conjunction with time constraints. In previous studies, participants
were allowed to work at their own pace to complete the worksheets and a set time limit
was not created in order to compare the students' response rates for a given amount of
time. The use of a two-minute interval in the current study may have prevented the tasks
from becoming boring (Skinner et al., 1989) and may have motivated the students to
respond at an accurate and rapid pace (McLaughlin & Skinner, 1996). Further, multiple
students scores could be compared on their fluency rates since they were given the same
amount of time to complete the worksheets. Instructional time to teach the task and the
administration time for the worksheets was very minimal. It took approximately 10
minutes each to teach the Cover, Copy, and Compare and Copy, Cover, and Compare
procedures to the students. Participants spent a total of eight minutes combined working
on all of the worksheets. Overall, as shown in previous studies (Larsen & McLaughlin,
1997; Murphy et al., 1990; McLaughlin & Skinner, 1996; Skinner et al., 1989), the
implementation of the Cover, Copy, and Compare and Copy, Cover, and Compare
intervention procedures proved to be efficient in terms of time and effort.
Although the current study supported and extended previous research on the Cover, Copy, and Compare and Copy, Cover, and Compare procedures, it is not without limitations. First, the ability to interpret which intervention procedure had a greater influence on the overall increase in digits correct per second on the posttest is difficult to ascertain. Although it would appear that the Cover, Copy, and Compare procedure had a greater impact since students completed more problems on this worksheet, this inference can not be proven. Future researchers should design a procedure that separates the two intervention procedures from pretest and posttest data collection so that a clear conclusion can be made as to whether the Cover, Copy, and Compare or Copy, Cover, and Compare intervention leads to increases in fluency.

Second, McLaughlin and Skinner (1996) suggest that students should be monitored when performing the Cover, Copy, and Compare procedures to make sure that they are following directions. In the current study, it was impossible for the examiner and teacher to monitor whether or not students were cheating or following directions correctly on the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets. A treatment integrity check was made by the examiner in data analysis; however, the results may not have been accurate since the integrity check was done after the administration was completed. Data collection for this intervention would be more accurate if it were used with a student in a one-on-one situation where direction following can be monitored. This also suggests that the intervention might be better to use with an individual student or small group of students rather than with a whole classroom.

Third, the timing and length of the study could have also affected the results. Students were only given two minutes to work on each worksheet. It is not known if
similar results would have been obtained had the students been given more time to work on the problems. Also, the study was only conducted over one week’s time. It is not known if the benefits gained would have been maintained over a longer period of time. Future research should look at the affects of implementing the intervention over a longer period of time with more time given to complete each of the worksheets.

Fourth, this study can only be generalized to one type of subtraction skill. Although this intervention has been shown to be effective with multiplication and division math skills, it is not known if this intervention would be effective with other types of subtraction problems. Future research should focus on whether the effects of this intervention can generalize to other types of subtraction problems and perhaps even addition problems. While students did improve their performance from pretest to posttest, it is not known if they improved their skills on the exact problems they completed on the pretest. In order to counterbalance the order of problems and due to time constraints, the majority of the students did not complete the same exact problems on the posttest as they were exposed to on the pretest. It appears that the participants were able to generalize the knowledge they gained from the intervention worksheets, but this inference can not be proven. Future research should consider giving participants enough time so that they are exposed to all of the items contained on both the pretest and posttest.

Despite the limitations mentioned above, there are several implications for a procedure like Cover, Copy, and Compare. First, the kind of information obtained from this study could be used in progress monitoring and instructional planning for each student. For instance, the pretest and posttest worksheets could be used as curriculum-
based measurement (CBM) probes to evaluate a student’s ability to successfully perform specific mathematical operations (i.e. two-digit by one-digit subtraction). If the student is not making adequate progress, the Cover, Copy, and Compare worksheets can be used as an intervention tool to help improve their fluency and performance on these mathematical tasks. The results of this study have shown that the use of the Cover, Copy, and Compare intervention can have a quick and significant impact on student performance.

Second, Skinner et al. (1989) suggested that the use of the Cover, Copy, and Compare procedures could be used to improve rates of correct “…responding for students in the acquisition or fluency stages of learning” (p.419). In the current study, some students appeared to be at an acquisition stage of learning the subtraction facts, while others appeared to be at the fluency stage as evidenced by the number of problems they completed on the pretest and posttest worksheets. Before the data collection began, the examiner did ask both teachers to identify a math skill where the majority of students were at an instructional level, but not a mastery level with the problems being presented. It is not known if the students’ skill levels had an effect on the size of the increase in digits correct per second. While the majority of the students did show an increase in digits correct per second from pretest to posttest, not all students showed an improvement. Skinner et al. (1997) indicated that while the Cover, Copy, and Compare intervention can be effective, it will not improve the performance of all students.

As predicted, the overwhelming majority of students preferred the Cover, Copy, and Compare intervention over the Copy, Cover, and Compare intervention. However, students were not asked to provide an explanation for why they chose one procedure over the other. There are two possible explanations. One possible explanation is that the
students' preferred the Cover, Copy, and Compare intervention because it required less work to complete a problem (i.e., effort). The Cover, Copy, and Compare procedure required the students to perform one less step (i.e., the initial copying step) than the Copy, Cover, and Compare procedure. Another possible explanation for the students' choice is that they may have felt the extra step of copying down the problem and answer first was not necessary in order for them to remember the problem and answer. Although no statistical test was conducted on teacher preferences, the two classroom teachers overwhelmingly preferred the Copy, Cover, and Compare procedure. They indicated that the Copy, Cover, and Compare procedure would be the better one for teaching their students basic math skills and helping their students achieve the greatest fluency in their basic math skills. Teachers were not asked to explain why they chose the Copy, Cover, and Compare intervention. A possible explanation for why they chose the Copy, Cover, and Compare intervention is that they may have felt having the extra copying step would aide the students' in their memorization of basic facts. Another possible explanation is that they might have felt the extra copying step would provide more rote practice with the correct problem and answer, leading to fewer errors in their responding. Clearly, the results of this experiment show that the extra copying step is not necessary to improve student fluency and accuracy. Future researchers should ask students' and teachers for an explanation as to why they prefer one intervention procedure over the other. The examiner also did not query students and teachers as to whether they preferred the "traditional worksheets" over the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets. Future research should ask whether they preferred the "traditional
worksheets” over the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets.

This study has extended the research on the utility of the Cover, Copy, and Compare intervention. It appears that the Cover, Copy, and Compare intervention can be used to help increase the rate of accurate responding on subtraction problems in a short amount of time. Future research should address the limitations of the current study to rule out alternative hypotheses that can be made about the results. More extensive research is needed on the Cover, Copy, and Compare intervention in order to justify its use for all basic math skills and to help expand its utility as an effective intervention tool for mathematics.

References


Table 1
Means and Standard Deviations for Digits Correct Per Second (DCPS) and Errors Per Second (EPS) For Pre-test and Post-test Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCPS</td>
<td>.129</td>
<td>.007</td>
</tr>
<tr>
<td>EPS</td>
<td>.001</td>
<td>.001</td>
</tr>
<tr>
<td>Post-test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCPS</td>
<td>.178*</td>
<td>.008</td>
</tr>
<tr>
<td>EPS</td>
<td>.001</td>
<td>.002</td>
</tr>
</tbody>
</table>

*Indicates statistically significant difference at p < .05
<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cover-Copy-Compare</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCPS</td>
<td>.317</td>
<td>.124</td>
</tr>
<tr>
<td>EPS</td>
<td>.001</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Copy-Cover-Compare</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCPS</td>
<td>.188*</td>
<td>.007</td>
</tr>
<tr>
<td>EPS</td>
<td>.001</td>
<td>.001</td>
</tr>
</tbody>
</table>

*Indicates statistically significant difference at p < .05
Table 3
Proportion of Students Who Chose Cover, Copy, and Compare and Copy, Cover, and Compare

<table>
<thead>
<tr>
<th>Cover-Copy-Compare 34*</th>
<th>Copy-Cover-Compare 10</th>
</tr>
</thead>
</table>

*Indicates statistically significant difference at p < .05
Figure Caption

*Figure 1.* Average digits correct per second and errors per second scores on the pretest and posttest worksheets.
Figure Caption

*Figure 2.* Average digits correct per second and errors per second scores on the Cover, Copy, and Compare and Copy, Cover, and Compare worksheets.
Cover and Copy Data

Cover Errors: 0
Copy Errors: 0
Appendix A

Traditional (Pretest)

SUBTRACTION: 1-digit number from a 2-digit number up to 18: no regrouping

Student Number: ____________________

<table>
<thead>
<tr>
<th>Item 1:</th>
<th>Item 2:</th>
<th>Item 3:</th>
<th>Item 4:</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>17</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>-5</td>
<td>-5</td>
<td>-6</td>
<td>-6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 5:</th>
<th>Item 6:</th>
<th>Item 7:</th>
<th>Item 8:</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>18</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>-3</td>
<td>-5</td>
<td>-4</td>
<td>-9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 9:</th>
<th>Item 10:</th>
<th>Item 11:</th>
<th>Item 12:</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>13</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>-2</td>
<td>-6</td>
<td>-9</td>
<td>-4</td>
</tr>
<tr>
<td>Item</td>
<td>13</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>------</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>15</td>
<td>14</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>- 1</td>
<td>- 9</td>
<td>- 3</td>
<td>- 5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>16</td>
<td>13</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>- 7</td>
<td>- 4</td>
<td>- 3</td>
<td>- 1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>21</th>
<th>22</th>
<th>23</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>15</td>
<td>14</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>- 2</td>
<td>- 4</td>
<td>- 7</td>
<td>- 9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>11</td>
<td>16</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>- 6</td>
<td>- 5</td>
<td>- 8</td>
<td>- 2</td>
<td></td>
</tr>
<tr>
<td>Item 29:</td>
<td>Item 30:</td>
<td>Item 31:</td>
<td>Item 32:</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>10</td>
<td>15</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>- 4</td>
<td>- 7</td>
<td>- 8</td>
<td>- 1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 33:</th>
<th>Item 34:</th>
<th>Item 35:</th>
<th>Item 36:</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>12</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>- 7</td>
<td>- 2</td>
<td>- 6</td>
<td>- 8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 37:</th>
<th>Item 38:</th>
<th>Item 39:</th>
<th>Item 40:</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>11</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>- 2</td>
<td>- 3</td>
<td>- 5</td>
<td>- 3</td>
</tr>
</tbody>
</table>
SUBTRACTION: 1-digit number from a 2-digit number up to 18: no regrouping

Student Number: ___________________ Date: ________________

Item 1:

\[
\begin{array}{c}
10 \\
- 9 \\
\hline
1
\end{array}
\]

Item 2:

\[
\begin{array}{c}
18 \\
- 3 \\
\hline
15
\end{array}
\]

Item 3:

\[
\begin{array}{c}
14 \\
- 7 \\
\hline
7
\end{array}
\]
Item 4:

\[
\begin{array}{c}
17 \\
- 4 \\
\hline \\
13 \\
\end{array}
\]

Item 5:

\[
\begin{array}{c}
11 \\
- 2 \\
\hline \\
9 \\
\end{array}
\]

Item 6:

\[
\begin{array}{c}
13 \\
- 9 \\
\hline \\
4 \\
\end{array}
\]

Item 7:

\[
\begin{array}{c}
16 \\
- 8 \\
\hline \\
8 \\
\end{array}
\]
Item 12:

\[
\begin{array}{c}
18 \\
- 7 \\
\hline
11
\end{array}
\]

Item 13:

\[
\begin{array}{c}
12 \\
- 4 \\
\hline
8
\end{array}
\]

Item 14:

\[
\begin{array}{c}
17 \\
- 2 \\
\hline
15
\end{array}
\]

Item 15:

\[
\begin{array}{c}
13 \\
- 5 \\
\hline
8
\end{array}
\]
Item 16:

\[
14 - 5 = 9
\]

Item 17:

\[
15 - 8 = 7
\]

Item 18:

\[
11 - 7 = 4
\]

Item 19:

\[
10 - 2 = 8
\]
Item 20:

\[
\begin{array}{c}
18 \\
- 1 \\
\hline
17
\end{array}
\]

Item 21:

\[
\begin{array}{c}
16 \\
- 2 \\
\hline
14
\end{array}
\]

Item 22:

\[
\begin{array}{c}
13 \\
- 3 \\
\hline
10
\end{array}
\]

Item 23:

\[
\begin{array}{c}
17 \\
- 9 \\
\hline
8
\end{array}
\]
Item 24:

\[
\begin{array}{c}
14 \\
- 3 \\
\hline \\
11
\end{array}
\]

Item 25:

\[
\begin{array}{c}
12 \\
- 9 \\
\hline \\
3
\end{array}
\]
Appendix C

Teacher Questions

1. Which assigned worksheet do you think is best for teaching your students their basic math facts?
   a) Cover, Copy, and Compare  
   b) Copy, Cover, and Compare

2. In your opinion, which assignment would help students achieve the greatest fluency in responding to basic math problems?
   a) Cover, Copy, and Compare  
   b) Copy, Cover, and Compare