The Effects of Direct Instruction Procedures with a Place Value Chart and Model-Lead-Test Error Correction Procedure to Teach Regrouping with Three-Digit Subtraction Accuracy: A Case Study Disabilities

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Abstract: *The ability to calculate in math is a critical lifelong skill for academic success. The purpose of the present study was to evaluate the effects of a model, lead and test (MLT) error correction procedure with a number line on teaching a fourth grade student regrouping. A non-concurrent multiple baseline design across problem types was employed. The overall outcomes indicated large improvements during the use of MLT, explicit instruction and a number line. Some generalization from learning regrouping with two problem types to a third type (regrouping with three digits) was found. Our participant enjoyed the procedures and improved his academic skills.*

Keywords: *Direct Instruction, Model, Lead, And Test, Multiple Baseline Design, Number Line, Error Correction, Percent Correct, Subtraction*.

Introduction

Mathematics is a skill that students have to use on a daily basis throughout all levels of their schooling careers. Students will be required to apply their math skills in a variety of real world situations. The progression of math skills happens like stair steps, starting with the basic facts at the bottom and continually building upon the previous skill from there. The basic facts are necessary for students to move to the next step, like a base floor, which eventually leads to more demanding arithmetic (Loveless, 2003). It is important for students to master their basic facts, in order to improve their success in further mathematics.

Direct Instruction (DI) is a teaching method designed to be explicit, systematic, and scripted (Marchand-Martella, Slocum, & Martella, 2004). It stresses mastery of the particular skill being taught before the moving on to another. Students are taught how to properly solve the question provided and given repeated practice working on those skills. DI is a well-supported research-based form of instruction that has been proven as being effective for students with diverse learning needs (Hicks, Bethune, Wood, Cooke, & Mims, 2011). It has been proven as being successful for students with a variety of different needs. In a research study assessing DI"s effectiveness on students with learning disabilities it found a substantial increase in efficiency by the students that were taught with Direct Instruction, as compared to the students that were taught with the standard basal math approach (Wilson & Sindelar, 1991). This study compared DI with other forms of instruction used by teachers. The significant improvement provides evidence that DI would be more useful when working with students on new skills. Another study, which used participants from a low-income elementary school, found that the one found the students whom received 3-4 full years of Direct Instruction performed significantly better in all mathematical subtests on a standardized achievement test than students that received any other form of instruction (Carnine & Gersten, 1984). Research studies have found that DI is not limited to a specific group of individuals, but instead provides significant improvement for a wide variety of children (Marchand Martella et al., 2004). The range of children DI supports makes it a useful instruction technique to implement in all schools.

The Model-Lead-Test (MLT) correction procedure is supported through numerous research studies that demonstrate its effectiveness. Sometimes this procedure has been labeled," I do," "We do," "You Do." MLT focuses on correcting the student's mistake immediately after it is made, then providing ample opportunities for the student to practice his error in the correct way. MLT is set up to reduce the student's chances of repeating an error because the correct way is systematically taught and modeled for them (Aldahri, McLaughlin, Derby, Belcher, & Weber, 2013; Aldahri, Weber, & McLaughlin, 2014; Bechtoldt, McLaughlin, Derby, & Blecher, 2014; Theobald, McLaughlin, Weber & Derby, 2015). This procedure allows for students to have constant practice of solving problems correctly, both with the instructor and individually (Marchand-Martella, Martella, & Slocum, 2004). Further research has shown that MLT is effective in teaching a wide range of skills to students with a variety of disabilities (Shouse, Weber, McLaughlin & Riley, 2012). The range of students that MLT can serve makes it an effective correction procedure to implement with children (Dundon, McLaughlin, Neyman, & Clark, 2013). MLT has been successfully employed with a wide range of student populations ranging from preschoolers (Bechtoldt et al., 2014; Bulkley et al., 2012; Dundon et al., 2013; Mortensen, McLaughlin, Neyman, & Girshick, 2013; Thomas, McLaughlin, & Derby, in press), elementary school students (Harris et al., 2015), middle school (DiJulio, Hallett, Neyman, McLaughlin, & Cole, 2015; Peterson et al., 2007), as well as high school and post high school students with disabilities (Brushwein, McLaughlin, Derby, & Shank, 2014; Hayter, Scott, McLaughlin, & Weber, 2007).

The place value chart is used to help students visually process math equations. It provides them with an opportunity to physically set up and manipulate the problem. Teachers have reported that students consistently disregard place value in math equations. An example is they will read 27

and 72 as the same number. They fail to recognize the importance of the column each digit is in and believe whichever number has the larger digit is greater in value (Cooper & Tomayko, 2011). Providing students with a chart divides up each number in the equation into the correct columns. The chart acts as a pictorial manipulative that provides place value concepts in a highly visual format (Mann, Moeller, Pixner, Kaufmann, & Nuerk, 2011). The place value chart is used as an instructional support for students as they work on building their subtraction skills.
The purpose of the present case report was to replicate and extend our previous research (Shouse et al., 2012; Theobald et al., 2015; Bulkley, McLaughlin, Derby, & Carosella, 2012) using MLT. A second purpose was to improve the math skills of a fourth grade student with an intellectual disability. A final purpose was to determine if teaching skills to in two types of subtraction problems with regrouping would generalize (Stokes & Baer, 1977, 2003) to other problem formats.

Method

Participant and Setting

The participant in the study was a 10-year-old in the fourth grade at a large urban public elementary school in the Pacific Northwest. He had been diagnosed with a Communication disorder with deficits in Math, Reading, Writing, and Social Skills. The participant had been diagnosed as Developmentally Delayed (DD) between the ages of 4-8 years-old. The IQ of the participant was 70 according to his score on the *Stanford-Binet Intelligence Test* (Roid, 2003) putting him on the cusp of qualifying as Intellectually Disabled (ID). The participant spent 75% of his day in a general education classroom. The other 25% of his day was spent in Special education classrooms consisting of a resource room and direct instruction room. The participant received individualized instruction for math, reading, and writing within his resource room classroom, while he worked on developing appropriate social skills in his direct instruction room. The focus of the study was decided based on the participant's need for mastery of three-digit subtraction problems. The student exhibited behavioral non-compliance problems, which were worked on coincide with the study.

The study was conducted at a table in the back of the participant's resource room, consisting of solely the participant and first author. The participant had difficulties focusing during group settings, therefore requiring a one-to-one setting. Constant attention from the first author helped the participant stay engaged during instruction. There were two other teachers with their own groups of students in the classroom at the time during which the study occurred. The noise level in the classroom did not serve as an overwhelming distraction for the participant.

Materials

Instruction with the participant used a place value chart with place holder chips to allow the student to physically display the subtraction problems he was working on. Each of the place holder chips had a value written on the front (1, 10, 100) to represent its value. The participant was highly reinforced by a break schedule. The break schedule was implemented to increase on-task behavior by requiring him to earn his number of break minutes. The participant consistently chose an iPad as a tangible reward for his breaks.

Dependent Variable and Measurement Procedures

The target objective of this study was to improve the participant's accuracy of solving three-digit subtraction problems. The participant was required to reach mastery in a specific problem set before starting intervention of the next set. Mastery was defined as completing an assessment with 90% accuracy for three consecutive trials. The problem sets were constructed based on a pretest, in which the student showed difficulty in solving specific types of subtraction problems. The student was given a daily assessment after instruction, which consisted of ten three-digit subtraction problems of the problem set. The assessments were measured by scoring the accuracy of each problem by leaving correct problems blank and putting an "X" through problems answered incorrectly.

Experimental Design

A non-concurrent multiple-baseline design (Kazdin, 2011; McLaughlin, 1983) was used in the study to determine the effectiveness of Direct instruction on the ability to solve subtraction problems. There were 2 sessions of baseline for Set 1, 3 sessions of baseline for Set 2, and 5 sessions of baseline for Set 3.

Baseline. The participant was tested on each problem set a minimum of 2 times prior to the start of intervention. Baseline consisted of 5 subtraction problem types based on the set that was being tested. Set 1 baseline occurred after the participant was given a pretest to determine the subtraction types he struggled with the most. This baseline was given before any instruction had taken place. Baseline for Set 2 was given to the participant as an additional 5 problems, after he completed the daily assessment for Set 1. The same procedure occurred for baseline for Set 3, which was given after instruction and assessment for Set 2. The participant had to show that he had not reached mastery of each set during baseline to initiate intervention.

Direct instruction + MLT + place value materials. The participant received direct instruction from the first author during intervention of each problem set. The first author combined a model-lead-test correction procedure and a place value chart with the direct instruction. A daily instruction worksheet consisting of problem types of the set being worked on would be given to the participant. The first author would go through each problem on the worksheet explicitly with the participant. He was required to set up each subtraction problem on the place value chart. The participant would work through the problem taking away the necessary amount of chips. Then, he would have to show the same results on the worksheet. The first author gave the student specific strategies to both solve for and double check his answer. Anytime the student solved the problem incorrectly the first author would intervene with a model-lead-test procedure. The first author would set up the problem for the student and go through it explicitly with the participant. After, the participant would have to perform the same problem on his own. The direct instruction focused on improving the participant's ability to solve the specific problem sets he showed difficulty in.

Reliability of Measurement

The first author would score each of the participant's daily assessments immediately after completion. The correct answers were left blank, while incorrect answers were marked with an "X". The first author had the participant's resource room teacher review daily assessments to check for accuracy. Over 75% of the daily assessments were reviewed by the resource room teacher (fifth author). The interobserver agreement between the first author and resource room teacher was 100%. Since, the assessments were given as worksheets the first author had hard evidence. The resource room teacher would review the assessments that had already been graded to evaluate for any mistakes in the grading.

Results

Baseline

The participant did not reach mastery in any of the sets during baseline. Set 1 baseline results show that the student was only able to answer 20% of the questions correctly. The participant had more difficult with Set 2 during baseline, mean = 0% on all three sessions. This is shown by an increase from 0% to 80% correct during baseline for Set 3 (range 0 to 80%; M = 36%) when intervention began for Set 2.

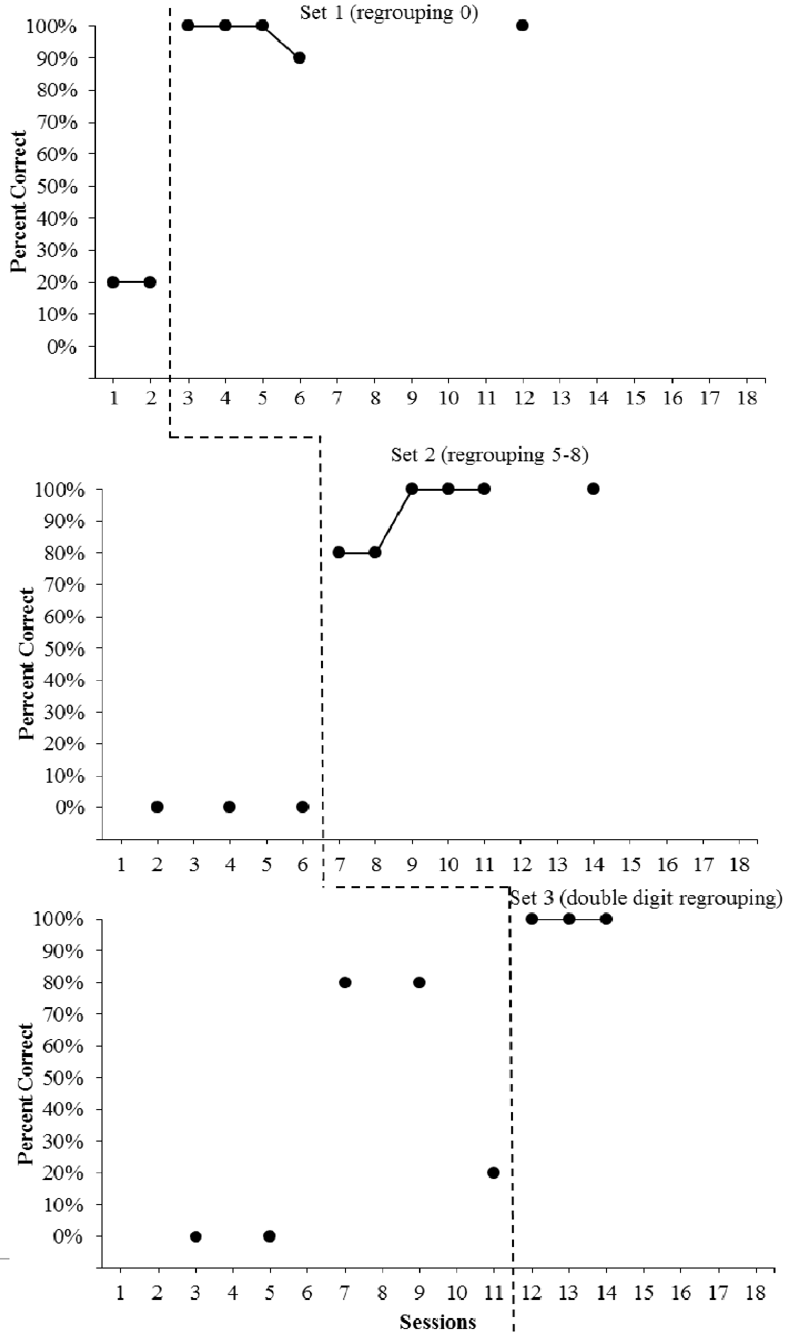
Direct instruction + MLT + place value materials.

Our intervention using direct instruction to explicitly teach the participant how to solve each problem set had a large t impact on the participant's ability to solve the subtraction problems. The participant was able to reach mastery (three consecutive sessions with at least 90% accuracy) in each set, never taking more than five sessions. Set 2 was the only set that the participant scored lower than a 90% on the daily assessment. He received an 80% on the first two sessions, than was able to raise it to a 100% for three consecutive sessions after that. The participant throughout all sets was able to bring his accuracy above 90% after the implementation of direct instruction to teach him problem solving strategies for the sets.

Percent of Non-overlapping Data Points

The percent of non-overlapping ({NDP) was 100%. This indicates a very large effect for the use of the three components of our intervention package (Scruggs &Mastropieri, 2001, 2013; Scruggs, Mastropieri & Casto, 1987).

Figure 1: The percent correct for our participant during baseline and direct instruction and number line.



Discussion

There was a direct relationship between the direct instruction intervention and the participant's ability to solve three digit subtraction problems. The participant had shown difficulties in consistently solving three digit subtraction problems correctly. The first author discovered specific problem sets that the participant would consistently miss in the pretest given to him. Intervention with direct instruction was able to significantly increase the participant's accuracy when solving these problems.

Prior to intervention the participant had been working on developing his subtraction skills. In the pretest he was able to get all problems correct that required no regrouping or did not have any 0's in them, which were the subtraction types that proved to be the most difficult for the participant. Throughout intervention of each set the participant began to show an understanding for how to properly solve the set. He consistently would score over 90% accuracy on each daily assessment given to him, which was one of the requirements for meeting mastery. The participant showed improvement in each problem set after intervention began. The significant increase in his accuracy correlated with the direct instruction. The impact of direct instruction can be seen specifically when comparing the participant's pretest and posttest scores. The participant scored a 33% on the pretest that was given to him and increased to a 100% on the posttest.

A strength of the present case study was the universality of direct instruction. Instruction could have occurred anywhere, all that was required was the participant and the first author. The materials were cheap and easy to make. Any material used could have been made out of a piece of paper. Since there were other teachers and students in the classroom, the first author and student were subjected to a different area each day. Instruction did not have to occur in any particular spot, making the inconsistency of where it occurred easy on the first author and participant. The lessons did not last long, which kept the participant focused and engaged the entire time. The fast timeframe of each lesson allowed the first author to be flexible when working with the participant. The use of the non-concurrent multiple baseline allowed the first author to spend less time in baseline once intervention began with the first set. This reduced the time required that the participant was not being provided instruction. Both the participant and the first author felt this was a very important issue when one is required to take baseline across different skills. Reducing the amount of times baseline measures are taken has also been suggested by others (Barberio-Kitts, McLaughlin, Neyman, Worcester, & Cartmell, 2014).

The research study provided evidence that direct instruction can help a student's ability to master subtraction problems. However, a weakness of this study was the participant's inability to generalize the learned skills to his general education classroom setting. He displayed mastery for each of the problem sets, but when he received similar problems in his other classroom the participant would resort back to old strategies. These old strategies often resulted in the participant answering the question incorrectly. The individualized setting with the first author created a supporting environment that allowed the participant to use the taught skills. In his general education classroom the student became frustrated, leading him to abandoning the skills that he developed during intervention. The next step for the first author would be to support the participant in his general education classroom when he is given subtraction problems. The first author would remind the participant that he can answer each question correctly, prompting him to remember the strategies he learned. Repeated practice of all his skills with the first author in another setting would further promote the participant of generalizing his ability to subtract. Overtime the participant would see an increase in his accuracy of all subtraction problems.

Overall, this study proved as being both successful and enjoyable for the participant. He was able to significantly improve his subtraction solving abilities. Direct instruction helped him learn how to properly solve each problem and maintain that ability. The participant communicated his appreciation of the skills by telling the first author he “liked” that he could understand the subtraction problems and solve them. Prior to the study the participant would never participate during math instruction. Towards the end of the study he would constantly ask the first author for more and harder problems, after he completed the daily assessments. The participant had gained confidence in his abilities through this study. This could indicate a possible why his performance improved across all three sets with no overlapping data points between baseline and our intervention package.

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Appendix A

Session	Accuracy (Percent Correct): Problem Set 1 (regrouping 0)	Accuracy (Percent Correct): Problem Set 2 (regrouping 5-8)	Accuracy (Percent Correct): Problem Set 3 (regrouping 2-digits)
1	20%	—	—
2	Baseline 20%	0%	—
3	100%	—	0%
4	100%	0%	—
5	100%	—	0%
6	90%	set 1 0%	—
7	—	80%	80%
8	—	80%	—
9	—	100%	90%
10	—	100%	—
11	—	100% set 2	20%
12	100%	—	100%
13	—	—	100%
14	—	100%	100%
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Appendix B

Figure 1. The number correct for baseline and DI flashcards