THE EFFECTS OF USING DIRECT INSTRUCTION MATHEMATICS FORMATS TO TEACH BASIC MATH SKILLS TO A THIRD GRADE STUDENT WITH A LEARNING DISABILITY§§§

Megan Heasty
Gonzaga University
USA.
mheasty@zagmail.gonzaga.edu

T. F. McLaughlin
Gonzaga University
USA.
mclaughlin@gonzaga.edu

Randy Lee Williams
Gonzaga University
USA.
williamsr@gonzaga.edu

Bonnie Keenan
West Valley School District
USA.

ABSTRACT

The purpose of this study was to examine the effects of Direct Instruction Mathematics formats to teach basic math skills. The participant in this study was a third grade girl who qualified for special education services in both math and reading. Several math skills were taught during the course of this study, including writing hundreds numbers, writing hundreds numbers in expanded notation, and completing two-digit addition problems with renaming. The research was carried out at a small, public, urban elementary school in the Northwest. The results indicated that the use of Direct Instruction substantially increased student performance on basic math skills.

Keywords: Direct instruction, math, learning disabilities, elementary school student, teaching strategies

INTRODUCTION

The teaching of math skills remains a basic part of the elementary school math curriculum. Outcome research has shown that students with learning disabilities often use slow counting strategies (e.g. finger counting) to solve basic mathematical problems (Lerner & Johns, 2012; Skinner, Beatty, Turce, &Rasavage, 1989; Resnick 1989). These strategies typically result in a general lack of speed in computing math problems, which can dramatically diminish the student's performance of mathematical functions commensurate with peers and the requirements of many math related tasks (Skinner et al., 1989). Further, math calculation skills are one of the predictors in assessing success in general academic performance (Lloyd, 1978; Haring, Lovitt, Eaton, & Hansen, 1978). Lloyd (1978) concluded from his work that poor academic performance as early as the third grade may be a predictor of laterschool failures and increased risk for eventually dropping out of school. Thus, building fluency (i.e. improving speed), as well as increasing accuracy may increase the probability for future academic and social success. Immediate recall of facts appears to superior to employing counting strategies, and permits students to complete their work in math with less effort and more speed across settings (Pieper, 1983; Resnick, 1989). For example, most of the math skills in everyday life at home, in the community, or on the job must be performed at certain fluency in order to be functional for the person (Johnson & Layng, 1994; Miller & Heward, 1992; Schloss, Smith, &Schloss, 2006). Further, individuals with deficiencies in math skills may even be unable to meet the requirements for certain vocational and career options (Resnick, 1989; Resnick, Wang, & Kaplan, 1973).

The purpose of this study was to examine the effects of the formats found in Direct Instruction mathematics (Stein, Kinder, Silbert, &Carnine, 2006; Stein, Silbert, &Carnine, 1990, 1997) when used to teach basic math skills to a child with learning disabilities. The skills examined included writing hundreds numbers, writing hundreds numbers in expanded notation, and completing two-digit addition with regrouping.

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METHOD

Participant and Setting

The participant was a 10-year-old third grade girl qualifying for special education services in both math and reading based on an assessed learning disability. She was referred for services based on low academic performance in reading, math, and written language. During this study, she received pullout instruction in both math and reading for a total of about 300 minutes per week. The participant often appeared to lack motivation and required repeated prompting from the first author in order for her to remain focused on the tasks being completed. She was chosen for this study to try to increase her performance on and understanding of basic math skills.

The study took place in a small, urban public school in the Northwest. The participant's school included students from a wide range of backgrounds. Nearly 50% of the students received free and reduced lunches, qualifying the school for Title I funding. The majority of the school's students were part of a parent involvement program, where teachers received additional funding for their classrooms based on yearly tuition dues from each student.

The participant in this study was pulled out of her regular classroom and worked with the first author in either a small office space located near the school's main entrance or in the school's faculty lounge. Data were gathered daily between 12:30 p.m. to 2:00 p.m. During this time, another student and occasionally an Educational Assistant were present. Each session was conducted with the participant for 30 minutes, five times per week.

Materials

As a part of this study, the first author created several worksheets and assessments based on the design presented at the end of the addition chapter in Designing Effective Mathematics Instruction: A Direct Instruction Approach (Stein et al., 1997, 2006). In addition to the formats used from the text, the first author also used a small whiteboard and dry erase markers to present strategies to the subject. The student was also provided with small plastic chips used as counters while completing addition problems.

Dependent Variable

The dependent variable measured in this study was the number of math problems answered correctly on a daily worksheet. During the first four conditions of the study, the first author measured the amount of correctly written hundreds numbers (hear/write dictated hundreds numbers). During the fifth and sixth conditions of the study, the first author measured the numbers correctly written numbers in expanded notation. During the last two conditions, the first author measured the number of correct answers written for two-digit addition problems with regrouping. The participant was presented with a worksheet containing 10 problems (9 problems during the last two phases of the study), and was provided with as much time as necessary to complete the objective being assessed. After the student finished each assessment, the first author immediately corrected the worksheet and provided the child with her score.

Experimental Conditions

Various interventions (baseline and DI math formats) were presented and removed in an A1B1A2B2A3B3A3B4 single-case design (Kazdin, 2010). This design was used to evaluate the effectiveness of Direct Instruction Mathematics on the number of correctly written hundreds numbers, correctly written numbers in expanded notation, and the number of correct answers for two digit addition problems requiring renaming.

Baseline (A1)

The first baseline consisted of the first author saying a series of ten hundreds numbers, pausing after briefly each number to allow the participant time to write her response. None of the hundreds numbers presented had a zero or one in the tens column. This condition was in effect for one session.

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Direct Instruction (D1)

The participant was introduced to the methods of reading and writing hundreds numbers presented in Formats 5.8 and 5.9 from Designing Effective Mathematics Instruction: A Direct Instruction Approach (Stein et al., 1997, 2005). The first author gave the participant a dry erase board, pen, and a worksheet depicting place value columns (i. e. 1's, 10's, and 100's) to present the formats and record the participant's work. After completing the Direct Instruction formats, the participant completed a structured worksheet and a supervised practice worksheet. The participant was then assessed on her ability to write hundreds numbers. The first author read a series of ten hundreds numbers out loud, pausing after each number to allow the subject time to write her response. None of the hundreds numbers presented had a zero or one in the tens column. This condition was in effect for four sessions.

Baseline (A2)

The second baseline consisted of the first author reading orally a series of ten hundreds numbers out loud, pausing after each number to allow the participant time to write her response. Each of the hundreds numbers had either a zero or one in the tens column. This condition was in effect for one session.

Direct Instruction (D2)

The subject was again taught the methods of reading and writing hundreds numbers presented in Formats 5.8 and 5.9 from Designing Effective Mathematics Instruction: A Direct Instruction Approach (Stein et al., 1997). During this phase, however, a strong emphasis was placed on reading and writing hundreds numbers with a zero or one in the tens column. A whiteboard and worksheet depicting place value columns were used to present the formats and record the subject's work. After completing the Direct Instruction formats, the subject completed a structured worksheet and a supervised practice worksheet. The participant was then assessed on her ability to write hundreds numbers with a zero or one in the tens column. The first author read a series of ten hundreds numbers out loud, pausing after each number to allow the subject time to write her response. All of the hundreds numbers presented had a zero or one in the tens column. This condition was in effect for four sessions.

Baseline (A3)

The third baseline assessed the participant's ability to write hundreds numbers in expanded notation. The student was given a worksheet listing ten hundreds numbers, each followed by three lines joined by addition signs. The directions at the top of the worksheet stated, "Write these numbers as addition problems." The participant was allowed as much time as needed to complete the worksheet. This condition was in effect for one day.

Direct Instruction (D3)

During this condition, Format 5.14 out of Designing Effective Mathematics Instruction: A Direct Instruction Approach (Stein et al., 1997) was used to teach expanded notation. The first author used a small whiteboard to present the structured board presentation portion of the format. Following the first author's board presentation, the subject completed practice problems on the whiteboard, with assistance from the first author. Finally, the participant was given a worksheet listing ten hundreds numbers, each followed by three lines joined by addition signs. The directions at the top of the worksheet stated, "Write these numbers as addition problems." The student was allowed as much time as needed to complete the worksheet. This condition was in effect for four days.

Baseline (A4)

The fourth baseline assessed the participant's ability to correctly complete two-digit addition problems with regrouping. The student was given a worksheet with nine addition problems, and was given as much time as necessary to complete the problems. This condition was in effect for one day.

Direct Instruction (D4)

During the final condition of this study, the first author presented Format 7.5, the format for adding three single-digit numbers, as well as Format 7.6, the format for adding two numerals with renaming

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(Stein et al., 1997). The first author used a small whiteboard to present the structured board presentation portion of the format. Following the first author's board presentation, the subject completed practice problems on the whiteboard, with assistance from the first author. At the close of each session, the student was given a worksheet with nine addition problems, and was given as much time as necessary to complete the problems. This condition was in effect for three days.

Reliability of Measurement

Because the dependent variable was a permanent product, inter-observer agreement was conducted during every session. The classroom teacher rechecked the first author’s scoring each day. Intergrader agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Reliability of measurement was 100%.

RESULTS

The effects of the various interventions can be seen in Figure 1. For baseline, her correct rate was 0 and her errors were 10. During the first phase of Direct Instruction, the mean corrects increased to 9.75, with a range of 9 to10. The mean correct rate during the second baseline was 4.0 while her errors increased to 6. During the second Direct Instruction phase, the mean for corrects improved to 9.75 with a range of 9 to 10. Errors were low and ranged from 0 to 1.

The third baseline produced no corrects and 10 errors. The mean for corrects during the third application of Direct Instruction was 9.75 with a range of 8 to 10. The participant's errors averaged .5 with a range of 0 to 1. During the last baseline, the participant's corrects declined to 0.0. During the final phase of Direct Instruction, corrects increased to a mean of 8.0 (range 7 to 9) and errors decreased to an average of 1.0 (range 0 to 2).

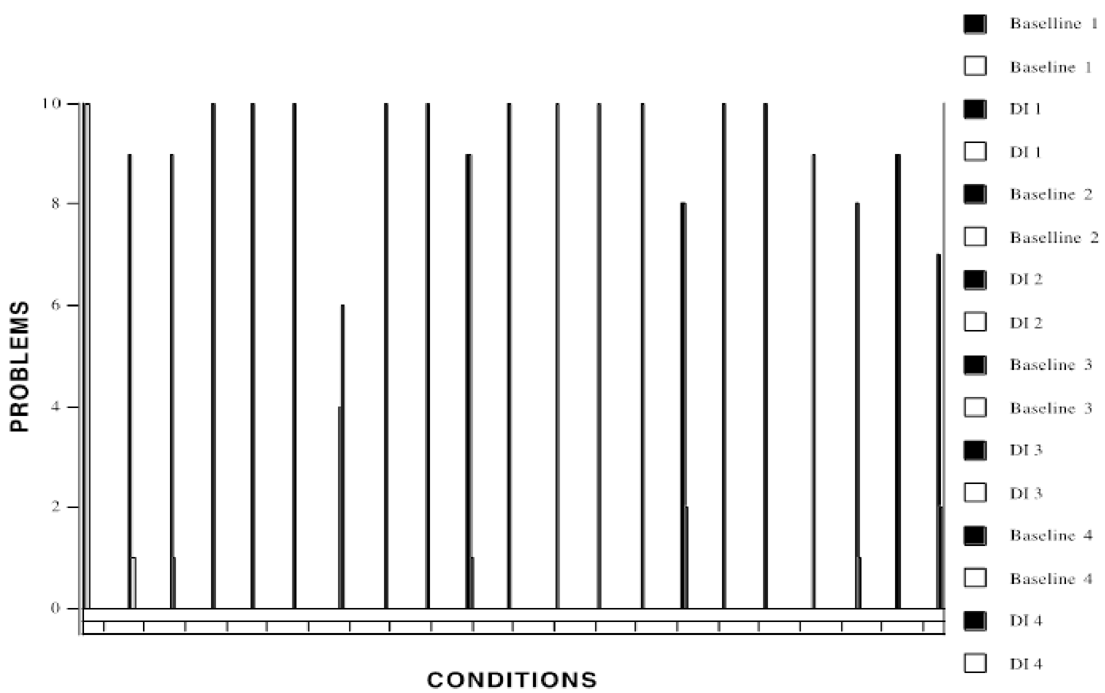

Figure 1.Number of corrects (Solid Bars) and Errors (Open Bars) for the participant in each of the experimental conditions

DISCUSSION

The results of this study clearly show that Direct Instruction was effective in teaching a third grade student math skills. The participant improved her accuracy levels in all four math areas assessed. The sequential curriculum presented in Designing Effective Mathematics Instruction: A Direct Instruction

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Approach (Stein, Kinder, Silbert, &Carnine, 2006; Stein et al., 1990, 1997) provided a structure, scripts, and presented specific strategies which led to the participant's success.

Upon completion of the study, the participant appeared confident in her skills to complete math problems. The first author, as well as the classroom teacher, felt her obvious improvement of self-concept was impart the success she found through Direct Instruction. Also, Direct Instruction procedures could be successfully employed across various problem types in math.

The use of Direct Instruction strategies in math was easy to implement and employ. These procedures were employed across various math skills with ease. The authors believe that Direct Instruction math has a great deal to offer both special and general education teachers. The authors urge the use of Direct Instruction in teacher training (McLaughlin, B. F. Williams, R. L. Williams et al., 1999). The present results add to the growing literature as to the effectiveness of Direct Instruction from our work (Blackwell, Stookey, & McLaughlin, 1996; Drago& McLaughlin, 1996; Edmondson, Peck, & McLaughlin, 1996; Holz, Peck, McLaughlin, &Stookey, 1997; Johnson, Luiten, Derby, McLaughlin, Weber, & Johnson, 2001) in the schools. Direct Instruction procedures are effective with typical students, as well as with special populations (McLaughlin, Williams, & Howard, 1997; McLaughlin, Williams, Howard, & Reyes, 1995) as have the developers of Direct Instruction. Direct Instruction procedures are not just effective with special education populations, but also with typical students and students at-risk. Both special and general education teachers should adopt Direct Instruction math procedures and curricula to teach math skills more effectively.

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Effective math teaching supports students as they grapple with mathematical ideas and relationships. Allow them to discover what works and experience setbacks along the way as they adopt a growth mindset about mathematics. 13. Build excitement and reward progress. Studentsâ€”especially those who havenâ€™t experienced successâ€”can have negative attitudes about math.Â You canâ€™t teach in a vacuum. Collaborate with other teachers to improve your math instruction skills. Start by discussing the goal for the math lesson, what it will look like, and plan as a team to be most effective. â€œTogether, think through the tasks and possible student responses you might encounter,â€ says Andrews. Reflect on what did and didnâ€™t work to improve your practice. Mathematics can be a challenging topic for students who have learning disabilities (LDs), especially as the concepts and instructional methods become more abstract. Prior literature reviews have found using direct and explicit instruction for students with LDs in mathematics to have strong effect sizes (e.g., Baker, Gersten & Dae-Sik, 2002; Gersten, Chard, Jayanthi, Baker, Morphy & Flojo, 2009; Zheng, Flynn & Swanson, 2013). Description of the CRA Strategy.Â Representational: In the representational stage of instruction, students are taught to use two-dimensional drawings (instead of the manipulatives from the concrete stage) to represent the same concepts. Mathematics Advisory Panels and Their Reports. How Disabilities Can Affect Math Achievement.Â Explicit instruction, often called direct instruction, refers to an instructional practice that carefully constructs interactions between students and their teacher. Teachers clearly state a teaching objective and follow a defined instructional sequence. They assess how much students already know on the subject and tailor subsequent instruction, based upon that initial evaluation of student skills.Â Systematic instruction focuses on teaching students how to learn by giving them the tools and techniques that efficient learners use to understand and learn new material or skills. INSTRUCTIONAL STRATEGIES. High-quality math instruction is essential to the math success of all student, as students who struggle with math in elementary school do not develop the necessary skills to succeed in critical later math courses, such as algebra. Therefore, it is essential that students receive effective instruction and intervention to â€œmitigate and prevent mathematics difficulties.â€4. Successful instructional practice can be gleaned from successful schools. A U.S. Department of Education summary of Blue Ribbon schools who have dramatically improved their studentsâ€™ math performance r... Todayâ€™s mathematics curriculum must prepare students for their future roles in society. It must equip them with essential mathematical knowledge and skills; with skills of reasoning, problem solving, and communication; and, most importantly, with the ability and the incentive to continue learning on their own. This curriculum provides a framework for accomplishing these goals. The choice of specic concepts and skills to be taught must take into consideration new appli-cations and new ways of doing mathematics.Â This curriculum has been designed to equip students with the algebraic skills they need to understand other aspects of mathematics that they are learning, to solve meaningful prob-lems, and to continue to meet with success as they study mathematics in the future.