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Effects of a modified di flashcards for number recognition 1 through 10 for a preschool child with developmental delays

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Abstract
Direct instruction is an evidenced teaching method for instruction for a wide range of skills. This study examined the effects of the Direct Instruction (DI) flashcard system with a five- year-old boy in a special education preschool classroom. The DI flashcard system was evaluated in a multiple baseline design across three sets of numbers. The dependent variable was the number of correct responses. An increase in number recognition was found in all three sets containing numbers 1 through 10. By the end of the study, our participant had mastered all the numbers in the sets. Therefore, increasing his knowledge of number recognition. The benefits of employing DI flashcards in a preschool setting were discussed.

Keywords: Number Recognition, DI Flashcards, Accuracy, Error Correction, Model, Lead, And Test, Developmental Delays, Preschooler, Case Report, Replication

1.0 Introduction

Mastery of number recognition is a critical skill needed to progress to more advance stages of the mathematics curriculum (Burns, 2007). This mastery of number recognition allows the student to focus on other critical components when solving more advanced math problems, such as addition and subtraction problems, and is imperative for success in k-12 math. The acquisition of accuracy is a target skill for students to achieve (Burns, 2007). Accuracy allows for students to identify numbers quicker and advance in math at a faster rate. Learning numbers 1 through 10 allows children to begin solving more advance tasks in and out of the classroom (Gersten & Chard, 1999; Silbert, Carnine, & Stein, 1981).

Automaticity in number identification is a fundamental component for students to achieve in other areas of math. "Without the ability to retrieve facts directly or automatically, students are likely to experience a high cognitive load as they preform a range of tasks" (Woodward, 2006). This cognitive load slows down the process of problem solving. When the student's process of problem solving is slowed down, the student is not able to perform as well as they can. A study completed with 58 fourth-grade students, 15 of which had learning disabilities and IEP's, showed that students who were taught in the direct instruction approach preformed better on tests than those who were not taught the direct instruction approach (Woodward, 2006). This strategy of direct instruction has proven to be effective in many other scenarios as well. In addition, Direct Instruction procedures have become part of many teacher training programs (Marchand-Martella, Slocum, & Martella; McLaughlin, B. Williams, R. Williams, Peck, Derby, Bjordahl, & Weber, 1999).

Klahr and Migam (2004) employed 112 students were used to assess the relative effectiveness of discovery learning and direct instruction. This research clearly indicated that the students clearly learned more science concepts from direct instruction than from discovery learning. When asked to make broader, richer scientific judgments, the children who learned about experimental design from direct instruction performed better than the few children who discovered the method on their own.

Direct Instruction (DI) flashcards is one of several teaching methods that have been employed to teach a wide range of discrete skills to a wide range of students (Silbert et al., 1980; Thomas, McLaughlin, & Derby, 2015).

Briefly, DI flashcard procedures provides the instructor with a series of steps to follow when teaching basic skills. First, a pretest covering the skill to be taught is administered. This can be either in writing or orally. This provides the teacher with the knowledge of which problems this student is struggling and those the student knows. Both types of problems are placed on flashcards. The problem is placed on one side while the problem and solution is written on the back. These flashcards maybe laminated or just placed on regular flashcards (Skarr, Zielinski, Ruwe, Harp, Williams, & McLaughlin, 2014). Then the flashcards are placed in sets or stacks. The number of flashcards constructed as well as the ratio of known to unknown facts range from 3 to 20 facts depending on the age of the student or students being taught. Typically, younger students, such as preschoolers, have fewer flashcards (Herberg, McLaughlin, Derby, & Gilbert, 2011; Mangundayo, McLaughlin, Williams, & Toone, 2013) while older students have from 15 to 20 flashcards per set or stack (Brasch, Williams, & McLaughlin, 2007; Fjortoft, McLaughlin, Derby, Everson, & Johnson, 2014; Skarr et al., 2014). The ratio of known to unknown facts has varied from 12 known to 3 unknown to having all the facts as unknowns (Skarr, McLaughlin, Derby, Meade, & Williams, 2012; Skarr et al., 2014; Thomas et al., in press). The student is explicitly taught by another adult or student using DI flashcards. The flashcard is presented and the student is allowed from two to three seconds to recite the problem and provide its solution. If the student is correct, this flashcard is placed at the bottom of the stack. If the student makes an error, a model, lead, and test error correction procedure is implemented. Briefly, the teacher models the problem and its solution. Next, the instructor and student recite the problem and its solution together. Finally, the student is required to state the problem and solution independently. This flashcard is placed two or three back from the top of the stack so it can be rechecked quickly. After the student makes no errors for three consecutive presentations, this card is finally placed at the bottom of the stack. After going through all of the flashcards, a daily timed or untimed test is carried out. The student's performance is then tallied and these results are placed on a graph or chart. If the student has a large number of sets or facts to learn, the other sets that are in baseline are presented every other day or every third day (Fox-Lopp, McLaughlin, Weber, & Hatch, 2015).

After the student is able to master a set of math problems, this set is put on maintenance and the instructor intervenes on the next set of problems. The number of times a complete set has been 100% correct usually requires three such sessions for maintenance to take effect (Brinegar, Armstrong, Neyman, McLaughlin, & Smith, 2014; Silbert et al., 1981; Thomas et al., in press). DI flashcards provides a teaching procedure that directly targets the skill that the students are learning. It has also been found that DI flashcards should be used on a daily basis with students with as well as without disabilities.

DI flashcards have been successfully implemented with preschoolers (Herberg et al., 2011; Mangundayo et al., 2013), elementary school students (Skarr et al., 2014), and middle and high school students (M. Bjordahl, Talboy, Neyman, McLaughlin, & Hoenike, 2014; Brinegar et al., 2015; Fox-Lopp et al., 2015; Hayter, Ruwe, McLaughlin, Derby, & Johnson, 2011; Scott, McLaughlin & Weber, 2007). DI flashcards have been employed to teach sight words (Crowley, McLaughlin, & Kahn, 2013), math facts (Skarr et al. 2014), letter recognition (Fitting, McLaughlin, Derby, & Blecher, 2013), letter names and sounds (Bechtoldt, McLaughlin, Derby, & Blecher, 2014) as well as colors and shapes (Mangundayo et al., 2013).

The purpose of the following study was to evaluate the effects of the DI flashcards to teacher a preschool student to recognize the numbers 1 through 10. Another purpose was to extend and replicate the use of DI flashcards with another student in another setting (Kazdin, 2011; McLaughlin, 1983). Such a replication adds to confidence of employing DI flashcards to teach number recognition (Jasny, Chin, Chong, & Vignieri, 2011; Nosek et al., 2015).

2.0 Method

2.1 Participant and Setting

"Lucas," our participant will be referred to throughout this study, was a 5-year-old-boy with is diagnosed with developmental delays. He attended a special education preschool classroom. Lucas has an IEP since he began at preschool due to his severe delay in pre- academics. Lucas's current level in accordance to our target skill is at a lower rate of identifying numbers 1 through 10. Lucas was chosen for this study because he needs to be able to identify numbers 1 through 10 for kindergarten and in relation to his IEP goal; which is counting objects 1:1 up to 10.

This study took place in the Pacific Northwest at a public elementary school in the Pacific Northwest. To qualify for this preschool program, students must be 1.25 standard deviations below the norm in two areas or 2.25 standard deviations below the norm in one area. The study was conducted in the preschool classroom where there were 8 students including the participant, 2 instructional assistants, 1 certified teacher, 1 student teacher, and therapists (physical, speech/language, and occupational therapists) would come in throughout the week. The classroom was usually loud, depending on the activities, which could be distracting at times. The first author conducted the sessions 4 times a week. Sessions were conducted in the afternoon during free play, for 10 minutes each time once a day for 14 weeks. This classroom has been employed in several classroom action research projects (Aldahri, McLaughlin, Derby, & Belcher, & Weber, 2013; Bechtoldt et al., 2014; Carson, McLaughlin, Derby, & Blecher, 2010; Fitting et al., 2014; Worchester, McLaughlin, Neyman, & Blecher, 2015).

2.2 Materials

Materials included a 4 x 6 index cards with the numerals 1 through 10 written on them. The flashcards were separated into three sets for intervention. The sets were determined based on the pretest that the first author gave to identify which numbers where known and unknown by the participant.

2.3 Dependent Variable and Measurement

The dependent variable for this study is the number of numerals correctly identified. Correct answers are the correct number touched with the corresponding number asked. An incorrect answer was no response or any other flashcard touched other than the correct answer corresponding to the number asked.

The first author used event recording. Event recording was measured through the number of correctly identified

flashcard touched that corresponded with the number asked. The flashcards were made up of 10 numbers (1-10) and 3 to 4 flashcards in the set that the first author was focusing on. The sets were broken down into 3 different sets; Set 1: 1,2, 3, Set 2: 4, 5, 6, and Set 3: 7, 8, 9,10. If a correct flashcard was touched that corresponded with the number asked it was placed into a correct pile. If there was no answer or an incorrect touch of a flashcard, then the flash card was placed into an incorrect pile. Each session was recorded on an iPad to use for IOA. The total correct was quantified by adding the number of correct answers from each set in the pile of corrects and then graphed.

2.4 Inter-observer Agreement

Inter-observer agreement was conducted for each session of baseline and intervention. For event recording an Instructional Assistant (IA) reviewed the video to identify which were said correctly in each set. Inter-observer agreement was collected through each data collector scoring independently, one during the event and the other after the session. Mean agreement for event recording was 100% for Set 1, 100% for Set 2, and 100% for Set 3.

2.5 Experimental Design

A multiple baseline (Kazdin, 2011; McLaughlin, 1983) across three sets of numbers was used to evaluate the effects of flashcards on the accuracy of number recognition. Three sessions of baseline were taken for Set 1 (numbers 1,2, and 3), eight sessions of baseline were taken for Set 2 (numbers 4, 5,and 6), and fourteen sessions of baseline were taken for Set 3 (numbers 7, 8, 9, and 10). For intervention set 1 was taken for eleven sessions, Set 2 was taken for thirteen sessions, and Set 3 was taken for eight sessions. A trend was three consecutive sessions with similar accuracy. For Set 1 this trend occurred at 0 correct. Once a trend occurred the first author began intervention for Set 1. Set 2 intervention occurred after Set 1 had shown a trend of three sessions which had reached mastery. Mastery was defined as at least 2 correct in the set. For Set 3, intervention occurred after Set 2 mastery (three consecutive sessions without an error).

2.51 Baseline: During baseline, the participant was shown all the flashcards in the set in random order. The participant was to touch the flashcard that corresponded to the number that the first author asked to the best of his ability. Receptive touch was used because the participant had difficulty processing the question and answering orally. After the participant completed the set, the participant was allowed to go back to free play activities. During baseline, no instruction was given to improve the participants' incorrect answers. Praise was given to the participant at the end of the session for his participation. The number of sessions for baseline for Set 1 was 3 days, 8 days for Set 4, and 14 days for Set 4.

2.52 DI flashcards: DI flashcards were used to help the participant master accuracy of number recognition. The participant was shown two flashcards that contained a numeral (1 through 10) face up on the table and was asked, "where is (number)?" After shown two flashcards, the participant was given 3 seconds to touch a flashcard. If the answer was correct the flashcard was placed in a "correct" pile on the table. If the participant did not correctly touch the flashcard within 3 seconds, or did not answer, the flashcard was moved back into the pile to be presented again. On the next presentation of the flashcard if the participant got the answer correct, the flashcard was placed back into the pile to be presented again for the second time. Once answered correctly after three presentations, then the card was moved into the correct pile. The first authors would review the correct answer with the participant when errors were made.

Flashcards were shuffled between each presentation of the deck. The deck was reviewed 5-6 times per session or until accuracy of all numerals was shown and accuracy had increased. Accuracy was determined by whether or not the first author had to review the answer. Once the participant had shown accuracy of all numerals the participant was shown the flashcards again for an intervention test for that for that set. Intervention test did not have prompts or correction procedures. These procedures were repeated for each set. The number of sessions for DI

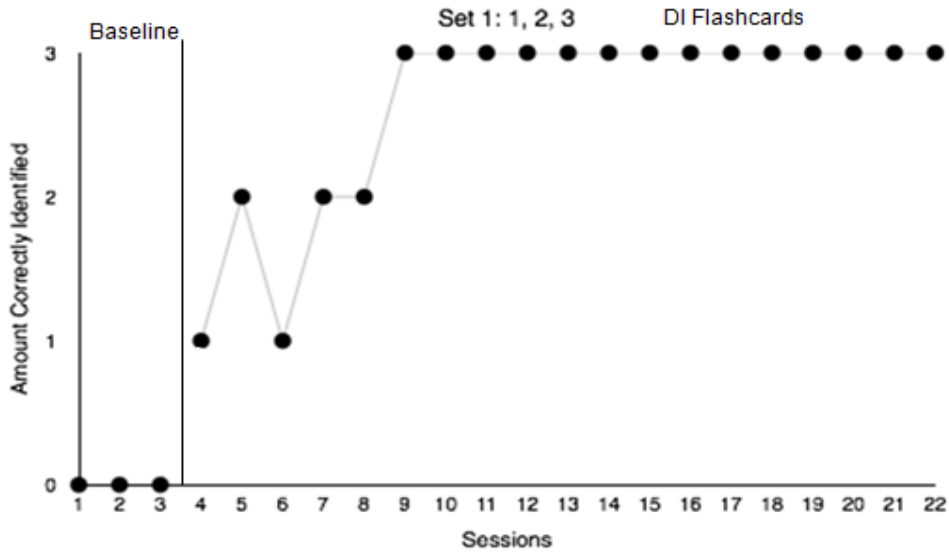

Fig 1: Amount correctly identified in Set 1 with the numbers 1, 2, and 3.

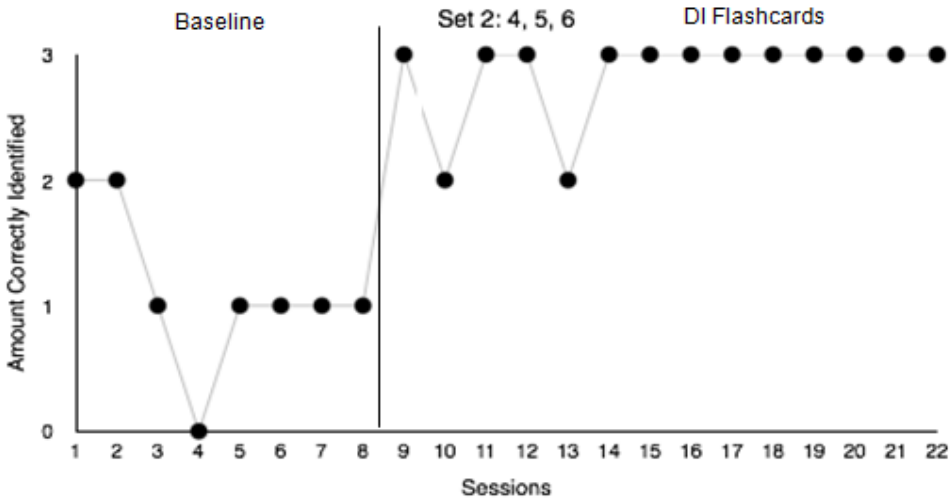

Fig 2: Amount correctly identified in Set 2 with numbers 4, 5, and 6.

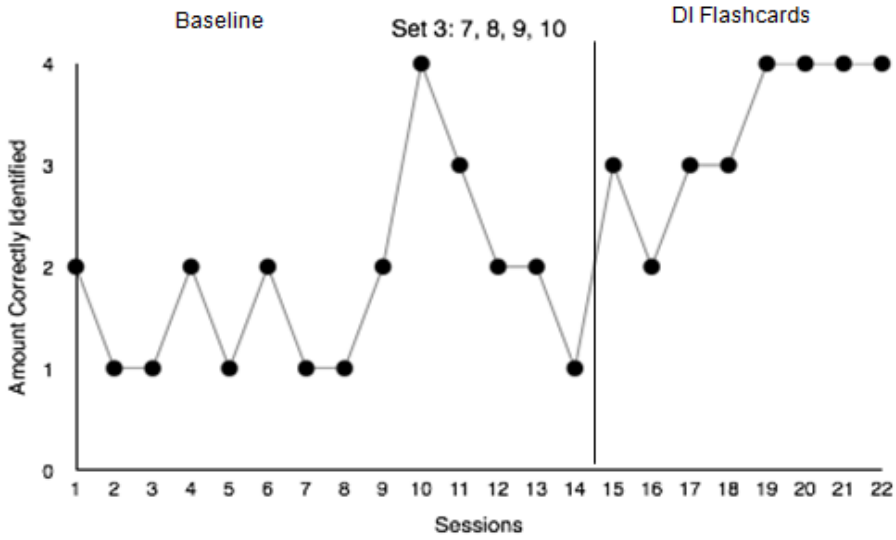

Fig 3: The frequency of numbers correctly identified in Set 3 with numbers 7, 8, 9, and 10.

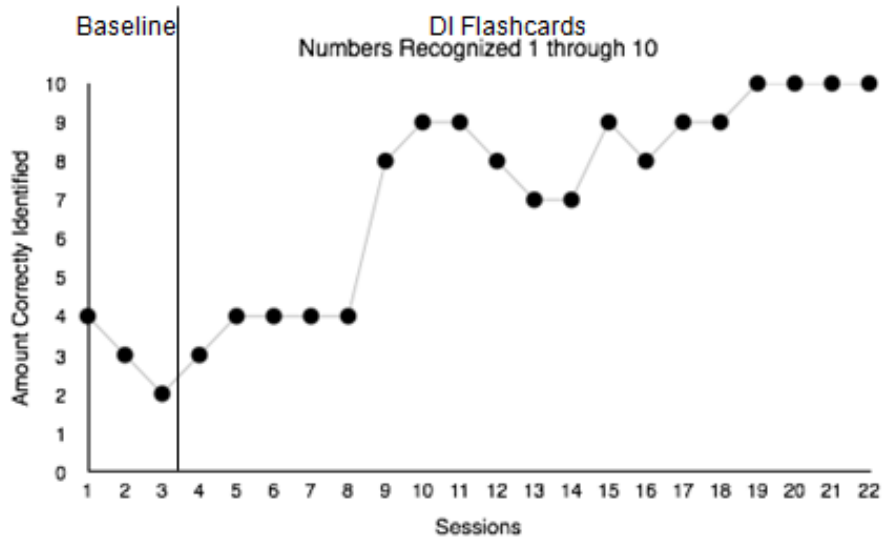

Fig 4: Number of numerals identified across all sets with numbers 1 though 10.

flashcards varied from 8 to 19 sessions. At the end of each session the first author provided our participant with a gummy bear candy for working hard.

3.0 Results

The accuracy for Set 1 during baseline, flashcard intervention, and maintenance is shown in Figure 1.

Accuracy average during baseline was 0 correct (range 0). Accuracy average during intervention was 3 correct (range 1 to 3 numbers).

The accuracy for Set 2 during baseline and flashcard intervention is shown in Figure 2. Accuracy average during baseline was 1.0 correct (range 0 to 2). Accuracy average during intervention was 3.0 (range 2 to 3).

The accuracy for Set 3 during baseline and flashcard intervention is shown in Figure 3. Accuracy average during baseline was 2 correct (range 1 to 4). The mean during intervention for Set 3 was 3.0 correct (range 2 to 4).

The overall accuracy for all 10 numbers can be seen in Figure 4. Over the duration of the study would participant was able to master all 10 numbers. For the last four sessions he was 100% correct for all 10 numbers.

4.0 Discussion

Using the DI flashcard system had a very positive effect on the participant's performance. The participant showed significant increase in accuracy from the first session to the last. The increase in numbers correctly identified showed that the subject gained efficiency with number recognition.

After the fourth session, the participant was directed to touch the flashcard that he thought corresponded to the number that the first author asked. During the first four sessions, the participant had difficultly orally saying the correct number and would guess at the number in order to complete the session faster. Due to his processing difficulties having to process the question asked, identify the number, and saying the number was difficult for the participant. Instead of orally identifying the number the participant was told to receptively touch the number when shown two flashcards in the set. This is how DI flashcards were modified. When told to receptively touch the flashcard, the participant increased the accuracy of numbers correctly identified. Other this instance, performance, development, and motivation remained consistent across all sessions.

The strengths of the study were that the DI flashcard system was an appropriate method for our participant. It was modified to use his preferred form of responding (pointing). The participant was motivated to work on his numbers for a gummy bear treat. He received at the end of the session for working. The participant also seemed to enjoy the one-on-one attention that he received during each session. Generalization occurred outside of the DI flashcard system through daily testing from the teacher, center time, and circle time. This showed that the DI flashcard intervention was successful because the participant was able to generalize number recognition to other areas of the classroom.

The practicality of data collection and evaluation of DI flashcards was quite practical. The only cost of the study was the flashcards for the intervention, which cost 50 cents. The study was easy to administer. After the participant was shown two flashcards, the first author asked the participant "where is (number in set)" then data was recorded. Implementing the intervention consisted of showing the participant the Set 1, 2, and 3 for about 5 minutes.

One of the weaknesses that occurred with the study was the area that the study was being conducted. The first author was not able to leave the classroom due to becoming the teacher during her student teacher program. The classroom had multiple distractions. Other students were loud and were playing during the time the study was being conducted causing the participant to get distracted at times. Finally, the effects of employing a candy reward at the end of each session during DI flashcards was not assessed or evaluated. However, the use of treats were a common feature of the preschool classroom. It was used only to reward effort in this and at other times in the school day for the entire class.

The present outcomes replicate and extend the use of DI flashcard with as well as without modifications (Fitting et al., 2014; Skarr et al., 2012, 2014; Thomas et al., in press). In the present case report number recognition was the behavior of interest. Other reports employing preschool students have employed a wide range of measures ranging from shapes and colors (Herberg et al., 2013; Mangundayo et al., 2014) to letters (Bechtoldt et al., 2014).

The replication of previous research adds confidence and strength for the use of DI flashcards in the schools. Also, a teacher can modify the response of interest and track the changes that occurred using a single case design. Since the present case report was used as part of the edTPA requirement in the State of Washington, more students could not be added to the study. We have changed our university requirements for action research (McLaughlin et al., 1999) due to the additional burdens placed on teacher education candidates by the edTPA requirement (edTPA, 2013).

If we were to be replicated, a quiet area should be considered when conducting the study causing fewer distractions. Adding more numerals for the participant could be beneficial if the study was replicated so that the subject can receive mastery with more numerals. Finally additional students could be assessed.

The authors were very pleased with the outcome of the intervention. They were able to develop a relationship with the subject. The special education teacher and the participant were also excited when mastery was accomplished. The special education teacher plans to continue to work on accuracy of number recognition with the participant.

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