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Zennetta Mann
Gonzaga University

T.F. McLaughlin
Gonzaga University

Randy Lee Williams
Gonzaga University

K. Mark Derby
Gonzaga University

Mary Everson
Spokane Public Schools

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The Effects of Direct Instruction Flashcards and Rewards with Math Facts at School and in the Home: Acquisition and Maintenance

Zennetta Mann, T. F. McLaughlin, Randy Lee Williams, K. Mark Derby,
Department of Special Education, Gonzaga University
Mary Everson, Spokane Public Schools

The purpose of the present study was to evaluate the effects of Direct Instruction (DI) flashcard procedure, combined with strategies and rewards on multiplication fact accuracy of two elementary school-age students. A single subject replication design across three and four sets of multiplication facts was used to evaluate outcomes. The results indicated improvement in math performance for each participant. Follow-up data indicated maintenance of treatment effects over time. Finally, pre and posttest outcomes found generalization to correct writing of math facts for each participant. The benefits of employing DI flashcards in a resource room or home were discussed.

Keywords: flashcards, elementary school, public school, math facts, rewards, DI flashcards, learning disabilities, at-risk students, home, school, parent

The Effects of Direct Instruction Flashcards and Rewards with Math Facts at School and In a Home: Acquisition and Maintenance

Math is extremely important in our culture, and understanding the concepts and strategies of it is highly important in order to be a contributing member of society (Cipani, 1988; McClosky & Macaruso, 1995; Montague, 2007). The comprehension of mathematics demands practice of the subject and realizing the patterns and relationships amongst numbers (Cruikshank, 1992). Today there are about 5 to 8% of students who have memory or other cognitive deficits that interfere with their ability to acquire, apply or master mathematical concepts and skills; using flashcards may help to overcome this challenge (Geary, 2004).

Even minimum wage jobs such as janitorial work, positions in fast food restaurants, and lawn care, use math. Without mastery of basic multiplication facts, students are likely to struggle

during their educational career and experience higher dropout rates then their peers that have mastered basic math facts. Many students lacking mastery may experience difficulty functioning productively in today's global economy (Lerner & Johns, 2008, 2011; Lloyd, 1978). Furthermore, the increased cost of living and instable economy make it difficult to survive on minimum wage due (Thompson, Bourget, & Brown, 2010). An increased knowledge in math could provide better job opportunities, thus allowing individuals to live a more comfortable lifestyle (Greenwood, 1991).

We use math on a daily basis. For example, when going to the grocery store or shopping for clothes people use math addition, subtraction and multiplication when deciding how much they have to spend, how much they are going to spend, and in calculating discounts and taxes. By learning mathematics an individual will be capable of doing that accurately and with confidence (Cipani, 1988).

According to Curico (1999), "learning basic facts is not a prerequisite for solving problems, but learning facts becomes a necessity to solve problems that are meaningful, relevant, and interesting to learners (p. 282). "When schools and students try to get around learning the facts, the results are failure (Curico, 1999). Difficulties in learning math are common in both special educations as well as in general education classes (Garnett, 1998). Basic math skills learned throughout the primary years are critical for students to learn and understand how to complete advanced mathematical concepts (Lerner & Johns, 2011). Students who struggle with the knowledge and understanding of basic facts will easily become frustrated and will most likely give up on doing math assignments altogether. significantly behind in the knowledge of basic mathematical facts can create major dilemmas. First, the students' deficiency could cause them to be at-risk for school failure and increase the possibility of being placed in special education. Second, students who are considered to be at-risk in mathematics, often do not qualify for services, and without intervention academic performances will decrease over time (Greenwood, 1991). Resulting in increased dropout rate (Lloyd, 1978).

There are documented and effective teaching strategies for teaching math skills. One such procedure is the Direct Instruction (DI) flashcard procedure (Silbert, Carnine, & Stein, 1981) was designed for individualized instruction sessions, incorporating systematic review of arithmetic facts combined with the presentation of new facts. Flashcards can help students learn facts faster and more accurately (Treacy, McLaughlin, Derby, & Schlettert, 2012; Van Houten & Rolider, 1989). A stack consisting of a number of flashcards is assembled consisting of both mastered and unmastered facts (Brasch, McLaughlin, & Williams, 2007; Silbert et al., 1981). If a student correctly states the answer to the presented fact within a predetermined time, the fact is placed at the back of the deck. If an error occurs or too much time has elapsed, the teacher models the correct answer, the student and teacher state the fact along with the correct answer, followed by the student stating the fact and the correct answer, finally the word is placed a couple of spaces back in the deck or stack (Silbert et al., 1981). As sets of math facts are mastered, new sets of facts are introduced (Becker,

McLaughlin, & Weber, 2010; Erbey, McLaughlin, Derby, & Everson, 2011; Hayter, Scott, McLaughlin, & Weber, 2007).

In order for students to reach their highest achievement, teachers need to format and systematically teach math (Silbert et al., 1981; Stein, Kinder, Silbert, & Carnine, 1990). DI flashcards "have been found to be effective at facilitating master of basic skills," such as multiplication facts (Brasch et al., 2008; Erbey et al., 2011; Hayter et al., 2007; Treacy et al., 2012). Flash cards work well because the teacher can choose which numbers and facts the student is working with and is not seeking too high or too low of levels (Stein et al., 1990). Implementing and employing flash cards should help overcome many memory or other cognitive deficits that interfere with a student's ability to master mathematical concepts and skills. Furthermore, flashcards can be implemented in almost any setting and teaches specific skills quickly and easily (Becker et al., 2010; Glover, McLaughlin, Derby, & Gower, 2010; Hopewell, McLaughlin, & Derby, 2010; Kaufman, McLaughlin, Derby, & Waco, 2011). Flashcards can also be easily implemented within a classroom with the classroom teacher or other classroom personnel (Kaufman et al., 2011; Ruwe, McLaughlin, Derby, & Johnson, 2011; Treacy et al., 2012).

Implementing academic interventions in the home has also been shown to be effective in teaching such skills as spelling (Stading, Williams, & McLaughlin, 1996), math facts (Stone, McLaughlin, & Derby, 2002), and reading (Owens, Violette, & McLaughlin, 2009). Flashcards have been successfully employed by parents (Brunner et al. 1996; Owen's et al.,), neighbors or family friends (Stone et al., 2002), or by students enrolled in preservice teacher education programs (Brasch et al., 2007; Erbey et al. 2011; Dagdag, McLaughlin, & Weber, 2002; Hayter et al., 2007; Lund et al., in press; Ruwe et al., 2011;). Clearly, being able to employ adults in the home would add to the applicability of such procedures.

The purpose of this study was to help the participants to learn and gain fluency with their multiplication facts. We hypothesized that using DI flashcard procedure would be highly effective in helping the participants gain automicity and mastery. An additional purpose was to examine and assess maintenance using a written posttest. This would allow for generalization (Stokes & Baer, 1977; Stokes & Baer, 2003) from an oral to a written format. The final purpose was to extend and possibly replicate the recent findings with DI flashcards in both math and reading (Bishop et al., 2012, Glover et al., 2010; Hayter et al., 2007; Herberg, McLaughlin, Derby, & Riley, 2012; Kaufman et al., 2011; Lund, McLaughlin, Neyman, & Everson in press; Ruwe et al., 2012) with another group of students in math. Finally, we employed a participant who was not enrolled in a special education classroom, but was receiving instruction in math in the home. We also felt that positive findings would add to the generality of employing DI flashcards (Kazdin, 2010) across skills, students, disability, and settings.

Method

Participants and Settings

There were two participants in this study. Student A was selected by the classroom teacher for participation in this research She needed additional practice with her basic multiplication

facts. Student B was selected by the first author because he had not yet mastered all of his multiplication facts.

Student A was an eleven-year-old girl who was in the fifth grade with multiple disabilities. She was diagnosed as other health impaired (OHI) and attended an elementary school in the Pacific Northwest. She received special education services in a resource room with goals in the areas of reading, writing, and mathematics. Prior to entering elementary school, she received special services for delayed language beginning at the age of 3. A complete evaluation in 2009 from the *Woodcock-Johnson III Test of Achievement* (Woodcock, McGrew, & Mather, 2008) showed her broad math score was first grade fifth month (1.5). When this same test was re-administered in September 2010, she scored at a 1.6 grade level.

Student B was an eight-year-old boy enrolled in the third grade, but did not attend a special education classroom. He was typically developing and only needed help with his automicity and knowledge in some of his multiplication facts. When first author conducted a *Woodcock-Johnson III Test of Achievement in* September 2010, he scored at a 5.2 grade equivalent in broad math.

Setting for student A. The study took place in a resource room at a public elementary school in the Pacific Northwest. The instruction in the resource room focused on a variety of areas including reading, math, and social skills. The students, who came into the resource room, usually attended general education classes most or part of the school day. They usually came to the resource room for about a half hour to close to two hours, depending on the needs of the individual child. On a typical day there would be two to ten students, second through sixth grade, and two adults (master teacher and an instructional aide). The instructional aide usually taught the second and fourth grade students. The study took place in the afternoon from 1:00 p.m. to 1:40 p.m. when the first participant would come in for reading and writing. Each session would last 10 to 20 minutes.

Setting for student B. The study took place at his home in the living room area. Data were gathered before, after school, and on weekends whenever possible. Each session would last approximately 10 minutes. On some occasions, two sessions would occur before and then after school.

Materials

Materials needed for this study were pre- and posttests consisting of 81 multiplication facts excluding zeros (for Student A), pre- and posttests consisting of 100 multiplication facts including zeros (for Student B). From pretesting, four sets of flashcards with designated multiplication facts (for Student A), three sets of flashcards with designated multiplication facts (for Student B) were made. Two master data collection sheets to record the results of each session for each participant, and an iPhone were used as a timer to accurately time the pre and posttests. Chap Stick, Halloween erasers, and a small digital recorder were used as rewards for Student A. A Fred Myer gift card was used as a possible reward for Student B.

Dependent Variables and Measurement

Two dependent variables were measured in this study. The first dependent variable was the number of correct multiplication facts. For Student

A, correct answers were defined as responses that accurately stated the answer within 3s after presentation of a flashcard. If the student immediately self-corrected prior to three seconds, this was also scored as a correct. For Student B correct answers were defined as vocal response that accurately stated the answer within 2s. However, if he self-corrected prior to two seconds, this was scored as a correct. An example of a correct answer was when the when the first author presented the fact on the card such as "8 x 2" the participants would have to say "16" within the allotted time. The second dependent variable was the number of errors. An error was defined as not answering within the allotted time, three seconds for Student A and two seconds for Student B, or stating incorrect answer within the allotted time.

Data Collection

The first author completed data collection. If the answer was correct it would be placed in a pile to the right and if the card was answered in error, it would be placed in a pile to the left. At the end of each session the first author would count the cards in the deck on the right and left and record the number correct and incorrect on the data sheet. (Appendix A).

Experimental Design and Conditions

A multiple baseline design (Kazdin, 2010) across sets of multiplication facts for Student A and across three sets of multiplication facts for Student B was employed. Set 1 for Student A consisted of all the twos and seven facts for a total of 18 cards. Set 2 consisted of all the threes and fives with the exception of the facts in the first set (3x2, 3x7, 5x2, 5x7) for a total of 13 cards. Set 3 consisted of all the fours and sixes facts with the exception of the facts which were in the first two sets (4x2, 4x3, 4x5, 4x7, 6x2, 6x3, 6x5, 6x7) for a total of nine cards. Set 4 consisted of all the eights and nines with the exception of the facts which were in the first three sets (8x2, 8x3, 8x4, 8x5, 8x6, 8x7, 9x2, 9x3, 9x4, 9x5, 9x6, 9x7) for a total of five cards in the set. Set 1 for Student B consisted of all the fives and eights facts with a total of 17 cards. Set 2 consisted of all the threes and sevens facts with the exception of the facts which were in the first set (3x5, 3x8, 7x5, 7x8) with a total of 13 cards. Set 3 consisted of all the fours, sixes, and nines facts with the exception of those in the first two sets (4x4, 4x8, 4x3, 4x7, 6x5, 6x8, 6x3, 6x7, 9x5, 9x8, 9x3, 9x7) for a total of 12 cards. Once skill sets were determined baseline was completed across all sets of flashcards for both participants. After establishing baseline the flashcard system was used to teach the sets of multiplication facts. Implementation of the Direct Instruction Flashcard procedure for sets two, three, and four did not take place for Student A because he failed to master the facts in Set 1. Implementation of the DI flashcard procedure took place on Set 2 when mastery occurred on Set 1. Once mastery was achieved on Set 2 DI flashcards were implemented with Set 3 for Student B.

Data collection and implementing the intervention took from 10 to 20 minutes for both participants. If time permitted two separate sessions occurred with Student A on the same day and four separate sessions occurred with Student B on the same day (two sessions in the morning and two sessions after school). The participants were given a duplicate set of flashcards to use at home to practice as the procedure had

been implemented for each set of flashcards.

Pre- and posttests. Both students were informed they were going to be given a pretest in order to determine what skills to teach. At the end of the study a posttest using the same content was given to determine their current skill level. Prior to implementing training a five-minute-timed multiplication test consisting of 81 facts excluding the zeros facts was given to Student A and a five-minute-timed multiplication test consisting of 100 facts including the zeros facts for Student B. The participants were given five minutes to complete as many facts as they could for each pre and posttest and were told they could skip any problems they did not know.

Baseline. The first author presented all four sets of flashcards to Student A and all three sets of flashcards to Student B. No feedback was provided to either participant in baseline. For Student A, baseline was taken for three consecutive sessions with Set 1, 28 consecutive sessions for Set 2, 28 consecutive sessions for Set 3, and 28 consecutive sessions for Set 4. For Student B baseline was taken for three consecutive sessions with Set 1, 18 consecutive sessions for Set 2, and 25 consecutive sessions for Set 3. All flashcards were shuffled in their respective sets for both students.

Direct instruction flashcards + rewards. After the initial training day, each session began with the participants being reminded. The methods used to teach the participants to determine the answer to the facts were association of numbers and various finger strategies, such as placing a finger down while counting by the given number within the multiplication fact (e.g. counting by 2's 7 times to get the answer of 14), and one for figuring out 9's facts (Student B only). For learning the 9's facts, Student B was told to hold his hands with his palms down on the table. Once the participant had his hands correctly placed the first author explained each finger represented a number from 1 to 10, starting with his left-hand pinky (1) and ending with his right-hand pinky (10). After Student B understood which digit represented which number, the first author orally stated a 9's fact, for example 9 x 3. After the fact was presented, Student B was instructed to bend his third finger. The first author then had the participant count the number of fingers before the third, and then the number of fingers after. The first author explained how the fingers before the third finger represented the number of tens in the answer, and the number of fingers after the third finger represented the number of ones in the answer. After Student B stated the number of tens and the number of ones being represented, the first author stated the fact and the answer to the fact so that Student B could compare the answer given to the placement of his fingers. Several examples were given to Student B to ensure he understood the strategy for 9's facts.

When utilizing the flashcards, the first author orally stated the multiplication fact to the participants. If the participants were unable to answer, gave an incorrect answer, or answered correctly but not within the given time frame (three seconds for Student A and two seconds for Student B), the first author stated the fact and modeled the answer to the participants. Next, the first author had the participants say the fact and the answer to the fact. The card was then placed behind two or three cards

stack until they were able to correctly state the answer three consecutive times. Mastery was never shown for two consecutive sessions for Student A's first set of multiplication facts. When mastery was shown for two consecutive sessions for Student B, the intervention was then implemented for Set 2. After mastery with Set 2, Set 3 was taught using the DI flashcard procedure.

Rewards were provided to the students at the beginning of the study for their participation. Both participants were also told they would receive the reward at the end of the study. Near the middle of the study the first author told Student A, she could earn a reward if she showed she show mastery for 10 cards in Set 1. Student A met the first authors' challenge and the reward was given. Approximately two weeks later Student A was challenged a second time by the first author. She was told if she had mastered at least 15 of the 18 facts for Set 2, she would be given another reward. Student A met the second challenge. Student A was told if she mastered Set 1 within a week, she could receive another reward. She failed to reach this criterion. Student A did not know what the rewards were going to be until she received them after she had met each challenge, or until the end of the study. The first author did not challenge Student B through the study and he did not know what the reward was going to be until the end of the study.

Follow up

For Student A, follow-up was conducted for Set 1 after a week and a half break and was gathered for six consecutive sessions. For Student B, a follow-up was conducted for all sets. Just as in baseline, no feedback was given to either participant. The number of sessions for follow up was six sessions.

Interobserver Agreement

Interobserver agreement data were collected having a secondary observer independently record data approximately one out of every four sessions for 25% of the total number of times for Student A and 30% of the total number of times for Student B. The secondary observer independently determined the number of correct and incorrect responses on a separate data collection sheet. This was an exact copy of the form used by the first author. For the interobserver agreement for Student A the interobserver listened to a digital recording of the first author stating the multiplication facts and Student A answering them. Tally marks were made in the correct session under the correct or incorrect columns on the final data sheet as the students answered. For the interobserver agreement for Student B the interobserver sat next to the first author and collected data during the session by making tally marks on the data collection sheet as answers to the flashcards were stated by the participant. Tally marks would be made in the correct session under the correct or incorrect columns on the final data sheet. For both participants the data were later compared to determine reliability of measurement. This was calculated by comparing the number of correct responses and errors for each session and student. The number of agreements was divided by the number of agreements plus disagreements and multiplied by 100. An agreement was defined as each observer recording the answer in the same manner. Any deviation in scoring

was defined as a disagreement. The mean agreement for Student A was 99.4% (range 96% to 100%). The mean agreement for Student B was 95.6% (range 80.7% to 100%).

Results

Pre- and Posttest Outcomes Student A and B

The outcomes for Student A can be seen in Figures 1 and 3 and for Student B in Figures 2 and 4. Pretest results for Student A indicated 19 correct and 62 incorrect. Errors occurred across a full range of multiplication facts including 1s to 9s. The posttest results for Student A were 39 correct with 42 errors when combined with unanswered facts. Pretest results for Student B were 55 correct with 45 errors. Errors occurred across a full range of multiplication facts including 1's to 9s. The posttest results for Student B increased to 81 correct with 19 errors.

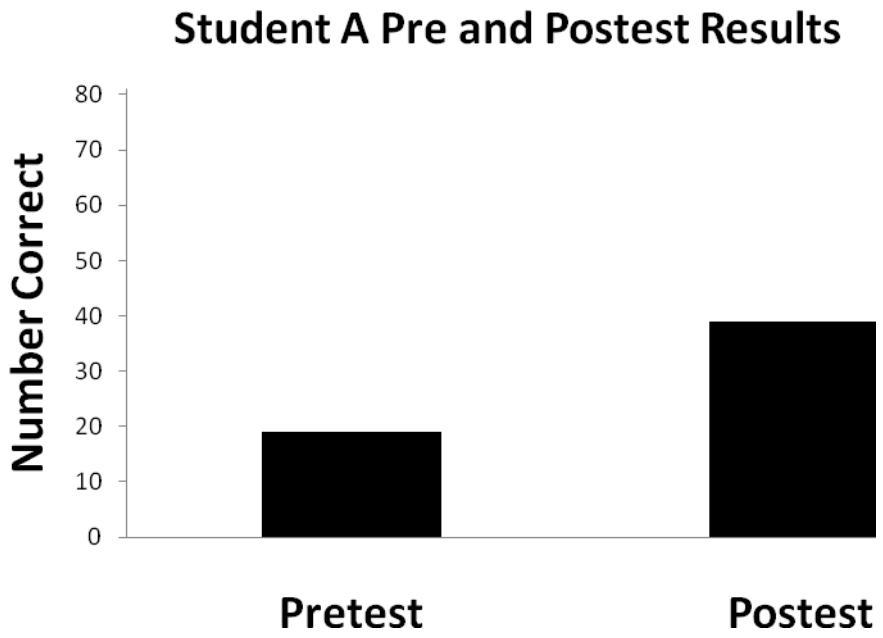


Figure 1

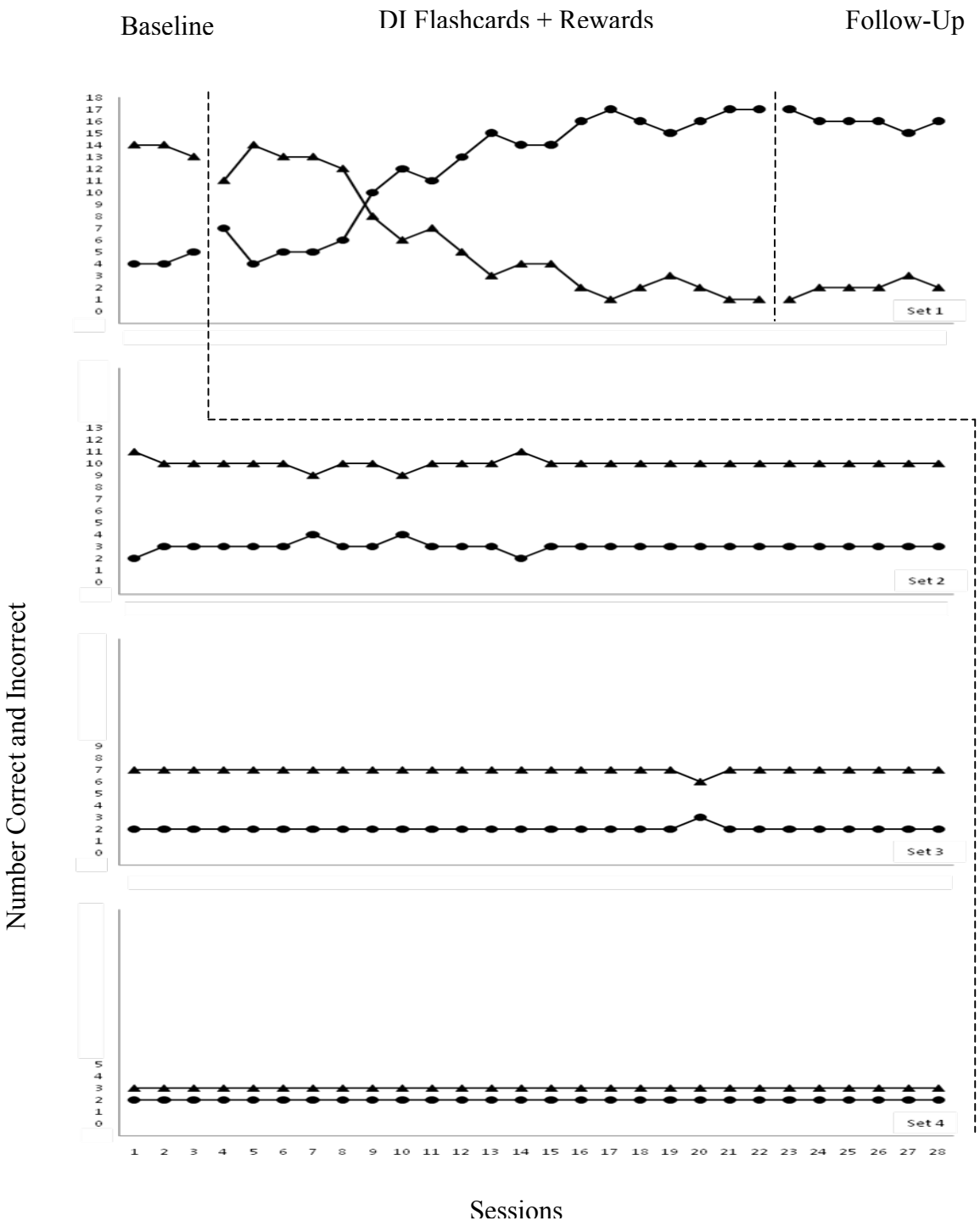

Baseline
DI Flashcards + Rewards
Follow-Up
Set 1
Set 2
Set 3
Set 4
Number Correct and Incorrect
Sessions

Figure 2

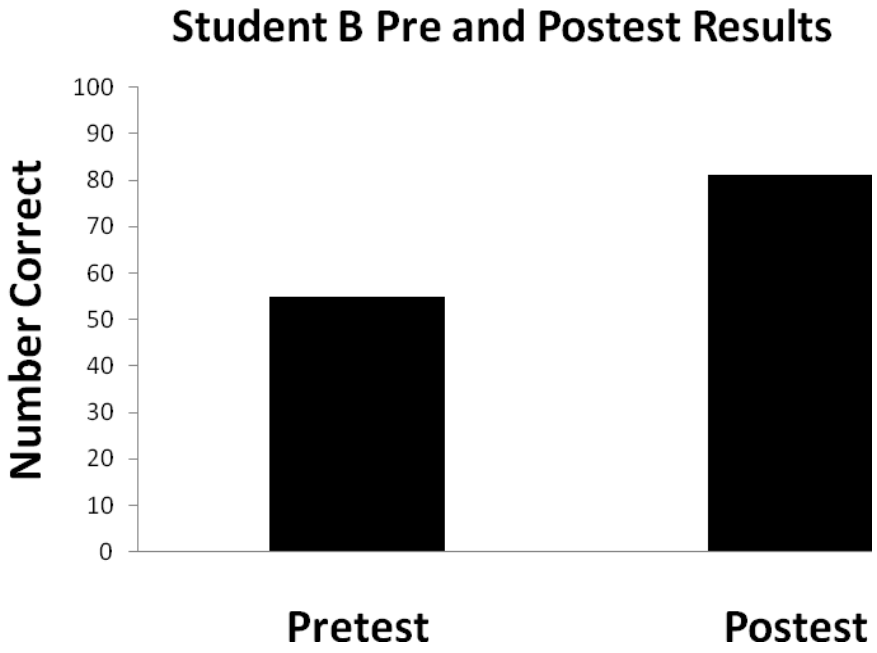
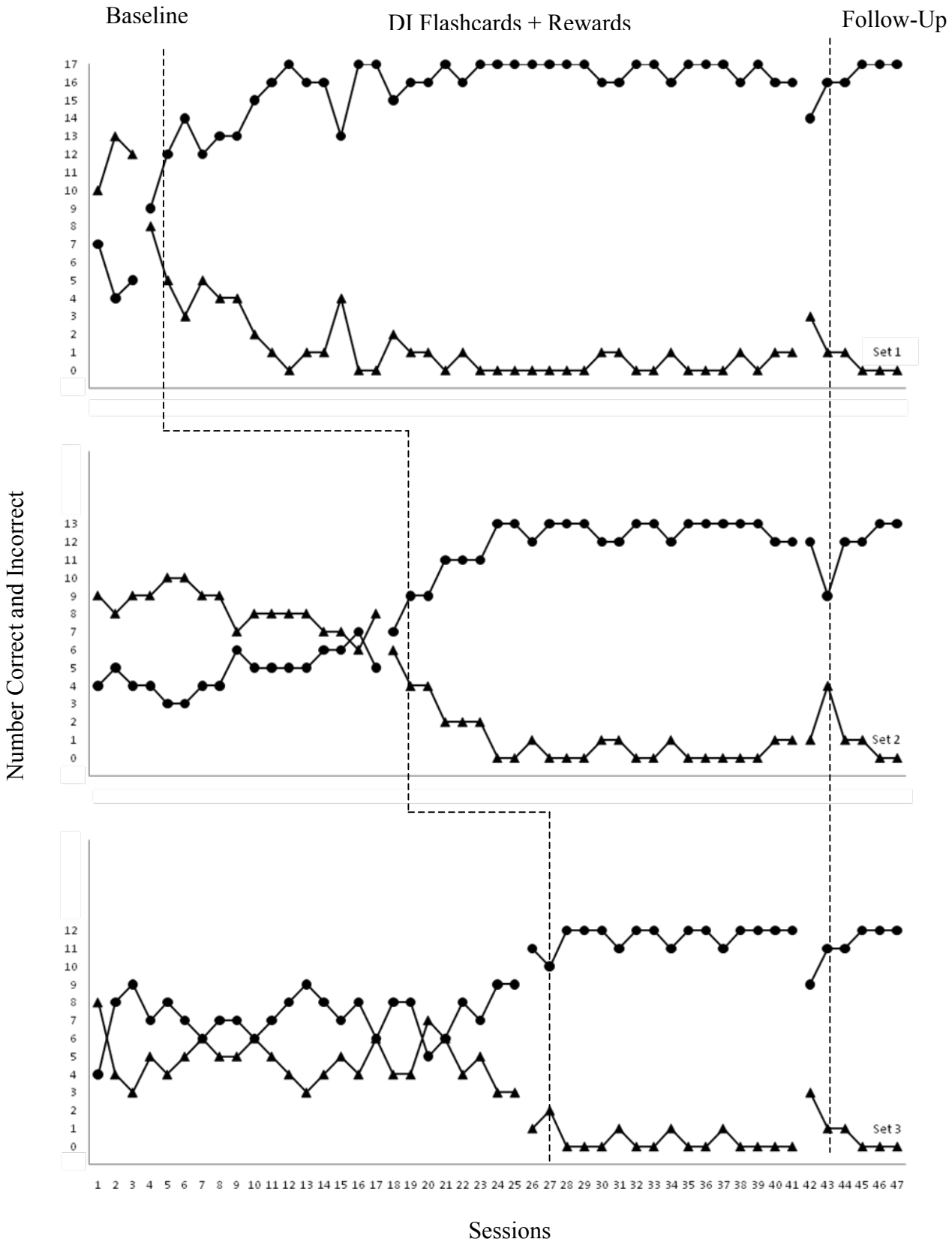

Student B Pre and Postest Results
Number Correct
100
90
80
70
60
50
40
30
20
10
0
Pretest
Postest

Figure 3


Baseline
DI Flashcards + Rewards
Follow-Up
Set 1
Set 2
Set 3
Number Correct and Incorrect
Sessions

Student: _____ Primary Observer: _____

Secondary Observer: _____

Definitions:

Corrects:
Accurately stating multiplication fact within 3 seconds
Immediately self-corrects within 3 seconds

Errors:
Does not state the product to the given multiplication fact within 3 seconds
States the wrong product and does not self-correct within 3 seconds

Session #	Date	Condition	IOA (Y/N)	Set 1 (7's & 2's)		Set 2 (5's & 3's)		Set 3 (6's & 4's)		Set 4 (8's & 9's)	
				C	I	C	I	C	I	C	I
1		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
2		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
3		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
4		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
5		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
6		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
7		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
8		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
9		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
10		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
11		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
12		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
13		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
14		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
15		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
16		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
17		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
18		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
19		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								

20		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
21		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
22		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
23		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
24		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
25		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
26		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
27		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
28		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
29		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
30		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
31		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
32		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
33		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
34		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
35		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
36		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
37		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
38		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
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41		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
42		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
43		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
44		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
45		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
46		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
47		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
48		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								

49		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
50		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
51		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
52		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
53		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
54		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
55		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
56		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
57		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
58		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
59		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
60		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
61		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
62		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
63		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
64		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
65		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
66		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
67		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
68		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
69		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
70		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
71		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
72		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
73		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
74		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								
75		$B_1B_2B_3B_4$ $D_1D_2D_3D_4$	Y/N								

Baseline Students A and B

During baseline correct responses for Student A for Set 1 were low (*M* = 4.3 range 4 to 5 correct). Errors for Set 1 averaged 13.67 with a range of 13 to 14. For Set 2 baseline corrects were low (*M* = 2.67 with a range of 2 to 3) and remained so over time. Errors for Set 2 with Student A averaged 10 with a range of 9 to 11. Baseline for Student A for Set 3 averaged 2.03 (range 2 to 3) for corrects and 6.96 for errors (range 6 to 7 errors). For Set 4 with Student A, he averaged just 2 correct and 3 errors for all sessions.

Student B baseline for corrects for Set 1 averaged 5.33 with a range of 4 to 7. Errors averaged 17.47 with a range of 10 to 13. The mean for corrects with Set 2 was 5.61 with a range of 3 to 7 in baseline. The errors averaged 8 with a range of 6 to 10 with Set 2. The mean number of corrects for baseline in Set 3 was 8.76 with a range of 4 to 9. Errors averaged 4.25 with a range of 3 to 8 in baseline for Set 4 with Student B.

DI Flashcards + Rewards Students A and B

Increased performance for correct responses was found for both participants when DI flashcards and rewards were employed. For student A with Set 1, his correct responses increased (*M* = 16.67 with a range of 11 to 14). Errors declined to an average of 1.25 with a range of 0 to 8). Student A remained in intervention with Set A for the duration of data collection.

For Student B, increases in corrects were found with Set 1, (*M* = 16; range 14 to 17 corrects). His errors decreased (*M* = 1.25; range 0 to 8 errors). For Set 2, corrects improved to an average of 11.91 with a range of 7 to 13 correct problems. Likewise, his errors decreased (*M* = 1.08; range 0 to 6 errors). For Set 3, the number of corrects increased to 11.62 with a range of 10 to 12. Errors decreased (*M* = .38; range 0 to 2 errors) for Set 3.

Follow Up Students A and B

Follow up data were gathered for each participant. For Student A, on Set 1 corrects, maintenance was found (*M* = 16; range 14 to 17). Her errors remained low for Set 1, (*M* = .56; range 0 to 3). No maintenance data were gathered for Sets 2 through 4. For Student B, maintenance of treatment effects was found for corrects and for errors across all three sets. The mean number of corrects during follow up was 16.67 with a range of 14-17. Errors remained low for Set 1 (*M* = .56; range 0 to 3 errors). With Set 2, corrects averaged 12.11 with a range of 9 to 13. Errors remained low (*M* = .01; range 0 to 4). With Set 3, corrects for Student B averaged 11.44 with a range of 9 to 12. Errors were also low (*M* = .56; range 0 to 3) during follow up.

Discussion

The use of the DI flashcard procedure was found to be somewhat successful for both participants. Student B was able to master more math facts than Student A. The flashcards procedures were relatively inexpensive to purchase, make and implement. This procedure increased the number of correct responses of multiplication facts for both participants and reduced errors.

Follow up data collection found maintenance of treatment effects. This finding was different across participants. Both students displayed maintenance with Set 1. Student B also maintained his performance for Sets 2 and 3. We

felt that having two consecutive sessions with mastery before we changed set, would have allowed both students enough opportunities to learn their facts. This was true for Student B, but not the case for Student A. The lack of progress by Student A needs further analysis and study.

When the first author began working with Student A, she was hesitant about attempting to answer the multiplication facts, and became anxious or upset when a fact was answered incorrectly. She was also frequently distracted by her surroundings. After implementing the DI flashcard procedure, Student A was more confident when stating her answers to her multiplication facts. By the end of the study, Student A did not appear to be as anxious, and did not get upset when she made an error. Throughout the study, Student As' confidence, speed and knowledge in her multiplication facts increased. Also, Student B would become frustrated when he answered a fact correctly but not within the allotted time. His frustration levels became low by the end of the study when he was able to say the answer to facts more fluently.

A weakness the first author observed with the implementation of the procedure, was the number of distractions within the classroom setting for Student A. These included noise levels, other students and teachers coming in and out of the classroom. Finally, Student A was never able to progress from Set 1 to other sets. Maybe employing an additional drill and practice procedure such as a math racetrack (Beveridge, Weber, Derby, & McLaughlin, 2005) would have been helpful. For Student B, distractions within the home setting involved such things as a dog barking or his sibling making noise.

The procedures were practical to implement. The first author did not have to spend a large amount of time with the procedures and each session took only between 10 to 20 minutes to carry out each session. The procedures were comparatively inexpensive and had been a technique that the first author had employed in other course work in special education. She had previously used with younger participants in learning their core words, and an older participant in learning his multiplication facts. Data collection and instruction could be completed with little effort. The cost for both students was around $35.00 with a majority of the cost being rewards for the two participants.

The teacher and her assistant were pleased with Student As' progress in learning her math facts. When time permitted, the first author would check in with the classroom teacher and her teaching assistant regarding progress for Student A. This was done to ensure material and procedures were appropriate.

The procedures in this study could easily be implemented within the classroom by pairing up students to be peer tutors, taking less instructional time by teachers, and allowing the teacher more time to help those students who are not as advanced in multiplication facts. By doing this, the entire class could make this procedure part of their daily routine. One student could be the tutor and present the facts while the other student would be the tutee and state the answers to the facts. Students could be taught how to properly take data so that they could keep a record of their progress for themselves and for the classroom teacher.

The present outcomes provide an additional replication and extension of employing DI flashcards in the classroom and now in the home. The present outcomes replicate our prior work in math (Brasch et al. 2008; Kaufman et al., 2011; Lund et al., in press; Hayter et al. 2007; Treacy et al., 2012) or improving sight word vocabulary (Erbey et al., 2011; Ruwe et al., 2011). In the present research we were able to successfully implement DI flashcards in the home.

The maintenance of treatment effects for both students was an interesting outcome. We were able to assess and obtain maintenance of treatment effects for both participants. Also, we were able to see generalization (Stokes & Baer, 1977) from an oral format to a written format with both students. These changes were more pronounced for Student B than for Student A. The exact parameters for obtaining such generalization merit further study and analysis. Was it the high criteria of two consecutive sessions at mastery for changing sets or was it the number of opportunities provided for our students to practice and improve their skills in math? This will have to be examined in future research.

References

Becker, A., McLaughlin, T. F., Weber, K. P., & Gower, J. (2009). The effects of copy, cover, and compare with and without error drill on multiplication fact fluency and accuracy. *Electronic Journal of Research in Educational Psychology, 18,* 747-760. Retrieved from http://www.investigacion-psicopedagogica.org/revista/new/english/anteriores.php

Beveridge, B., Weber, K. P., Derby, K. M., & McLaughlin, T. F. (2005). The effects of a math racetrack with two elementary students with learning disabilities. *International Journal of Special Education, 20*(2), 58-65. Retrieved from http://www.internationaljournalofspecialeducation.com/

Bishop, L., McLaughlin, T. F., & Derby, K. M. (2011). A comparison of direct instruction flashcards and reading racetracks on the acquisition and generalization of core words in context for a seven-year-old elementary student with health impairments, learning delays, and behavioral concerns. *International Journal of Social Science and Education, 1*(4), 525-539. Retrieved from: http://advasol.net/?q=node/19

Brasch, T., Williams, R., & McLaughlin, T. F. (2008). The effects of a Direct Instruction flashcard system on multiplication fact mastery by two high school students with ADHD and ODD. *Child & Family Behavior Therapy, 30*(1*)*, 51-59.

Cipani, E. (1988). *Transitioning exceptional children and youth in the community: Research and practice*. New York: Haworth Press.

Cruikshank, D. E. (1992). *Teaching and learning elementary and middle school mathematics* (2nd ed.). New York: Macmillan Publishing Company.

Curico, F. R. (1999). Dispelling myths about reform in mathematics. *Mathematics: Teaching in the Middle School*, *4*, 282-284.

Dagdag, R., McLaughlin, T. F., & Weber K. P. (2002). The use and evaluation of a sound out or error only sound out procedure on the spelling performance of a third grade student. *International Journal of Special Education, 17*(2), 92-98. Retrieved from http://www.internationaljournalofspecialeducation.com/

Erbey, R., McLaughlin, T. F., Derby, K. M., & Everson, M. (2011). The effects of using flashcards with reading racetrack to teach letter sounds, sight words, and math facts to elementary students with learning disabilities. *International Electronic Journal of Elementary Education, 3*(3), 213-226. Retrieved from: http://www.iejee.com/index.html

Garnett, K. (1998). Math learning disabilities. Learning Disabilities Journal of CEC. Reprinted by Learning Disabilities Online: LD In-Depth. Retrieved November 25, 2010, http://www.ldonline.org/ld_indepth/math_skills/garnett.html.

Geary, D. C. (2004). Mathematics and learning disabilities. *Journal of Learning Disabilities, 37*, 2-4.

Green, C., McLaughlin, T. F., Derby, K. M., & Lee, K. (2010). Using reading racetracks and flashcards to teach sight words to students with disabilities: Effects for acquisition and response maintenance. *Journal of Educational Research: JER, 13*(2), 84-98. Retrieved from: http://www.iub.edu.pk/jer/previous_issue.html

Glover, P., McLaughlin, T. F., Derby, K. M., & Gower, J. (2010). Using a direct instruction flashcard system employing a back three contingency for errors with two students with learning disabilities. *Electronic Journal of Research in Educational Psychology, 8,* 457-482. Retrieved from http://www.investigacion-psicopedagogica.org/revista/new/english/anteriores.php

Greenwood, C. R. (1991). Classwide peer tutoring: Longitudinal effects on the reading, language, and mathematics achievement of at-risk students. *Reading and Writing Quarterly, 7*, 105-123.

Hayter, S., Scott, E., McLaughlin, T. F., & Weber, K. P. (2007). The use of a modified direct instruction flashcard system with two high school students with developmental disabilities. *Journal of Physical and Developmental Disabilities, 19,* 409-415.

Herberg, K., McLaughlin, T. F., Derby, K. M., & Gilbert, V. (2011). The effects of direct instruction flashcards on shape recognition and recall for two preschool students with disabilities. *Academic Research International, 1*(3), 55-59. Retrieved from: http://174.36.46.112/~savaporg/journals/issue.html

Kaufman, L., McLaughlin, T. F., Derby, K. M., & Waco, T. (2011). Employing reading racetracks and DI flashcards with and without cover, copy, and compare and rewards to teach of sight words to three students with learning disabilities in reading. *Educational Research Quarterly*, *34,* 24-44.

Kazdin, A. E., (2010). *Single case research designs: Methods for clinical and applied settings* (2nd ed). New York: Oxford University Press.

Lerner, J., & Johns, B. (2008). *Learning disabilities and related mild disabilities: Characteristics, teaching strategies, and new directions.* Boston: Houghton Mifflin Co.

Lerner, J., & Johns, B. (2011) *Learning disabilities and related mild disabilities: Characteristics, teaching strategies, and new directions.* Boston: Houghton Mifflin Co.

Lloyd, D. N. (1978). Prediction of school failure from third-grade data. *Educational and Psychological Measurement, 38*, 1193-1200.

Lund, K., McLaughlin, T. F., Neyman, J., & Everson, M. (in press). The effects of DI flashcards and math racetrack on multiplication facts for two elementary students with learning disabilities. J*ournal of Special Education Apprenticeship, 1*(1). Retrieved from: http://josea.info/index.php?page=archives.

McClosky, M., & Macaruso, P.(1995).Representing and using numerical information. *American Psychologist, 50*, 351–363.

Montague, M. (2006). *Teaching mathematics to middle school students with learning disabilities*. New York: The Guilford Press.

Owens, A., Violette, A., Weber, K. P., & McLaughlin, T. F. (2009). The effects of using direct instruction curricula in the home to teach reading comprehension to a 12-year-old student with cerebral palsy. *The Open Families Studies Journal, 2,* 9-14. Retrieved from: http://www.benthamscience.com/open/tofamsj/

Ruwe, K., McLaughlin, T. F., Derby, K. M., & Johnson, K. (2011). The multiple effects of direct instruction flashcards on sight word acquisition, passage reading, and errors for three middle school students with intellectual disabilities. *Journal of Developmental and Physical Disabilities, 23,* 241-255.

Silbert, J., Carnine, D. W., & Stein, M. (1981*). Direct instruction mathematics*. Columbus, OH: Charles E. Merrill.

Skarr, A., McLaughlin, T. F., Derby, K. M., Meade, K., & Williams, R. L. (in press). A comparison of direct instruction flashcards and cover, copy compare to teach spelling to elementary school students. *Academic Research International, 2*(2). Retrieved from: http://174.36.46.112/~savaporg/journals/issue.html

Sobel, M. A. (1999). *Teaching mathematics* (3rd ed.). Needham Heights, MA: A Viacom Company.

Stading, M., Williams, R. L., & McLaughlin, T. F. (1996). Effects of a copy, cover, and compare procedure on multiplication facts mastery with a third grade girl with learning disabilities in a home setting. *Education and Treatment of Children, 19*, 425-434.

Standish, K., McLaughlin, T. F., & Neyman, J. (in press). The effects of direct instruction flashcards and math racetrack on math facts with one elementary student. *Academic Research International, 2*(2). Retrieved from: http://174.36.46.112/~savaporg/journals/issue.html

Stein, M., Kinder, D., Silber, J., & Carnine, D. W. (2006). *Designing effective mathematics instruction: A Direct Instruction approach* (4th ed.).

Upper Saddle River, NJ: Pearson Education, Inc.

Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*, 349-367.

Stokes, T. F., & Baer, D. M. (2003). Mediated generalization: An unfinished portrait. In K. S. Budd & T Stokes (Eds.), *A small matter of proof: The legacy of Donald M. Baer* (pp. 125-138). Reno, NV: Context Press.

Stone, S., McLaughlin, T. F., & Weber, K. P. (2002). The use and evaluation of copy, cover, and compare with rewards and a flash cards procedure with rewards on division math facts mastery with a fourth grade girl in a home setting. *International Journal of Special Education, 17*(2), 82-91. Retrieved from http://www.internationaljournalofspecialeducation.com/

Thompson, C. J., Bourget, E. M., & Brown, H. Q. (2010). Improving welfare employability: Exploring factors for predicting employment of welfare in transition participants. *The Journal of Workforce Development*, *6*(1), 1-9.

Treacy, R., McLaughlin, T. F., Derby, K. M. & Schlettert, E. (2012). The effects of flashcards and student selected reinforcers with goals and additional practice with multiplication facts for two intermediate elementary students with behavior disorders. *Academic Research International, 2*(1), 469-476. Retrieved from: http://174.36.46.112/~savaporg/journals/issue.html

Van Houten, R., & Rolider, A. (1989). An analysis of several variables influencing the efficiency of flash card instruction. *Journal of Applied Behavior Analysis, 22,* 111-118.

Woodcock, R. W., McGrew, W. S., & Mather, N. (2008) *Woodcock Johnson Tests of Achievement (WJ III)*. Rolling Meadows, IL: Riverside Publishing Company.

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