THE GRADUAL AND DIFFERENTIAL EFFECTS OF DIRECT INSTRUCTION FLASHCARDS WITH AND WITHOUT A DRH CONTINGENCY ON BASIC MULTIPLICATION FACTS FOR TWO STUDENTS WITH SEVERE BEHAVIORS DISORDERS

By

KEVIN D. PIERCE * T. F. MCLAUGHLIN ** J. NEYMAN *** K. KING ****

** B. Ed, Department of Special Education, Gonzaga University.*
*** Ph. D, Professor, Department of Special Education, Gonzaga University, Spokane.*
**** Lecturer, Department of Special Education, Gonzaga University, Spokane.*
***** M. Ed, Gonzaga University.*

ABSTRACT

The purpose of the present research was to evaluate the efficacy of DI flashcards on the math performance of two students with behavior disorders. The number of correct digits per minute was assessed. The outcomes indicated the DI flashcards were somewhat effective in improving the number of math facts that each participant could correctly write. When the participants earned additional rewards for increasing their performance (DRH) over that of the previous session, additional increases in digits per correct per minute were found. The use of DI flashcards with and without a DRH procedure was discussed.

Keywords: Behavior Disorders, Math Facts, Multiplication Facts, Elementary School Students, Academic Interventions, DRH.

INTRODUCTION

Math is one of the most important skills that a student can possess throughout and beyond their educational career (Stein, Kinder, Silbert, & Carnine, 2006). Since such a high priority has been place on math in our society, it is important to have a strong skill set and knowledge over those facts early in the elementary school (Cipani, 1988; McClosky & Macaruso, 1995). Not only are math facts important, but also knowing basic multiplication facts are a skill that is necessary to being successful in the transition to middle and high school. Math seems to be the one subject that continues to decline and is affecting students of all ages. Finally, low performance in math is linked to dropping out of high school and all the issues that brings (Lloyd, 1978).

One particular population of students who struggle with math is students with behavioral disorders. These students who have behavior issues are often also at risk for difficult classroom learning (Kauffman & Landrum, 2009; Nelson, Benner, Lane, & Smith, 2004). These students are also at risk of lower grade point averages and dropping out as they get into high school. The one academic area that seems to provide behaviors students with the highest level of deficiencies is mathematics (Kauffman & Landrum, 2009; Lerner & Johns, 2008, 2011). Without the basic skills these students have a more difficult time building upon a foundation and achievement of mastery is rare (Erbey, McLaughlin, Derby, & Everson 2011).

The goal for this population of students is to provide the most comprehensive and effects forms of intervention to improve these basic skills and help them to avoid failure and drop out. One effective researched based intervention is the use of Direct Instruction (DI) Flashcards. DI flashcards are a systematic, effective mode of instruction for increasing a student's skill set across multiple academic areas, including reading (Hopewell, McLaughlin & Derby, 2011; Kaufman, McLaughlin, Derby, & Waco, 2011; Ruwe, McLaughlin, Derby, & Johnson, 2011) and math (Brasch, Williams, & McLaughlin, 2008; Lund, McLaughlin, Neyman, & Everson, 2012). Brasch et al. used DI flashcards to teach math facts to two high school students were severe behavior disorders. The DI flashcard procedure requires

that the student and another person (teacher, peer, parent) present the materials in a quick and straight-forward manner. If the student makes a correct response to the flashcard, teacher praise is provided and this card is placed at the bottom of the stack and the next flashcard is then presented. If the student answers incorrectly, the teacher employs a model, lead, and test form of error correct. First, the teacher says the math fact and solution. Second, the teacher and student say the fact and its solution together. Finally, the student is presented the flashcard and if it is answered correctly, it is placed from 2 to 3 cards from the top of the stack. If the student misses the problem again, the model, lead, and test error correction format is again carried out (Becker, McLaughlin, Weber, & Gower, 2008; Glover, McLaughlin, Derby, & Gower, 2010).

The purpose of this study was to increase the fluency and accuracy of two students with behavior disorders by implementing a DI Flashcards system. Another purpose of this study is to replicate the findings from Treacy, McLaughlin, Derby, & Schlettert, (2012). By replicating the findings we would be able to gain additional confidence in the efficiency of the use of DI flashcards with elementary students with behavioral issues.

Method

Participants and Setting

The cooperating teacher and the first author chose the participants. Participant 1 was an 11-year-old male who during the project was going through the process of inclusion, which meant he would spend part time in the behavior intervention room and part time in a 5th grade general education classroom. He qualified for a 504 plan under conduct disorder, but had no academic goals in addition to his behavior goals. He had been in a self-contained behavior intervention classroom for the past year and a half before inclusion started. It is unsure to the cooperating teacher and myself as to what behaviors have resulted in him being in a behavior intervention classroom. Based on classroom observations, both the cooperating teacher and first author noticed that Participant 1's ability to perform basic multiplication quickly was absent. While he has some methods to solving basic multiplication, he is still inaccurate in his responding. In order to help Participant 1 increase his multiplication skills, the implementation of Direct Instruction Flashcards were used.

Participant 2 was a 12-year-old female in the same self-contained behavior intervention classroom. It was unknown as to when Participant 2 was referred for an Individualized Educational Plan (IEP), but she was recommended to the behavior intervention classroom in January 2011. Her qualifying factor listed her IEP was an emotional disorder. While there was a desire by the Participant 2 to be a candidate for inclusion, her inappropriate behavior, herself defecating and tantrums, disrupted her education and that of her peers in the general education classroom. Also, her skill levels in all academics, which were extremely below grade level prevented inclusion. Her reading was close to her grade level, but an academic area of need was math. She was unable to complete basic fact problems. She typically took a very long time to complete her math and at times, refused certain tasks all together due to insufficient knowledge in mathematics. The goal for Participant 2 was to implement an effective intervention that would increase her performance in multiplication. Direct Instruction (DI) flashcards (Silbert, Carnine, & Stein, 1981; Erbey et al., 2011) were used to improve her mathematic skills.

Both participants in this study began the study as members of an intermediate self-contained special education classroom for students with behavior disorders. The elementary school is located in a middle class urban neighborhood in the Pacific Northwest. There were 11 students in the classroom. Their achievement levels ranged from the 2nd to the 6th grade. Only three students in the class were pulled out of class to join a general education class for physical education, art, and library. The classroom was staffed with one certified teacher and one certified instructional aide. The classroom was connected with the primary self-contained behavior room, but collaboration between the two classrooms was limited. Participant 1 typically was taught math during the last 30 minutes of class, each day of the week. Consistency and desire to learn aided Participant 1 in

allowing for daily teaching. Due to absences and inappropriate behaviors, Participant 2 saw sporadic teaching time when compared to Participant 1. Instruction for both participants either occurred at a back table away from other students or in the hallway where there were no students or teachers to interrupt teaching. This classroom has been part of an ongoing program to work with preservice teacher education candidates to detail and provide then with opportunities for them to document their skill sets in data-based decision-making (McLaughlin, B. Williams, R. Williams, Peck, Derby, Bjordahl, & Weber, 1999; Poff, McLaughlin, Derby, & King, 2012).

Materials

There were several materials that were used in the implementation of this study. These materials included 3 x 5 note cards that were used for the flashcards, worksheets containing multiplication sets from 2's-8's, a timing device, and preferred reinforcers such as origami, football cards, and McDonalds food.

Dependent Variable and Measurement

The dependent variable was the number of correct digits that were written in one minute. A correct digit was defined as any numeral written correctly in the appropriate place value. If the numeral written were partially correct, the participant would earn only the digit that was written correctly. The goal for both students at the beginning of the study was to reach 80 digits in one minute. Reinforcers were earned differently for Participant 1. For one phase of the study, Participant 1 could earn an origami sheet or football card for completing the work. For the next phase the student earned one or the other only if he was able to increase his correct writing digits. Participant 2 earned a point towards McDonalds during the study if she increased her corrects each time. Points were recorded on her data sheet when they were earned.

Data Collection and Inter-Observer Agreement

Data were collected as permanent product during the study. As the student finished a test, primary researcher would count the correct and incorrect digits. The number of digits that were correct was written under the correct column and the incorrect number of digits was written in the incorrect column. Both participants had their own data sheets, so correct and incorrect totals were recorded accordingly. The totals of correct and incorrect digits would then be inputted into the data collection table. The tests would then be given to the cooperating teacher for grading. The primary researcher would not make marks on the test as to ensure that the secondary grader was not skewed by any prior knowledge of the results of the test. The secondary grader then would record their answer on the test and write the number of correct digits out of the total number of digits at the top of the paper. The tests where returned to the primary researcher and scores were compared. Agreement was then documented on the data collection sheet.

For Participant 1 inter-observer agreement was taken on 25 out of 25 days, which constituted 100% of the days. (The primary researcher and cooperating teacher independently graded the tests. Scores were compared with each other to determine whether or not agreement was reached. The inter-observer agreement was a mean of 99% (range 98%-100%). For Participant 2 inter-observer agreement was taken on 11 out of 12 days, which constituted 92% of all days. On days that inter-observer agreement was taken, the agreement was 100%.

Experimental Design and Conditions

A multiple baseline (Kazdin, 2010) across both sets and participants was employed. Based on data, interventions were modified to increase student output. The study for Participant 1 lasted for 25 days over the course of 1.5 months from the beginning of baseline till the completion of the study. While the study for Participant 2 lasted for 12 days over the course of 1.5 months from the beginning of baseline to the end of the study.

Baseline

During the baseline condition a test was handed to each students assessing their performance for one of the sets. The participants were told that they had a minute to complete the test and do it to the best of their ability. If the student asked for help or said that they could not do it, the

first author would respond only to tell them to do their best. No assistance or feedback was provided during the baseline phases. Both participants were tested on multiplication basic facts that included 2's, 3's, 4's, 5's, 6's, 7's, and 8's. Therefore, different sets were in baseline for differing amounts of time. Some sets were only tested in baseline once in hopes to achieved mastery without intervention.

Direct Instruction Flashcards

The implementation of Direct Instruction Flashcards was used for Participant 1 for Set's 2, 3, 4, and 5. During this phase the first author worked with each participant. Flashcards were conducted three times per set before a test was given on the multiplication facts. The flashcards would be in a random order and the student would be asked to provide the answer orally. If an answer was not know or said incorrectly, the primary researcher would state the correct answer and then ask the participant to restate the whole problem (e.g., 4 x 5 = 20). The card would then be placed two to three cards back in the deck to be presented again. As the participant's knowledge of the facts increased, students were asked to answer the flashcards as quickly as he or she could say the answer. Based on results, intervention was changed for sets 2 and 5 to increase performance. Reinforcement was provided after the completion of each set that was tested. Participant 1 also received a set of identical flashcards that would he took home to practice. They were practiced under the same condition so that the phase was consistent.

Direct Instruction Flashcards+ Differential Reinforcement of Higher Rates (DRH)

This phase was conducted sets 2 and 5 of the study for Participant 1 and for the entirety of the intervention phase for Participant 2. During this phase flashcards were presented in the same manor that they were during the Direct Instruction Flashcards. However during this phase at the completion of a test, the primary researcher would compare the score of the current test to the score of the previous test. If the score increased, reinforcement during this phase was earned or delivered. This strategy was implemented to work on continually trying to increase the number of correct digits everyday that data was collected.

Results

Participant 1

Baseline

As can be seen in Figure 1, during the baseline phase for times 2's data showed a decreasing trend. He averaged 30 digits written in a minute with a range over three sessions from 28 to 34 digits per minute. During baseline for times 5's, there was a decreasing trend over two days, with an average of 29.5 digits written. Baseline for times 3's revealed an increasing trend over the first two days. After two days taken off there was a fall off in the data for one day before intervention was implemented. The average was lower for times 3's at 20 correct digits written per minute. Times 4's show an increasing trend over six days of data. The average of the data were 17 correct digits per minute. Baseline data for times 6's showed a static trend over five days with an average of 11 correct digits written per minute. Data were also static for the times 7's, with an average of 14 correct digits written per minute. No trend was established for times 8's, but in the one day of data the participant wrote 31 correct digits in a minute.

Direct Instruction Flashcards

During baseline Participant 1 averaged 34 correct digits written per minute for times 2's. Improvement was shown when DI flashcards were implemented. The student had a strong increasing trend, where he averaged 45.3 correct digits written per minute. However, the data plateaued during the 4th- 6th day of data. A strong increasing trend was also displayed by the data for times 5's. Over the six days data was taken on 5's during this phase, an average of 42.5 correct digits per minute. These data also began to plateau in the 3rd- 5th day intervention. Times 3's data also showed a very strong increasing trend till mastery of the skill was shown over the last 3 days was shown. For times 3's, Participant 1 began intervention with 26 correct digits written and ended with 69 correct digits written.

Direct Instruction Flashcards + Differential Reinforcement of Higher Rates (DRH)

Based on data from the previous phase, a new

intervention was implemented for times 2's and times 5's. During the phase, data for both times 2's and times 5's showed increasing trends. On the 14th - 16th days the data for times 5's began to plateau again, but then made a large increase to finish the study. Times 2's data were more sporadic in their trend. The data would increase then decrease but then bounce right back up. The participant met the mastery level on the 21 day for both sets. Give me some means and ranges here.

Participant 2

Baseline

As shown in Figure 2, Participant 2 was very consistent during baseline with very low rates of correct digits. This was observed across all sets. Her performances in each set were in the same range of 10-15 correct digits written per minute. However, for her times 8's, she set a baseline level during day six of 17 correct digits written per minute.

Direct Instruction Flashcards + Differential Reinforcement of Higher Rate (DRH)

During this condition for times 2's and 5's, Participant 2 showed very small change in her levels of his responding. Data for times 2's, showed a slight increase over baseline levels. The average number of correct digits was 27 per minute. For times 5's data showed a slight increasing trend over the first four data points of intervention. However, there was a decreasing trend over the last three data points of intervention. The average for times 5' s was 65 correct digits written per minute.

Discussion

This study examined the effects of DI flashcards along with differential reinforcement of higher rate behaviors (DRH) on multiplication skills for two participants with behavior disorders. The results for Participant 1 showed that there was a large increase from his performance in baseline to that found during the two interventions. Participant 2, while not as impressive an improvement as Participant 1, also increased her ability to quickly complete basic math facts for 2's and 5's. Initially it was thought that the study would encompass basic multiplication facts for all the way up to 9's, but instruction occurred at a slower pace. The other hope was that flashcards would not actually have to be used for the 8's and 9's because the students would generalize the facts across the different numbers, but this did not happen. The hope for Participant 1 was to establish a way to quicken the multiplication process for him as he developed as was in the general education classroom more. As a 5th grader basic multiplication is something that should be quick, and Participant 1 showed the development to be able to quickly respond when given a multiplication problem. The goal for Participant 2 was to give her another method to solve basic multiplication that was different than using a multiplication chart, which was actually slower down her responding time. While this was established, it was established only for her 2's and 5's. Another positive that came from the study that affected both participants, was the confidence to attempt to answer a multiplication question. This confidence actually led both students to become more eager in their approach towards math.

The study did however have weaknesses, both controllable and non-controllable in nature. The most apparent was the difference that occurred in the amount of instruction days between Participant 1 and Participant 2. This discrepancy arose from two main sources. The first reason was the amount of time each of the participants was in school. Participant 2 missed many days due to appointments and sickness. Whenever days are missed at such a high rate this participant's academic success takes a step back, which in this case occurred with the rate of which Participant 2 was able to develop her multiplication skills. The other main reason was the student's behavior. There were many days when she attended school, but because of her unwillingness to work or inappropriate behaviors data was not taken, as it would have been detrimental to the overall study. Participant 1 did not have many set backs, but struggled when immediate success was not achieved. They always wanted to always complete the task with the highest results the first time, hurt the student in the ability to move on to more than just three sets of multiplication facts. Within the structure of the study, the main

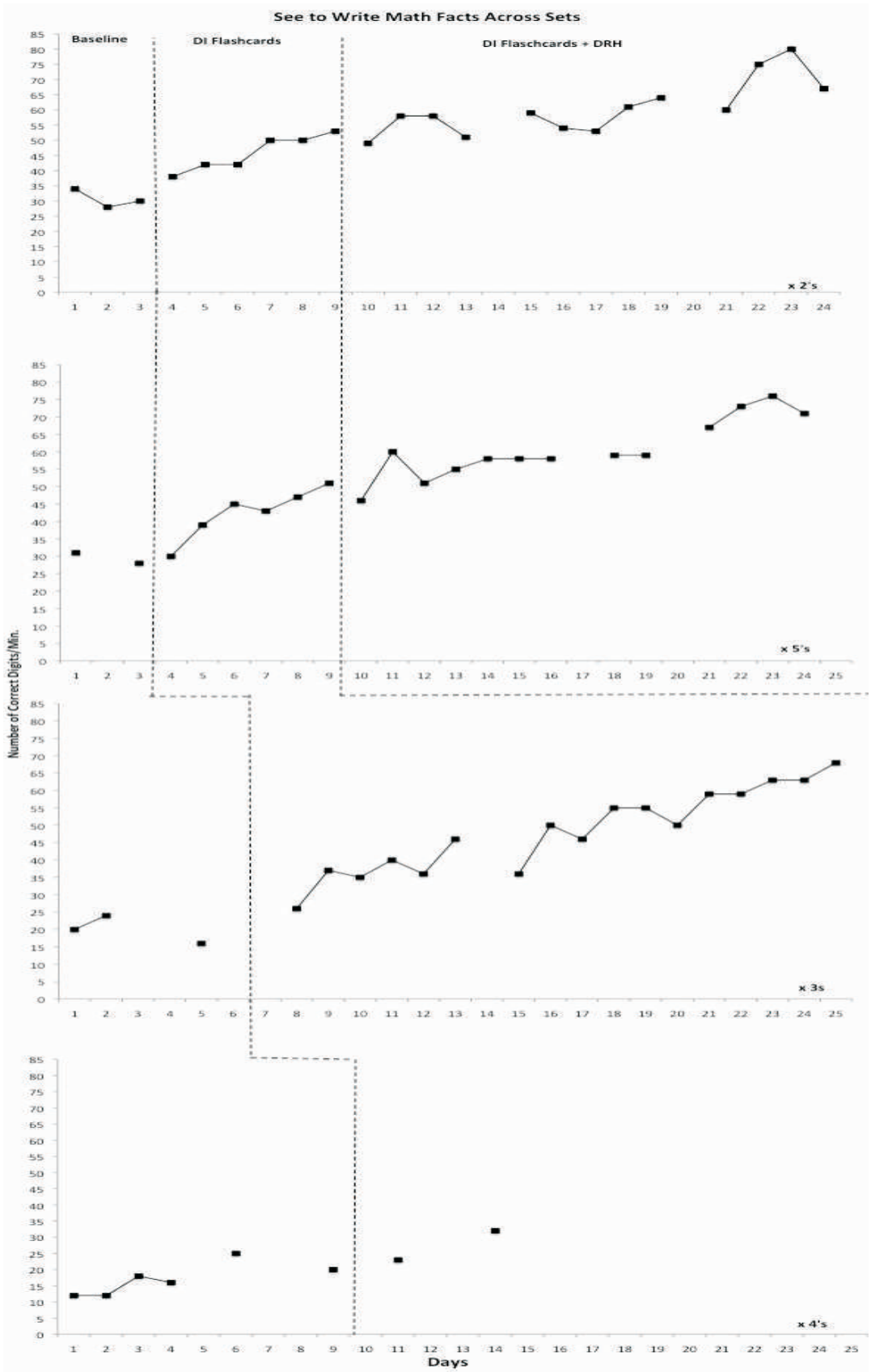

Figure 1. The Number of Correct Digits Per Minute Over 4 sets of Basic Multiplication Facts for Participant 1

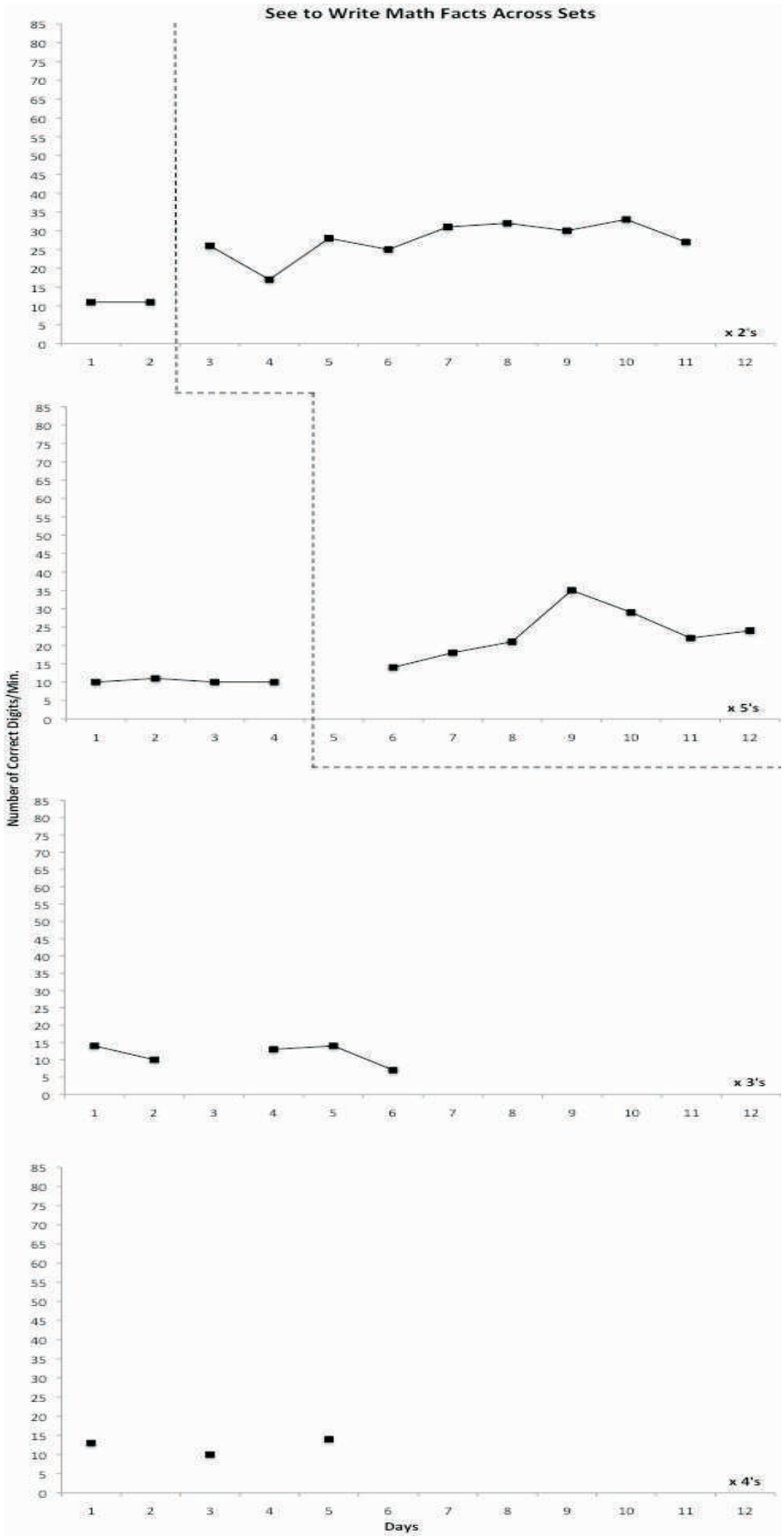

Figure 2. The Number of Correct Digits Per Minute Over 4 sets of Basic Multiplication Facts for Participant 2

weakness was not establishing the DRH earlier with Participant 1. The reason that only 2's and 5's were placed into a new phase was because they were not progressing at a high rate like the researcher and participant wanted. Thus, the differential reinforcement of higher rate behaviors was implemented and the student then strived to achieve a higher total each time in order to earn a reward. Also the original standard that was set, 80 digits written per minute, was found to be to high for the student to ever consistently achieve. Therefore, after the researcher discussed with a supervisor it was deemed that the aim goal should be lowered to 60 digits per minute.

The outcomes for Participant 1 replicated our previous work using DI flashcards in math (Brasch, McLaughlin & Williams, 2007; Erbey et al., 2011; Glover, McLaughlin, Derby, & Gower, 2010) as well as in reading sight words (Bishop, McLaughlin, & Derby, 2011; Green, McLaughlin, Derby, & Lee, 2010; Hopewell et al., 2011; Ruwe, McLaughlin, Derby, & Johnson, 2011).

The differential outcomes with Participant 2 were of interest. She replicated some recent research using DI flashcards with preschool students with DI flashcards (Chandler, McLaughlin, Neyman, & Rinaldi 2012 Ehlers, McLaughlin, Derby, & Rinaldi 2012; Higgins, McLaughlin, Derby, & Long, 2012). We have indicated that the age of the children in these three studies may have impacted our outcomes. However, in the present analysis, the age of the participant was well within the age ranges where we have had success employing DI flashcards. A recent study (Mann, McLaughlin, Williams, Derby, & Everson, 2012) also found differential outcomes with elementary school students with and without disabilities. The efficacy of DI flashcards varied depending on the severity of the students issues in math. Finally, these outcomes failed replicated the work of Treacy, McLaughlin, Derby, and Schlettert, (2012) where consequences were added to DI flashcards. The reasons for our differential outcomes could be several. For example, Participant 2 was absent on many occasions and was much more resistant to working and improving her basic skills. Whereas, Participant 1 was excited and always asking to work on flashcards, in order to improve his basic multiplication facts. This may provide an explanation of the present outcomes.

We have also tried some additional procedures such as adding a math racetrack (Standish, McLaughlin, & Neyman, 2012) with Participant 2 as it has been shown to be effective across a wide range of student ages and populations (Herberg, McLaughlin, Derby, & Gilbert, 2011; Walker, McLaughlin, Weber, & 2012). This will have to be examined in future research. Finally, maybe employing an additional forced choice preference assessment (Alberto & Troutman, 2012) may have informed us of a consequence that Participant 2 would be willing to work.

In summary, the present research indicated that DI flashcards may produce very rapid changes in student performance or these effects may be gradual. In addition adding additional consequences to assist some students maybe needed. As discussed above, both adding a math racetrack or special consequences may be needed to increase the effectiveness of DI flashcards. Teachers and other school personnel who advocate for the use DI flashcards, need to keep these issues in mind. Finally, additional research using different students and research groups appears needed.

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ABOUT THE AUTHORS

Kevin Pierce is a full time teacher in North Shore School District in the State of Washington. He teaches special education in the transition program for the North Shore School District. He is interested in special education, behavior disorders single case research, academic interventions.

T. F. McLaughlin, Ph. D. is a full professor in the Department of Special Education at Gonzaga University. He teaches courses in research, ADHD, behavior disorders, and supervises student teachers. His areas of interest include ADHD, Academic Interventions, Applied Behavior Analysis, Special Education, Teacher Education and Special Education.

Jennifer Neyman is a lecturer in the Department of Special Education Gonzaga University Spokane. She teaches courses on special education law, introduction to assessment, classroom management, and autism. Her areas of interest include functional assessment, consulting in the schools, academic interventions, severe behavior disorders, teacher training.

Mr. King is behavior intervention specialist in Arizona. He is interested functional behavioral assessment, behavior disorders, learning disabilities, classroom management, basic skills, and Direct Instruction.