7-2019

EFFECTS OF CHOICE ON MULTIPLICATION AND DIVISION FLUENCY ACQUISITION FOR THIRD GRADE STUDENTS

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THESIS

Submitted to
Northern Michigan University
In partial fulfillment of the requirements
For the degree of

MASTERS OF SCIENCE

Office of Graduate Education and Research

July 2019

SIGNATURE APPROVAL FORM

EFFECTS OF CHOICE ON MULTIPLICATION AND DIVISION FLUENCY ACQUISITION FOR THIRD GRADE STUDENTS

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ABSTRACT

EFFECTS OF CHOICE ON MULTIPLICATION AND DIVISION FLUENCY ACQUISITION FOR THIRD GRADE STUDENTS

By

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Students with the most pronounced behavioral needs are the ones missing the most instruction. A three-tiered system of intervention that is data driven and uses evidence based interventions is used within schools to meet the needs of all students. Within this tiered system, Positive Behavioral Interventions and Supports (PBIS), founded in the sciences of Applied Behavior Analysis (ABA), are used. Of the many PBIS interventions, instructional choice at Tier I has been established as an effective, low intensity, teacher delivered support that aims to reduce challenging behaviors and increase academic engagement. Instructional choice involves two parts: selection in response to present multiple selections and differential outcomes in response to the selection. A concurrent chain schedule contains an initial link, point in which the selection response is made and a terminal link, response required to acquire the differential outcome. By utilizing a concurrent chain procedure, teachers can effectively and efficiently condition student choice making to increase engagement in academic tasks to increase skill acquisition while promoting positive behavior responses. This study examines the effects of using instructional choice to assess its effect on multiplication and division skill acquisition for third grade students. The results of this study were consistent with previous research that found a preference for choice and an increase in skill acquisition.

ACKNOWLEDGMENTS

The author of this thesis has many people to thank who all had a hand in helping to inspire, drive, and ultimately find success with this project. I am grateful for the genuine guidance and support from my thesis chair, Professor Ashley Shayter. Her advice and thoughtfulness along the way proved to be invaluable. I would also like to thank Dr. Jacob Daar and Dr. Joe Lubig for their significant feedback in helping to shape this project. A special and huge thank you to my mother, Peggy Farley, for the countless hours she spent with my children to make this degree possible.

This thesis follows the format prescribed by the Publication manual of the American Psychological Association and the Department of Psychological Science.

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CHAPTER 1

INTRODUCTION

Promoting academic engagement and skill acquisition in public education classrooms are tasks faced by educators on a daily basis. Every day teachers are confronted with a variety of challenges from students with an extensive range of academic, behavioral, mental and social health needs, as well as expanding class sizes (McAdams, 2010) while schools themselves are faced with dramatically raising expectations (Jacob, 2007). Barrett, Bradshaw, and Lewis-Palmer (2008) state the number of students with maladaptive behaviors (i.e. aggressive, disruptive, antisocial behaviors) have been increasing, resulting in a greater need for special education services. Additionally, students with the most pronounced behavioral needs are the ones who miss the most instruction (Lane et al., 2015).

In order to combat this, behavior management systems are often utilized to help increase instructional time. These systems typically focus on punishment consequences, such as time-out, which are not effective in teaching appropriate alternatives to these students (Dunlap et al., 1994). Instead, researchers have sought to find ways to prevent rather than suppress maladaptive behaviors.

As teachers and schools look for ways to ensure academic success, there has been an increased interest in school-wide prevention models (Barrett, Bradshaw, & Lewis-Palmer, 2008). Lane and colleagues (2015) notes that educational agencies have established a tiered system of interventions to help combat these challenges. This tiered system uses data-driven and evidence-based decisions to determine which students require more intense interventions to achieve school success. Within this system of interventions, Positive Behavioral Intervention and Support (PBIS) strategies have been developed (Lane et al., 2015), which aim to make

positive changes to both student and teacher behavior by altering the school environment by improving the programing and procedures within the school that impact discipline, reinforcement, training, and team-based decision making. This continuum of tiered supports provides an effective and efficient organization for the resources, interventions, and systems within and across schools (Barrett, Bradshaw, & Lewis-Palmer, 2008).

Whether all components of PBIS fall under the umbrella of behavior analysis, it is considered to be a three tiered system of supports founded upon the science as evidenced by an emphasis placed on the operational definitions of behavior, the logic behind selecting interventions to change behavior, and the continuous assessment of the interventions and student outcomes (Horner & Sugai, 2015). According to Horner and Sugai (2015) within this three tiered system of support, Tier I, is often referred to as primary interventions, which consist of universal school wide and classroom management systems and practices aimed to promote positive social behavior and academic performance for all students. These supports are highly efficient and logical and used as an antecedent intervention before the students have had the opportunity to engage in behavior that results in failure (Horner & Sugai, 2015). Tier II, or secondary interventions, aim to meet the behavioral and educational needs of students who have been identified as at risk of failure in conjunction to Tier I interventions. Tier III, or tertiary interventions, are more intense individual interventions that address the behavioral and academic needs for students who are failing to develop or improve despite the other tiers of intervention. Tier III interventions are characterized by a formal procedure which includes individual assessments, support plans, and management by a team put together to monitor the implemented plan and its effectiveness as well as meet the needs of the individual student (Horner & Sugai, 2015).

Of the many PBIS strategies that can be implemented within the tiered system, providing instructional choice at Tier I has been established as an efficient, low-intensity, teacher-delivered support that has been shown to reduce challenging behaviors while maximizing engagement in higher quality academic tasks (Lane et al., 2015). Choice is defined as "the allocation of responding among concurrently available response options" (Ackerlund Brandt, Dozier, Juanico, Laudont, & Mick, 2015, p. 344). It is thought of as an opportunity to freely select what one wants and is an important and necessary skill for quality of life (Cote Sparks & Cote, 2012). Typically, choice making involves two parts (Tiger, Hanley, & Hernandez, 2006). The first part involves a selection response in the presence of multiple selections. The second requires that selection responses be followed by differential outcomes (Tiger et al., 2006). This is known as a concurrent-chain procedure where the initial link is the point in which the selection response is required and the terminal link is the response required to access the associated differential reinforcement outcome (Christianson & Grace, 2010).

Christianson and Grace (2010) identified various models of the concurrent chain procedure, such as the delayed reduction theory and contextual choice model, have been used to study choice making and response allocation with the task of describing how they depend on the initial and terminal link schedules. Research has shown there are many variables that may influence response allocation, but the most extensively studied has been reinforcer rate (Borrero et al., 2007). The various models of concurrent chains all relate to the matching law which states that when given two concurrently available response options, the response allocation has been shown to be a function of the reinforcement rates associated with the response option (Borrero et al., 2007). Thus, the initial link depends on the value of the terminal link stimuli (Christianson & Grace, 2010).

Researchers have aimed to study response allocation by changing the value of reinforcers (Kearns, 2019; Kyonka & Grace, 2008), thus creating an establishing operation (EOs). As such, EOs have become one of the most behavior-analytic methods of influencing motivation in a variety of applied settings (Laraway, Snycerski, Michael, & Poling, 2003).

Within the concurrent chain procedures, studies have demonstrated choice is preferred even when terminal link consequences were identical (Ackerlund Brandt et al., 2015; Tiger, Hanley, Hernandez, 2006) and has more reinforcing strength versus a no choice option not only with people, but across other species as well (Cerutti & Catania, 1997). Optimal foraging theory (OFT) suggests organisms utilize resources as efficiently as possible to maximize benefits (Tyson, Friedlaender, & Nowacek, 2016). Studies have also suggested that a history of differential reinforcement outcomes from choice making is a conditioned preference (Ackerlund Brandt et al., 2015).

Researchers have wrestled with the question of whether the effectiveness of choice is due to choice being a reinforcer or by the differential outcomes produced by choice. In order to test this, studies have been conducted to test the outcomes when using choice conditions versus no choice conditions using high preference reinforcers in all conditions (Lerman et al., 1997) and by delivering identical reinforcers in all conditions (Tiger, Hanley, and Hernandez, 2006).

To test the reinforcing effects of choice, Ackerlund Brandt and colleagues (2015), set out to systematically assess preschooler preference for choice. Here the researchers presented the participants with three choice options in each session: control (no choice), experimenter choice, and child choice. The control choice was defined as the child selecting a blank piece of paper. The terminal link connected to this choice was an empty plate and praise. Experimenter choice lead to a terminal link connected to this choice was a plate with five identical edible reinforcers

in which the experimenter selected one edible from and presented it to the child paired with praise. Child choice was associated with the presentation of a plate with five edible reinforcers identical to the reinforcers in the experimenter choice paired with praise. In this condition, the child selected one edible reinforcer from the plate. At the initial link, the experimenter told the child to "pick your favorite". After selection, the experimenter implemented the terminal link and the reinforcement consequence that was connected with the initial link following a correct response. Results of the choice assessment for the 30 participants in the study found that ten displayed no preference between the child choice and experimenter choice, however 20 of the participants (66%) preferred the child choice over experimenter choice or control. No participants preferred the experimenter choice over the child choice condition. These results indicated most of the children that participated in the study showed a preference for choice, even when the outcomes were identical. This suggests that typically developing children prefer the option of choice rather than having someone choose for them.

Though ten of the 30 participants did not show a preference over experimenter choice and child choice, the researchers note there may be several reasons the responses between these two choices were similar. Ackerlund Brandt and colleagues (2015) state the possibility that the participants did not have a history with choices which would have resulted in better outcomes. They also noted the possibility the discriminative stimuli used in the trials were not effective enough. Therefore the researchers sought to analyze whether implementing a history of more preferred outcomes for one choice option would influence choice making toward that choice even when outcomes were again made equal across all choices (Ackerlund Brandt et al., 2015).

To attempt this, Ackerlund Brandt and colleagues (2015) utilized 11 participants from the initial study, of which six participated in the experimenter choice conditioning while the

remaining five participated in child choice conditioning. Each session was run identical to the first study with the child's choice being made at the initial link and the terminal link being implemented after correct responses. However, this time the experimenter choice conditioning phase paired the experimenter choice option with a larger variety of highly preferred edible reinforcers, while the child choice option was paired with a small variety of lower preferred edible reinforcers. At the initial link, the experimenter placed a plate with either highly preferred edible reinforcers behind the experimenter choice option and a plate with two low preferred edible reinforcers behind the child choice option. An empty plate was placed behind the control choice option. The opposite was done in the child choice conditioning phase, using a larger variety with highly preferred edible reinforcers paired with the child choice condition and a smaller, lower preferred variety of edible reinforcers for the experimenter choice option. This was done identically to the experimenter choice conditioning phase except the eight highly preferred reinforcers were placed behind the child choice while the plate with 2 lower preferred reinforcers were placed behind the experimenter choice. Results of the follow-up indicated all participants preferred the choice with the most preferred outcomes during conditioning, which demonstrated that preference shifted for the more favorable outcome. This was consistent with previous findings that participants will shift responding to a previously lower preferred option if the consequence outcome is better than the previous outcome (Fisher, Thompson, Piazza, Crosland, & Gotjen, 1997). However experimenter choice conditioning was not effective for any of the participants (Ackerlund Brandt et al., 2015). This may indicate a preference for choice may be challenging to change after a history of differential reinforcement.

Consistent with the research results of Ackerlund Brandt and colleagues (2015), other researchers have demonstrated the opportunity to choose is more preferred than not choosing.

For example, Tiger, Hanley, and Hernandez (2006) extended their research to examine what influence the number of items in the array from which the participant had the opportunity to choose from in a choice condition had. To test this, they chose typically developing preschoolers, who had previously demonstrated a preference for choice. Participants were presented with two initial links both associated with child choice, but the number of reinforcers presented in the array during the terminal link were manipulated. Under one choice condition (orange), correct responses resulted in praise and access to a plate with four identical edible reinforcers where the participant could choose one. Under a second choice condition (blue), correct responses resulted in praise and access to a plate with two identical edible reinforcers in which the participant could choose one. The final choice condition (yellow), the control, correct responses resulted in praise and no edible reinforcers. The number of items was systematically manipulated as the trials occurred from four to eight, 12, and 16. When the number of reinforcers in the orange link was increased from four to eight, one of the participants almost always chose the initial link associated with the larger array (orange link). This indicated that as the number of items increased, so did the value of the terminal link. To reverse this, the researchers decreased the number of items in the terminal link back to four. After doing so, the participant continued to choose the orange choice link, even when the researchers decreased the number of items to two so that both the orange and blue terminal links were identical.

To determine if the orange worksheet had developed a reinforcing effect from conditioning, the researchers increased the number of items to choose from in the blue link. After increasing the blue link from two to four and then four to eight, the participant almost always selected the blue link. The researchers then decreased the blue link from eight to four and then back to two. Selection of the blue link maintained which replicated the effects found prior with

the orange link. This indicated that increasing the number of items to choose from enhances the preference for choosing. It also indicated that varying the number of items in the array to choose from may lead to the development of a conditioned reinforcement effect.

Tiger, Hanley, and Hernandez (2006) extended their study further to establish the value of choice. The participants for the third part of their study consisted of three children from a previous study. Two of the participants did not have a consistent preference for a choice link and one participant did not show sensitivity to choice as a reinforcer. The purpose of their study was to establish the choice option as a preferred choice for these three children. This procedure was similar to previous studies, however it differed at the initial link in the choice condition, where the number of items in the array at the terminal link was systematically increased from five to ten and fifteen. The no choice terminal link remained consistent with only one item available. Results of the study showed all participants demonstrated that an array of five edible reinforcers was no more preferred than one, however as the number of items in the array increased, the choice option became more preferred. This suggested the opportunity to choose was a reinforcer for responding but only when there was a large difference between the numbers of items presented. Additionally, results suggested that increasing the number of items in the array may have functioned as an establishing operation that increased the reinforcing value of choice and therefore increased the prospect of the behavior responses related with that choice.

Tiger, Hanley, and Hernandez (2006) extended their research even further with the purpose to detect what value choice as a consequence has for academic responses. To do this, the researchers progressively increased the response requirement needed to access the consequence, i.e. the number of academic tasks required were progressively increased from 2, 3, 4, 8, 12, 16, and 32. The no-choice initial link and control initial link required only one correct

response for the academic task. No-choice link resulted in one edible reinforcer being presented and the control link resulted in no edible reinforcer. Results indicated participants preferred the choice link when the response effort favored the no-choice link. The researchers noted the results of their combined studies suggest that providing the opportunity to choose serves as a reinforcer or an EO, increases the effectiveness of differential reinforcement, is an easy and inexpensive way to increase the effectiveness of reinforcers, and that providing choice among different reinforcers may be effective as it would allow access to relatively high preferred reinforcers and the opportunity to choose.

Consistent with previous research (e.g. Ackerlund Brandt et al., 2015; Tiger, Hanley, & Hernandez, 2006), the opportunity of child choice versus the opportunity for experimenter choice or no choice has resulted in a demonstrated preference of choice conditions. Researchers however have wondered if individuals prefer situations in which they are presented with the option to choose between tasks or between the outcomes characterized by the completion of the tasks. Fenerty and Tiger (2010) set out to study ways to assess children's preference to task choice and consequence choice when all qualitative variables were held constant.

To do this, the Fenerty and Tiger (2010) designed an experiment to assess children's preferences for task choice versus consequence choice while equating the task and consequence choices across each condition to identify the choice making opportunity. A modified concurrent chain procedure was developed using four terminal links (task choice, consequence choice, no choice, control), each with differently colored index cards to be used as a discriminative stimulus during the initial link. During each trial, researchers presented the participants with two choices (colored index cards) and prompted a selection of one card as the initial link of the concurrent chain. The participant was then prompted to engage in an academic task, worksheets, which

would result in the follow through of the terminal link and paired consequence. Following a correct response requirement, one edible item and praise was delivered by the experimenter. The consequence choice terminal links consisted of presenting the participants with one identical academic task as used in the task choice. Following a correct response requirement, the participant was provided an array of identical edible reinforcers to choose one from. The no-choice terminal link consisted of a single, identical academic task being presented. After a correct response, the participant was presented with one edible reinforcer identical to those in the other conditions. The control terminal link consisted of the participant being presented with an academic task identical to those used in other conditions. Following a correct response, no edible reinforcer was delivered.

Results of the study found a pattern of preference for the consequence choice condition, which indicates a preference for opportunities to engage in choice making, more specifically for consequence choice making. The researchers recommend future research to evaluate the independent and combined effects of providing choices and preferred items to promote desirable behavior.

With evidence that choice procedures are reinforcing, there has been little evidence to suggest that it results in increases in the rate of skill acquisition (Toussaint, Kodak, & Vladescu, 2016). To test choice making on skill acquisition, Toussaint and colleagues (2016) mimicked the procedures most likely to occur in clinical practice by providing choice among different items in the array, rather than identical reinforcers. In their study, the researchers found all participants preferred choice making conditions over no choice and found increases in achieving mastery criterion when choice making conditions were in place.

Incorporating choice-making into everyday instruction in normal academic activities can easily be done without the need to create new curriculums (Cote Sparks & Cote, 2012). Offering choice across tasks, such as what order tasks are completed in or the choice between two tasks, or within tasks, such as which materials (markers vs. crayons) requires minimal effort for the teacher but results in increased academic engagement and less disruption (Lane et al., 2015). By utilizing a concurrent chain procedure, teachers can effectively and efficiently condition student choice making to increase engagement in higher quality academic tasks to increase skill acquisition while promoting positive behavior responses. By providing concurrent choices on a chain schedule, students have the choice at the initial link of the chain to choose the task that results in choice of reinforcer at the terminal link. Following the Optimal Foraging Theory (OFT), students are predicted to engage in tasks in the most efficient and effective way with respect to their effort and reward. By providing concurrent choices on a chain schedule, students are provided choices across tasks at the initial link of the chain to produce the preferred and optimal schedule of reinforcement at the terminal link thus setting up the OFT paradigm within the classroom. By offering choice in this way, both as an antecedent choice at the initial link and as a consequence, teachers can promote academic engagement in more challenging tasks for faster skill acquisition which will result in the most preferred consequence. Therefore, the purpose of this study is to expand upon previous research to examine the differential effects on skill acquisition by utilizing instructional choice on a concurrent schedule of reinforcement.

CHAPTER 2

METHODS

Methods

Participants

A total of 25 third graders from a rural mid-western area in the United States participated in this study. They ranged in age from eight to nine years old (M=**, SD=**). All students attended the same public school and were in the same inclusive general education classroom five days per week. At the time of the study, the participants had been in third grade for seven months. As this study was part of the daily math instruction as it was considered an instructional strategy, parents/guardians of the students within the targeted classroom were informed that the study was being conducted.

Winter results of the Northwest Evaluation Association (NWEA) Measure of Academic Progress (MAP) test in the area of mathematics, the class mean Rasch UnIT (RIT) score, in number and operations is 200 with a standard deviation of 7.1. The national norm is 198.2 with a standard deviation of 13.39. Of the 25 participants assessed, 3 were categorized as "low average" (between 21-40 percentiles) in number and operations. Within the participant group, 9 have been identified as at risk in the academic area of math by the NWEA MAP assessment, formal and informal classroom assessments as well as teacher feedback. These 9 participants receive 30 minutes of pull out intervention five days per week. The intervention supports regular math instruction in all common core areas, not just multiplication fluency. This intervention is in addition to regular classroom math instruction which takes place for 60 minutes five days per week.

Materials and Setting

The study took place in the students' general education classroom between 9:30 am and 10:00 am. One session was conducted per day and took approximately 10 minutes from start to finish. During sessions, participants sat at their assigned tables using a standing folder to ensure privacy and to prevent any cheating.

Task materials, reinforcers, and discriminative stimuli were present during all sessions. Identical worksheets containing a mixture of multiplication and division equations in random order were used. Worksheets consisted of 25 randomly mixed equations, with the difficulty level of the equations balanced across worksheets. Equations with multiples of 4, 6, 7, and 8 were used. Each worksheet was assigned a color as a discriminative stimulus for the concurrent schedule.

Measurement

Participant skill acquisition of fluency (accuracy and speed) of multiplication and division equations was the primary measure during this study. The average class percentage correct was measured along with number of students reaching mastery (100%). Data was also collected on initial link selection when concurrent choices were present to see what choice option was preferred.

Participant skill acquisition of fluency (accuracy and speed) of individual multiplication and division equations (probes) was another measure during this study. Individual percentages correct were measured for each multiple along with number of sessions required to meet mastery criterion for each multiple during the study.

Preference Assessment

A preference assessment of color (white, blue, pink, green, purple, yellow, salmon) was given to the class prior to colors being assigned to ensure no color bias via a class survey. The two most preferred colors (blue and green) and the two least preferred colors (pink and white) were excluded from this study to prevent nuance variables from influencing initial link choices based on color. The three most neutral colors were used as the discriminative stimuli for choice conditions. Figure 1 shows the results of the survey. Salmon was used for the control condition, yellow for the teacher choice (or no choice) condition, and purple for the child choice condition.

A preference assessment for reinforcers was conducted by providing a survey to the class via paper and pencil to identify the most to least preferred reinforces. Figure 2 shows the five most selected reinforcers that were chosen for this study. They included the following: 10 dojo points, candy, five minutes on the Chromebook, prize from the prize box, and read a book to the class.

Procedure

Prior to the first choice condition session, conditioning of each concurrent chain schedule was conducted. Conditioning for each of the three choice conditions was conducted to introduce the participants to the initial link and associated terminal link. Each conditioning session occurred once and lasted for three consecutive sessions.

At the start of each conditioning session, the teacher introduced the initial link and explained the terminal link consequence for the correct response requirement. Identical worksheets consisting of 25 multiplication equations (multiples of 1, 2, 5, and 10) in random order was used for each session to ensure task difficulty was equated. Participants were given 225 seconds to complete all 25 multiplication equations. The time allotment was calculated by

taking the standard measure of fluency (3 seconds per equation) and multiplying by 3 (i.e. 25 equations * 3 seconds= 75 seconds, 75 seconds * 3= 225 seconds). The required response requirement to access the terminal link was 100% accuracy (25/25 correct) within the 225 second time allocation. Following the correct response requirement, the terminal link associated with the initial link was delivered.

During the no choice terminal link (yellow worksheet), correct responses resulted in praise and the teacher selecting and presenting one reinforcer. During the child choice terminal link (purple worksheet), correct responses resulted in praise and access to an array of five reinforcers the participant could choose one from. During the control link (salmon worksheet), correct responses resulted in praise only.

After conditioning for each condition, an alternating treatment design was used. A six-sided di was used to randomize the sessions. Rolling a "1" resulted in the control (salmon worksheet) condition. Rolling a "2" resulted in the no choice (yellow worksheet) condition. Rolling a "3" resulted in the child choice (purple worksheet) condition. Rolling a "4" resulted in a concurrent choice where all choice conditions were presented. When the concurrent choice was selected, the teacher presented all three conditions and prompted the participants to "pick your favorite". Participants then approached the table and selected a worksheet and returned to his/her seat. If a "5" or "6" were rolled, the teacher rerolled the di.

When rolling the di to establish each session's initial link, two consecutive rolls was allowed, thus allowing for two consecutive sessions to have the same initial link. However, if on the third roll the number on the di was repeated, a reroll was triggered and the di was rolled again until a new number resulted in a different choice condition. This was put in place to prevent the unlikely situation of over selecting one or more conditions and to ensure a more balanced design.

At the start of each session, the participants put their names and dates on their worksheets. Next, they put up a privacy folder followed by putting their pencils in the air to signal they were ready. When all participants were ready, the teacher initiated the terminal link by saying "begin" and started a timer for 225 seconds. Participants remained seated during the entire 225 seconds. At the end of the 225 seconds, all students turned their papers over and put their privacy folders on top of the worksheet to provide a visual check that no participants were continuing to solve equations.

Worksheets were collected and corrected immediately following the session by the paraprofessionals working in the classroom. For participants with correct responses (100% of equations correct), the teacher provided praise in the form of a high five paired with "great job on math today" and the consequence associated with the initial link. Twenty-two total sessions were conducted in the study.

Fluency probes were conducted every day at the end of the math period to assess student skill acquisition of fluency on individual multiples. Fluency probes consisted of 20 equations of multiplication or division equations for each multiple (4, 6, 7, 8). The fluency probes consisted of either multiplication or division, not a mixture, for each individual multiple. The procedure for the probes was identical to that of the mixed multiplication and division worksheets. Mastery criterion was set at 100% (20/20) within 60 seconds (3 seconds per equation). Data on skill acquisition was collected for individual students.

CHAPTER 3

RESULTS

Data was collected across all variables and graphed based on an alternating treatment design in order to conduct a visual analysis. Figure 3 displays the average class percentage correct for each of the conditions in the alternating treatment design. Skill acquisition of multiplication and division fluency shows an increasing trend in all four conditions will little variability. The greatest increase in trend was during the child choice condition showing an increasing trend with a moderate to high level of skill acquisition. The concurrent choice condition showed an increasing trend with medium to high level of skill acquisition in the beginning but then remained consistent. The no choice condition shows a slight increasing trend at the moderate level while the control condition shows a very slight increasing trend.

While all conditions indicated in an increasing trend in skill acquisition, the overall class averages did differ among conditions. The concurrent choice condition showed an overall average of 68.8% correct. The control condition showed an overall average of 68.6% correct. The child choice condition showed an overall average of 60.1% correct. The no choice condition showed an average of 58.7% percent correct.

Figure 4 displays the initial link selections made when the concurrent choice options were presented. Consistent with previous research (Ackerlund Brandt, Dozier, Juanico, Laudont, & Mick, 2015;Fennerty & Tiger, 2010; Tiger, Hanley, & Hernandez, 2006; Toussaint, Kodak, & Vladescu, 2016) a preference for child choice was consistent for most participants when concurrent choices were made available versus no choice or control choice options.

Figure 5 shows the total number of students reaching mastery (100%) across all sessions. An increasing trend was observed from low to moderate levels. Overall, the highest number of student reaching mastery resulted in the concurrent choice condition where 16 students met mastery. Though each condition showed an increasing trend, there was a difference between conditions. The concurrent condition (M=11.5) resulted in the most students meeting mastery followed by control (M=9.6), child choice condition (M=8.5) and the no choice condition (M=8). Overall the increasing trend of students meeting mastery along with the increasing trend in class averages indicates that providing choice as an antecedent and consequence did improve skill acquisition during the study.

Due to the varying ability levels of students within the classroom, data for the top six participants who were at mastery level beginning at session one and who remained at mastery level throughout the sessions, was eliminated. Figure 6 displays the overall class percentage correct when these outliers were removed. While all conditions indicated in an increasing trend from moderate to high levels of skill acquisition, the overall averages did differ among conditions. The concurrent choice condition showed an overall average of 58.9% correct. The control condition showed an overall average of 58.6% correct. The child choice condition showed an overall average of 48.7% correct. The no choice condition showed an average of 47.1% percent correct.

Figure 7 shows the initial link selection during the concurrent choice condition with outliers removed also demonstrates a student preference for choice. Figure 8 shows the total number of students reaching mastery (100%) at each session with outliers removed. An increasing trend from low to moderate levels is observed in all conditions. The concurrent choice condition (M=5.7) resulted in the highest number of students, eight, reaching mastery. This was

followed by the control condition (M=4.2), child choice condition (M=3.1), and no choice condition (M=2.3). These results are consistent with the results found when total class averages were examined.

Data for both the whole class and the data with outliers removed resulted in the same increasing trends of skill acquisition, a preference for choice versus no choice or control, and the concurrent choice condition resulting in the highest overall averages correct and number of students meeting mastery.

Data for seven individual participants from the study was analyzed. Figure 9 shows skill acquisition for Student Three. Figure 9 shows an increasing trend with some variability. Student Three did not meet mastery criterion during the study but did show more skill acquisition during the concurrent choice condition (M=37.3%) versus child choice (M=29.5%), control (M=28%), and no choice (M=26.7%). During the concurrent choice, Student Three selected the child choice condition on all six occasions.

Figure 10 displays skill acquisition data for Student Eight. An increasing trend from moderate to high level is observed. Though variability in the data occurs early in the study, the trend becomes stable at a high level. Student Eight did meet mastery criterion during the child choice condition. Though an increasing trend was found in all conditions, they did differ slightly. The concurrent choice condition (M=91.3%) showed the highest level of skill acquisition versus child choice (M=88%), control (M=83.2%), and no choice (M=78.7%). During the concurrent choice condition, Student Eight selected the child choice condition on all six occasions.

Figure 11 displays skill acquisition data for Student Nine. An increasing trend from low to moderate level is observed in the no choice, child choice, and concurrent choice condition. A

slight decreasing trend is observed in the control condition. Student nine did not meet mastery criterion during the study. Though an increasing trend was found in overall data, the conditions did show differences in the average percent correct. The concurrent choice condition (M=34%) showed the highest level of skill acquisition versus control (M=28.8%), child choice (M=26.5%), and no choice (M=17.3%). During the concurrent choice condition, Student Nine selected the control condition on one occasion, the child choice condition on one occasion, and the no choice condition on four occasions.

Figure 12 shows skill acquisition for Student Ten. A sharp increasing trend is observed early in the sessions from moderate to high levels. The trend then becomes stable as Student Ten reached mastery criterion. Though mastery was reached early in the study, some of the conditions did show more skill acquisition. The control condition (M=99.2%) showed the highest level of skill acquisition versus concurrent choice condition (M=98%), child choice condition (M=88%), and no choice (M=84%). During the concurrent choice, Student Ten selected the no choice condition on two occasions and the child choice condition on three occasions.

Figure 13 displays skill acquisition data for Student Fifteen. An increasing trend from low to high levels is observed in all conditions. Student Fifteen did meet mastery criterion during the study. Though an increasing trend was found in overall data, the conditions did show differences in the average percent correct. The concurrent choice condition (M=69.3%) showed the highest level of skill acquisition versus control (M=53%), child choice (M=46.5%), and no choice (M=32%). During the concurrent choice condition, Student Fifteen selected the child choice condition on all occasions.

Figure 14 displays skill acquisition data for Student Eighteen. An increasing trend from low to high levels is observed in all conditions. Student Eighteen did meet mastery criterion during the study. Though an increasing trend was found in overall data, the conditions did show differences in the average percent correct. The control condition (M=86.4%) showed the highest level of skill acquisition versus concurrent choice (M=84%), child choice (M=59.5%), and no choice (M=58.7%). During the concurrent choice condition, Student Fifteen selected the child choice condition on four occasions and the no choice condition on two occasions.

Figure 15 displays skill acquisition data for Student Twenty-Two. An overall increasing trend is observed in all conditions. The child choice condition increases from low to high levels while the concurrent choice and control is observed to increase from moderate to high levels. The no choice condition did have a slight increasing trend at a high level. Student Twenty-Two did meet mastery criterion during the study. Though an increasing trend was found in overall data, the conditions did show differences in the average percent correct. The control condition (M=88%) and no choice condition (M=88%) showed the highest level of skill acquisition versus concurrent choice (M=84.7%) and child choice (M=76.5%). During the concurrent choice condition, Student Twenty-Two selected the child choice condition all six occasions.

The results of this study found that providing instructional choice as an antecedent combined with choice as a consequence during the concurrent choice condition showed the highest overall skill acquisition for four (Student Three, Student Eight, Student Nine, and Student Fifteen) out of the seven participants analyzed. Of the remaining three participants analyzed, the control condition resulted in the highest skill acquisition and for two participants (Student Ten and Student Eighteen) while both the control condition and no choice condition resulted in an equal score for the highest skill acquisition for one participant (Student Twenty-

Two). For the two participants whose highest average percent correct did not occur during the concurrent choice condition, the second highest level of skill acquisition did occur in that condition while the next highest level of skill acquisition for Student Twenty-Two was the concurrent choice condition as well. For six of the seven participants analyzed, the no choice condition resulted in the lowest average score of skill acquisition. For one participant (Student Twenty-Two), the lowest average score resulted in the child choice condition.

Next data was analyzed for the seven selected participants to examine the overall influence of the study on skill acquisition of fluency based on individual multiples. Figure 16 shows skill acquisition for Student Three. A slight increasing trend of skill acquisition from moderate to high levels for multiplication of four is noted. Overall time needed to complete each probe was steady with no variability and remained at the fully allotted 60 seconds. Student Three did not meet mastery criterion of the multiplication of four probe and did not move past it.

Figure 17 shows skill acquisition for Student Eight. Student Eight successfully mastered all probes for multiplication and division except for division of eight as the study ended. A moderate to high level of skill acquisition is observed for all multiples. Time needed to complete each probe remained steady with a range of 52 to 60 seconds. Skill acquisition was observed to increase based on the number of sessions needed to meet mastery criterion and move to the next probe.

Figure 18 shows skill acquisition for Student Nine. Student Nine mastered the probe for multiplication of four's in three sessions before moving on to division of four's. Student Nine did show an increasing trend from low to high levels of skill acquisition for division of four's with high variability, but was unable to meet mastery criterion and move on past this probe. The overall amount of time needed to complete each probe remained stable at 60 seconds.

Figure 19 shows skill acquisition for Student Ten. Student Ten met mastery criterion for all probes. A steep increasing trend was observed from low to high levels of skill acquisition for the multiplication of four's. An increasing trend from moderate to high levels was observed for the division of four's. Skill acquisition for all probes then remained at a high level with no variability. The overall time needed to complete each probe was steady with little variability and ranged from 45 to 60 seconds.

Figure 20 shows skill acquisition for Student Fifteen. Student Fifteen met mastery criterion for multiplication and division probes of four's and six's during the study. An increasing trend from moderate to high levels with moderate variability was observed for multiplication of four's. As skill acquisition improved, the number of sessions required to meet mastery along with the variability of scores decreased. Time needed to complete each individual probe was steady and ranged from 57 to 60 seconds.

Figure 21 shows skill acquisition for Student Eighteen. Student Eighteen met mastery criterion for multiplication probes of four's and six's and division of four's. An increasing trend from moderate to high levels with little variability was observed for the multiplication of four's. An increasing trend was observed for the division of four's and multiplication of six's at high levels. The amount of time needed to complete individual probes remained steady for most of the probes and ranged from 35 to 60 seconds.

Figure 22 shows skill acquisition for Student Twenty-Two. Data for Student Twenty-Two showed an increasing trend of skill acquisition from moderate to high levels with little variability to meet mastery criterion for the multiplication of four's. A slight increasing trend from low to moderate levels was observed with little variability for the division of four's. Mastery criterion

for division of four's was not met. The time needed to complete individual probes remained steady at 60 seconds.

Analysis of individual student data on multiplication and division probes does show an increasing trend of overall skill acquisition. Of the seven participants analyzed two of the participants reached mastery of all probes while two remained in the multiples of six and three remained in multiples of four.

Social validity surveys were conducted with the students and with the paraprofessionals working in the classroom following the study. The survey was on a rating scale from one to four with one indicating "strongly disagree" and four indicating "strongly agree". Figure 23 shows the results of the student survey. The survey indicated a strong student preference for the opportunity to make choices (M=3.5). Overall, students preferred the consequence of choosing the reward (M=3.8) over teacher choice (M=2.5) and no reward (M=1.5). Results from the survey also indicated students felt the option for choosing was helpful to improve skill acquisition (M=2.75) and motivated them to work harder (M=3.3).

Figure 24 shows results of the social validity survey conducted with the paraprofessionals indicated a belief that the study motivated students (M=4), increased skill acquisition (M=4), and was easy to assist their target students in(M=4). The paraprofessionals agreed they noticed a decrease in unwanted behaviors (M=4) while observing students to be more engaged (M=4). Overall, the survey indicated the paraprofessionals found this educational practice to be very beneficial to the students (M=4).

CHAPTER 4

DISCUSSION

Results of this study were consistent with previous studies (Ackerlund Brandt, et al., 2016; Dozier, Juanico, Laudont, & Mick, 2015; Fenerty & Tiger, 2010; Tiger, Hanley, & Hernandez, 2006) that found participants demonstrated a preference for choice-making opportunities, increased skill acquisition (Tiger, Hanley, & Hernandez, 2006), and was an easy educational strategy to utilize universally within the classroom consistent with PBIS practices. Results of the current study utilizing choice conditions indicate choice along with concurrent choice options does have an influence on the establishing operations of a large group of students. Overall, student skill acquisition did increase and students indicated they were more motivated to work harder to achieve mastery on the multiplication and division worksheets within the study and on the fluency probes as well.

Though a preference for choice conditions, both as an antecedent and a consequence, was consistent with previous research, it is interesting to note some curious results. It was unexpected that the control condition would result in the second highest overall class average following the concurrent choice condition. It was anticipated that the child choice condition would result in the second highest class average based on results of previous research and the social validity survey. This unexpected result lead to the parsing out of data and removal of the six participants with previous high academic abilities.

The removal of the outliers from the total data however resulted in the same findings. The highest percentage correct was in the concurrent choice condition followed by the control condition, child choice condition, and no choice condition. In both data sets (whole class vs.

removal of outliers), the concurrent choice condition and control condition were only separated by a two to three tenths of a percentage.

It is important to note some of the causes the control condition resulted in the second highest level of skill acquisition. One of the reasons this may have occurred is due to the control condition not occurring until session eight. By session eight, experience and practice with the equations in the study along with the established motivation may have influenced the results. Another reason for the higher class average in the control condition may be related to the decrease of stress placed on achieving mastery. With no reward available, some students may have found less stress to perform under the pressure of the time limit. Another reason the control condition may have resulted in the second highest level of skill acquisition is due to the positive social attention paired with mastery in all phases, even in the control condition. Also, it should be noted that the number of participants changed from session to session as students were absent. This along with confounding variables such as changes in student emotional needs, medication changes, and other life events may have had an influence on individual daily scores which in turn may have skewed the overall averages. Future research should begin with the control condition for the first session or establish baseline using the control condition before implementing the alternating treatment design. Doing this would allow a clearer picture of each conditions effect on student skill acquisition.

The data results in this study were very closely linked between conditions and across sessions, however this was expected. A carryover effect from session to session was anticipated as the participants were learning. Future research should examine whether having a combination of choice conditions, concurrent choice, has an impact on overall student skill acquisition versus having no choice (i.e. initial link assigned). One way to achieve this would be to use statistical

data binning. This would allow researchers to reduce the effects of small observation errors and to allow a clearer picture of each condition's effect on skill acquisition for the whole class as well as for individual students.

Future research should examine whether using instructional choice as an antecedent combined with a consequence will have differing results when occurring on a varying schedule and not on consecutive days. During the current study, students were observed to be motivated by the contingencies set in place by the choice conditions, however data for each condition may not have accurately captured it. Student fatigue during the study may have played a part. Future research should examine whether using concurrent choice will generalize into other academic areas across the classroom setting. Improving other areas of math, reading fluency and comprehension, as well as writing, science and social studies are areas that teachers offering instructional choice can improve student skill acquisition and engagement on challenging tasks. By alternating the procedures and contingencies within the classroom setting, teachers may be able to enhance the value of choice itself. Often students become less motivated over time when the same contingencies are in place with the same reinforcement schedules. By alternating the choice contingencies on a varying schedule, the differential outcomes may therefore enhance the value of the reinforcers and lead to increased skill acquisition in higher quality tasks while still maintaining a decrease in maladaptive behaviors. Future research should also examine the probabilistic effects of instructional choice where the students roll the di to assign the initial link. This may enhance the EOs and increase motivation even further.

Another thing to consider for future research is individual preference for the reinforcers in the array. Using a survey to conduct a preference assessment does give an overall idea of most preferred reinforcers for a group, however it does not account for variability among

individuals. Though five items may result in the most highly preferred for a group, it is possible there are individuals who valued other reinforces instead, therefore the reinforcing value of the differential outcomes may not have been established as effective EOs. Future research may examine how individual preference for reinforcers may impact overall results as well as individual results. Increasing the number of different highly preferred reinforcers in the array may have a more positive effect on a large group of participants and thus increase the control of the intervention.

Another limitation of this study was identified as the varying academic abilities of the participants. Though some reached mastery criterion early, they were also identified as the top performing students and therefore were anticipated to reach mastery in a short period of time regardless of the conditions. Future research may differentiate the tasks used to study skill acquisition with large groups such as a whole classroom to get a clearer picture of its effectiveness on students of all skill levels and whether it can be used to push top performing students further in academics.

Within monitoring of the fluency probes to study student skill acquisition, a limitation was found as students were able to move to the next probe once mastery was achieved. Future research may examine skill acquisition throughout the study by running maintenance probes. This would allow researchers or teachers to ensure skill acquisition was mastered and the skill was maintained throughout the study.

Another limitation of this study was with the nature of the social validity survey. The survey results may be biased as there were only two paraprofessionals working closely with the classroom teacher and their relationships may have influenced the results. Also, future surveys should ask specific questions to obtain specific opinions of the paraprofessionals in regards to

how they perceived each treatment condition. They should examine if the paraprofessionals believed the control, no choice, child choice, or concurrent choice conditions motivated students differently and if so, what they believed to be the most effective.

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APPENDIX A

Color Preference Assessment Survey

Color	Hate It	It's Ok	I like it	LOVE it
white	1	2	3	4
pink	1	2	3	4
yellow	1	2	3	4
blue	1	2	3	4
salmon	1	2	3	4
purple	1	2	3	4
green	1	2	3	4

APPENDIX B

Reinforcer Preference Assessment Survey

Reinforcer	Don't Want	Kind Of Want	Want	REALLY Want
gumball	1	2	3	4
pixie stick	1	2	3	4
pencil	1	2	3	4
10 dojo points	1	2	3	4
5 minutes on Chromebook	1	2	3	4
read to the class	1	2	3	4
candy	1	2	3	4
prize from prize box	1	2	3	4

APPENDIX C

Multiplication/Division Worksheets for Conditioning

Name: _____ Date: _____

2 x 5 _____	90÷10= _____	6 * 5= _____	8÷ 2= _____	7 x 10 _____
10 / 1 = _____	8 * 2= _____	5 x 5 _____	20 ÷ 2= _____	2×3=____
8 x 1 _____	40 / 10 = _____	15 ÷ 3= _____	7 * 1= _____	30 / 3 = _____
16 ÷ 2= _____	50 ÷ 5= _____	10 x 10 _____	2 x 6 _____	12 ÷ 2= _____
5 x 3 _____	2 x 7= _____	50 / 5 = _____	6 ÷ 2= _____	10 x 6 _____

Control

Name: _____ Date: _____

5 x 5 _____	20 ÷ 2= _____	7 x 10 _____	12 ÷ 2= _____	$\frac{10}{1}$ = _____
6 * 5= _____	10 x 10 _____	7 * 1= _____	2 x 5 _____	8 * 2= _____
15 ÷ 3= _____	6 ÷ 2= _____	2 x 7= _____	$\frac{40}{10}$ = _____	10 x 6 _____
5 x 3 _____	$\frac{50}{5}$ = _____	8 x 1 _____	50 ÷ 5= _____	$\frac{30}{3}$ = _____
2×3=_____	8÷ 2= _____	2 x 6 _____	16 ÷ 2= _____	90÷10= _____

No choice

Name: _____ | Date: _____

12 ÷ 2= _____	6 ÷ 2= _____	10 x 10 _____	50 / 5 = _____	5 x 3 _____
10 / 1 = _____	6 * 5= _____	2 x 7= _____	10 x 6 _____	8÷ 2= _____
7 * 1= _____	2 x 6 _____	2×3=_____	50 ÷ 5= _____	40 / 10 = _____
2 x 5 _____	30 / 3 = _____	90÷10= _____	16 ÷ 2= _____	8 x 1 _____
20 ÷ 2= _____	7 x 10 _____	5 x 5 _____	8 * 2= _____	15 ÷ 3= _____

Child Choice

APPENDIX D

Multiplication/Division Worksheets

Control Condition

Name: _____ Date: _____

4 x 4 _____	56 ÷ 8= _____	6 * 4= _____	24 ÷ 4= _____	7 x 7 _____
49/7 = _____	8 * 6= _____	8 x 8 _____	32 ÷ 8= _____	7×4=____
7 x 6 _____	36/6 = _____	42 ÷ 7= _____	8 * 4= _____	48/6 = _____
16 ÷ 4= _____	24 ÷ 3= _____	7 x 8 _____	6 x 6 _____	28 ÷ 7= _____
4 x 3 _____	6 x 7= _____	24/4 = _____	18 ÷ 6= _____	3 x 6 _____

No Choice Condition

Name: _____ Date: _____

6 * 4= _____	$\frac{49}{7}$ = _____	7×4=____	8 * 4= _____	6 x 6 _____
24 ÷ 3= _____	7 x 7 _____	$\frac{36}{6}$ = _____	24 ÷ 4= _____	16 ÷ 4= _____
32 ÷ 8= _____	18 ÷ 6= _____	8 x 8 _____	6 x 7= _____	3 x 6 _____
$\frac{24}{4}$ = _____	4 x 4 _____	28 ÷ 7= _____	7 x 6 _____	42 ÷ 7= _____
56 ÷ 8= _____	$\frac{48}{6}$ = _____	8 * 6= _____	7 x 8 _____	4 x 3 _____

Child Choice

Name: _____ Date: _____

24 ÷ 3= _____	8 x 8 _____	7 x 7 _____	8 * 6= _____	7 x 6 _____
24 ÷ 4= _____	3 x 6 _____	56 ÷ 8= _____	16 ÷ 4= _____	4 x 4 _____
18 ÷ 6= _____	7×4=____	7 x 8 _____	48/6 = _____	49/7 = _____
32 ÷ 8= _____	42 ÷ 7= _____	24/4 = _____	28 ÷ 7= _____	4 x 3 _____
6 * 4= _____	36/6 = _____	6 x 6 _____	6 x 7= _____	8 * 4= _____

APPENDIX E

Data Collection Form

Session	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Initial Link																									
Participant																									
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
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24																									
25																									
26																									
27																									
28																									
29																									
30																									
Total Meeting Mastery																									
Class Mean																									

Initial link selected for each session is indicated as follows: control A, no choice B, Child Choice C, Concurrent Choice options indicated with *
Data reported as number of problems correct/total number of problems * 100

APPENDIX F

Fluency Probes

Name _____ Date _____

4 × 0	4 × 5	4 × 8	4 × 9
4 × 3	0 × 4	7 × 4	1 × 4
4 × 7	2 × 4	4 × 10	6 × 4
4 × 4	4 × 1	10 × 4	4 × 2
8 × 4	3 × 4	5 × 4	4 × 6

Name _____ Date _____

6 × 4	0 × 6	6 × 7	6 × 10
6 × 6	8 × 6	4 × 6	6 × 8
1 × 6	6 × 2	6 × 9	6 × 0
5 × 6	2 × 6	7 × 6	6 × 5
3 × 6	10 × 6	6 × 1	9 × 6

Name _____ Date _____

7 × 2	7 × 0	1 × 7	8 × 7
7 × 8	7 × 4	7 × 9	4 × 7
6 × 7	2 × 7	7 × 7	7 × 3
7 × 10	7 × 5	7 × 1	10 × 7
5 × 7	0 × 7	7 × 6	3 × 7

Name _____ Date _____

3 × 8	8 × 0	8 × 7	2 × 8
8 × 6	7 × 8	8 × 9	6 × 8
8 × 8	0 × 8	8 × 10	8 × 5
9 × 8	8 × 3	8 × 2	10 × 8
8 × 4	4 × 8	5 × 8	1 × 8

Name _____ Date _____

32 ÷ 4 = ____	8 ÷ 4 = ____
0 ÷ 4 = ____	24 ÷ 4 = ____
16 ÷ 4 = ____	4 ÷ 4 = ____
20 ÷ 4 = ____	36 ÷ 4 = ____
40 ÷ 4 = ____	12 ÷ 4 = ____
28 ÷ 4 = ____	20 ÷ 4 = ____
36 ÷ 4 = ____	24 ÷ 4 = ____
8 ÷ 4 = ____	4 ÷ 4 = ____
32 ÷ 4 = ____	0 ÷ 4 = ____
12 ÷ 4 = ____	40 ÷ 4 = ____

Name _____ Date _____

18 ÷ 6 = ____	12 ÷ 6 = ____
6 ÷ 6 = ____	48 ÷ 6 = ____
30 ÷ 6 = ____	0 ÷ 6 = ____
54 ÷ 6 = ____	60 ÷ 6 = ____
42 ÷ 6 = ____	36 ÷ 6 = ____
24 ÷ 6 = ____	0 ÷ 6 = ____
48 ÷ 6 = ____	6 ÷ 6 = ____
42 ÷ 6 = ____	30 ÷ 6 = ____
60 ÷ 6 = ____	36 ÷ 6 = ____
54 ÷ 6 = ____	18 ÷ 6 = ____

Name _____ Date _____

0 ÷ 7 = ____	35 ÷ 7 = ____
70 ÷ 7 = ____	42 ÷ 7 = ____
49 ÷ 7 = ____	21 ÷ 7 = ____
63 ÷ 7 = ____	14 ÷ 7 = ____
28 ÷ 7 = ____	56 ÷ 7 = ____
7 ÷ 7 = ____	14 ÷ 7 = ____
7 ÷ 7 = ____	35 ÷ 7 = ____
0 ÷ 7 = ____	56 ÷ 7 = ____
21 ÷ 7 = ____	63 ÷ 7 = ____
70 ÷ 7 = ____	42 ÷ 7 = ____

Name _____ Date _____

80 ÷ 8 = ____	16 ÷ 8 = ____
40 ÷ 8 = ____	32 ÷ 8 = ____
8 ÷ 8 = ____	56 ÷ 8 = ____
64 ÷ 8 = ____	72 ÷ 8 = ____
24 ÷ 8 = ____	48 ÷ 8 = ____
0 ÷ 8 = ____	40 ÷ 8 = ____
32 ÷ 8 = ____	16 ÷ 8 = ____
8 ÷ 8 = ____	72 ÷ 8 = ____
80 ÷ 8 = ____	56 ÷ 8 = ____
64 ÷ 8 = ____	0 ÷ 8 = ____

APPENDIX G

Fluency Probe Data Collection Sheet

Participant: _____ Fluency Probes

Date	Multiple	Score	Time
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
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	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		
	* 4 6 7 8 ÷		

APPENDIX H

Social Validity Survey for Students

	Strongly Disagree	Disagree	Agree	Strongly Agree
1. I liked the opportunity to make choices.	1	2	3	4
2. I liked when the teacher chose my reward.	1	2	3	4
3. I liked when I chose the reward.	1	2	3	4
4. I liked when there was no reward.	1	2	3	4
5. Having choice helped me learn multiplication and division faster.	1	2	3	4
6. Having choice made me want to work harder.	1	2	3	4

APPENDIX I

Social Validity Survey for Paraprofessionals

	Strongly Disagree	Disagree	Agree	Strongly Agree
1. I feel like the students were motivated by the choice conditions.	1	2	3	4
2. I believe this study increased student multiplication and division fluency.	1	2	3	4
3. I believe the students understood each of the choice conditions.	1	2	3	4
4. I feel this study was easy for me to assist my target student.	1	2	3	4
5. I feel like students were engaged during this study.	1	2	3	4
6. I noticed a decrease in unwanted behaviors.	1	2	3	4
7. Overall I feel this study was beneficial to the students.	1	2	3	4

APPENDIX J

Figures

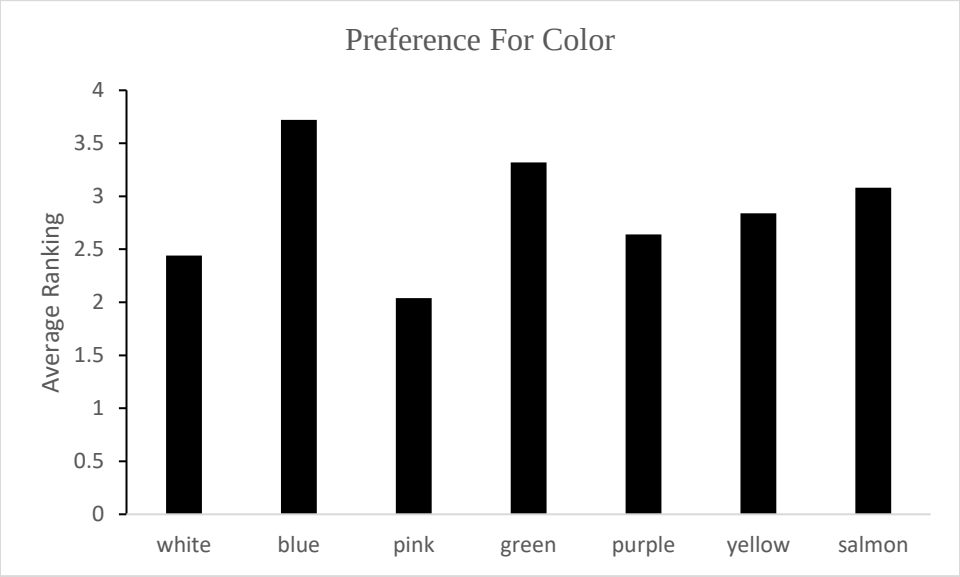

Figure 1. Average score of color preference assessment. The three most "neutral" colors were used for the study (purple, yellow, and salmon).

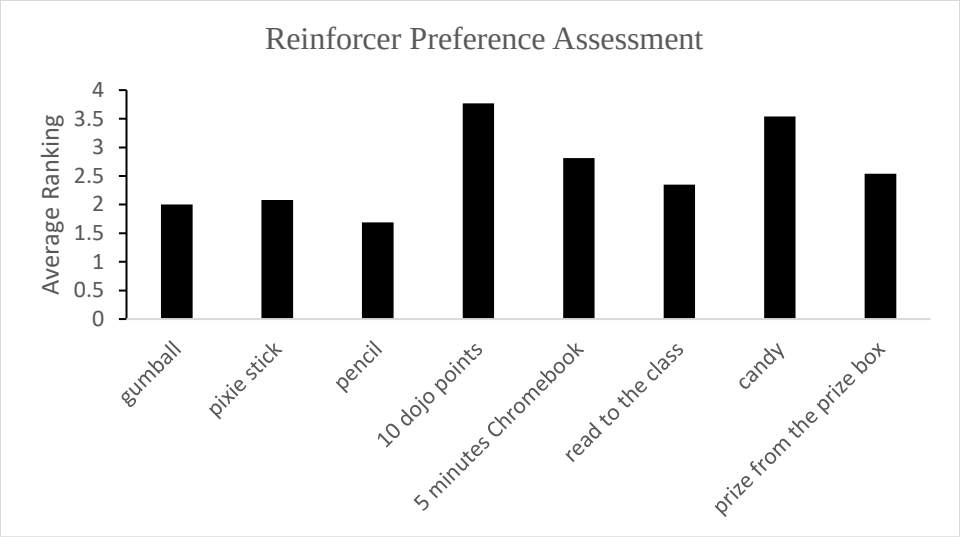

Figure 2. Average ranking for reinforcer preference assessment. The top five reinforcers shown are 10 dojo points, candy, five minutes on the Chromebook, prize from the prize box, and read to the class.

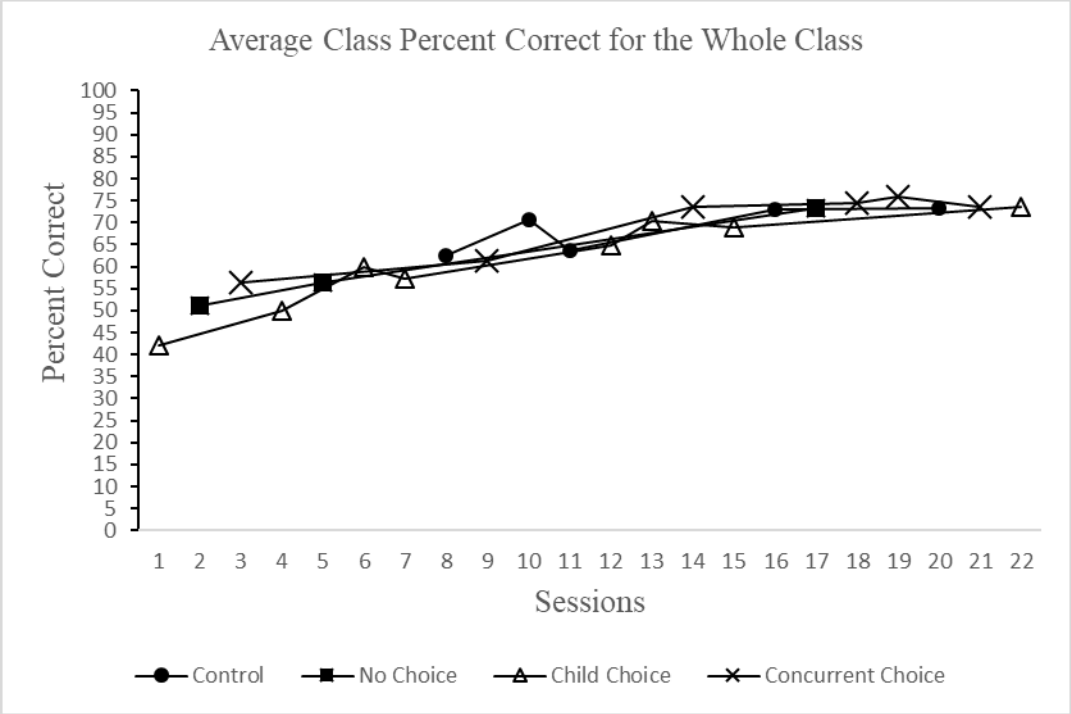

Figure 3. Average percent of equations correctly completed by the whole class and associated choice condition.

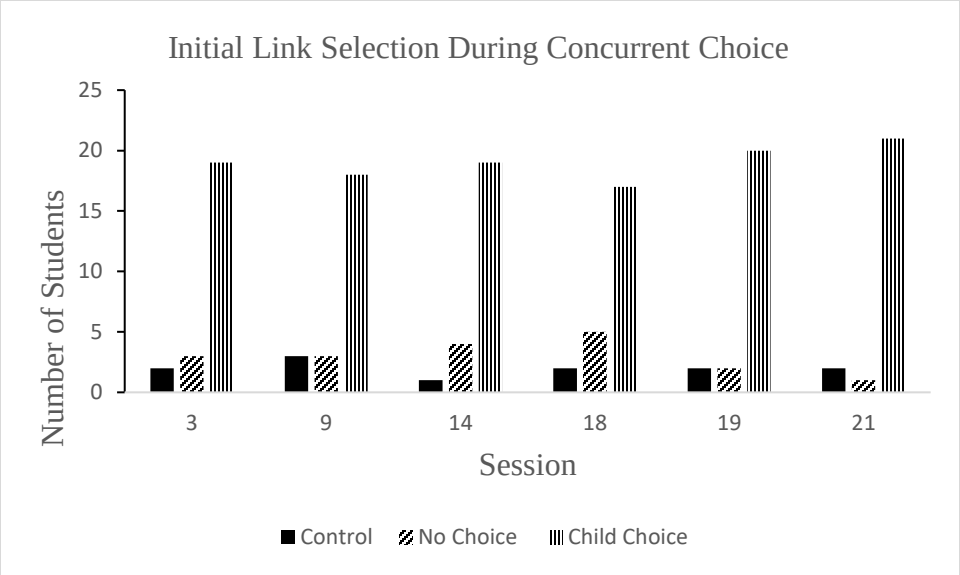

Figure 4. Number of students who selected the control, no choice, and child choice initial link during the concurrent choice option.

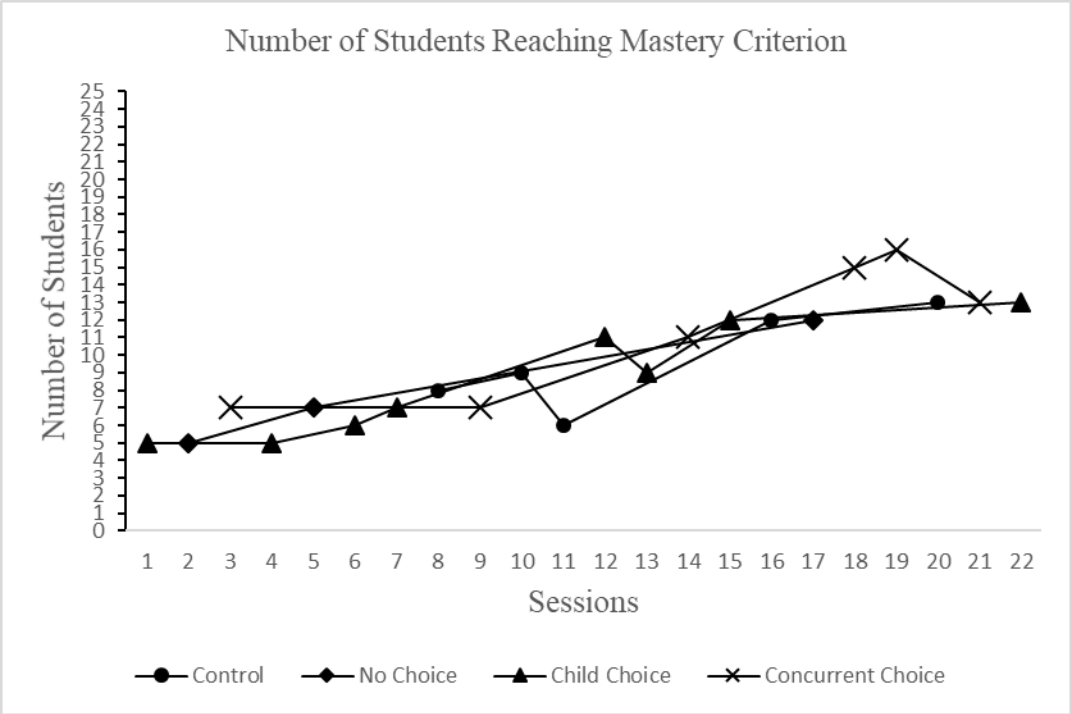

Figure 5. Total number of students reaching mastery (100%) at each session.

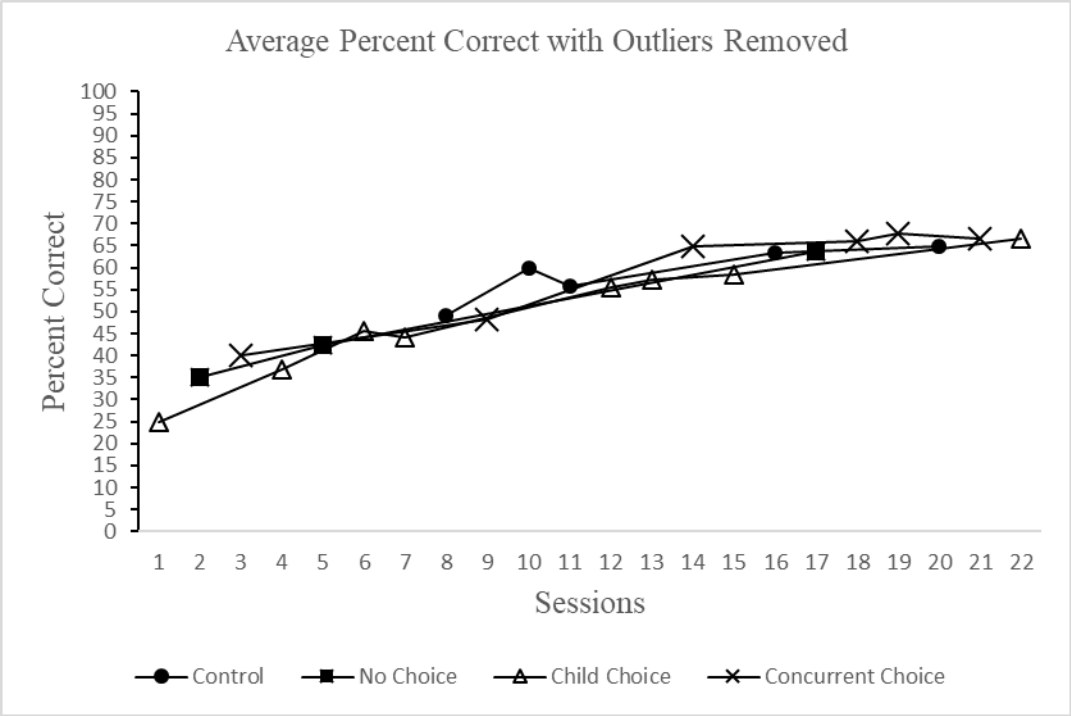

Figure 6. Average percent of equations correctly completed with outliers removed from data and the associated choice condition

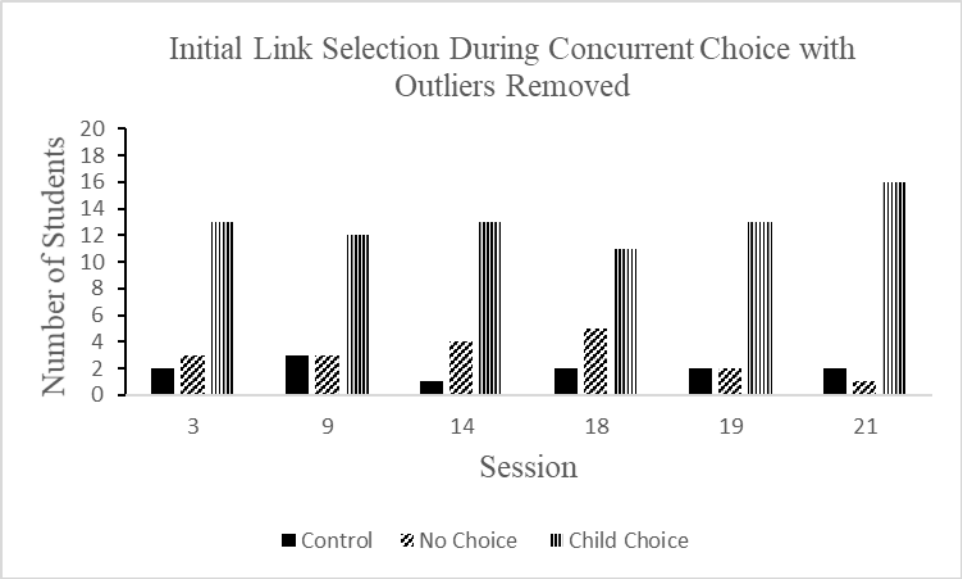

Figure 7. Number of students who selected the control, no choice, and child choice initial link during the concurrent choice option with outliers removed from data.

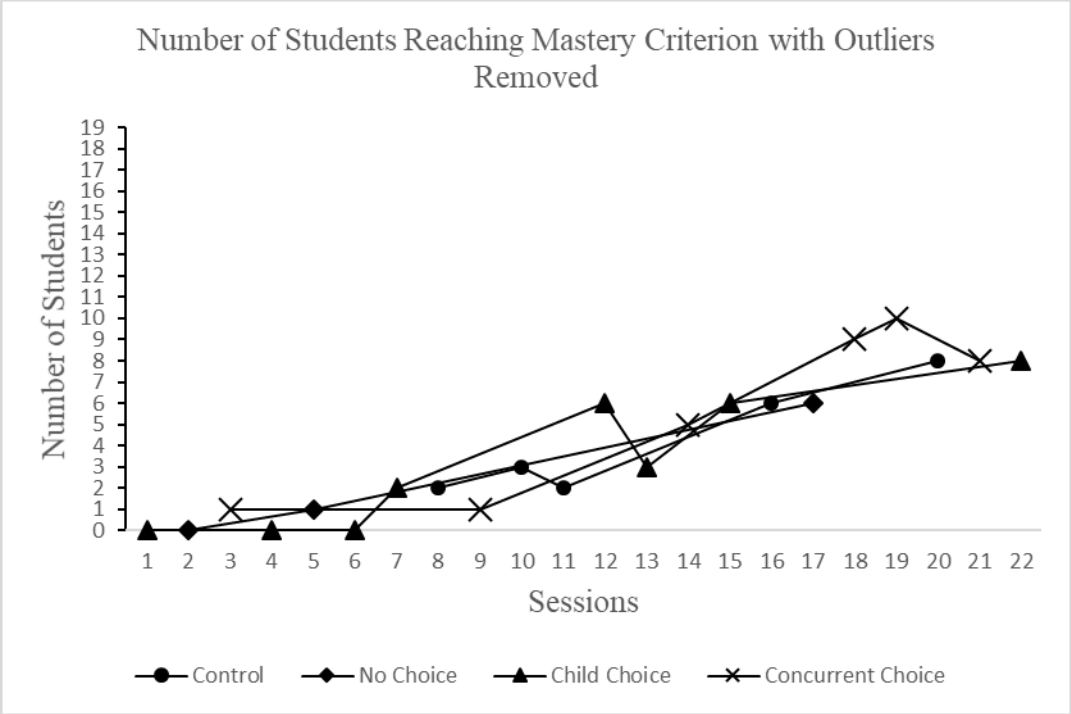

Figure 8. Total number of students reaching mastery (100%) at each session with outliers removed from data.

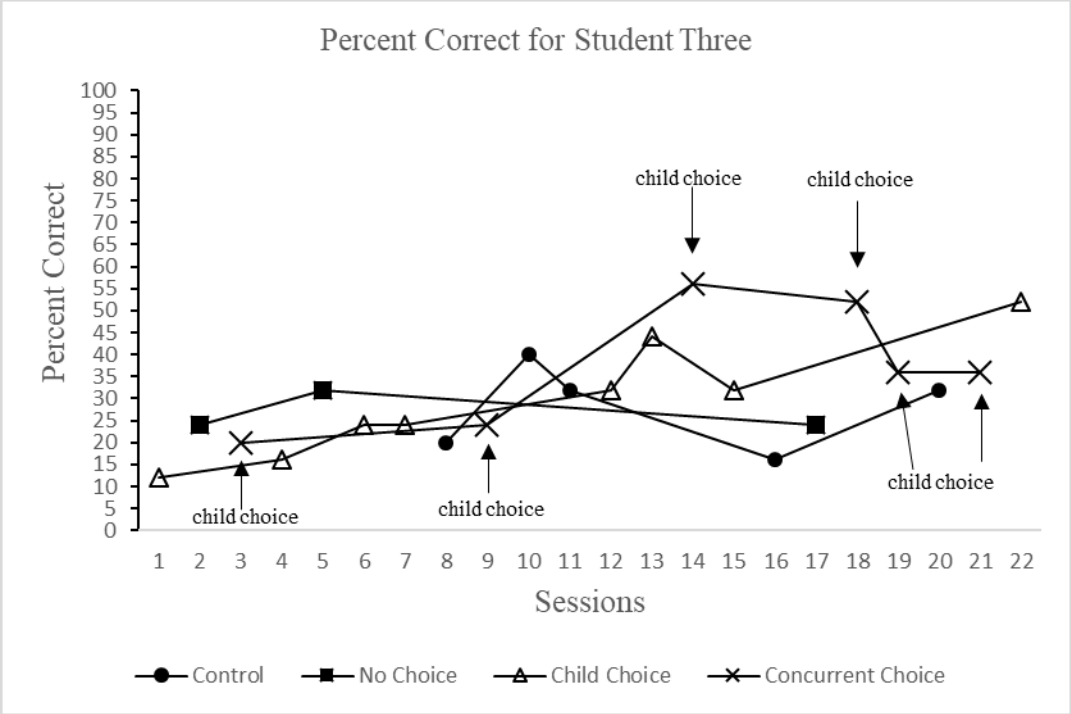

Figure 9. Percent correct for one participant, Student Three, on skill acquisition of multiplication and division fluency and associated choice condition.

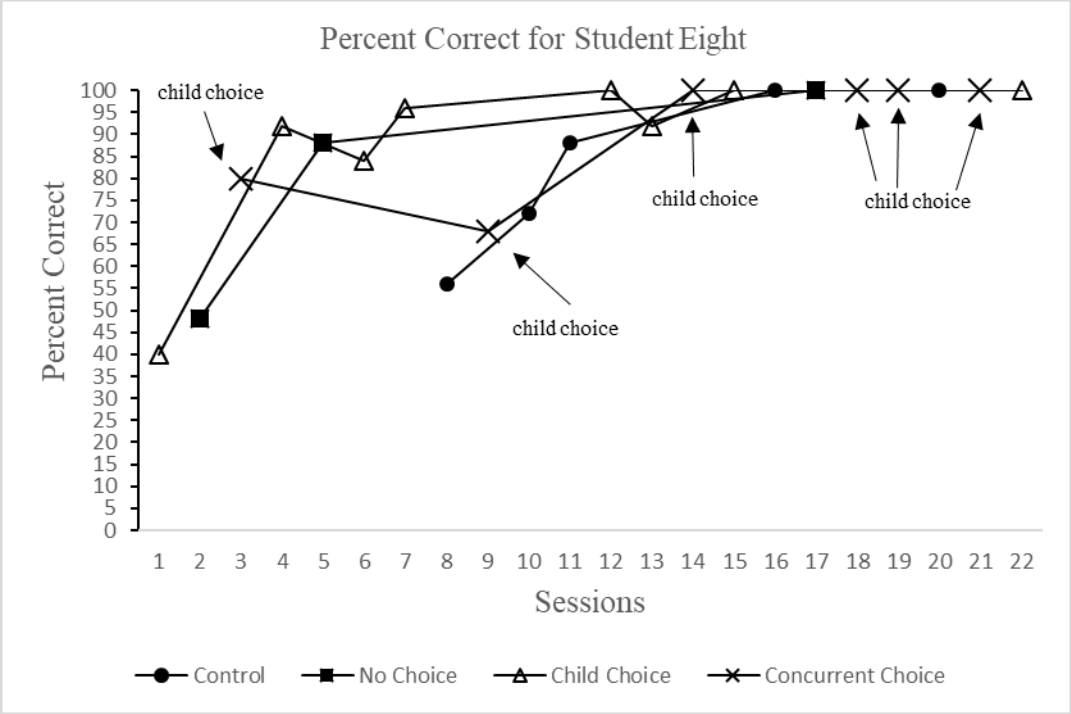

Figure 10. Percent correct for one participant, Student Eight, on skill acquisition of multiplication and division fluency and associated choice condition.

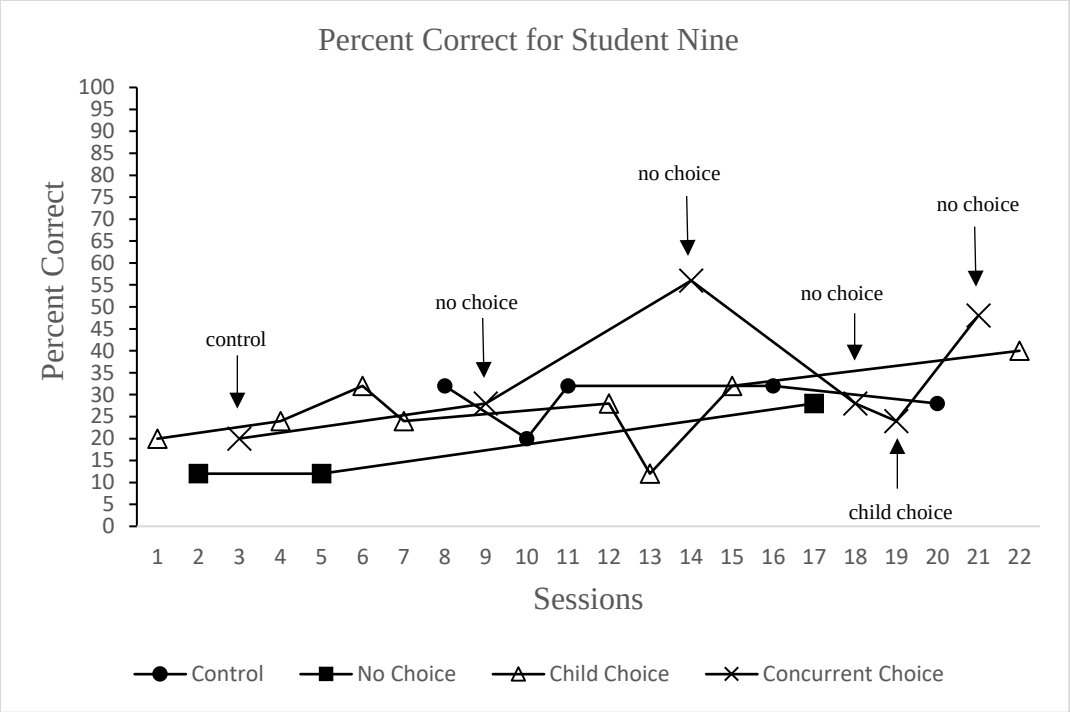

Figure 11. Percent correct for one participant, Student Nine, on skill acquisition of multiplication and division fluency and associated choice condition.

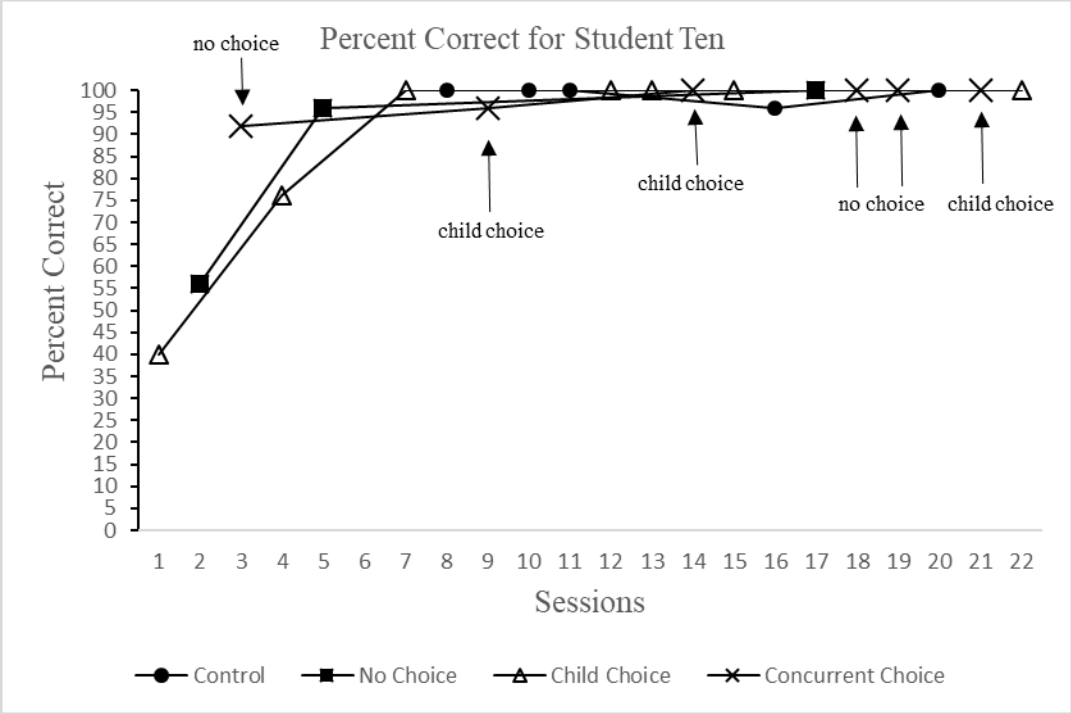

Figure 12. Percent correct for one participant, Student Ten, on skill acquisition of multiplication and division fluency and associated choice condition.

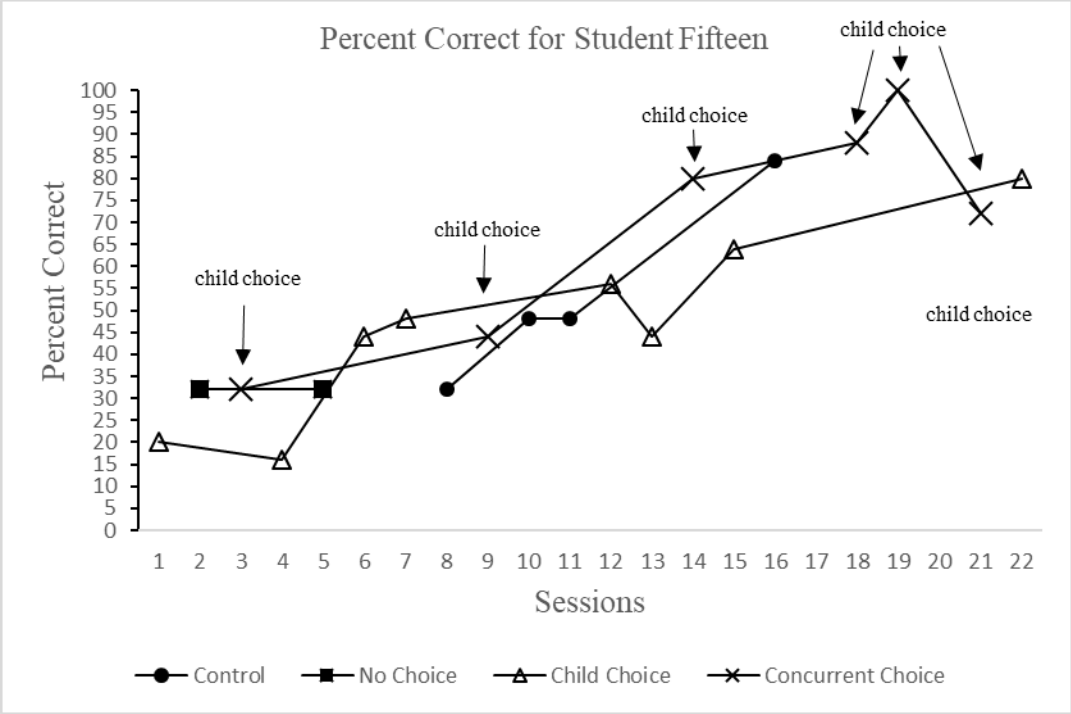

Figure 13. Percent correct for one participant, Student Fifteen, on skill acquisition of multiplication and division fluency and associated choice condition.

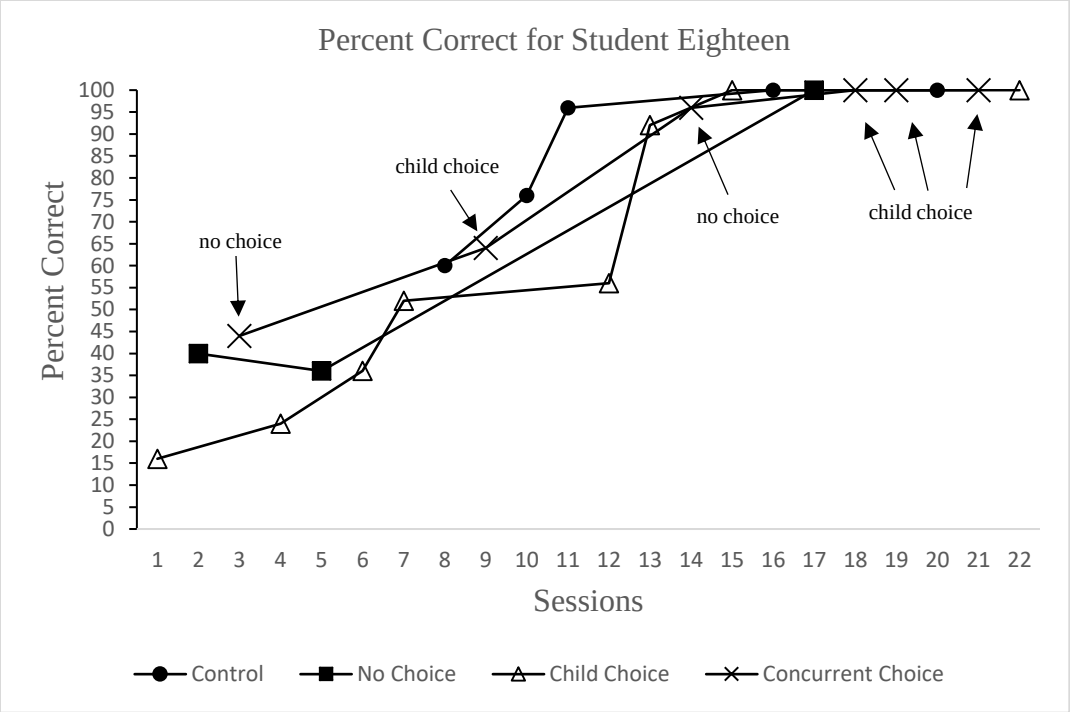

Figure 14. Percent correct for one participant, Student Eighteen, on skill acquisition of multiplication and division fluency and associated choice condition.

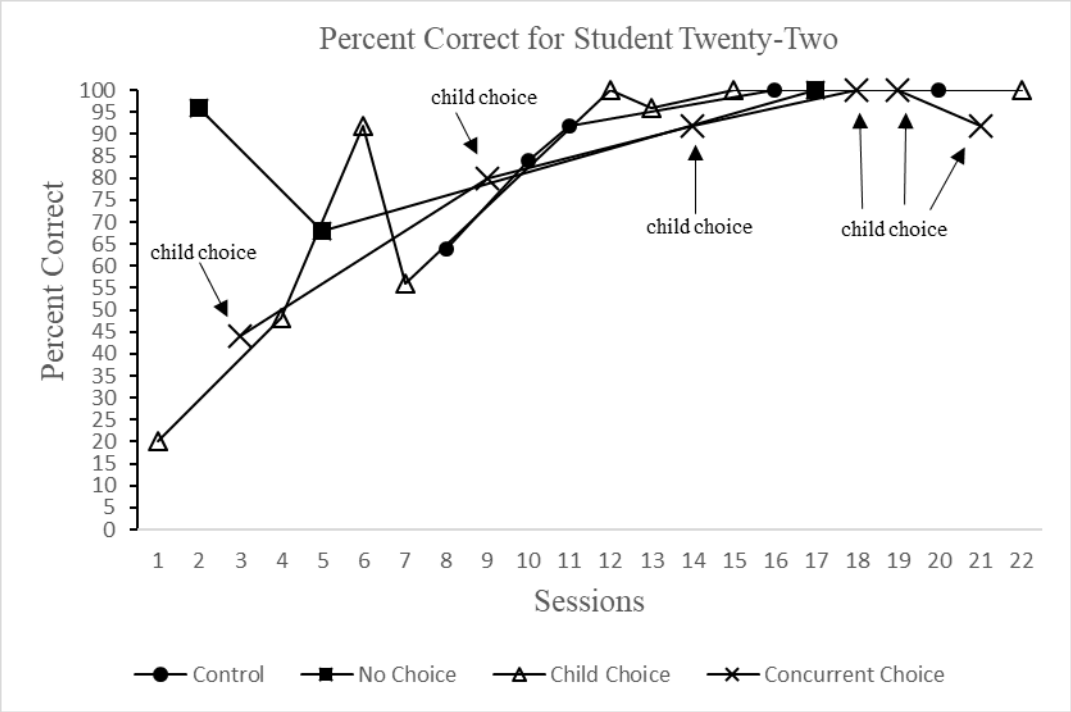

Figure 15. Percent correct for one participant, Student Twenty-Two, on skill acquisition of multiplication and division fluency and associated choice condition.

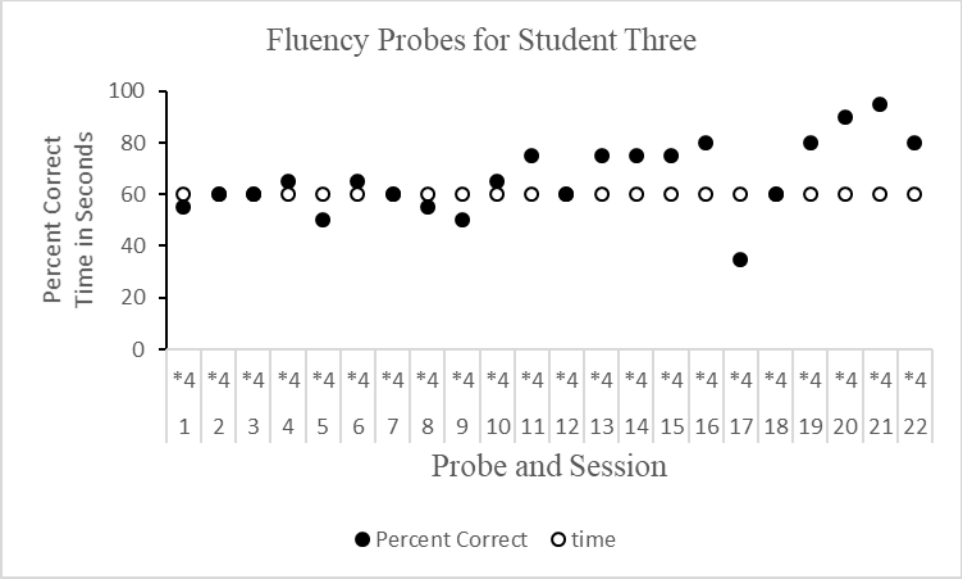

Figure 16. Results of fluency probes for Student Three. Results shown as percent correct and time required to finish each probe. Probes are indicated to identify whether the fluency probe was multiplication (*) or division (÷).

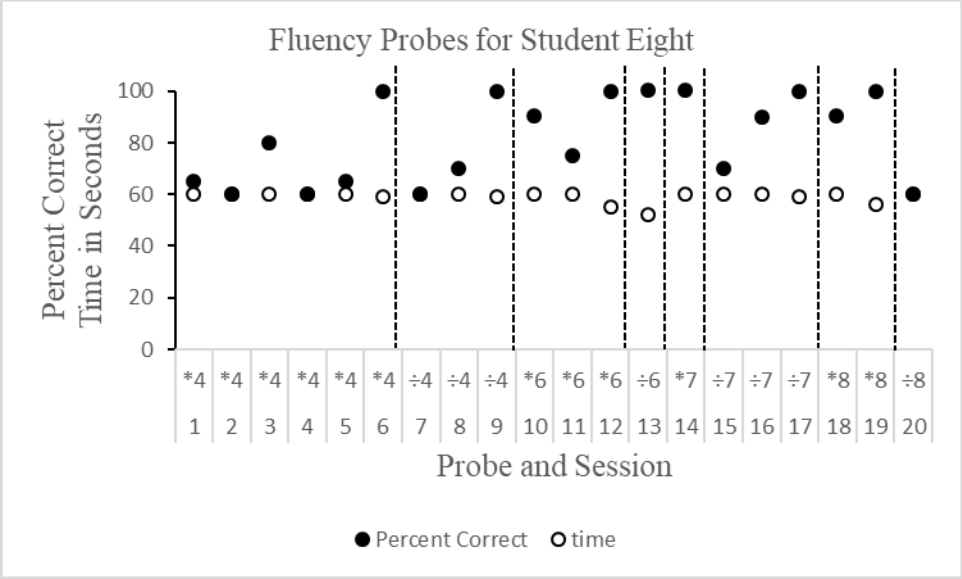

Figure 17. Results of fluency probes for Student Eight. Results shown as percent correct and time required to finish each probe. Probes are indicated to identify whether the fluency probe was multiplication (*) or division (÷).

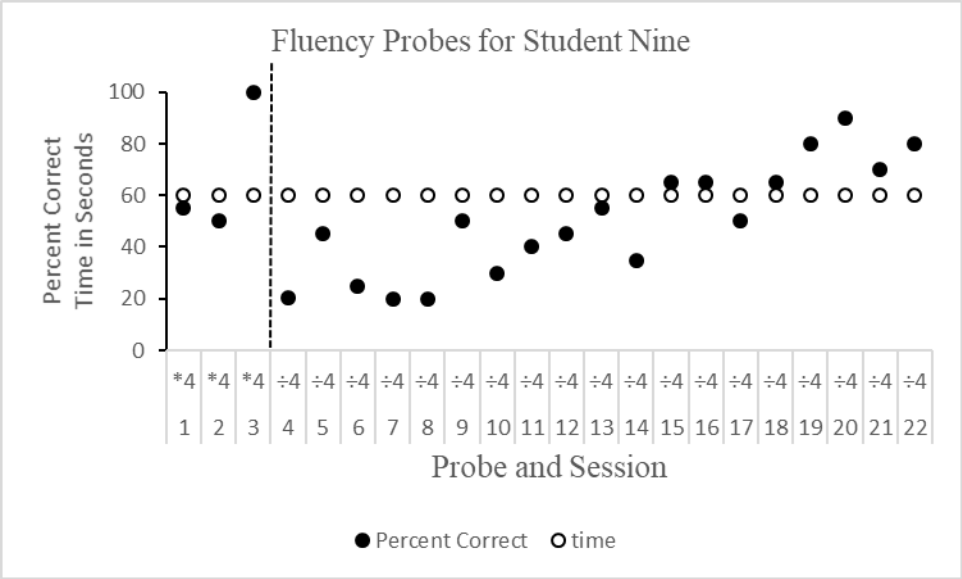

Figure 18. Results of fluency probes for Student Nine. Results shown as percent correct and time required to finish each probe. Probes are indicated to identify whether the fluency probe was multiplication (*) or division (÷).

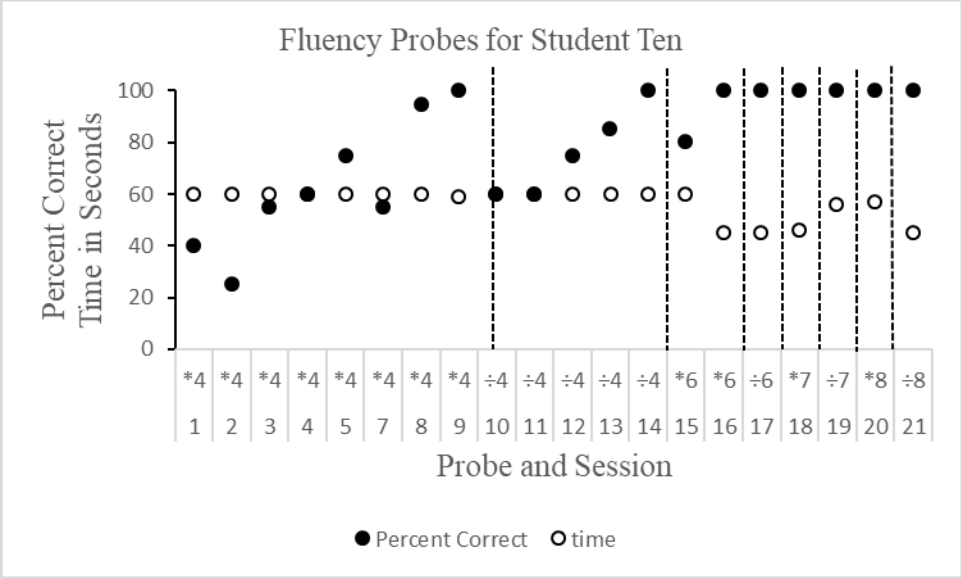

Figure 19. Results of fluency probes for Student Ten. Results shown as percent correct and time required to finish each probe. Probes are indicated to identify whether the fluency probe was multiplication (*) or division (÷).

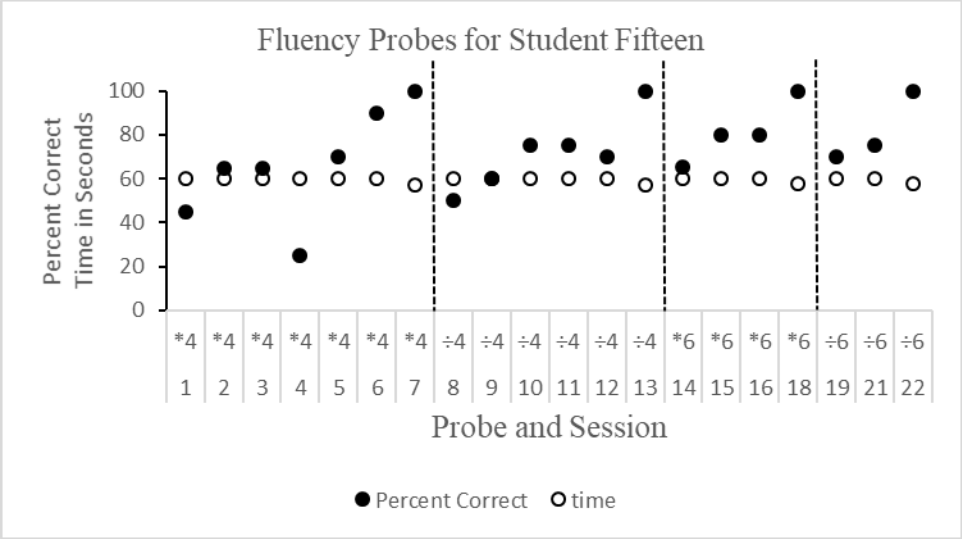

Figure 20. Results of fluency probes for Student Fifteen. Results shown as percent correct and time required to finish each probe. Probes are indicated to identify whether the fluency probe was multiplication (*) or division (÷).

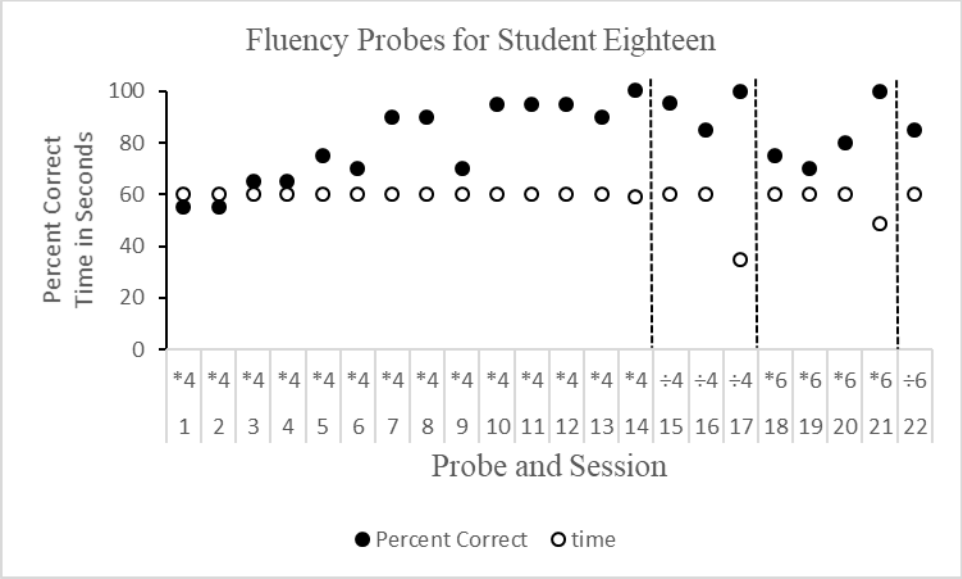

Figure 21. Results of fluency probes for Student Eighteen. Results shown as percent correct and time required to finish each probe. Probes are indicated to identify whether the fluency probe was multiplication (*) or division (÷).

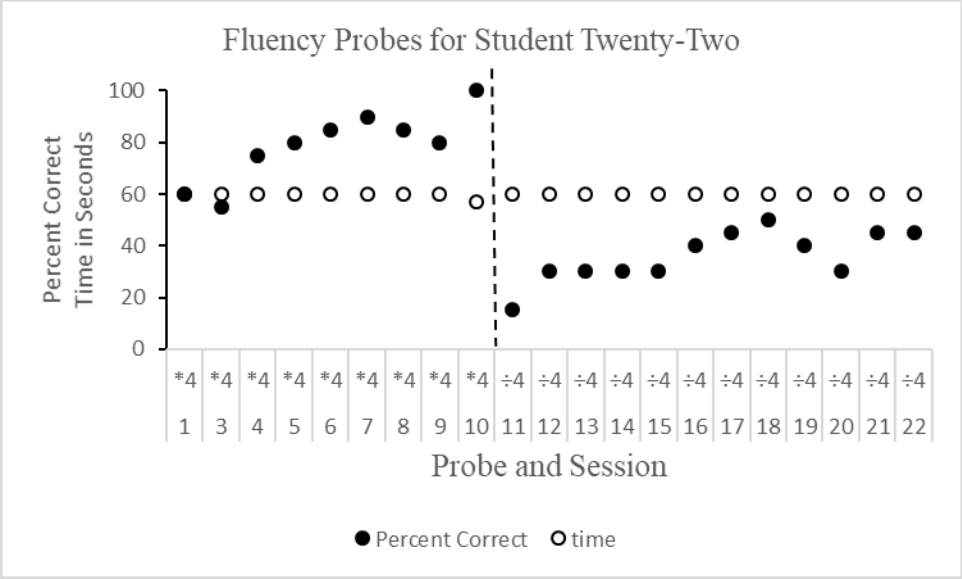

Figure 22. Results of fluency probes for Student Twenty-Two. Results shown as percent correct and time required to finish each probe. Probes are indicated to identify whether the fluency probe was multiplication (*) or division (÷).

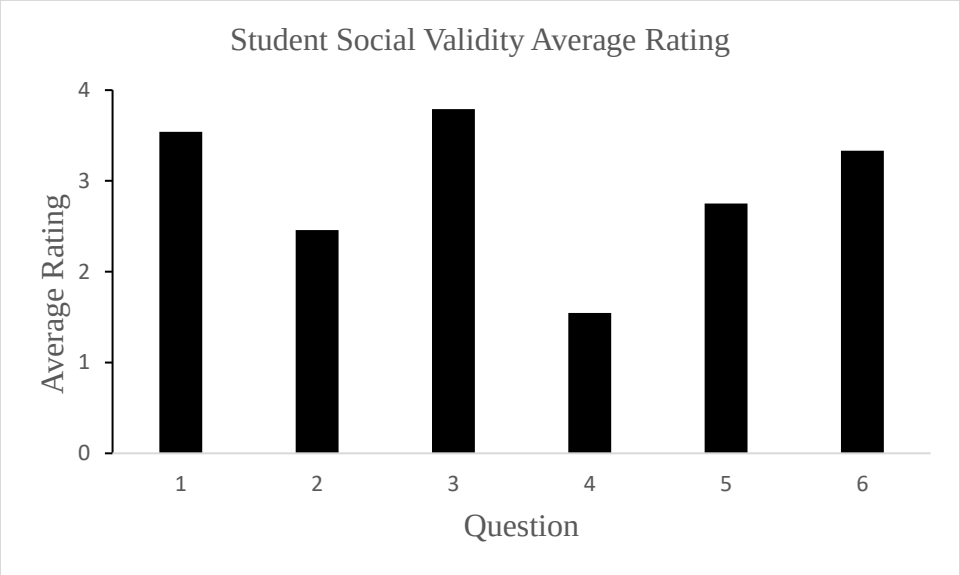

Figure 23. Average rating on a scale of 1 (strongly disagree) to 4 (strongly agree) for social validity for students per question on survey.

Question 1: “I liked the opportunity to make choices

Question 2: “I liked when the teacher chose my reward.”

Question 3: “I liked when I chose the reward.”

Question 4: “I liked when there was no reward.”

Question 5: “Having choice helped me learn multiplication and division faster.”

Question 6: “Having choice made me want to work harder.”

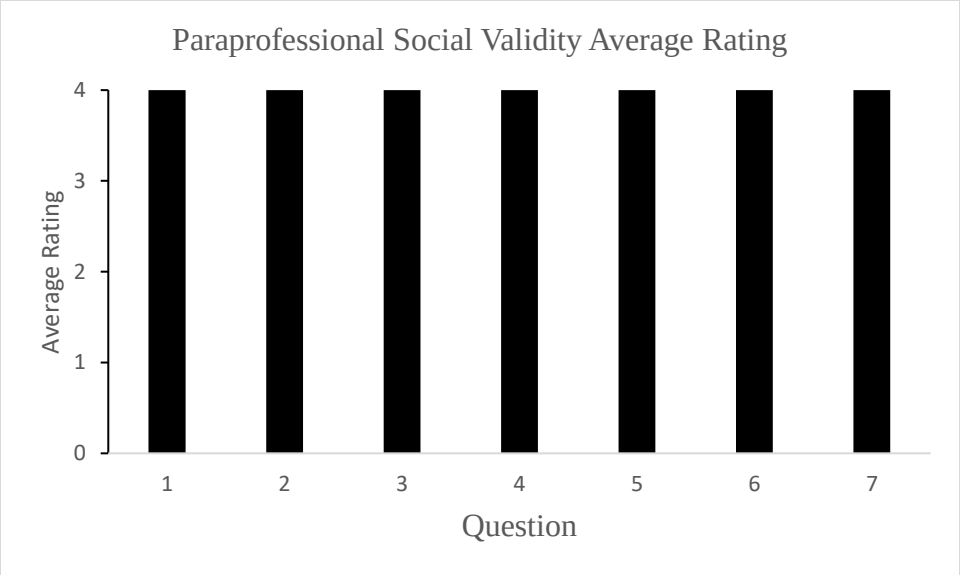

Figure 24. Average rating on a scale of 1 (strongly disagree) to 4 (strongly agree) for social validity for paraprofessionals per question on survey.

Question 1: "I feel like the students were motivated by choice conditions."

Question 2: "I believe this study increased student multiplication and division fluency."

Question 3: "I believe the students understood each of the choice conditions."

Question 4: "I feel this study was easy for me to assist my target student."

Question 5: "I feel like students were engaged during this study."

Question 6: "I noticed a decrease in unwanted behaviors."

Question 7: "Overall I feel this study was beneficial to the students."

APPENDIX K

IRB Approval Form

NORTHERN MICHIGAN UNIVERSITY

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MEMORANDUM

TO: Terri Tammelin
Psychological Science Department

CC: Ashley Shayter
Psychological Science Department

FROM: Dr. Lisa Schade Eckert
Interim Dean of Graduate Education and Research

DATE: April 26, 2019

RE: Modification to HS19-1038
Original IRB Approval Date: 4/22/19
Modification Approval Date: 4/26/19
Expiration Date: 4/21/20
"Effects of Choice on Multiplication and Division Fluency Acquisition for Third Grade Students"

Your modification for the project "Effects of Choice on Multiplication and Division Fluency Acquisition for Third Grade Students" has been approved under the administrative review process. Please include your proposal number (HS19-1038) on all research materials and on any correspondence regarding this project.

Any additional changes or revisions to your approved research plan must be approved by the IRB prior to implementation. Unless specified otherwise, all previous requirements included in your original approval notice remain in effect.

If you complete your project within 12 months from the date of your approval notification, you must submit a Project Completion Form for Research Involving Human Subjects. If you do not complete your project within 12 months from the date of your approval notification, you must submit a Project Renewal Form for Research Involving Human Subjects. You may apply for a one-year project renewal up to four times.

NOTE: Failure to submit a Project Completion Form or Project Renewal Form within 12 months from the date of your approval notification will result in a suspension of Human Subjects Research privileges for all investigators listed on the application until the form is submitted and approved.

If you have any questions, please contact the IRB at hsrr@nmu.edu.