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Improving Fact Fluency for Students with Learning Disabilities

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EDU635: Capstone Project: An Action Research Project

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Abstract

The intent of this action research project was to assess the impact of fact fluency when implementing the Direct Instruction (DI) Flashcard intervention for students in special education using curriculum-based measurements. The participants were elementary students who all received specially designed instruction in the area of math due to their Individualized Education Programs (IEPs) in that area. In addition to the body of research in place regarding fact fluency and the DI Flashcard intervention, this study also took into account the students' initial skill levels as outlined in their IEPs. The intervention occurred over three weeks in a special education classroom. Three sets of flashcards were used throughout the intervention for all participants. Pre-test and post-test data were collected and compared. An improvement was not shown between pre-test and post-test scores. IEP progress monitoring data did show marked improvement for all participants. Study limitations were included and future research recommendations were offered.

Keywords: DI flashcards, fact fluency, addition, elementary, special education, disabilities, interventions

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Every day, people are faced with opportunities to utilize foundational math skills. To eliminate frustrations, it is critical for people to acquire number sense and problem-solving skills to support these daily decisions (Baker & Cuevas, 2018; Skarr et al., 2014). In addition, the ability to solve basic facts fluently and accurately provides a foundation for future mathematical skills to be acquired (Lin & Kubina, 2005; Nelson et al., 2016; Nordness et al., 2011; Skarr et al., 2014). Ultimately, these initial skills are essential for developing more complex skills. There are countless students who do not attain fact fluency and this can lead to overall math difficulties (Hawkins et al., 2017). Unfortunately, according to the 2023 Conditions of Education Report, student proficiency scores in mathematics performance dropped five points for students in fourth grade and eight points for students in eighth grade from 2019 to 2022 (The Nation's Report Card, n.d.). Baker & Cuevas (2018) noted students with learning disabilities find the development of fact fluency and automaticity to be extremely difficult. Therefore, it is vital that appropriate interventions are implemented to support these foundational skills for students with learning disabilities. Research has shown several types of interventions to have a positive impact on fact fluency for students with learning disabilities. The researcher will utilize an evidence-based intervention and complete further analysis of the impact of students' initial skill levels and the effectiveness of the intervention (Delong et al., 2013; Glover et al., 2010; Skarr et al., 2014). The problem remains, if effective fact fluency interventions for students with learning disabilities are not implemented, mathematics deficits may continue to grow, which will have a significant impact on acquiring further concepts and skills.

The purpose of this action research project is to determine if using a consistent Direct Instruction Flashcard intervention, with students with math Individualized Education Program

(IEP) goals, will increase their overall fact fluency. A second purpose is to determine if there is a relationship between the fact fluency impact and the student's current level of mastered skills based on curriculum-based measurements. The researcher currently serves five students who have a math goal in their IEP. The students are not at the same level, nor do they have the same goals. Skill rubrics are utilized to measure progress towards individualized student math goals which are aligned to common core math standards.

Research in this project included peer-reviewed studies gathered from the online DeWitt Library accessed from Northwestern College, Orange City, Iowa, and Google Scholar. The majority of these studies were conducted within the last 10 years. A portion of the studies included are older than 10 years because they provide essential and foundational research in math fact fluency. To be included in the literature review, the studies needed to focus on the importance of fact fluency and evidence-based interventions used to improve the automaticity of facts. In addition, the focus of this study is specific to students with learning needs at the elementary level. Studies were also included which focused on these areas. The scope of this action research included elementary-aged students who have identified learning needs in math and deficiencies in fact fluency.

The researcher believes by implementing a consistent evidence-based fact fluency intervention, specifically a Direct Instruction Flashcard intervention, students' fact fluency and automaticity will improve as supported by research completed by Skarr et al. (2014). The researcher was able to find information that suggested students' prior knowledge could impact the type of intervention used; however, she was not able to find any studies related to the correlation between fact fluency growth and students' initial skill levels (Baker & Cuevas, 2018). The researcher believes if a student starts with fewer fact fluency skills, they will have a lower

rate of growth. In contrast, the researcher expects students with a higher level of fact fluency skills to have a greater rate of growth. This data can influence and support the need for additional fact fluency interventions to be implemented across the special education department and possibly all elementary classrooms for students experiencing math difficulties. Findings will be shared with other special education teachers, general education teachers, parents, and administration. The research findings will help determine if regular flashcard routines should be implemented in addition to current math interventions. Math intervention routines followed by general education teachers and math interventionists throughout the school district could also be impacted.

The literature review section includes several critical pieces of information based on the importance of fact fluency and automaticity for all students, but especially for those with learning disabilities. The literature review begins by explaining what fact fluency is and its importance to future mathematics learning. The second section describes the process for developing fact fluency. Next, the literature review focuses on the key qualities of an effective intervention, which then leads to specific and effective fact-fluency interventions for students with disabilities. The final section summarizes the key points and connects the studies to the current research.

Review of the Literature

Mathematics skills are critical components for all people to live a self-sufficient life. The mastery of basic facts is one such foundational competency that prepares students for more complex problem-solving as well as essential life skills (Berrett & Carter, 2018). The impact of fact fluency has been researched over the decades along with the various types of interventions which have proven to show fact fluency improvement. This literature review will provide an

overview of fact fluency's importance, key definitions, principles of effective interventions, and a description of various research-based interventions aimed at improving overall fact fluency for students with learning disabilities.

Fact Fluency and Its Importance

According to Baker and Cuevas (2018) and Nordness et al. (2011), mathematic skills are essential for learning, independent living, and being successful in multiple career areas. Balancing bank accounts, paying bills, using measurements in cooking and construction, and daily shopping require these skills (Poncy et al., 2010). To prepare for these future activities, students need to acquire foundational math skills. One of these foundational math skills, typically acquired in elementary, can be referred to as math fact fluency or number combinations. Nelson et al. (2013) shared that students who have a deficit with fact fluency are "at risk for math difficulties" (p. 659). Therefore, the importance of fact fluency cannot be taken lightly.

Fuchs et al. (2008) define number combinations as "problems with single-digit operands, which can be solved by counting or committing to long-term memory for automatic retrieval" (p. 80). Math fluency is the ability to accurately and quickly solve math facts (Lin & Kubina, 2005; Poncy et al., 2010). To acquire math fluency, one must first develop automaticity (Baker & Cuevas, 2018). Automaticity is defined as "the ability to deliver the correct answer immediately from memory without conscious thought" (Stickney et al., 2012, as cited in Baker & Cuevas, 2018, p. 13). Students must first be able to answer the math facts accurately using memory-based retrieval before becoming fluent, which includes both accuracy and speed (Fuchs et al., 2008). Therefore, math fact fluency using number combinations is the ability to quickly and

accurately solve single-digit math facts with automaticity and be able to retrieve them from memory.

The research suggests if students are not able to master fluency and accuracy skills in elementary, they will not have the expertise "to acquire more advanced skills" (Poncy et al., 2010, p. 917). When students have not developed fact fluency, research shows they need to use more cognitive resources when solving advanced or complex mathematic applications (Berrett & Carter, 2018; Burns et al., 2015). Students who are unable to have automaticity with their facts are also "more likely to make computational errors" when solving higher-level math problems (Riccomini et al., 2017, p. 319). Nelson et al. (2016) echo these theories by sharing the idea that as students improve in fact fluency, a positive correlation of being able to solve more complex problems is achieved. In addition to the impact on future problem-solving, it is proposed that achievement of fact fluency skills can also lead to a reduction in math-related stress (Musti-Rao & Plati, 2015; Poncy et al., 2010). The idea of math-related anxiety or stress suggests yet another concern for students with poor fact fluency skills.

Fact fluency is foundational to developing future math skills (Nelson et al., 2016). Acquired math skills serve as building blocks for further acquisition of skills. Consequently, when foundational skills are not mastered, students are at further risk of increasing the learning gap. This creates an even greater task for students identified with math learning disabilities. Fuchs et al. (2008) suggest most general education curriculums include fact fluency or number combination work in kindergarten through second grade. The expectation for students to acquire their basic addition facts by memory is by the end of second grade (Kleinert et al., 2018). However, students are not typically identified as having a math learning disability until third grade. This presents the issue of students with math learning disabilities not receiving

appropriate fact fluency interventions or remediation (Fuchs et al., 2008). Additionally, students who have learning disabilities are shown to have great difficulty in acquiring automaticity of facts and fall further behind in skills throughout elementary into secondary school if effective interventions are not implemented (Baker and Cuevas, 2018). Furthermore, it is crucial to not only understand the importance of fact fluency and its impact on students with disabilities but also the process for developing fact fluency and identifying appropriate interventions.

Process for Developing Fact Fluency

To develop fact fluency, there is a natural progression of skills which occurs. Typically, this starts by counting all numbers in a problem (i.e. in problem 2+4 the student would count 1, 2, 3, 4, 5, 6 counting each set individually) (Fuchs et al., 2008). The next progression would start with the first number and continue to count which leads to counting on from the larger number. This progresses to using various strategies for solving equations such as finding the doubles fact and adding on, etc. Eventually, "memory-based retrieval of answers" is established (Fuchs et al., 2008, p. 80). For students with math disabilities, these steps can propose many difficulties making memory-based retrieval even more challenging (Fleishner, Garnett, & Shepherd, 1982, as cited in Fuchs et al., 2008, p. 80). This reinforces the need for appropriate, research-based math interventions to be used with students with learning disabilities to improve their fact fluency.

To support the development of fact fluency for all learners, the process must consist of short opportunities for practice which include the following key components: "modeling, feedback, timed practice, self-management, and reinforcement" (Daly et al., 2007; Fuchs et al., 2008; McDougall & Brady, 1998; and Rivera & Bryant, 1992 as cited in Nelson et al., 2013, p. 660). Riccomini et al. (2017) state the added component of having a suitable ratio of facts

(known to unknown) is critical. Furthermore, as pointed out by Burns et al. (2015), students who had lower skills in math required more repetitions to master facts. In contrast, students with higher skills required fewer repetitions. The type of math fact and the student's grade level also played a factor in the number of repetitions required (Burns et al., 2015). In other words, the process of acquiring math fact fluency must include an adequate understanding of the student's current abilities and allow for multiple opportunities for repeated practice.

Key Qualities of Effective Interventions

In the article by Fuchs et al. (2008), seven key principles of effective interventions are identified and defined. These principles include explicit instruction, instructional design, using conceptual instruction, opportunities for repeated practice, reviewing previously learned skills, identifying key student motivators, and progress monitoring (p. 85). Interventions that incorporate these principles have been shown to be effective with students with disabilities.

Explicit instruction can be defined as "a way to teach in a direct, structured way" with feedback and multiple opportunities to practice skills (Greene, 2023, para. 1). This is an instructional strategy used in general education and special education classrooms with a variety of student groups or individuals. Explicit instruction must also utilize evidence-based practices. Ledford et al. (2016) consider effective evidence-based practices to include "the identification of individualized procedures for implementing the interventions, and [utilize] the continual collection and monitoring of data to make adaptations or changes to the procedures or target behaviors" (p. 89). The next principle for effective intervention is instructional design. Fuchs et al. (2008) suggest instructional design is an "often overlooked principle" and involves the "use of carefully sequenced and integrated instruction" (p. 84-85). It is essentially the planning out of the lessons based on a specific sequence while trying to anticipate the gaps in learning.

The next two components are key to an effective intervention and are repeated practice and reviewing learned skills. Multiple researchers have suggested repeated practice or drill and practice opportunities based on the individual learner's skill set have shown improvements in math fact fluency (Berrett & Carter, 2018; Crowley et al., 2013; Fuchs et al., 2008; Musti-Rao & Plati, 2015; Nelson et al., 2013; Riccomini et al., 2017; Ruwe et al., 2011). Although not specifically mentioned by Fuchs et al. (2008), the concept of immediate feedback has also been referenced as a significant component of any effective intervention to prevent the repeated practice of incorrect answers (Berrett & Carter, 2018; Crowley et al., 2013; Dennis et al., 2016; Musti-Rao & Plati, 2015; Nelson et al., 2013; Riccomini et al., 2017; Ruwe et al., 2011). As well as the principles listed above, another critical component to achieving math fact fluency is practicing the appropriate ratio of unknown to known facts. For students with disabilities, this ratio may be 1:9, meaning for every one unknown fact, nine known facts should be included with the practice set (Berrett & Carter, 2018). This aligns with the concept of reviewing previously learned skills.

The final two cornerstones of effective intervention are determining student motivators and using consistent progress monitoring. Students are motivated by different things, and it is up to the educator to determine the motivator while providing effective instruction or intervention. Riccomini et al. (2017) suggest students are motivated by getting answers correct, which supports the need to include known with unknown facts. The use of technology as a motivator and tool to reinforce was also shared by multiple researchers (Berrett & Carter, 2018; Fuchs et al., 2008; Musti-Rao & Plati, 2015). It is imperative that relationships are built with students to determine their specific motivators before beginning any intervention. Additionally, it's worth noting the tools used to reinforce may need to change throughout the intervention.

For purposes of this study, several research-based interventions will be described and considered for their effectiveness in improving math fact fluency. The overall objective of this study is to determine if using a math fact flashcard intervention with students with disabilities will increase their overall fact fluency based on their current level of mastered skills.

Fact Fluency Strategies for Students with Disabilities

Several researchers have proposed various ways to improve fact fluency. In the first study, three second-grade students with learning and behavior disabilities practiced subtraction math facts using the application Math Magic for 10 minutes three times per week. They were assessed weekly by taking a curriculum-based measurement (CBM) which included 100 subtraction problems. Students were given five minutes to complete the assessment (Nordness et al., 2011). A CBM is described as "an assessment that features an efficient and reliable measure that is sensitive to student growth of skill acquisition in basic academic domains" (Fuchs & Fuchs, 2006, as cited in Shapiro et al., 2015, p. 470). All students completing this intervention improved their overall fact fluency on the CBM but did not meet the district goal. The research did show a positive trend for subtraction fact fluency; however, it did not have a comparison with other fact fluency methods. This leads to the question of whether the time spent would have a greater impact using a different fact fluency intervention.

Additional studies conducted by Glover et al. (2010), DeLong et al. (2013), and Skarr et al. (2014) utilized the Direct Instruction (DI) Flashcard method. Glover et al. (2010) implemented the strategy with elementary students with learning disabilities focusing on multiplication and division. In contrast, Skarr et al. (2014) included a student without learning disabilities in elementary along with fifth-grade students with disabilities, again focusing on multiplication facts. In addition, the study by Skarr et al. (2014) also included a component of

using a Math Racetrack game to practice skills. Both studies had positive results and showed improvement in multiplication fact fluency. The study conducted by DeLong et al. (2013) implemented the DI Flashcard method as well, but instead of being used for fact fluency, it was used to improve number identification for a non-verbal preschool-aged student. This study included several elements of an effective intervention, specifically modeling, leading, testing, and reinforcing the student. The sample sizes of all studies are of concern. The first study only had two participants, while the second had three and the third had only one. The studies were also conducted in a short amount of time, leaving the question of if long-term retention was attained. However, these studies provided a positive outlook on the effects of a specific math fact flashcard intervention on students with learning disabilities.

Similar to the Direct Instruction Flashcard studies described above, Crowley et al. (2013) and Ruwe et al. (2011) also conducted research to improve sight word recognition for students with disabilities using this intervention. The first study focused on improving sight word acquisition for two students with autism in first grade and kindergarten. In addition to the DI flashcards, the Reading Racetrack intervention was also used. The DI Flashcard intervention consisted of 22 Dolch sight words for the first participant and 18 for the second, along with a multiple baseline approach (Crowley et al., 2013). The second study also used the DI Flashcard intervention with three middle school-aged students who had intellectual disabilities (Ruwe et al., 2011). Baseline data was collected by showing student flashcards of all words targeted in the study. This was completed over three consecutive sessions. A pre-intervention passage was also given to determine the accuracy of targeted sight words in a 100-word passage. The intervention was implemented with student response, modeling, and feedback (Ruwe et al., 2011). Both studies showed increases in sight word recognition using the DI Flashcard intervention.

Limitations of this study include participant size as well as using a limited number of sight words. Additional studies are needed to determine the impact on students of varying ages and abilities.

In a study conducted by Fuchs et al. (2008), the intervention Math Flash was provided to third-grade students with significant math deficits. The intervention provided practice with a warm-up using flashcards, direct instruction on new concepts, lesson-specific fact practice, computer game-based practice, and ended with a pencil/paper review (Fuchs et al., 2008). This intervention was provided as additional tutoring. Results were measured via pre-tests and post-tests and showed significant improvement over students who did not receive the intervention.

This study provided all of the key components of what was defined earlier to be an effective intervention. Students had repetitive practice in a variety of ways which included a technology component. Technology can be used as a motivator for some students who find it to be more engaging. One concern with this intervention is the time it took to implement. A single session took 20-25 minutes and was implemented three times per week (Fuchs et al., 2008).

The studies referred to above all include a fact flashcard component to them. The repeated practice was either independent, teacher-led, or computer-based. The various studies all showed student improvement in overall fact fluency or sight word recognition regardless of the type of operation or word selection.

An additional study reviewed had the goal of improving addition math skills by utilizing a precision teaching (PT) framework with students who had intellectual and developmental disabilities (Vostanis et al., 2020). This study included 16 students who ranged in age from seven to twelve years and occurred over 60 days. The intervention focused on specific training for five key component areas and then on the composite skill of addition. The results of the

study supported the use of precision teaching as all of the students in the PT group made significant improvements with their component and composite (addition) skills. They also maintained the skill after a length of time (Vostanis et al., 2020). The precision teaching framework aligns with the components mentioned previously supporting the success of defined effective interventions.

Further studies reviewed included research supporting multiplication math fact fluency improvement utilizing some form of technology. Berrett and Carter (2018), Musti-Rao and Plati (2015), and Nelson et al. (2013) all showed positive impacts on their participants when implementing a technology-based math intervention. The first study determined the effectiveness of a computer-based intervention, Timez Attack by Imagine Math Facts with third-grade students over the course of twelve weeks. The researchers had the participants take multiple baseline assessments and then divided the participants into three random groups. The baseline assessments consisted of 30 multiplication fact questions (consisting of digits between one and nine) timed for one minute. The assessments were scored based on correct answers. The Timez Attack game first administers a pre-test to determine facts to work on (known and unknown) then when the student shows mastery a post-test is given. All three groups showed an increase in multiplication fact fluency scores. Students were also asked to share their appreciation for the intervention. Positive comments were shared in the study along with comments that supported student engagement in the intervention (Berrett & Carter, 2018).

Musti-Rao and Plati (2015) conducted a similar study with third-grade students, but compared two different technology-based applications: Detect-Practice-Repair (DPR) and Math Drills App (on the iPad) both focusing on multiplication facts. The DPR process used was teacher-led with a PowerPoint Presentation guiding students through the Detect-Practice-Repair

process. Students were shown slides with a multiplication fact on them for three seconds. Students recorded their answers on the "Detect" sheet. Once they got through all twelve problems, students were instructed to score their sheets (answers were shown on the next slide). They then picked five problems that they skipped or were incorrect to practice using the Cover-Copy-Compare (CCC) procedure. Following this, they completed a one-minute assessment and graphed their results. The second group of students utilized individual iPads and practiced multiplication facts using the Math Drills App. During the practice mode, students were required to answer the facts correctly before moving on. In the test mode, the students were also required to get the fact correct before moving on, but the application kept track of the students' scores. The students then completed a one-minute assessment and graphed their results. Both of the interventions showed an increase in overall fact fluency, however, there was a greater increase in using the Math Drills App on the iPad vs. the DPR intervention (Musti-Rao and Plati, 2015).

Nelson et al. (2013) compared a technology-based intervention, Math Facts in a Flash (MFF) with a mnemonic teacher-led strategy, Times Tables the Fun Way (TTFW). The goal of both of these interventions was to improve multiplication fact fluency. Pre-test data was collected on the first day consisting of multiplication problems associated with the student's assigned fact grouping (e.g. 6s and 7s or 8s and 9s). Students in the MFF group took a baseline test consisting of 40 problems in two minutes. Students then practiced assigned math facts with automatic feedback provided. Students in the TTFW group discussed solving facts with zero, one, and two on the first day and were provided with stories that illustrate how to make connections to solve various facts on days two through four. On the last day of the study, students took post-tests for both fact retention and application consisting of the same problems as the pre-test (Nelson et al., 2013). Overall, the practice-based intervention (MFF) showed higher

fluency scores compared to the control group. The TTFW (mnemonic strategy) also improved but was not statistically significant as compared to the control group. Studies involving technology were an important aspect of this literature review as they were potential interventions considered by the researcher.

In contrast to the previous studies, the final research reviewed compared two different instructional approaches to improving overall math skills. The two approaches reviewed in the final study were behavioral and constructivist. The behavioral approach emphasizes "the importance of repeated practice of targeted skills and reinforcement for correct responding" (Poncy et al., 2010, p. 918). Constructivists, on the other hand, believe "learning should take place in a largely unguided environment" (Poncy et al., 2010, p. 918). The studies mentioned previously in this literature review were all aligned with the behavioral approach. A comparison of both approaches included second-grade students who did not have learning disabilities. The study concluded the behavioral approach had greater gains, however, there were many limitations to this study. First, the study did not include any students who had learning disabilities. It also only took into account one specific behavioral strategy versus one specific constructivist strategy. More research is needed to determine if comparable results are achieved when different strategies of both approaches are implemented.

Summary and Connections

In conclusion, the results of the various studies indicate that a consistent approach to using fact flashcards as an intervention has a positive effect on students with disabilities. As McKenna et al. (2015) suggest in their research reviewing the extent to which research-based practices are implemented into regular teaching practices for students with disabilities, additional research is necessary. In their study, McKenna et al. (2015) noted there were minimal checks for

understanding, use of explicit instruction, and use of visuals with students with disabilities. These are all components of effective interventions as laid out in this literature review.

After reviewing the importance of fact fluency, the process for acquiring fact fluency, the key characteristics of an effective intervention, and various interventions that support students with disabilities, the researcher has determined additional research is still necessary to validate the Direct Instruction Flashcard intervention for students starting at varying levels of fact fluency competence. The studies conducted by Glover et al. (2010), DeLong et al. (2013), and Skarr et al. (2014) all had limited participants. Two of the three studies focused on multiplication facts while the third focused on number identification. The researcher was not able to find any recent studies focused on addition fact fluency for students with learning gaps using the DI approach. Therefore a gap in the studies still exists. Additionally, the question remains on whether a student's current level of mastery, based on common core standards, impacts the effect of the flashcard intervention. For example, if students have not mastered their facts within 0-5, does this impact their ability to master facts 0-10 or 0-20 using a flashcard intervention? These are questions this study will address.

Methods

The goal of this research study is to determine if using a consistent direct instruction flashcard intervention, with students with math Individualized Education Program (IEP) goals, will increase their overall fact fluency and to determine if there is a relationship between the fact fluency impact and their current level of mastered skills based on curriculum-based measurements. The overarching research question for this study is as follows: how is overall fact fluency impacted by using a Direct Instruction Flashcard intervention with students with learning gaps in relation to their current level of mastered skills?

Intended Research Site

This study will be conducted in an elementary special education classroom primarily used to support students with learning gaps and behavioral disabilities. The special education classroom is one of three in the elementary school building serving students with various types of disabilities. This specific classroom is used primarily as a pull-out, resource setting to help students with academic and behavioral gaps. The majority of students receive their core instruction in the general education classroom.

The elementary school is located in the Midwest, in a town of less than 5,000 residents. The demographics of the district are 98% white with 2% of students having two or more races. The median household income is just over $90,000 (National Center for Education Statistics, n.d.). Approximately 16% of students qualify for free or reduced lunch. The school district serves just over 1000 students ages preschool through twelfth grade and employs approximately 70 full-time teachers. It has a graduation rate of about 95% (U.S. News & World Report, n.d.).

Intended Participants

In the special education classroom, there are currently five students with math IEP goals. Students are provided with math intervention services daily. These students are currently working on a variety of skills during different times of the day for different amounts of time based on their IEPs. Skill rubrics are utilized to measure individual progress toward math goals that align with common core standards. Some students are seen individually while others receive services in small groups. Four of the students have skill deficits in the area of fact fluency. Three of these students will be invited to participate in the study.

Of the students invited to participate in this study, all three are male and are currently in the fourth grade. All of the participants are considered to have a socioeconomic status of

medium to high. Two of the students have learning gaps in the area of math. The third student has been diagnosed with learning disabilities in writing, reading, and math. He also has an ADHD diagnosis and anxiety disorder. In addition to the students all having math IEP goals, two of the three students have writing IEP goals and two have additional reading IEP goals. Two of the students are in the same general education classroom and the third is in a different fourth grade room. All three students come to the special education classroom together to work on gap areas in a small group setting.

These students will be invited to participate because they all need to improve on fact fluency and are starting with different foundational skills. The students are all working towards fact fluency mastery in addition and subtraction. This study will focus on addition math facts using the digits within the range of 0-9. In the current environment, some of the students have been provided with some fact fluency practice using flashcards. None of the students have received consistent flashcard practice using the Direct Instruction Flashcard system. A special education teacher will be responsible for implementing the intervention.

Intervention

The Direct Instruction (DI) Flashcard intervention will be used for all participants. Prior to starting the intervention, a timed curriculum based measure (CBM) pre-test consisting of single-digit addition problems ranging from 0-9 will be given to all students. They will be given two minutes to complete the pre-test made up of 60 problems. The same CBM will be given as a post-test following the last day of the intervention.

Based on the addition facts presented in the pre-test, 3x5 flashcards will be prepared with all unique facts tested. The flashcards will be divided into five sets, with this intervention/action research project utilizing the first three sets (each consisting of seven cards) due to time. The

fourth set will have seven cards and the fifth set will have the remaining ten cards and will be prepared for use at a later time. Each student will have their own five sets of flashcards to account for differences in progress.

For four days out of the week during the intervention period, students will be given all three sets of flashcards to record a daily baseline score. Correction procedures will not be used during the baseline assessment. Students will say the facts and answers. The researcher will count silently in their head and slowly to two seconds when the fact is presented to the student. Correct answers will be recorded with a + sign and incorrect answers will be recorded with a - sign. If the student does not answer, answers incorrectly, or answers correctly past the two-second timeframe, the response will be counted as incorrect. If a student says the fact and answers it correctly within two seconds, it will be counted as correct.

After the entire baseline set is presented and responses are recorded, the researcher will begin the DI flashcard procedure for the first set or whichever set the student is currently working on. The researcher will show the student the addition fact flashcard, then the researcher will start to count to two silently and slowly. The researcher will then record correct and incorrect responses on a separate intervention data recording sheet. If the student gets the addition fact correct, the math fact will be recorded with a + sign and the card will be put at the end of the deck. If the student gets the fact incorrect for any reason, the administrator will model the correct procedure with the model, lead, and test procedure. The researcher will state the fact and the answer, the student will repeat the fact and the answer, and then the researcher will put the card back in the pile three cards back for repeated practice. Only the first response for each unique fact will be recorded. This will continue until all flashcards in the current set are presented and incorrect responses are reviewed a minimum of three times. When the student can

complete the entire set of seven cards correctly for three consecutive sessions, they can move to the next set of flashcards. Following the twelve sessions, a post-test identical to the pre-test will be given to determine progress made.

Timeline

The proposed research project will occur in the fall of 2023. The researcher will submit the proper documents to gain exemption from the IRB for the study. The study will be reviewed and approval gained from the district administration by the end of August. After gaining the appropriate approvals, the researcher will confirm the eligible participants in September. This will be completed by reviewing special education rosters and current IEP goals. Also in early September, a letter of introduction and consent form will be drafted and reviewed with the administration. Once approved, the letter of introduction and consent forms will be sent to the parents of eligible participants.

After consent is provided, baseline data will be collected from late September to early October. The baseline data will be collected using a timed curriculum based measurement assessment consisting of addition math facts using digits within the range of 0-9. During this time, a separate spreadsheet will capture students' mastered skills gathered from their Individualized Education Programs as aligned with the core standards. This information will be used for analysis at the end of the study. Another action occurring simultaneously will be training on the Direct Instruction Flashcard intervention.

The Direct Instruction Flashcard intervention will occur four times per week over three to four weeks beginning in October. A timed CBM will be administered at the beginning of the study to determine the pre-test fact fluency score. The final CBM (post-test) will occur in the final week of the intervention and will be compared to the pre-test score to assess impact. Data

will be collected and graphed weekly throughout the study. In November, data will be analyzed to determine growth or decline as well as any correlations to foundational skills. As part of the analysis process, a determination will be made to continue or discontinue the intervention. A summary of findings and action research report will be shared with the capstone supervisor in early December. Overall findings, study limitations, and future research will be shared with the administration and colleagues following the completion of the study.

The timeframe for this research project will be approximately sixteen weeks in length. Of this time, three to four weeks will be used for collecting data and administering the intervention.

Variables and Measurement Tools

The independent variable is the Direct Instruction Flashcard intervention. This intervention will be conducted four times per week for addition math facts with numbers 0-9. Data collected in relation to this variable is if the student is in attendance and if they complete the intervention. The dependent variable is the fact fluency result as measured by the curriculum-based measurement (CBM) pre-test and post-test. A control group will not be used, therefore, the study will utilize the pre-test and post-test methodology for a single group of students making the study quantitative in nature.

The data will be captured in an Excel spreadsheet tracking student names, dates, attendance, intervention completion, pre-test, post-test, baseline, and intervention scores. Data will be entered the same day the intervention is administered. The CBM pre-test and post-test to be administered will align with the CBM guidelines provided by Vanderbilt University (n.d.) and Hosp et al. (2016). Determination of CBM for computation performance levels will be determined based on fluency norms compiled by Wright (2013). The Excel tracking spreadsheet

will be researcher-created. The researcher will input data and review the data entered multiple times before consolidating data. The researcher will also employ the expertise of an instructional coach to review and confirm the validity of the data. The researcher will utilize Excel formulas to count correct vs. incorrect answers and statistical functions to analyze the data. The Excel graphing features will use the data to create visual representations.

Additional data will be used for further analysis from the Iowa IEP ACHIEVE system. This system stores student IEP goal progress monitoring data based on teacher input. Individualized rubrics are used to capture students' data. Ongoing progress monitoring data related to students' math IEP goals will be collected twice monthly throughout the study as outlined in the students' IEPs. These are unique measures individualized per student based on math goals and objectives.

Anticipated Analysis

The dependent variable will be the results of a curriculum based measure (CBM) measuring fact fluency. The action research will measure the cause-and-effect relationship of an intervention on the fact fluency CBM. It will compare the pre-test score with the post-test score to determine if and how much progress has been made with fact fluency. Therefore, this research will be quantitative in nature.

For the independent variable, the researcher will be collecting two pieces of data for each student daily during the intervention. The first is if the student is in attendance on the day of the intervention. The second piece of data will be if the student completes the intervention. There are several reasons why a student may not be able to complete the intervention (e.g. negative behavior, special event, competing priorities, etc.). The dependent variable (fact fluency CBM score) will produce a specific score of correct answers based on the CBM administered. CBM

baseline data will be captured at the beginning and end of the study. At the end of the intervention, the pre-test CBM score will be compared to the post-test CBM score to determine the impact of the intervention.

To complete data analysis on this research, data will be shown using a bar graph. The bar graph will be organized by student (horizontal x-axis) and CBM score (vertical y-axis). It will show the baseline and final CBM scores for each student. To compare the baseline to final scores, a paired sample *t*-test will be used. The paired *t*-test uses mean scores and compares pre-test and post-test scores for the same group of students (Efron & Ravid, 2020). This *t*-test will indicate if the intervention is effective (p. 206). Measures used in this data analysis will be the mean to look at the average scores for both the pre-test and post-test. Standard deviation will be included to determine how spread out the scores are from the average which will assist in determining score reliability. In addition to the above-mentioned measures, the probability (p value) will be calculated to determine if the study is statistically significant. Finally, the Pearson correlation coefficient will be implemented to compare the intervention results with the student's attendance data (Efron & Ravid, 2020, p. 207). This will allow the researcher to determine if there is a correlation between the students' attendance and the CBM intervention score. Through this data analysis, specific assumptions will be made regarding the research study and determinations on whether the data suggests a positive or negative intervention impact.

IRB Exemption and Other Approvals

This research study will require a completed Northwestern Application for Educational Practice Exemption form to be submitted to the Institutional Review Board (IRB). The researcher believes this study will be exempt from the full IRB application because it meets the following criteria: the research would be conducted in an already established classroom setting

where the students currently attend, it uses normal educational practices, student identity would be protected, data collection would be in the format of educational assessments and observations, behavioral interventions are not included in this study, and the study poses minimal to no risk to the students ("Part 46", 2018).

Prior to starting the study, the researcher will acquire support from the school district and gain appropriate approvals to move forward with the study. Since the participants will be students, parent consent will be attained and parents will be informed of the study's intent as well as the option to opt out of the study at any time. Introductory letters and consent forms will be drafted, approved by the administration, and provided to parents before starting the study.

Data Collection

The data collected from this action research project was all quantitative in nature. The first piece of data collected throughout the intervention was student attendance. Students' attendance was collected daily and input directly into an Excel spreadsheet marking in attendance with a "yes" and not in attendance with a "no". On the first day of the action research, the three participants were given a curriculum based measure (CBM) comprised of 60 addition facts including single-digit addends 1-9. They had two minutes to complete as many facts as possible. The correct responses out of 60 were scored, collected, and stored in the Excel spreadsheet. A calculation was completed to also capture the number of correct answers in one minute by dividing the total by two.

Following the initial CBM pre-test, students participated in the intervention for four days weekly over three weeks. During this time, the researcher used paper copies of the baseline data template and intervention data template to collect correct and incorrect fact responses. One at a time, students met with the researcher and were given all three sets of facts to collect baseline

data during each session. The researcher would show the facts, count silently and slowly to two, and record on the sheet if the student answered the fact correctly or incorrectly. The paper was marked with a "+" sign if the answer was correct and answered within two seconds and with a "-" if the answer was incorrect or answered outside the two-second timeframe. After the baseline facts were all presented, one of the sets was presented to the student as the focus of the intervention. If the student got the fact correct and within two seconds, the researcher marked the fact as correct with a "+". If the student was incorrect or answered outside the two seconds, the fact was marked incorrect with a "-" and the correction intervention procedure was followed. The correct vs. incorrect responses were transferred from the paper templates to the Excel online spreadsheet daily and organized by date.

After the twelve intervention sessions, a final addition fact fluency CBM was administered. The CBM post-test was an exact copy of the pre-test. After the two-minute test, the CBMs were scored for correct responses. The responses were input to the post-test section of the Excel spreadsheet. The number correct out of the total in two minutes was input to one column. In the next column, the researcher divided the number correct by two to determine correct responses in one minute. After the intervention, the researcher procured the assistance of a district instructional coach to review and validate the data which was transferred from the paper copies to the online spreadsheet. The review resulted in a 100% match when validating the paper to online data responses.

Data Analysis

Three students consistently participated in this research project over the course of three weeks. As a result of the study, multiple data were collected throughout the project. This section will share the specific data and analysis related to the following areas: baseline facts

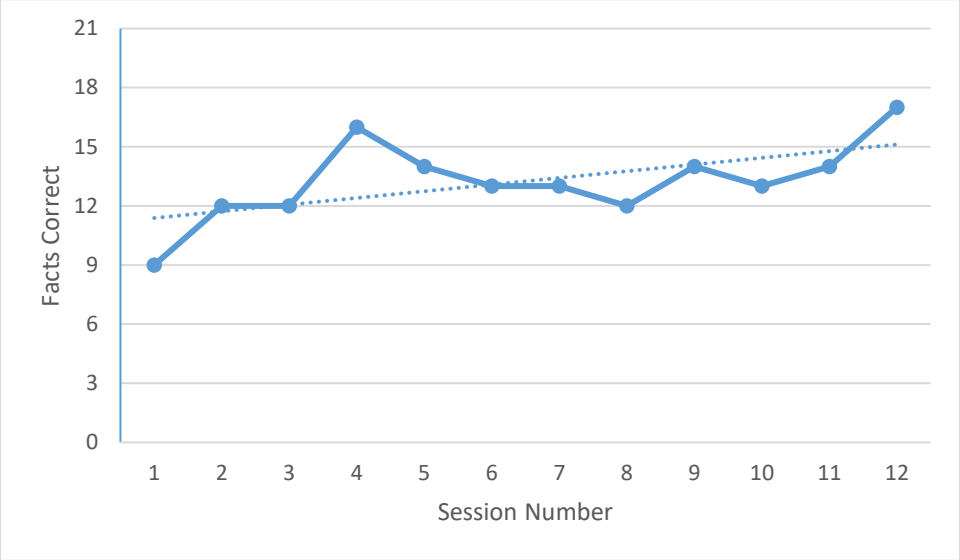
correct, intervention facts correct, pre-test and post-test results, attendance data, and information related to student educational goals. Each section will share the specific outcomes and the researcher's analysis.

Baseline

Each participant attempted to solve twenty-one facts correctly within two seconds daily throughout the twelve-day intervention period. In Figure 1 (below), the baseline results are shown for student 1. The students' correct answers ranged from 9 to 17 with a mean score of 13.25. The student data showed an overall upward trend line (indicated by the dotted line) in facts correct throughout the intervention period. The student participated in all twelve intervention sessions. The data shows some variability throughout the sessions. The student did achieve their top score during the final session of the intervention. Feedback on whether the fact was correct or incorrect was not provided during the baseline portion of the flashcard routine. This could have impacted the overall learning of the baseline facts.

Figure 1

Student 1 Baseline Scores

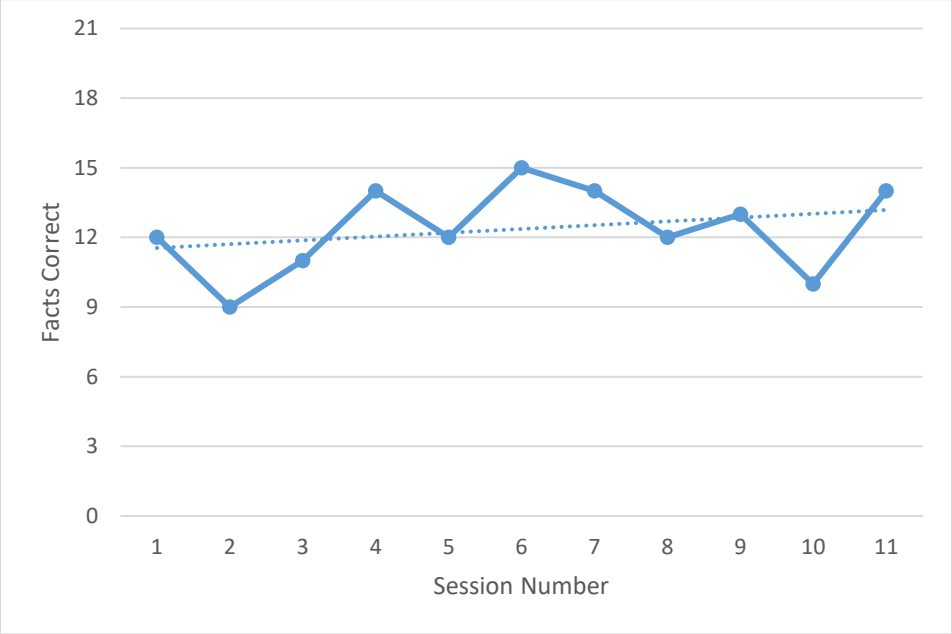


Note. The number of facts correct for the three sets of addition facts during the baseline portion of the intervention for Student 1.

Student 2 was in attendance for eleven of the twelve sessions. In Figure 2 (below), the baseline results show a range of correct answers from 9 to 15 with a mean of 12.36 over the course of the intervention. The trend line for this participant is more level showing a slight upward trend from the beginning to the end of the project. The student also showed more variability between data points. This student exhibited nervousness at the beginning of the intervention due to only having two seconds to answer the questions. This subsided as the intervention continued over the course of the eleven sessions. Compared to other participants, this student also took longer to develop the habit of saying each fact and then answering which was a requirement of the DI Flashcard procedure. This student wanted to state the answer only which would be counted incorrect based on the intervention.

Figure 2

Student 2 Baseline Scores



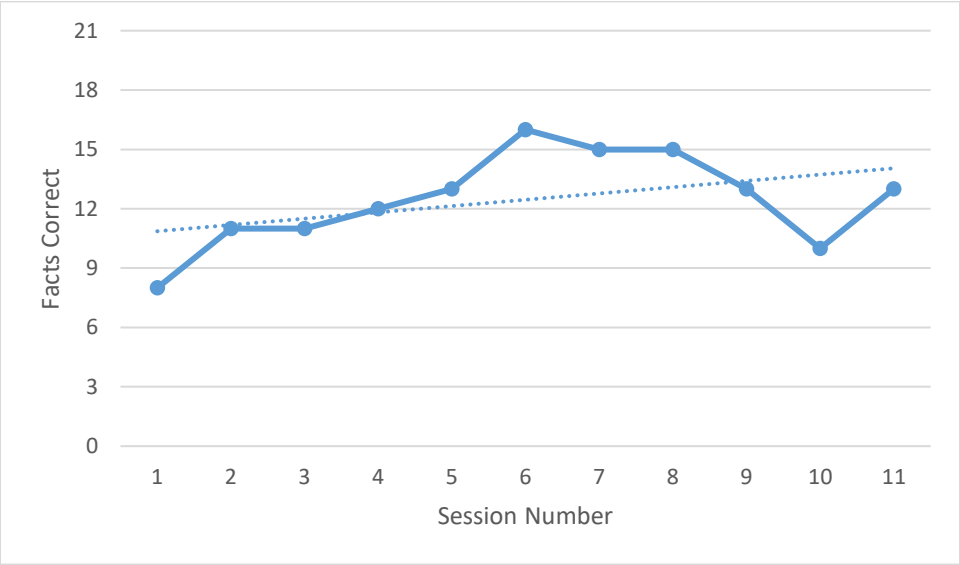
Note. The number of facts correct for the three sets of addition facts during the baseline portion of the intervention for Student 2.

Student 3 was also in attendance for eleven out of the twelve sessions. This participant, as shown in Figure 3 (below), shows a positive trend line for increasing their number of facts correct. They ranged from 8 to 16 in correct responses with a mean score of 12.45. The student peaked during session six which was approximately halfway through the intervention timeframe. This student showed growth with their fact fluency by starting with 8 facts correct and increasing to an overall average above 12. This participant caught on quickly to the requirements of the intervention and was motivated by getting additional answers correct. The student was absent during the final week of the intervention which could account for the decline in scores. However, after they returned, their scores started to rebound. Additional studies are

necessary to determine the long-term ability to maintain skills following student absences or extended breaks.

Figure 3

Student 3 Baseline Scores



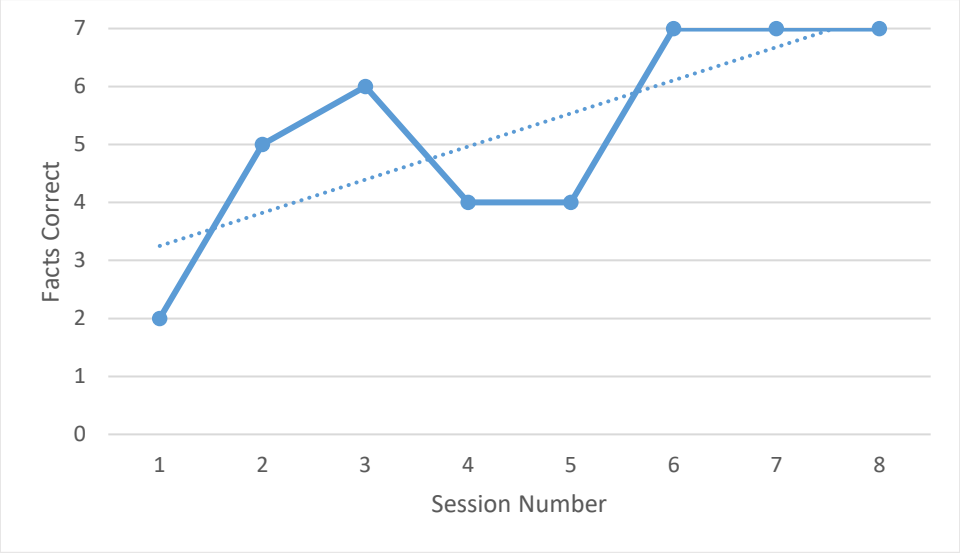
Note. The number of facts correct for the three sets of addition facts during the baseline portion of the intervention for Student 3.

Direct Instruction Flashcards with Back Three Intervention

Each day of the intervention period, after the participants were given their baseline facts, they focused on using the Direct Instruction Flashcard intervention for a set of seven specific facts. Student 1 showed significant growth and an upward trend line in their Set 1 facts as presented in Figure 4 (below) (M = 5.25; range 2 to 7). The criteria for moving to the next set of facts was to get all facts correct in a set for three consecutive sessions. Student 1 met this after session 8 and was able to move to Set 2 during session 9.

Figure 4

Student 1 - Intervention Data Set 1

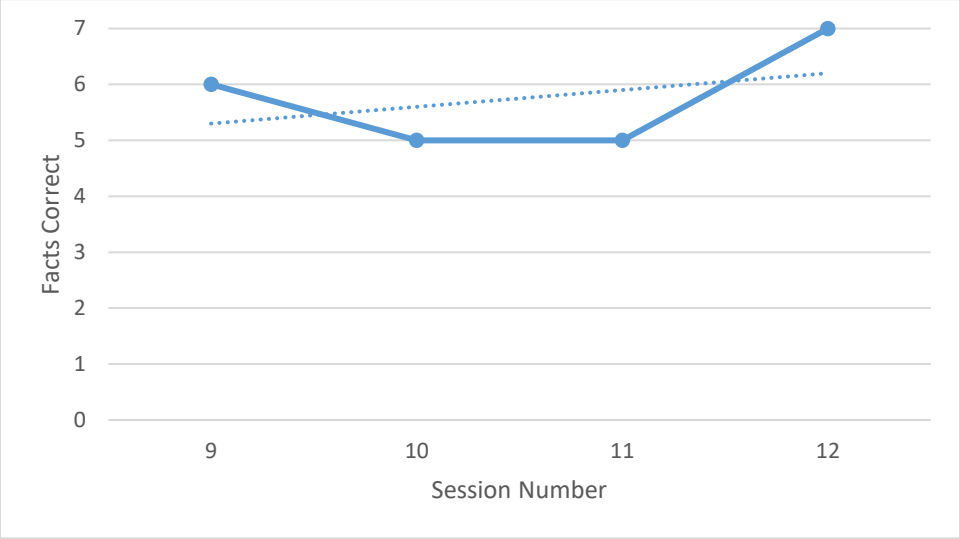


Note. The number of facts correct for Set 1 of addition facts consisting of seven facts during the DI Flashcard intervention for Student 1.

During sessions 9-12, the student completed the intervention using Set 2 of addition facts with results ranging from 5 to 7 correct and a mean of 5.75 as shown in Figure 5 (below). The student started at a higher level of mastery for this set potentially due to the repetition of all of the facts during the baseline portion of the intervention. On the last day of the intervention, the student did get all of the seven facts correct and showed an upward trend of improvement. With only seven facts in each set, this participant demonstrated the ability to not only start with more correct than the first set but also reach fact mastery of the second set over the course of only four sessions. This is compared to the first set where it took the student six sessions before they were able to get all of the facts correct.

Figure 5

Student 1 - Intervention Data Set 2



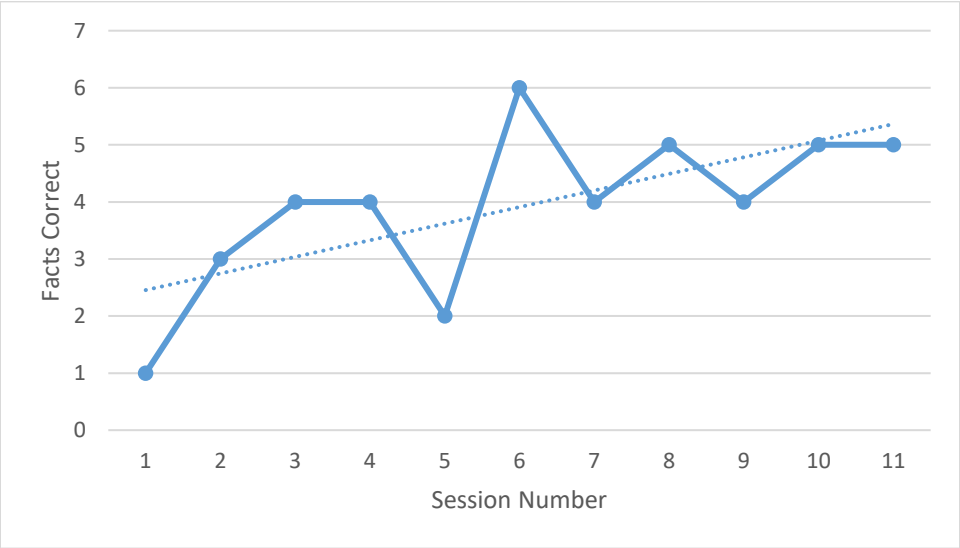
Note. The number of facts correct for Set 2 of addition facts consisting of seven facts during the DI Flashcard intervention for Student 1.

The second student in the study worked on data Set 1 throughout their eleven sessions. Figure 6 (below) shows that throughout the study, the student showed an upward trend of fact fluency ranging from 1 to 6 correct with a mean score of 3.9. The participant showed one of the steepest trends of improvement and started with the lowest level of mastery. The student showed a peak of correct responses during week 6 and did not have a session where they were able to get all facts correct or correct within the two-second time limit. However, this participant only had three sessions where they declined from the session prior. Two of the three declines occurred after a weekend break. This could indicate the need for consistent and additional fact practice at home over breaks to maintain their scores. Despite this finding, it is encouraging to see how quickly the student's scores rebounded after continued practice. This was also the same student who showed nervousness during the baseline portion of the intervention where corrections were

not provided. It can be noted that when corrections were provided during the DI Flashcard intervention phase, this student responded with positive and substantial growth.

Figure 6

Student 2 - Intervention Data Set 1

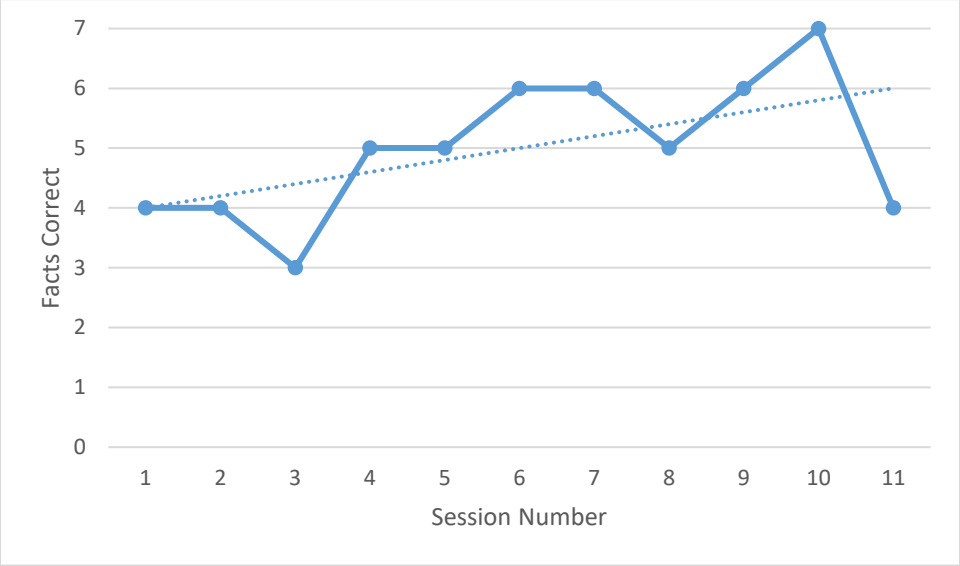


Note. The number of facts correct for Set 1 of addition facts consisting of seven facts during the DI Flashcard intervention for Student 2.

The final participant in the study, Student 3, also showed growth throughout the Direct Instruction Flashcard intervention. Figure 7 (below) indicates a positive and upward overall trend. The student's correct responses ranged from 3 to 7 and had a mean score of 5 over the course of their eleven sessions of intervention. The student was making steady progress up until the last session where they regressed. An interesting observation regarding this participant was the data indicates they were able to answer more questions correctly earlier in the week and their data seemed to decline during sessions held later in the week. The student completed four sessions each week for two weeks until the final week when they were absent and only completed three. This is an area to explore further to determine if this is student-specific or more common for this intervention.

Figure 7

Student 3 - Intervention Data Set 1



Note. The number of facts correct for Set 1 of addition facts consisting of seven facts during the DI Flashcard intervention for Student 3.

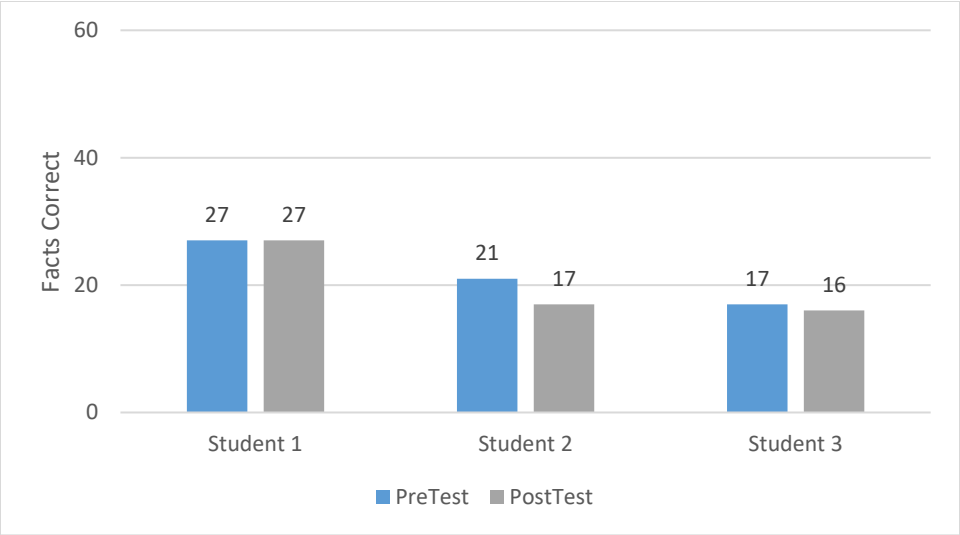
Pre-test and Post-test Results

A key component of this study was to determine if the Direct Instruction Flashcard intervention had an impact on overall fact fluency. For this study, the determining factor was to provide the participants with a pre-test and identical post-test of addition facts with addends of nine or lower and compare the results. Figure 8 (below) shows a side-by-side comparison of the pre-test score and the post-test score of correct facts answered by individual students. The pre-test was given before the intervention and the post-test was administered one day after the intervention was completed. As noted by the data and graph, student 1's score stayed the same while both student 2 and 3's scores declined slightly. The standard deviation from the pre-test to the post-test increased from 5.03 to 6.08. This increase could indicate more variability in how the students responded to the intervention. A *p* value was also calculated using Excel to

determine if the results were statistically significant. The *p* value was .1499 and therefore the *p* > .05. This indicates the result of this study could have happened by chance and there is not a significant correlation between the intervention and the post-test results.

Figure 8

Pre and Post-Test Comparison by Student

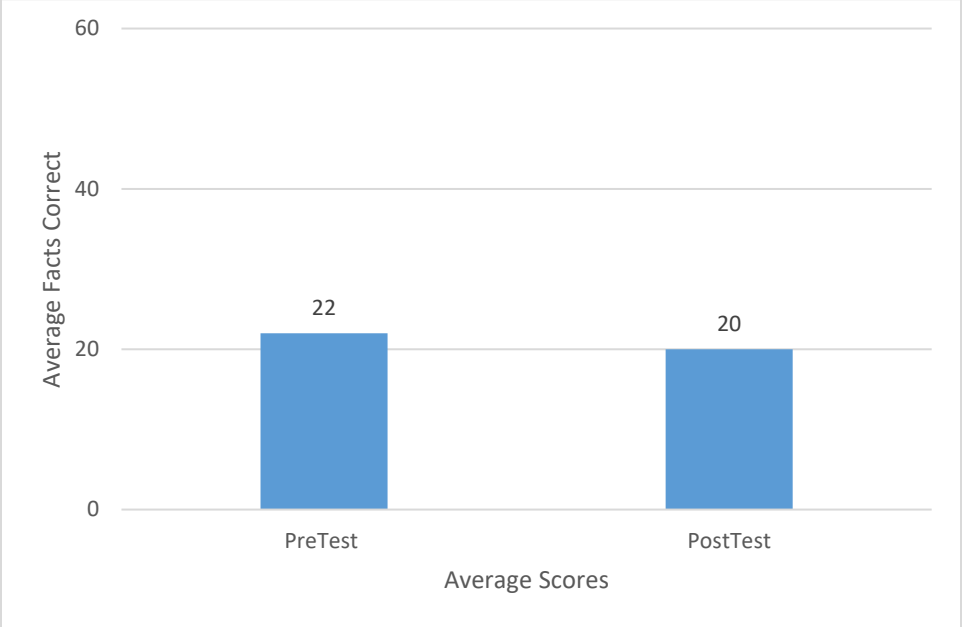


Note. The number of facts correct, by student, in both the pre-test and post-test CBM.

Figure 9 (below) shows the average of all pre-test and post-test scores and the decrease from one to the other. These results may indicate that the Direct Instruction Flashcard intervention is not an effective intervention for students with learning disabilities. An important factor to note is that the CBM pre-tests and post-tests consisted of addition problems with addends from 1-9. The problems from these tests are made up of five sets of unique math facts. Only three of the math sets were used during this intervention. This could have potentially impacted the students' abilities to show improvement from the pre-tests to post-tests since two sets of facts were not reviewed.

Figure 9

Average Pre and Post-Test Comparison



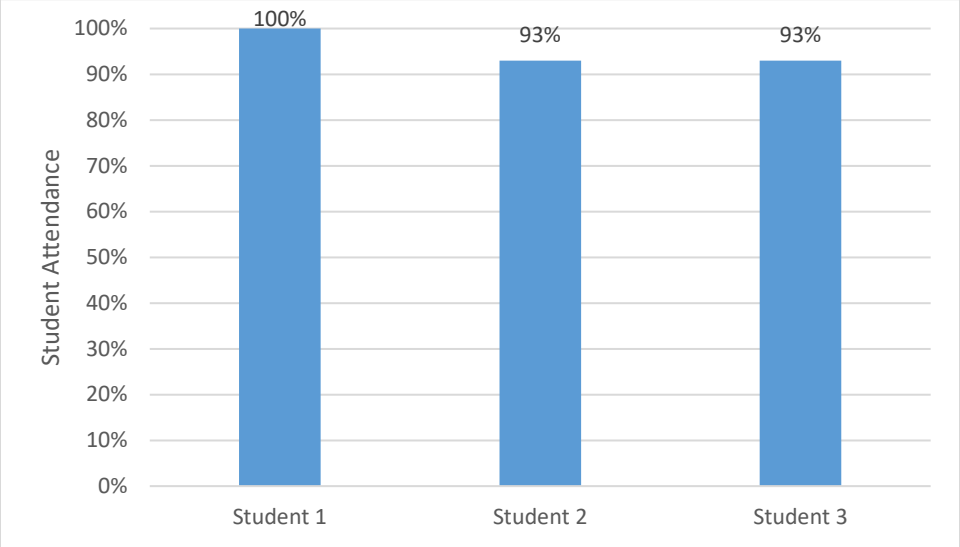
Note. The average CBM pre-test and post-test scores of facts correct for all participants.

Attendance and Attendance Correlation

As mentioned in earlier results, one of the students had perfect attendance throughout the intervention. Two of the participants missed one day each. All students were in attendance on both days the pre-tests and post-tests were administered. Figure 10 (below) shows the attendance percentage by student. A Pearson correlation calculation was determined through the use of Excel. The data correlated was post-test score with attendance percentage. The Pearson result was .996. When the score is closer to 1, there is a stronger correlation. Therefore, this score indicates a positive correlation between the test score and attendance. However, even though data shows a strong correlation, the students' CBM scores did not improve. It can be observed that the student who did not miss any sessions was able to maintain their score from the pre-test to the post-test.

Figure 10

Participant Attendance



Note. Attendance percentage during the intervention by the student.

Student Individualized Goals

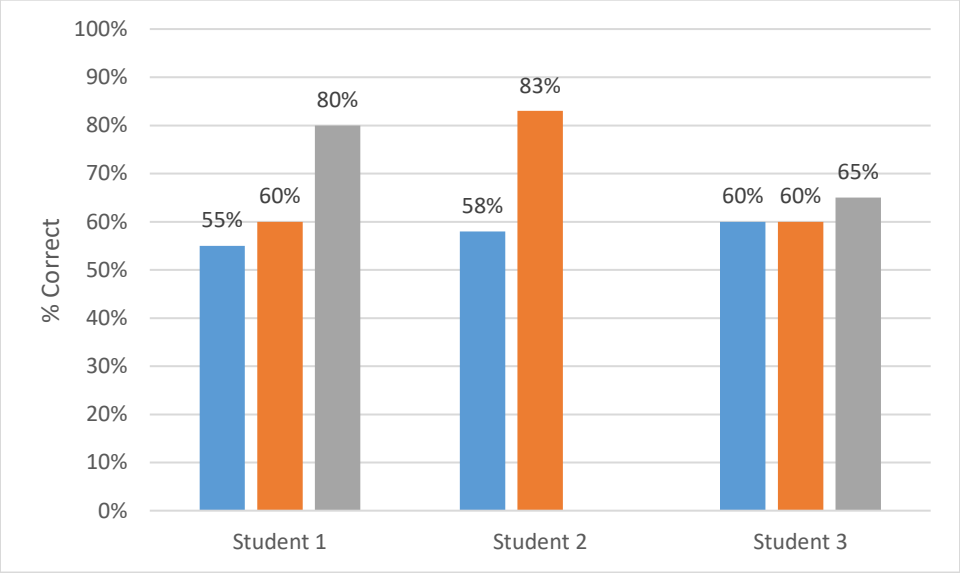
The project's research question stated: how is overall fact fluency impacted by using a Direct Instruction Flashcard intervention with students with learning gaps in relation to their current level of mastered skills? The results of this study would show that the Direct Instruction Flashcard intervention did not have a positive impact on the pre-test and the post-test CBM but did have a positive impact on the fact fluency set practice. After looking at Figure 11 (below), the data shows the intervention could have had a positive impact on the students' individualized education goals in the area of math. All three students showed improvements throughout the intervention with their math IEP goal areas. It should be noted that student 2 only has two data points due to an extended absence following the intervention.

The data collected in Figure 11 was taken at the beginning of the intervention, in the middle of the intervention, and the week following the completion of the study and calculated

from data collected from the IEP system. It clearly shows student improvement in individualized goals throughout the time of the intervention. Additional data should be collected and compared to determine if the intervention was a possible factor in the increased scores or if it is the result of other strategies and curricula used in the special education classroom. This information supports the potential positive impacts of the intervention even though the pre-test and post-test did not show the same positive effect.

Figure 11

Student Progress Toward IEP Goals



Note. Student progress toward IEP goals before, during, and following the intervention.

Overall, the research did not support the improvement of addition fact fluency as measured by a CBM pre-test and post-test. However, intervention data collected did show an improvement in fact fluency. Overall IEP goal improvements were also significant throughout the intervention. Therefore, even though there was not a positive impact on overall CBM scores, it is possible the intervention contributed to providing other encouraging student results.

Discussion

Summary of Major Findings

The intent of this study was to determine the impact of a DI Flashcard intervention on students with learning disabilities based on their current level of mastered skills. The data from the pre-test to the post-test were compared to determine this impact. The results of the CBM pre-test to the identical post-test showed a decline in math fact fluency for two students, and one student's score stayed the same. This is contrary to previous studies which will be addressed in the next section. However, the probability ($p > .05$) indicates there is not a significant correlation between the intervention and the post-test results.

There was an increase in fact fluency during the intervention and all three participants showed growth on their individualized math goals as captured in their IEP probe data. This indicates there could be a positive correlation between the DI Flashcard intervention and student math goals related to the area practiced. In this research the focus area was addition. A portion of all three students' individualized goals contained an addition fact component. The data also suggests a strong correlation between student attendance and outcomes. The student who stayed the same from the pre-test to the post-test did not miss a session and improved the most on their intervention facts. This student was the only one to master Set 1 and move to Set 2. Due to the increase in fact fluency during the intervention sessions, one could imply the fluency of a specific set of facts improved, but not enough to impact the CBM post-test which assessed the accuracy and speed of all of the identified facts.

Impact on Teaching and Learning

The DI Flashcard intervention was an inexpensive and easily implemented intervention strategy. The intervention itself took approximately five minutes to administer to each participant for each session. The CBM pre-tests and post-tests were provided by the Area

Educational Agency special education consultant. The flashcards were made with index cards and took less than an hour to create. Premade flashcards could also be utilized. Research by Kosko (2019) suggests flashcards are typically available to most classroom teachers stating over 70% of third-grade educators already have and use them. Data spreadsheets were created using Excel and were easily updated and maintained.

The researcher found the students to be excited to start the new intervention, yet intimidated by the idea of having to answer the facts within two seconds. The nervousness primarily lasted only during the first and second sessions. After the students started to make improvements with their facts, they no longer commented on the time constraint. The researcher did not offer a motivator other than students taking pride in making progress with their facts. In reflection, the researcher would more than likely offer some kind of motivator to the students when they show improvement or pass a set of facts in the future.

Due to the increase in students' individualized math goal scores, the researcher plans to continue with the DI Flashcard intervention. This is as long as the targeted intervention skill aligns with the student's goals. The researcher also plans to modify the CBM to only include facts that are used during the intervention, specifically facts in sets 1-3. The researcher will give another pre-test of facts in sets 1-3, offer three additional weeks of the intervention, and then follow with an identical post-test to see if the facts practiced show CBM improvement.

Additional Reflections

As discussed earlier in this report, students with learning disabilities can find the development of fact fluency and automaticity to be tremendously difficult (Baker & Cuevas, 2018). The researcher found this to be the case with the three participants of this study as well. During the early stages of this intervention, the students felt pressured to get the answer correct

within a short period of time. After many repetitions, students began to see positive results and showed less concern for the time element of the intervention. As mentioned previously, the students also did not show gains from their pre-test to their post-test. This is contrary to a study conducted by Glover et al. (2010) where one student showed a 9% increase from the pre-test to the post-test while the other showed a 17% increase throughout 19 and 22 sessions respectively. Four major differences between this study and that of Glover et al. (2010) were the number of intervention sessions, the age of the participants, the type of math fact, and the type of reinforcement offered.

Fuchs et al. (2008) stated that before students can become fluent with facts, they need to be able to answer the facts accurately using memory-based retrieval. This study shows the students made improvements with their individual math goals which were not timed. This may indeed show that the DI Flashcard intervention has improved the students' accuracy of facts, which if continued, may improve overall fluency. Additional data will need to be tracked and collected to determine if this is accurate.

McKenna et al. (2015) shared five key components of research-based practices used in mathematics for students with disabilities: explicit instruction, checking for understanding, use of visuals, opportunities for the student to verbalize their reasoning, and time for independent practice. Unfortunately, the DI Flashcard intervention utilized only three of these five components. However, opportunities for independent practice could be easily implemented. In contrast, Vostanis et al. (2020) provided six varying practices to support students with disabilities: instruction that meets the student's present level of skills, providing feedback, giving the student time to respond, using timed practice, using reinforcement, and student self-

tracking. The DI Flashcard intervention uses all of these with the exceptions of reinforcement and self-tracking which could also be incorporated.

Limitations of Study

There were several limitations to this specific study. First, the intervention was only able to be implemented for three weeks and a total of twelve sessions. This was not enough time to fully understand the long-term effects of such an intervention and to determine if the skills could be maintained after a longer period. Previous studies by Skarr et al. (2014) and Crowley et al. (2013) were conducted over 20 sessions when they implemented the DI Flashcard intervention and showed successful outcomes. This intervention timeframe was shortened due to the need to complete the research during a portion of a semester-long college course.

The second limitation was the number of participants. Only three students were able to be included in this study due to the researcher's current special education roster and the specific skills students were working on. The cultural background and socioeconomic status of the participants was another limitation. The majority of participants were of similar backgrounds both culturally and socioeconomically. By having a more diverse group of participants, determinations could be made on whether this intervention has a similar or varying impact.

Another study limitation is related to the specific facts targeted. At the beginning of the research, the participants took a 60-question CBM consisting of addition facts. All of the unique facts were put on individual flashcards and divided into five sets. Only three of the sets were reviewed during the intervention due to the time and volume of facts. However, the post-test was identical to the pre-test and contained facts not reviewed throughout the intervention. This could be considered a limitation of the study because the intervention did not cover all items being assessed.

A final study limitation was the focus on addition facts only. The study assessed the DI Flashcard intervention for students with learning disabilities, but only concentrated on one area of learning. Other studies have shown the DI Flashcard intervention has been used to support students with learning disabilities on other types of math facts, number identification, and sight words (Crowley et al., 2013; Delong et al., 2013; Glover et al., 2010; Ruwe et al., 2011; Skarr et al., 2014). Therefore, this study may have had different results if it was not limited to addition fact fluency.

Further Research

The body of research previously conducted regarding the impact of flashcard interventions on overall fact fluency is limited to very specific interventions and participants. This study advanced the research by not only looking at fact fluency results using the DI Flashcard intervention but also taking into consideration the initial skills mastered by the student before implementing the intervention. The focus of this study was limited to students with math IEP goals. As stated by Greene et al. (2018), the computation of math facts is "a fundamental skill in the progression of mathematical abilities" (p.146). Additional studies are necessary to continue the pursuit of finding the most effective interventions for improving fact fluency for students with disabilities.

Further research is necessary to determine if there is a difference in results based on the type of facts used during the DI Flashcard intervention (addition, subtraction, multiplication, or division). Previous studies by Glover et al. (2010) and Skarr et al. (2014) focused on multiplication and division facts. The researcher was unable to find supporting studies in the areas of addition and subtraction using the DI Flashcard intervention for students with learning disabilities. In addition, during this study, only three of the five sets of addition facts were

included in the baseline and intervention. However, all facts from all five sets were in the pre-test and post-test. The researcher plans to conduct further studies to determine the impact of pre- to post-test when all facts are included in the DI Flashcard intervention.

Musti-Rao et al. (2015) shared that students with disabilities may have difficulty in transferring skills explicitly taught to a more generalized setting, "especially when there are changes in the stimulus presentation and/or response requirements of the skill" (p. 113). Students first experiencing the explicitly taught DI flashcard intervention and then being assessed on an independent test would be an example of a change in presentation and may impact their scores. Further studies are necessary to compare the outcomes of these various types of fact assessments. The researcher also intends to collect additional data when preferred reinforcement is awarded to the participants as they increase their scores or pass a set of flashcards to determine if this influences their overall fact fluency scores.

Another need for continued research is in regard to the impact of the intervention when students implement additional independent flashcard practice outside of school or in the general education classroom. Throughout this study, the students only practiced the flashcards during the specific intervention time. Further studies are necessary to determine if additional practice would have a positive impact on the participants' overall fact fluency. Parent or general education involvement would be essential to assist with the data tracking of this additional practice.

This study focused on students with learning disabilities. The students all had, at a minimum, a math IEP goal. However, the students had a variety of diagnoses. A larger sample size of study participants is necessary, including students of varying disabilities, to determine if the DI Flashcard intervention would have the same impact. Furthermore, additional research is

needed to compare various fact fluency interventions for students with and without disabilities. A study utilizing a control group could also be implemented to compare pre-test and post-test fact fluency assessment scores by group.

Future research is needed to take into account the number of intervention days and the amount of time spent. This study was limited to three weeks with four intervention sessions each week. If the intervention occurred over a year, additional data could be gathered to determine long-term effects and students' abilities to retain fact fluency and accuracy over extended breaks. Additional data could also be collected to determine if there is an effect on standardized tests and yearly math screeners. If the study is extended, the researcher would need to be cognizant of a possible decline or flat line of scores and review progress monitoring regularly. In special education, interventions need to show a positive impact, or other interventions need to be considered.

Conclusion

Mathematics is used daily to help us navigate the necessary functions of typical living tasks like paying our bills, buying groceries, and balancing our finances. Being able to compute these day-to-day calculations quickly and efficiently helps eliminate frustrations and improve our abilities to solve more complex problems (Baker & Cuevas, 2018; Poncy et al., 2010; Skarr et al., 2014). Regrettably, our current 2023 Conditions of Education Report has shown a decline in math scores over the last four years (The Nation's Report Card, n.d.). This problem can be compounded for students with learning disabilities where fact fluency can be even more difficult to acquire (Baker & Cuevas, 2018; Nordness et al., 2011). Therefore, it is imperative that we implement and utilize research-based interventions that are effective in improving fact fluency for students with learning disabilities. If we do not address this with our students with learning

disabilities early and effectively, the math deficit may continue to grow and further impact their future math skills.

As stated by Fuchs et al. (2008), the process of acquiring fact fluency starts with counting all numbers, progresses to counting on from the first number being added, learning specific adding strategies, and eventually attaining "memory-based retrieval of answers" (p. 80). This process can take longer for students with learning difficulties which supports the need for appropriate and effective interventions (Fleishner, Garnett, & Shepherd, 1982, as cited in Fuchs et al., 2008, p. 80). One research-based intervention shown to improve fact fluency for students with learning disabilities is the Direct Instruction Flashcard procedure (DeLong et al., 2013; Glover et al., 2010; Skarr et al., 2014). This intervention was utilized in this study and was comprised of the following effective intervention qualities: explicit instruction, opportunities for repeated practice, reviewing previously learned skills, and progress monitoring (Fuchs et al., 2008, p. 85). It, unfortunately, did not include clear instructional design, a "strong conceptual basis" or student motivators (p. 86).

Previous research was found to support the DI Flashcard intervention and its positive impact on students' multiplication and division fact fluency scores (Glover et al., 2010; Skarr et al., 2014). However, there remained a gap in determining if the DI Flashcard intervention would improve addition fact fluency scores for students with learning disabilities based on their current level of ability. Therefore, the researcher conducted this study to determine the impact on fact fluency addition scores following the implementation of the DI Flashcard intervention. The researcher also captured data from individual student IEP goals to determine if there was a possible correlation between the intervention and progress monitoring scores.

The study showed one participant's CBM pre-test and post-test data remained the same while the other two participants showed a decline in their scores. However, the probability ($p > .05$) indicated there was not a significant correlation between the intervention and the post-test results. Additional data needs to be collected to determine if this finding stands true when more participants are included. Even though there was not a positive impact from the pre-test to the post-test, there were encouraging results with student IEP math data. All of the participants showed increases in their bimonthly progress monitoring scores. Their individual addition fact data also improved overall from the first to the last day of the intervention.

Based on this information, the researcher will plan to continue with the intervention, collect data, and make minor changes to the process. The first change will be to give a pre-test and follow-up post-test consisting of only facts in sets 1-3. These are the sets utilized in the intervention. A second change will be to implement the practices that support students with disabilities mentioned by Vostanis et al. (2020) which include instruction at the student's current level, providing feedback, giving students opportunities to respond, using timed practice, implementing reinforcement, and self-tracking. The majority of these are already put into practice in the overall DI Flashcard process. Finally, after tracking data and determining if the impact is positive, the researcher will continue with the process using different operations and will track schoolwide screener and standard assessment data to determine long-term effects. This research shows a potentially positive impact for students with learning disabilities as related to their overall IEP math goals. However, additional studies are necessary to determine the impact of the DI Flashcard intervention on students acquiring addition fact fluency and if the impact changes when the intervention is implemented over a longer period of time.

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