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The effect of cross age tutoring on math fact automaticity using students with disabilities as tutors

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THE EFFECT OF CROSS AGE TUTORING ON MATH FACT AUTOMATICITY USING STUDENTS WITH DISABILITIES AS TUTORS

by

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Dedications

To my future students, may I be the teacher that you need and deserve. And to all the fearsome and hard working teachers who spend their free time, cash, and vivid imaginations to the benefit of their charges.

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Abstract

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THE EFFECT OF CROSS AGE TUTORING ON MATH FACT AUTOMATICITY USING STUDENTS WITH DISABILITIES AS TUTORS
2018-2019
S. Jay Kuder, Ed.D.
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The purpose of this study was to determine if the math fact knowledge and recall of students with disabilities improved when they acted as tutors in cross-age tutoring situations. I hypothesized that students with disabilities would exhibit increased recall, improved engagement and enhanced self-concept when they took on the role of expert. All the participants in our study were special education students with Individualized Education Plans and met for 15 three-minute tutoring sessions. The tutor and tutee did not change roles. Addition fact cards were presented and tutees were given a pre-determined amount of time to answer. All participants were given probes on three separate occasions: first to establish a baseline, then at the conclusion of the intervention, and finally, three weeks later to measure retention of skills.

The math fact knowledge of all increased markedly. Tutors increased by at least 67%; the tutees increased by no less than 79%. The target group exhibited behaviors consistent with a mentor or teacher, redirecting the behavior of their younger counterparts when necessary and were invested in the collaborative work. The students with disabilities made excellent tutors and were able to handle the leadership role, improving their own self-image and the perception of others. Peer tutoring empowers students with disabilities to take charge of their learning and facilitate the learning of others.

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Chapter 1

Introduction

Schools today face more accountability then ever before for the learning that is taking place within their walls. Federal and state standards mandate what is taught at each grade level. In addition, changes to our educational philosophy assert that children are more capable at younger ages to perceive and internalize more complex concepts. Today's educational culture is placing more stringent requirements on schools to expose students to more complex learning environments and teach higher-level thinking skills at earlier ages. Yet, despite a combined effort by policy makers and educators to improve math proficiencies, student math scores remain mediocre.

I started teaching as a first grade teacher. In the beginning, we spent our days playing games, learning the names and sounds of letters, and reciting math facts until they were reflexive and mindless. It was from this continual recitation and rote memorization that my students began to build their math sense. What we couldn't get to in school, students would take home to practice for homework. Flashcards were a common and regular part of our day, and at the beginning of each year, I stressed to parents and families the importance of buying or creating a set for practice at home. It was obvious from my students' differing abilities who were practicing at home and who weren't. Because my students knew their facts, we could discuss more complex ideas. Having the strong foundation in basic math facts allowed my students to comfortably explore new concepts.

Later, I was an 8th grade inclusion teacher for several years. The classes consisted of a general education teacher, a special education teacher and a mix of both regular education and special education students. Most of these students (both general and special education) did not have a solid foundation of basic math facts. For instance, while working out the slope of a line or learning 3-step equations, students would often calculate basic addition or multiplication by counting on their fingers. I have seen fingers used for the simplest of addition, the factors of 10. The lack of expediency with their math facts increased the time it took to complete more complex problems and created needless obstructions to their success. Because the flow of the new concept was interrupted by the necessity to focus on basic math, students often became frustrated and would frequently give up, indicating an inability to complete the task. That frustration and feeling of incompetence would then be transferred to math in general, producing an intense dislike for the subject matter.

What traditionally was introduced and reinforced in early elementary grades is now being replaced with more complex skills without the solid foundation necessary to be successful. At one point first grade included playtime and naps, but today most students are expected to read by the end of first grade. Multiplication, typically a skill taught in third grade in the past, is now introduced in first grade. Many students with disabilities lack the rapid recall of their basic math facts. These difficulties may occur because of marginal exposure to math facts, shortfalls in visual or auditory memory, insignificant teaching strategies, or neurological issues (Jewett, 1988). Irrespective of the reason, the deficiency in basic math fact knowledge creates a gap that makes learning more difficult. My goal with this study is to explore the use of an evidence-based practice to improve the math skills of students with disabilities, one that could be easily integrated into the classroom.

Research Question and Hypothesis

The purpose of this study is to determine whether the use of cross-age tutoring improves the math fact automaticity of students with disabilities when they are the tutors. We hypothesize that students with disabilities will exhibit increased math fact recall, improved engagement and enhanced self-concept when they take on the role of expert in a peer-tutoring situation. Cross age tutoring involves an older student tutoring a younger student to review critical academic or behavioral concepts. Students will often rise to meet the high expectations or standards placed on them. Older students will frequently make better choices when they understand that younger students are observing them; they seem to want to model better behavior, to help the younger students make better choices and take pride in the responsibility of showing correct behavior.

Key Terms

The key terms of this study are peer tutoring (cross-age, class-wide, reciprocal), math fact automaticity, and cognitive and affective gains.

Peer tutoring is defined as "a flexible, peer-mediated strategy that involves students serving as academic tutors and tutees. Typically, a higher performing student is paired with a lower performing student to review critical academic or behavioral concepts." (Hott & Walker, 2012). According to Hott and Walker (2012), peer tutoring has been found to be a highly effective replacement strategy to traditional methods of classroom instruction, with definite advantages:

- A strong research base shows wide benefits across grade levels and subject areas
- Students receive one-on-one support

- Increased opportunities are presented for individual student responses
- Academic and social development is fostered for both the tutor and tutee
- Increased student engagement and time on task
- Self-confidence and self-efficacy are encouraged

The most frequently used peer tutoring models include:

1. Cross-age Peer Tutoring: Older students are paired with younger students to teach or review academic or behavioral concepts. Tutor and tutee do not change roles. The older student is an "expert" with the material being taught.
2. Class-wide Peer Tutoring (CWPT): an entire class participates in teacher-planned, peer tutoring activities, with each student acting as tutor, tutee, or both.
3. Reciprocal Peer Tutoring (RPT): Students at the same skill level are paired. Roles are switched and both participants have an opportunity to be both tutor and tutee.

Implications

Peer tutoring has implications for improvement in areas other than just academic (The National Tutoring Association, 2017). Improvements in social as well as cognitive and affective gains have been observed. Social behaviors are behaviors exhibited as people interact with each other. Cognitive abilities include reasoning, thinking, understanding, learning and remembering. Affective capacities involve a person's emotional state or feelings. The National Tutoring Association (n.d.) reports many benefits to the tutor as well as the tutee:

- Review of previously learned material

- Encourages higher level thinking
- Improves subject specific knowledge
- Improves general knowledge
- Develops confidence in learning ability
- Improves motivation for studying
- Improves knowledge of learning, studying and test-taking techniques
- Builds self-esteem and creates a sense of pride in helping others
- Develops communication skills
- Provides experiences that may help with later employment or career goals
- Develops empathy for others
- Improves attitudes towards subject area
- Increases general knowledge
- Develops a sense of responsibility

Summary

This study involved eight students - four students with disabilities from a fourth grade self-contained class, three second graders and one first grader from a math resource room. Since there is limited data on the effect on special education students when they take on the role of tutor, our target students were the older four fourth graders: three girls and one boy, three classified as specific learning disability and one classified as other health impaired. Addition assessments were administered to all the students before the study began, and then again at completion. Tutoring pairs met in a resource room for three-minute tutoring sessions, three times a week for five weeks.

Students were ranked from the highest to the lowest performing based on the scores on the addition assessments. Partnerships were formed by matching the highest-performing student with the lowest-performing student, the second highest student with the second lowest student, and so forth. Pairs remained the same for the entire study. Tutor and tutee roles were not reversed.

Tutoring sessions must be carefully structured and clear objectives must be conveyed to the tutors. Because training for the peer tutors needs to be well defined and systematic, a PowerPoint presentation was presented. Following the recommendations of The National Tutoring Association (2017), before the tutoring began forty-minute training sessions were provided for the tutors to review:

- Establishing rules for confidentiality
- Defining appropriate social skills to be exhibited during the sessions (i.e., sharing, taking turns, using respectful language, and accepting criticism or feedback)
- Presenting a prepared script for ensure most beneficial interactions
- Modeling tutoring sessions and allowing students to practice before beginning
- Training students to provide suitable feedback for correct and incorrect peer responses, including praise
- Teaching students how to carefully monitor their own and their partner's progress

The tutees were given fifteen-minute training sessions as well. Objectives for the tutoring sessions were reviewed; a detailed overview of what would take place during a session and expectations for the tutees. Two older tutors, one playing the tutee and one the tutor, modeled a typical tutoring session for the tutees. My goal was to make the tutoring experience a fun learning opportunity.

Materials for the study included addition fact cards with vertical equations. The study focused on learning addition fact families to 20. The front side of each card had a vertical equation with no answer. Answer was on the backside. Cards were divided into fact families, with ten cards in each rubber-banded set. The tutor presented the front side to the tutee, and recited the equation. If the tutee answered correctly within the time limit (three seconds), the tutee was praised and the next fact card presented. If after three seconds, the tutee had not answered or had answered incorrectly, the tutor would repeat the equation with the correct answer and ask the tutee again. The tutoring sessions lasted three minutes, at which time the tutor would reshuffle the ten cards and once again present them one by one to the tutee, but this time without feedback, recording the number correct and incorrect on a score sheet to monitor the tutee's progress. A prepared script was provided to facilitate proper presentation of the equations as well as proper handling of incorrect answers. The tutor assessed the progress of the tutee at the end of each session, and all students involved (tutoring pairs and the control group) were assessed at the end of the five weeks.

The ability to automatically recall basic math facts is essential for students in conquering higher-level math skills. Without it, more complex concepts are more difficult to understand. If the focus while learning new math concepts is diverted to calculating basic facts, the thinking capacity of an individual is diverted from understanding the higher-level processes. Rapid math fact recall has been shown to be an effective predictor of future scores on standardized tests. An improvement in the rapid recall of basic math facts can only help the overall success of the all the students involved, with obvious implications for school-wide achievement.

Chapter 2

A Review of the Literature

Math proficiency begins in early elementary school with mastering basic skills before moving on to more advanced concepts. Competency in foundational skills sets the tone for achievement with higher order math concepts (Loveless, 2016). The learning of basic math skills involves mastering addition, subtraction, multiplication and division of whole numbers, decimals and fractions. A student's ability to master basic math in a timely manner is a good predictor of success in secondary grades, post-secondary arenas, and of expected future earnings (Belyavskava, 2014). Loveless (2016) describes basic math skills as a floor, not a ceiling.

Research shows that students who advance beyond algebra II are likely to finish high school, go on to college and succeed in the workforce (Gomer & Nedeljkovic, 2016). Unemployment rates are lower among those who achieve higher math (Gomer & Nedeljkovic, 2016). Research has found that the complexity of math subjects that students undertake in high school relates directly to the likelihood of a student completing a college degree (Gomer & Nedeljkovic, 2016). A student who studied calculus had more than a 70% chance of obtaining a bachelor's degree, while someone who completed vocational math had less than a 5% chance (Gomer & Nedeljkovic, 2016). This may be best interpreted as a combination of correlation and causation, not one or the other. As Gomer and Nedeljkovic (2016) stated, "Students who show an interest in math and related fields are often drawn into an orbit of higher-paying job opportunities, like finance and consulting."

Students with disabilities are especially at risk for failure in school (Loveless, 2016). In most school systems, special education services are provided more frequently for reading difficulties than for math (Garnett, n.d.). In fact, difficulties in learning math seldom cause children to be referred for evaluation, but if they are evaluated and then identified as learning disabled, few are provided practical and applicable remediation for math difficulties (Garnett, n.d). Unfortunately, deficiencies in math are usually cumulative. Insufficient skills early on lead to struggles later. There are several areas in which math difficulties manifest themselves: number facts, computation, knowledge transfer, the language of math, and spatial organization (*Signs of a Math Disability*, 2012).

Number facts refer to the basic computation that most students memorize in early elementary grades. They are commonly known as fact families. Recalling these facts automatically permits a student to tackle higher-order math without being bogged down by simple calculations (*Signs of a Math Disability*, 2012). In addition to lacking rapid recall, math fact deficiencies may cause the student to have difficulty remembering procedures or formulas, or using formulas with exactness (*Signs of a Math Disability*, 2012).

Computation is another area where math difficulties may manifest themselves. Despite understanding math concepts, inconsistency in computing may be caused by an inability to remember previously learned patterns, difficulties sequencing multiple steps, focusing too much on the individual steps and losing sight of the final goal, becoming overloaded when faced with an entire worksheet of problems. Handwriting sometimes will slow down the math process. Sloppy handwriting can interfere with proper alignment of numbers; cause a student to misread signs; or numbers may be too sloppy to read correctly (*Signs of a Math Disability*, 2012).

Knowledge transfer is the ability to easily connect the abstract and conceptual parts of math to real life (*Signs of a Math Disability*, 2012). Students may not be able to distinguish between what information in a problem is important and what is not (especially in word problems where much of the information is irrelevant); have trouble switching between multiple steps in a complex problem or manipulating geometric configurations (*Signs of a Math Disability*, 2012).

For some students, a math disability is related to problems with language (*Signs of a Math Disability*, 2012). The language of math is inherently foreign, and terminology may not be heard outside the math classroom. Students struggling to understand the language of math may have difficulty translating word problems, learning and recalling specialized terms, understanding directions, remembering assigned values, reading texts to direct their own learning, or even being able to verbalize their confusion (*Signs of a Math Disability*, 2012). These students may also be having difficulties in reading, writing, and speaking (*Signs of a Math Disability*, 2012).

Students with math disabilities may also have difficulty with spatial organization (*Signs of a Math Disability*, 2012). Spatial organization refers to the inability to effectively visualize math concepts. Students are forced to rely almost entirely on rote memorization of descriptions of concepts. Students may have difficulty neatly organizing problems, describing a three-dimensional object after it has been rotated, or applying quantities and mathematical formulas to the real world (*Signs of a Math Disability*, 2012).

Regardless of a student's aptitude for abstract mathematical thinking, difficulties in the ability to rapidly and accurately do basic math inhibits students from success with higher-order concepts (*Signs of a Math Disability*, 2012). Many students with disabilities have trouble memorizing math facts and resort to counting fingers, using pencil marks or scribbled circles to calculate (Garnett, n.d.). Finding effective, efficient strategies for use in everyday educational settings is critical to supporting students with disabilities.

The National Research Council (Steedy, Dagoo, Arefeh, & Luke, 2012) describes peer tutoring as a highly effective intervention strategy for students with learning difficulties in math. Peer tutoring is a strategy that pairs students together to learn and practice an academic skill (Steedly et al., 2012). According to Steedly et al. (2012), peer tutoring works best when students of differing ability levels are paired together, and cross-age tutoring was found to be more effective than same-age tutoring (Daggett & Pedinotti, 2011). A substantial advantage of peer tutoring is the decreased amount of teacher responsibility in executing the intervention (Menesses & Gresham, 2009). Already stretched thin, classroom teachers are finding it difficult to address the needs of all their students, especially those with disabilities in inclusion settings. Because students are the primary participants, peer tutoring is an efficient method for providing individualized instruction to many students simultaneously (Menesses & Gresham, 2009).

Willard Daggett and Gerald Pedinotti in *Cross-Age Peer Teaching: An Effective and Efficient Model for Supporting Success in the Classroom* (2011) state that the goal of peer tutoring is to teach students to self-regulate and control their own learning, to move from being student to being teacher. A peer as co-teacher is a powerful tool to increase learning, and has positive effects on both mathematics and reading. After studying various instructional strategies for effectiveness, Daggett and Pedinotti (2011) reported that peer tutoring was the most effective intervention on mathematics instruction. Since explaining a concept to another student helps extend one's own learning, peer tutoring gives both the tutor and the tutee the opportunity to better understand the material being presented (Steedly et al., 2012). The tutor's own skills improve through the process of formulating an explanation of the problem for the tutee.

Daggett and Pedinotti (2011) reported on two success stories using cross age tutoring in two different schools. The schools were demographically very different, but both had a large at-risk population. Highly structured, peer-tutoring programs in both math and reading were established in the schools to boost academic achievement for both the tutee and tutor. In addition to building confidence and academic competence, the programs hoped to reduce math anxiety experienced by students. Although the tutoring sessions were scripted, the tutors received direct instruction from a trained teacher before every lesson to ensure understanding of the higher-order thinking skills imbedded in the lessons. The training included role-playing each lesson and completing all reading and math activities ahead of time.

The same methodology was followed each week for all sessions in both schools. A typical week of the peer-tutoring program included prep with their teacher for the upcoming lesson on Monday, tutoring sessions on Tuesday, more tutor prep on Wednesday with tutoring again on Thursday, and an assessment of the material being taught on Friday. After each tutoring session, the monitoring teacher reviewed the tutor's performance with the tutor.

Data was collected from these schools to directly measure and report on the merits of cross-age peer teaching and learning (Daggett & Pedinotti, 2011). In one case, tutees showed a 26% increase in reading and a 33% increase in math after participating in the program for two years. Tutors at the same school showed a 7% increase over the same two-year period. The second school profiled showed similar results. The achievement gap between at-risk and non at-risk students closed dramatically. The at-risk student's reading proficiency rate before beginning the peer-tutoring program was 71%, compared to 91% for the non at-risk students. That achievement gap closed from 20% to 8% when scores for the participating at-risk students increased to 84%. The achievement gap narrowed by 24% in two years. The scores for the math tutoring program had similar results. The achievement gap in math narrowed by 18% in the same two year period, with proficiency ratings increasing from 49% to 64% for at-risk students participating. The results are even more dramatic as the third grade tutees become fifth grade tutors and the achievement gap completely disappeared.

In another study entitled *Cross Age/Cross Disability Peer Tutoring: a Strategy for Math Instruction,* Holecek (2012) looked specifically at the effects of cross-age and cross disability peer tutoring on the math success of students with disabilities. Three types of peer tutoring were studied: cross-age, bi-directional, and unidirectional. Unidirectional is defined as the most traditional type of peer tutoring. One student assumes the role of tutor, and the other student is the tutee. Bi-directional tutoring involves students switching roles and therefore, is exposed to the material twice. Cross-age tutoring is the pairing of students from different grade levels. Same age peer tutoring was used for both the unidirectional and bi-directional tutoring.

Holecek (2012) held 30-minute sessions, twice a week, for 6 weeks. During each session, students were monitored for time on-task as well as academic achievement. Behaviors such as talking, putting head down, drawing, handling a cell phone, and watching others were considered off task. At the end of the study, for every 30 minutes of tutoring, the data showed an overall net increase of 4 minutes in engagement time for students participating in the peer tutoring. Total time of engagement increased compared to the traditional daily math lessons experienced in the classroom. Students with disabilities were reported to have more time on task and reportedly fewer disruptive behaviors during peer tutoring sessions. Students showed a small improvement in basic math skills as assessed with posttests administered at the end of the study, but exhibited a higher level of interest in learning. This study also reported an improvement in student self-esteem, comprising both self-worth and self-competence. Other benefits noted by Holecek (2012) were positive feedback from parents regarding the teacher's recognition of their child's need, and support of their child acting as tutor to another student.

In a similar study of 59 at-risk elementary students in grades 2, 3, and 4, Menesses and Gresham (2009) compared the academic gains of two peer-tutoring methods in math fact acquisition to a control group. All students had scored below average on a computer-generated curriculum-based math probe. Students involved in the peer tutoring were trained to tutor basic math facts using a constant time delay procedure. The study used two distinct peer-tutoring techniques: reciprocal (RPT) and non-reciprocal (NPT). Reciprocal peer tutoring involves participants at the same instructional level taking turns acting as tutor and tutee. Roles are switched halfway through the tutoring session. Students participating in non-reciprocal peer tutoring do not switch roles. The student designated as tutor will always be tutor. Tutor and tutee may be of similar academic levels or a higher-achieving student might be paired to tutor a lower-achieving student.

The study set out to specifically compare RPT with NPT techniques. The authors found that, in the past, the two methods had not been directly compared to each other. Previous studies, it was noted, involved differing aspects to the point where they could not be directly compared. For instance, in one study, student rewards were involved with the reciprocal but not the non-reciprocal. Menesses and Gresham (2009) wished to directly compare reciprocal and nonreciprocal peer tutoring to determine which program resulted in greater academic gains. Another purpose of the study was to determine the effect of using only at-risk students as tutor and tutee, rather than one high achieving student and one low. Basic math facts were chosen as the tutoring material because of their importance to complex, higher order mathematical concepts.

Two screening assessments were administered to seven classrooms with approximately 22 students each. The first was a computer generated probe containing 60 addition, subtraction, multiplication and division problems. Types of problems were determined by discussions with the teachers about what had recently been taught in the class. Thus, the probes screened for students who did not attain or retain facts recently taught. Any student falling into the frustrational level as determined by national benchmarks were moved to the second level of screening, individual. Students earmarked for addition/subtraction tutoring were asked to identify numbers from 0-to 18, and students earmarked for multiplication/division were asked to identify numbers 0-81. Students also had to be able to read completed mathematical equations correctly to be included in the tutoring program. Screening procedures ensured that students were at an appropriate level of math competence. Students selected to participate were given probes similar to the first screening assessment as a benchmark prior to beginning the peer-tutoring program. Finally, students could not be receiving any intervention services in math already. Students could drop out of the program at any time. 59 students were selected to participate and grouped by classroom.

To control for preferential effects, the three types of instruction were randomly assigned in each classroom. Each student was then randomly assigned a tutoring partner. The NPT consisted of the same student always being the tutor and the other always being the tutee. In contrast, the RPT students switched roles as tutor and tutee in the same tutoring session. Students in the control group received conventional classroom instruction. All screenings, tutoring training sessions and tutoring sessions took place in a quiet hallway with desks and chairs. Times of sessions varied depending on classroom schedules.

Tutor training took place with each individual student. A "tell, show, do" approach was used; an explanation of the procedures was followed by a demonstration of a tutoring session, and finally the tutors role-played to ensure understanding. Training trials were identical to the 3-minute tutoring sessions that took place during the intervention. Positive and corrective feedback was given during all training trials, and tutors were trained until they reached 100% accuracy on three consecutive trials. Tutors were also trained to monitor the progress of the tutees. Progress required four behaviors: 1) present each card for 3 seconds, 2) no talking, 3) sort cards into correct and incorrect piles, and 4) count and record number of correct cards with tutee.

Tutoring sessions averaged three sessions a week until they reached the required 15 sessions. A timer was set for three minutes, and the tutor then began presenting cards to the tutee. Each set of cards contained ten math fact equations. The tutor presented each card to the tutee and if the tutee answered correctly within 3-second, the tutor gave praise and presented a new card. If the answer was incorrect, the tutor gave the correct answer and moved on. If all 10 cards were used before the timer sounded, then the pile was shuffled and used again until time was up. Correct answers were counted and recorded. All ten cards had to be mastered before a new set was given. Mastery consisted of ten correct answers in two consecutive sessions.

The two members of each tutoring pair were considered a team. To increase student cooperation and performance, members of each team were responsible for earning points for their team. During each session, teams could earn up to four points; two for correct tutoring behavior and two for correct tutee behavior. Points were plotted on a chart and members could choose a reward of their liking each time five points was earned. Booster training sessions were provided if tutors had to be prompted more than once during a session.

At the end of the tutoring program, individual scores were compared to national benchmarks. Results indicated that the two types of peer tutoring produced comparable gains in basic math facts (Menesses & Gresham, 2009). Additionally, both types of peer tutoring methods showed significantly larger academic gains than the control group, demonstrating at-risk students could successfully tutor each other (Menesses & Gresham, 2009). The RPT group had the largest mean score, with tutees in the NPT the next highest. 12 of the 14 students in the RPT group and 10 of the 14 tutees in the NPT moved from the frustrational level to instructional level for basic math facts. In contrast, 6 of the 14 tutors and 5 of the 16 control students moved to instructional level. No significant differences were shown between post and follow-up scores.

These findings inform practice in several ways. First, there was no significant difference between the two tutoring techniques, reciprocal and non-reciprocal. The study shows that either can be applied with success to school settings. It is worth noting that while both were successful, the reciprocal method did expose all students to the cards twice. Secondly, this study contributes to the idea that low-achieving students can be used as tutors for other low-achieving students. The use of cards with answers eliminated the need for the tutor to know the correct answer, thereby empowering the low-achieving student. Also, any risk of awkwardness or ridicule by using a higher achieving student was eliminated. These findings advocate for using a wider range of student ability as tutor.

Successful peer tutoring approaches involve several key features (Steedly et al., 2012)):

- Comprehensive training for both the tutor and the tutee before beginning the program
- Highly structured routines and activities followed closely during the sessions
- Well-thought-out and systematic teaching materials
- Continuous monitoring and feedback to both students to ensure integrity of sessions

In a peer-tutoring program initiated by guidance counselors Christi Bello and Susie Borgnini (*Cross-Age Tutoring,* n.d.) cross-age tutoring was used to increase learning in students who would benefit from extra one-on-one help. The counselors realized that teachers could not always give individual attention to every student who needed it. SPICE (Students Promoting Individual Career Enhancement) as the program is called, provides an opportunity for both tutors and tutees to bolster their academic abilities, fine tune their organizational skills, and be altruistic. They tailored the name SPICE after the popular musical group to appeal to the students. Bello and Borgnini's (*Cross-Age Tutoring,* n.d.) tutoring program at the Northfield Elementary School in Ellicott City, Maryland, is set up like a job, complete with an application process, training, and professional accountability.

Experienced fifth grade SPICE members recruit new members to the team by putting on skits depicting what the SPICE team is and the positive impact it has on the academic and social lives of younger students. Joining the SPICE team is a five-step process. After expressing an interest, perspective members submitted a persuasive letter defining why they should be picked, completed an application accompanied by a resume with details about prior experience and a parent's signature, and went through a formal interview process, including introducing themselves, shaking hands with the interviewer, and thoughtfully answering questions. For those "hired," tutors were required to present periodic evaluations to outline their tutee's progress.

Unlike the Menesses and Gresham (2009) study in which participants were selected, the SPICE team was made up of tutor volunteers, who made a great effort to be part of the program. The facilitators made it a school-wide initiative that attracted students to participate as tutors. According to Bello and Borgnini (*Cross-Age Tutoring,* n.d.), about 30% of the school's 116 fifth graders are committed members of the SPICE team and spend much of their free time in tutoring sessions and team meetings. Participation cannot interfere with their every day responsibilities as a student. They must be prepared for each school day before they fulfill their mentoring duties. Tutors must be well organized and plan ahead for each session. Teacher support is high for the program. Fourth and fifth grade teachers allow students to come and go from their classrooms, and first-grade teachers monitor the sessions for professionalism. Both tutor and tutee exhibited growth in academic as well as organizational skills. Each part of the process from recruiting to training to monitoring progress is highly structured and outlined beforehand in detail. The program adheres to the requirement of meaningful training. Tutees show more academic improvement when their tutors had been effectively trained as opposed to having non-trained tutors (Menesses & Gresham, 2009).

Benefits to both tutee and tutor during a peer-tutoring program include the acquisition of academic skills, improvement of peer relations and better classroom behavior (Menesses & Gresham, 2009). Increased engagement time, more opportunities for individual responses, immediate feedback, and continuous progress monitoring were described as additional benefits to the tutee (Menesses & Gresham, 2009)). Other benefits to the tutor include more positive attitudes toward the subject matter, improved self-esteem and improved attitude toward school (Menesses & Gresham, 2009). Students participating in peer tutoring programs have been found to have higher attendance records than those not involved in peer tutoring (Daggett & Pedinotti, 2011).

Classrooms seeking to create learning environments that reach all learners must employ highly effective teaching strategies. These strategies must be used within a safe and nurturing environment, in which each student's affective filter falls away and they are receptive to learning (Daggett & Pedinotti, 2011). The holistic, one-on-one approach of peer tutoring provides the social and emotional support needed to engage students in positive interactions. The use of a cooperative learning environment such as peer tutoring increases social motivation since participants become teachers, sharing their knowledge and ability (*Using Peer Tutoring*, 2013). Peer tutoring provides higher academic achievement, improved relationships with peers, improved personal and social development as well as increased motivation (*Research Spotlight*, n.d.).

The purpose of the present study was to look at the effectiveness of cross-age tutoring on math fact automaticity of students with disabilities acting as tutors using constant time delay. Peer tutoring has been shown to be a highly effective teaching strategy. However, little research has been done using students with disabilities as tutors to lower-achieving students. Menesses and Gresham (2009) indicated that tutoring procedures integrating constant time delay into the sessions enable at-risk students to tutor other at-risk students with positive results. Teaching and learning math concepts are complex endeavors (Steedly et al., 2012). The National Research Council refers to math proficiency as interlocking multifaceted strands, each tied to the other like building blocks that support and expand as learning takes place. Old skills must be remembered and applied as new skills develop (Steedly et al., 2012). For the purposes of this study, acquisition of basic math facts was chosen as the tutoring material because of its necessity for success with more complex, higher order concepts.

Chapter 3

Methodology

The purpose of this study was to determine whether the use of cross-age tutoring improved the math fact automaticity of students with disabilities acting as tutors. This study involved eight students - four students with disabilities from a fourth grade self-contained class, plus three second-grade and one first-grade exceptional students from a resource room class in need of remediation in rapid math fact recall. The four fourth grade tutors included three girls and one boy, three classified as specific learning disability and one classified as other health impaired.

Fairfield Township School is a Title 1 district, with 586 students in grades preschool to eight. The district is more than 50% African American and 25% Hispanic, with all other ethnic/racial groups represented in the remaining percentile. Male and female students are represented evenly. It is a predominantly English speaking community, with some Spanish speaking homes. The 2015-16 School Report Card for the district reported 11% of the student population classified as students with disabilities, 73% as economically disadvantaged, and 2% as ELL.

Research Subjects

For this study, all the participants were selected based on the following criteria:

- Students must be able and willing to follow directions
- Students must be able to focus on an activity for 10 minutes
- Students must be able to name all numbers from 0-20

- Student's median score for three non-identical computer generated, math computation probes with 60 addition problems must be less than 42 correct answers
- Students could not be receiving remedial math instruction

Additional criteria for the four special education fourth graders included having a classified disability and being able to correctly and clearly read aloud a sampling of 10 math fact cards, including the equation and the answer.

Participant 1 (P1) was a 10-year-old female fourth grader with a Specific Learning Disability diagnosis. She was working below grade level in math and spent her day in a self-contained classroom. Formal assessments indicated that P1 fell into the low average range for total achievement. She scored in the borderline range for general intellectual ability, compared to individuals her age. Verbal comprehension and working memory fell into the low average range. Her teacher described her as friendly towards her peers, respectful of adults and loves to learn. Weaknesses included being easily distracted, talkative, and low self-esteem.

Participant 2 (P2) was a 9-year-old female fourth grader classified with a Specific Learning Disability. Qualitative descriptions included low and very low averages for general intellectual ability and cognitive performances. Academic performances were below average in reading, oral language and mathematics. She exhibited no behavioral problems in class that interfered with her learning or the learning of others around her. Her full-time placement was in a self-contained classroom. For the prior two years, she was an inclusion student, spending most of her day with her grade-level peers, but resource room for math and language arts.

Participant 3 (P3) was a 9-year-old female fourth grader with a Communication Impairment classification. She received occupational and speech therapy. Currently, she was working on grade level in math and was described by her teacher as very polite, works well with others, and very quiet. Weaknesses included a lack of ambition and goals. Her placement was in a self-contained classroom. She interacted with her general education, grade-level peers during specials and lunch.

Participant 4 (P4) was a 9-year-old male fourth grader with a Specific Learning Disability diagnosis. His overall cognitive ability fell into the very low range, with academic performance in the low range as compared to peers his age. He struggled primarily in math, reading and spelling. His performance in numeric operations was below average. P4 was moved to a self-contained classroom this year in hopes of providing a small, less distracting environment to facilitate his success.

Materials and Training

Materials needed for this study included addition fact family cards in sets of ten with equations written vertically on the front and correct answers on the back (Appendix A), Tutoring Score Sheet for the tutee (Appendix B), a prepared Tutoring Script for the tutor (Appendix C), a Coach Integrity Checklist (Appendix D), two 5 X 7 pieces of paper, one red and one green, and a pencil. These materials were kept in a folder designated for each pair.

Explicit instruction was used to train each tutor individually prior to the start of the sessions, starting with confidentiality. The importance of confidentiality for both the tutors and tutees was stressed; the identity of the students and their progress in learning the skills was not to be discussed with anyone outside of the sessions. During the training, it was explained that the tutor would be known as the "Coach" and the tutee would be the "Player." The tutor was taught appropriate responses to both correct and incorrect tutee answers; when the player gives the correct answer, the coach responds with a "good" or similar affirmation, and then shows the next card. If the player does not respond within 3 seconds or answers incorrectly, the coach reads the equation again, states the correct answer, and repeats the equation again, prompting the player to repeat the correct answer. For example: Coach says "9 + 7." Player responds "14." Coach then says "9 + 7 equals 16. What is 9 + 7?" Player responds "16." A prepared script was provided to facilitate proper presentation of the equations as well as proper handling of incorrect answers.

The investigator and tutor role-played a few sessions with the investigator as tutee; the coach and player sat across from each other at a small desk, with the pile of ten math fact cards between them, with the answers facing down. The three-minute timer was started and the coach held up a card with the equation facing the player and read the equation aloud. The coach then silently counted three seconds. If within the three seconds, the player answered correctly the coach said "good," and placed the card in a discard pile and picked up another card, repeating the procedure. When the pile was completed, it was shuffled and the presentation of cards continued until the three minutes were up.

The score sheet was also reviewed with the tutor. This is a worksheet, taken from Intervention Central (Curriculum-Based Assessment, 2017) used at the end of each tutoring session to log the Player's performance during that session. After the three-minute timer sounded, all the fact cards were again placed in a pile with the equations facing up, with the green and red 5X7 pieces of paper on either side of the pile. The coach held up each fact card again to the player for three seconds, but remained silent as the player answered, giving no feedback. Instead, cards were sorted into correct and incorrect piles; correct cards were placed on the green card and incorrect on the red. After all cards were presented, the coach counted the number of correct and incorrect answers in each pile and recorded the totals on the score sheet. Lastly, the coach filled out the Coach Integrity Checklist (Appendix D). After three consecutive correct role-play sessions, the tutor was considered trained.

Procedures and Assessment Instruments

The intervention took place over a five-week period. To set a baseline of prior knowledge, the tutors were given three single skill computation probes with sums to 18, adding two digit numbers with no re-grouping, and the tutees were given three single skill computation probes with sums to 18 but one digit numbers were added. The exact same probes were administered immediately following the completion of the intervention, and then again three weeks after the conclusion of the intervention to gauge its long-term effect.

At predetermined times set with the classroom teachers, pairs of students met in the resource room for the three-minute tutoring sessions, fifteen times during the five-week period. Tutors and tutees were paired according to the results of the initial probes. Students were ranked from the highest to the lowest performing based on the scores on the addition assessments. The highest-performing student was matched with the lowest-performing student, the second highest student with the second lowest student, and so forth. Tutor and tutee did not change roles; the older students were always the "experts" and the younger students were always the players. Assignment of pairs did not change for the entirety of the intervention.

Each pair had a pocket folder holding all the needed materials for a session, as discussed earlier. After the folders were distributed and the students were ready and settled across a desk from each other, the investigator started the timer set for three minutes, saying, “Begin.” The Coach then showed each card to the Player for three-seconds, reading the equation aloud and appropriately responding to the answers. Praise was given if the answer was correct and correction if the answer was incorrect. For correction, the Coach restated the equation with the correct answer and asked the Player the equation again and prompted the correct answer. Once all ten cards were presented and if time remained, the pile was shuffled and the pair continued until the time was up. The Coach then immediately administered the post-tutoring probe; the same ten cards were presented again to the Player for three-seconds each but without any feedback from the Coach. Cards were sorted into correct and incorrect piles using the green and red cards. Fact cards answered correctly were placed on the green paper, and fact cards that were responded to incorrectly were placed on the red paper. The pile of cards on each paper was then counted and the Score Sheet was completed. Students with ten correct answers on two consecutive post-tutoring probes were given a new set of ten fact family cards at the next tutoring session. The investigator monitored the integrity of each pair during the tutoring sessions using the Observer Checklist for Tutoring Sessions (Appendix E) and during the administration of the post-test probe using the Observer Checklist for the Assessment Phase (Appendix F), and gave corrective prompts as needed. The tutor used the Coach Integrity Checklist (Appendix D) to monitor his/her own behavior.

At the completion of the fifteen tutoring sessions, all participants were again administered the same three math probes given prior to the intervention. The repeat of these same probes allowed for an accurate comparison of the results, gauging the effectiveness of the cross-age tutoring. Identical probes were given a third time three weeks after the completion of the study to measure the lasting effect of the intervention.

Research Design

This study utilized a pretest-posttest, single subject design. The independent variable in this study was the implementation of the cross-age tutoring intervention procedures. The dependent variables included:

- tutee scores on the post-tutoring probes
- tutor and tutee scores on the post-intervention computation math probe
- tutor and tutee scores on the follow-up probes given three weeks after completion

Chapter 4

Results

This study focused on the effectiveness of using students with disabilities as tutors in cross-age tutoring situations to improve their addition fact automaticity. A constant time delay format was implemented. Eight students with classified disabilities (four fourth-graders, three second-graders and one first-grader) met for fifteen three-minute tutoring sessions, over a five-week period. The older students acted as the experts, tutoring the younger students. The tutor and tutee did not change roles. Before the tutoring sessions began, all participants were given three identical addition probes, appropriate for their grade levels. The score was the number of correct answers given by the student for that assessment. The mean of these three probes was used as a baseline for each student's addition fact knowledge.

This study utilized a pretest, posttest, single subject design. At the completion of the fifteen tutoring sessions, the same three addition probes used previously to set a baseline were administered again. Again, the score was the number of correct answers given by the student. The averages of these post tests were compared to the baseline averages to represent any increase or decrease in addition fact knowledge and recall for each participant. Subsequently, the identical three assessments were given again three weeks after completion of the tutoring intervention to measure the amount of retention of the addition facts in the participants. A mean was calculated for these follow-up probes as well.

Results for Peer Tutoring

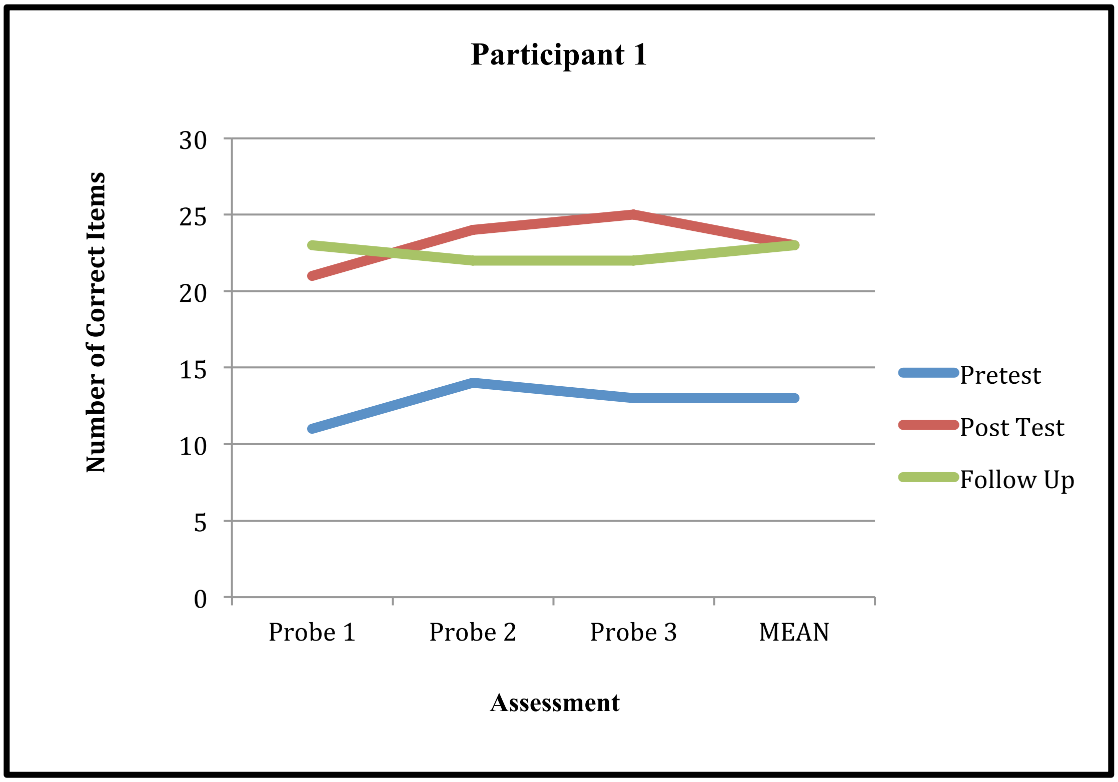

Figure 1. Results for Participant 1

This figure represents the results for Participant 1 (P1), a tutor. Three identical assessment probes were administered at three different times: before the intervention began (the pretest), at the end of the intervention (the post test) and then three weeks after the completion of the intervention (the follow up). The blue line is the number of correct answers in two minutes for the pre tests; the red line is the number of correct answers in two minutes for the post tests; the green line is the number of correct answers in two minutes for the follow up tests. A mean was calculated for each set of probes. P1 was a tutor for the entire intervention and showed an average increase of 77% from the pre test to the post test. The same average increase (77%) was noted from the pre test to the follow up.

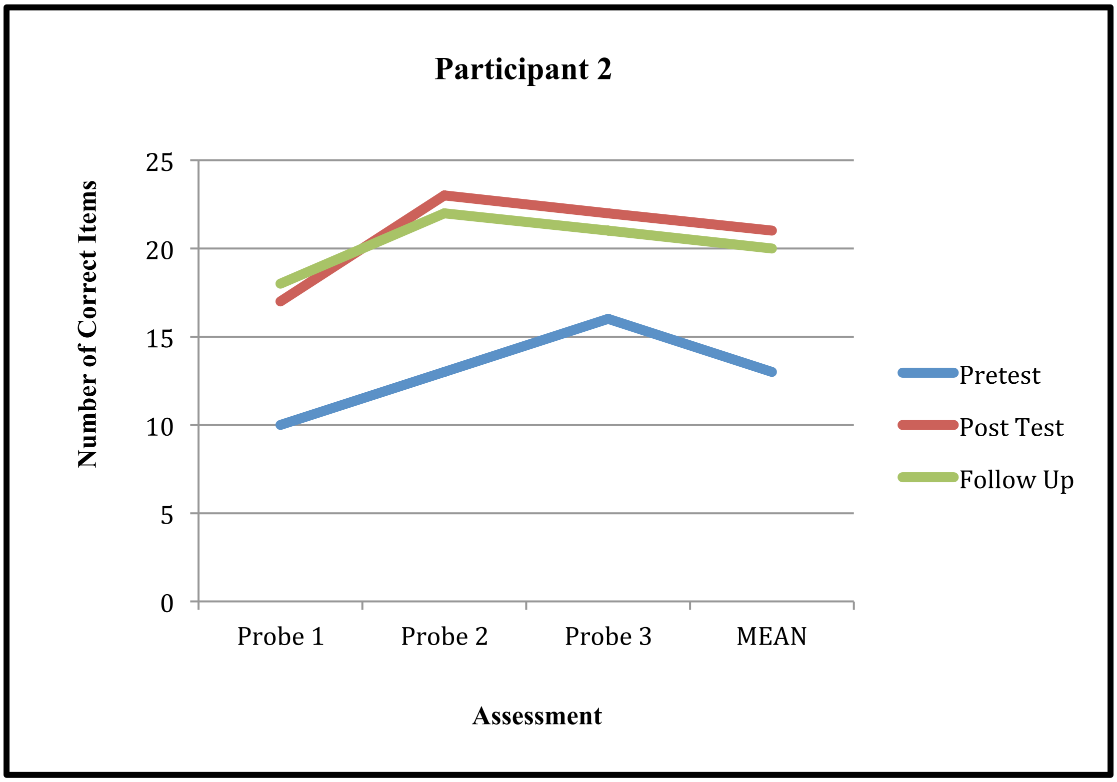

Figure 2. Results for Participant 2

This figure represents the results for Participant 2 (P2), a tutor. Three identical assessment probes were administered at three different times: before the intervention began (the pretest), at the end of the intervention (the post test) and then three weeks after the completion of the intervention (the follow up). The blue line is the number of correct answers in two minutes for the pre tests; the red line is the number of correct answers in two minutes for the post tests; the green line is the number of correct answers in two minutes for the follow up tests. A mean was calculated for each set of probes. P2 was a

tutor for the entire intervention and showed an average increase of 62% from the pre test to the post test. An average increase of 54% was noted from the pre test to the follow up.

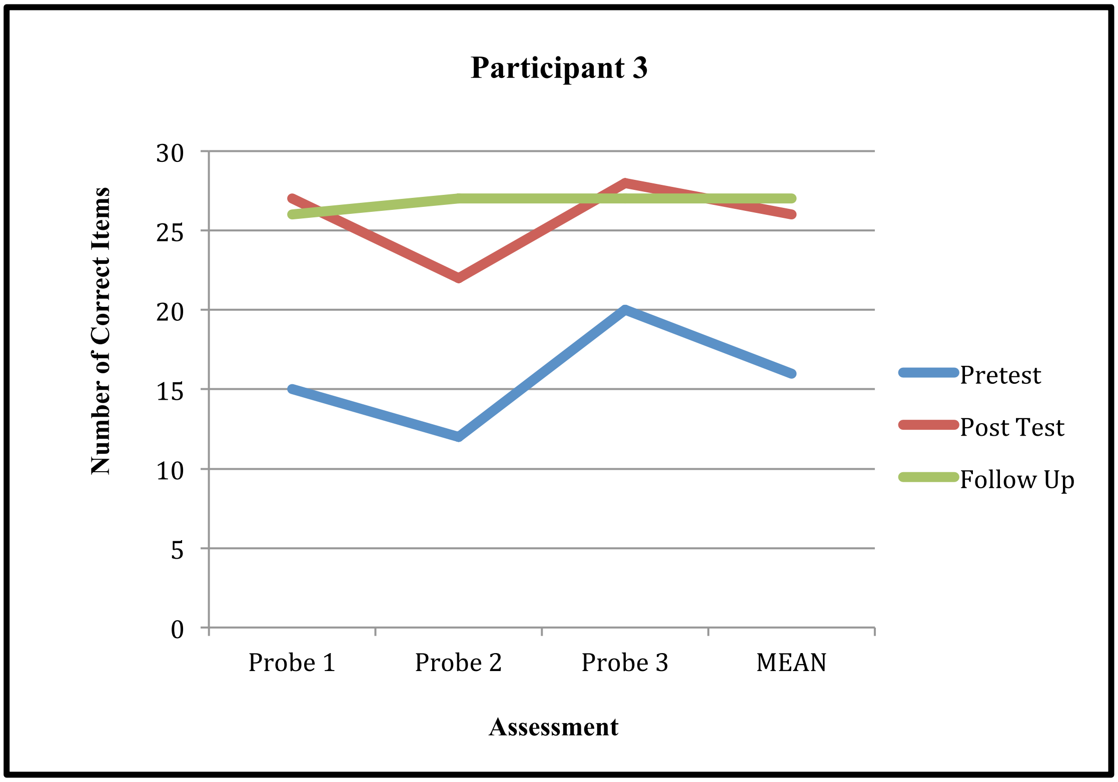

Figure 3. Results for Participant 3

This figure represents the results for Participant 3 (P3), a tutor. Three identical assessment probes were administered at three different times: before the intervention began (the pretest), at the end of the intervention (the post test) and then three weeks after the completion of the intervention (the follow up). The blue line is the number of correct answers in two minutes for the pre tests; the red line is the number of correct answers in two minutes for the post tests; the green line is the number of correct answers in two minutes for the follow up tests. A mean was calculated for each set of probes. P3 was a

tutor for the entire intervention and showed an average increase of 63% from the pre test to the post test. An average increase of 69% was noted from the pre test to the follow up.

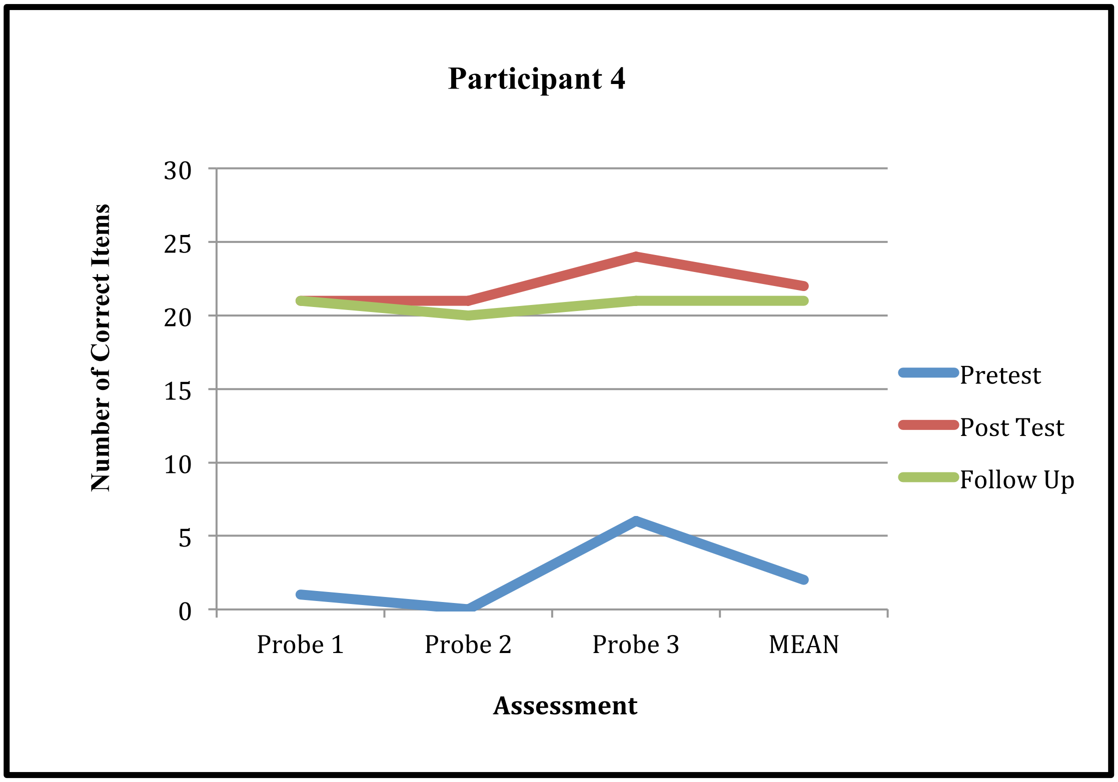

Figure 4. Results for Participant 4

This figure represents the results for Participant 4 (P4), a tutor. Three identical assessment probes were administered at three different times: before the intervention began (the pretest), at the end of the intervention (the post test) and then three weeks after the completion of the intervention (the follow up). The blue line is the number of correct answers in two minutes for the pre tests; the red line is the number of correct answers in two minutes for the post tests; the green line is the number of correct answers in two minutes for the follow up tests. A mean was calculated for each set of probes. P4 was a

tutor for the entire intervention and showed an average increase of 1000% from the pre test to the post test. An average increase of 950% was noted from the pre test to the follow up. P4 was considered an outlier.

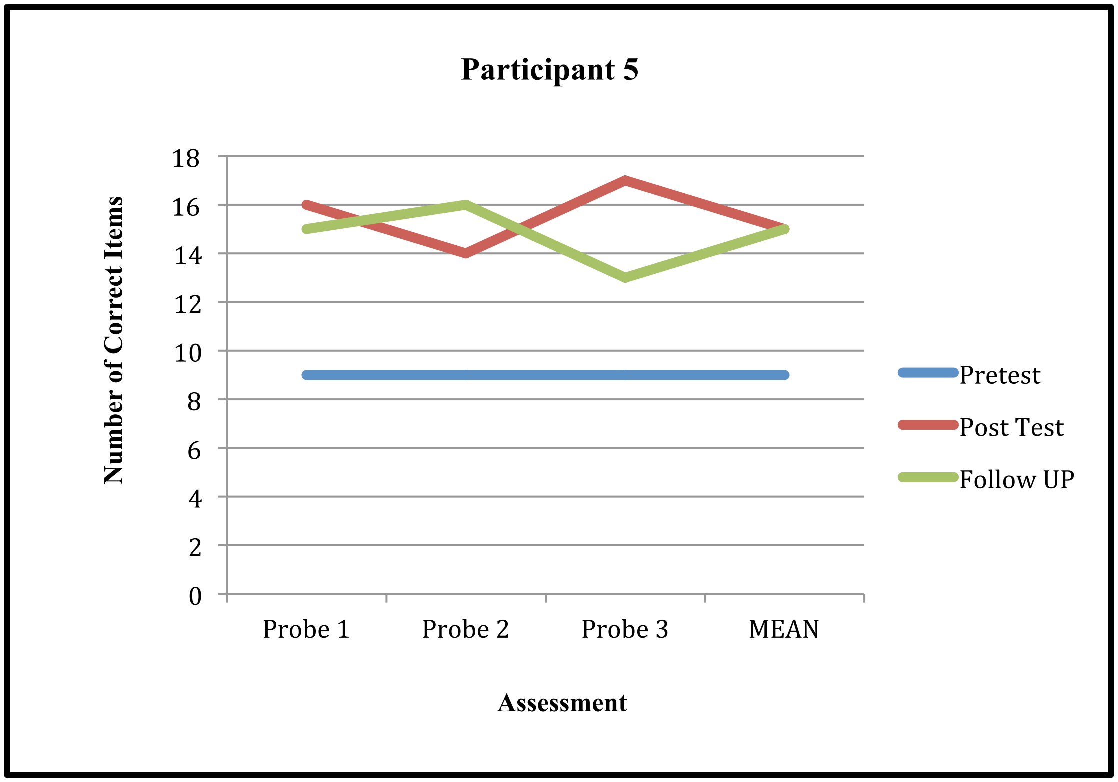

Figure 5. Results for Participant 5

This figure represents the results for Participant 5 (P5), a tutee. Three identical assessment probes were administered at three different times: before the intervention began (the pretest), at the end of the intervention (the post test) and then three weeks after the completion of the intervention (the follow up). The blue line is the number of correct answers in two minutes for the pre tests; the red line is the number of correct answers in two minutes for the post tests; the green line is the number of correct answers in two minutes for the follow up tests. A mean was calculated for each set of probes. P5 was a tutee for the entire intervention and showed an average increase of 67% from the pre test to the post test. The same average increase of 67% was noted from the pre test to the follow up.

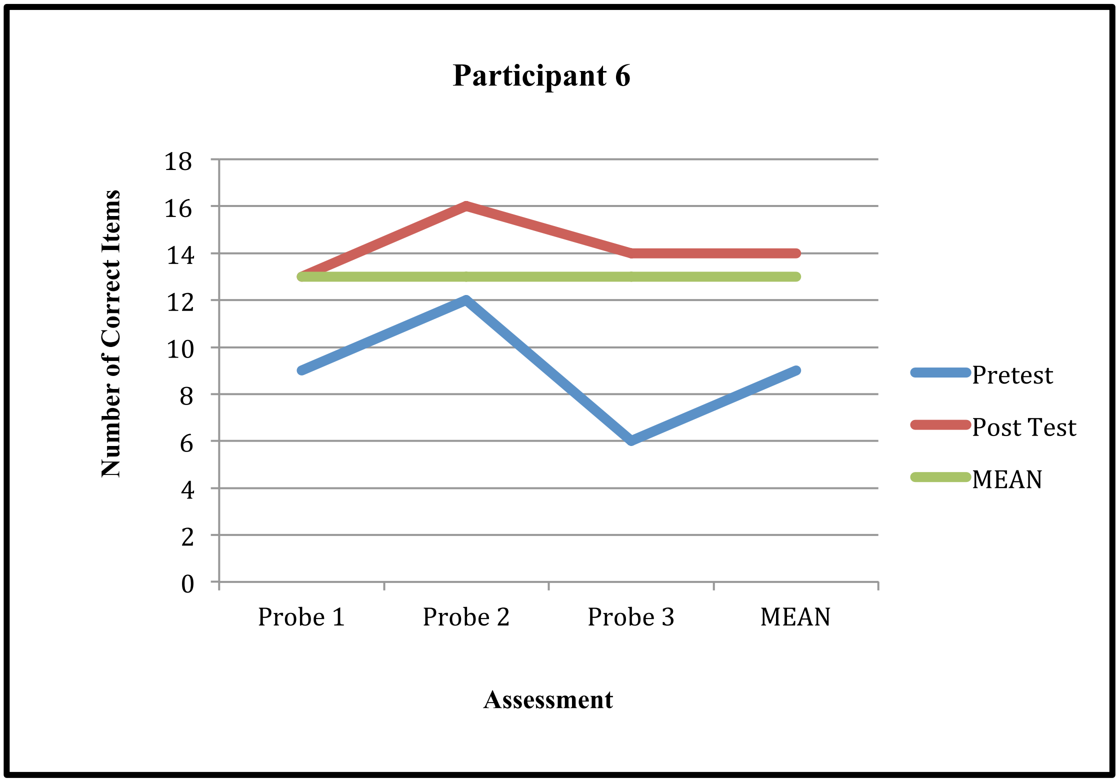

Figure 6. Results for Participant 6

This figure represents the results for Participant 6 (P6), a tutee. Three identical assessment probes were administered at three different times: before the intervention began (the pretest), at the end of the intervention (the post test) and then three weeks after the completion of the intervention (the follow up). The blue line is the number of correct answers in two minutes for the pre tests; the red line is the number of correct answers in two minutes for the post tests; the green line is the number of correct answers in two minutes for the follow up tests. A mean was calculated for each set of probes. P6 was a tutee for the entire intervention and showed an average increase of 56% from the pre test to the post test. An average increase of 44% was noted from the pre test to the follow up.

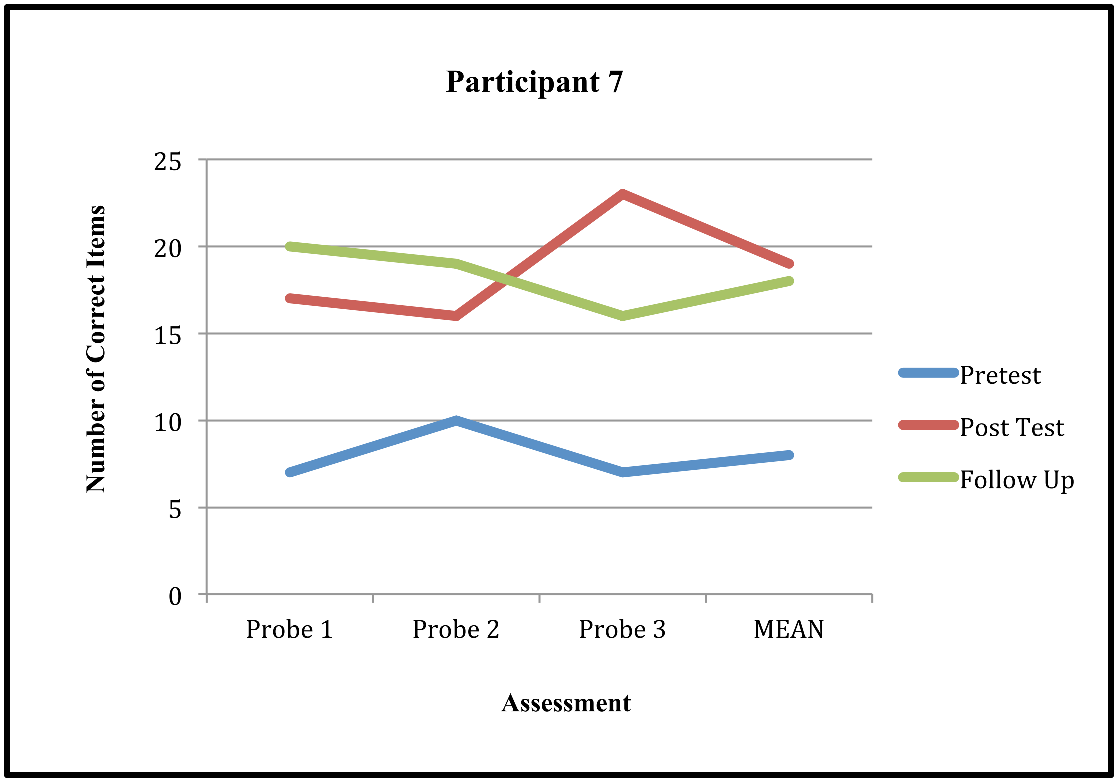

Figure 7. Results for Participant 7

This figure represents the results for Participant 7 (P7), a tutee. Three identical assessment probes were administered at three different times: before the intervention began (the pretest), at the end of the intervention (the post test) and then three weeks after the completion of the intervention (the follow up). The blue line is the number of correct answers in two minutes for the pre tests; the red line is the number of correct answers in two minutes for the post tests; the green line is the number of correct answers in two minutes for the follow up tests. A mean was calculated for each set of probes. P7 was a tutee for the entire intervention and showed an average increase of 138% from the pre test to the post test. An average increase of 125% was noted from the pre test to the follow up.

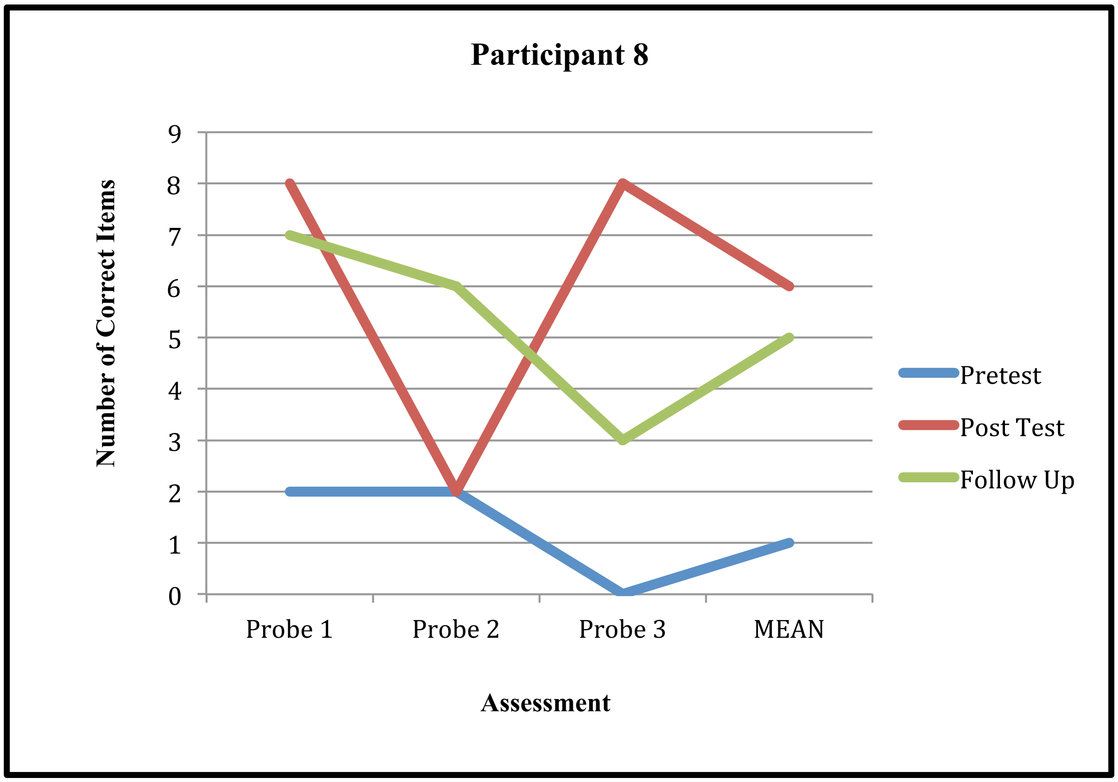

Figure 8. Results for Participant 8

This figure represents the results for Participant 8 (P8), a tutor. Three identical assessment probes were administered at three different times: before the intervention began (the pretest), at the end of the intervention (the post test) and then three weeks after the completion of the intervention (the follow up). The blue line is the number of correct answers in two minutes for the pre tests; the red line is the number of correct answers in two minutes for the post tests; the green line is the number of correct answers in two minutes for the follow up tests. A mean was calculated for each set of probes. P8 was a tutee for the entire intervention and showed an average increase of 600% from the pre test to the post test. An average increase of 400% was noted from the pre test to the follow up. P8 was considered an outlier.

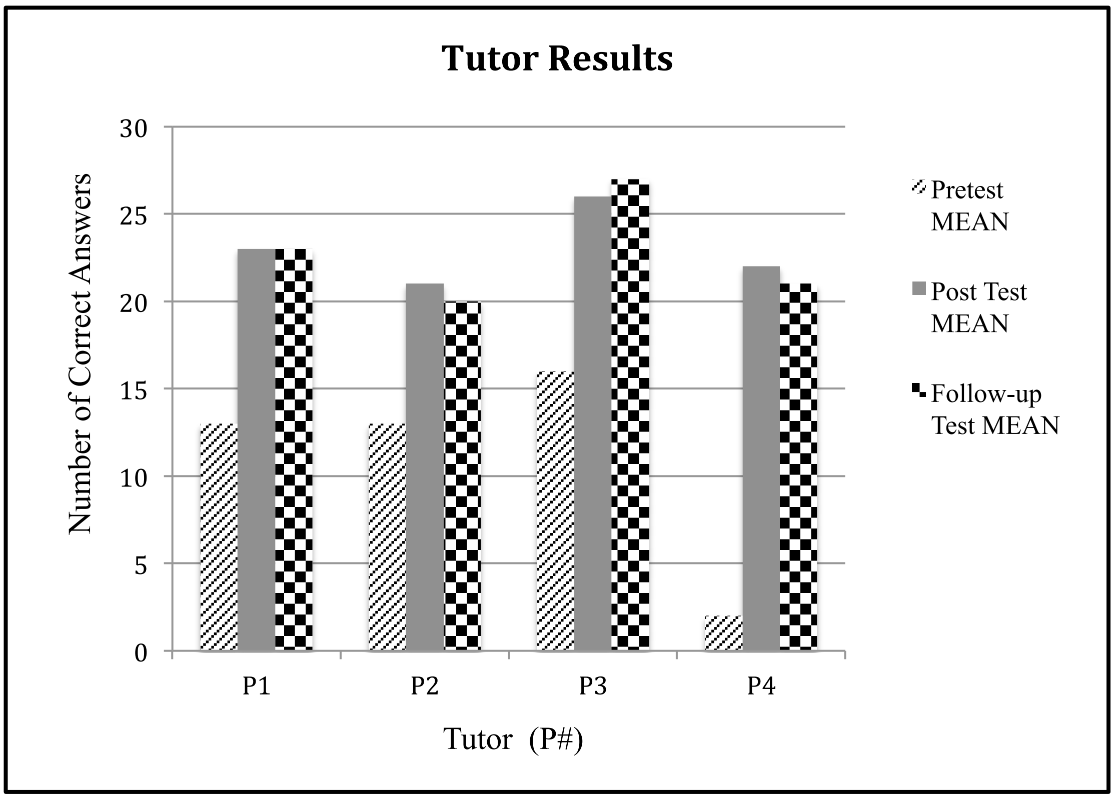

Figure 9. Tutor Pre and Post Addition Fact Assessment Scores with Means

The figure above represents the tutors' collective results, showing the effectiveness of the tutoring sessions on their math fact knowledge and rapid recall. Tutors and tutees did not switch roles. The pre and post test means were determined by the administration of three identical addition probes given prior to the intervention and then again at completion. The same probes were administered three weeks after completion of the intervention to gauge retention of skills. The results for these probes is noted as the follow-up test mean. All the probes were timed. Students were asked to answer as many problems as possible within two minutes. There is one outlier (P4) among the tutors, with extreme data points. Using only the means of the three remaining tutor participants, the average percent increase in addition fact knowledge based on the post assessment scores is 67%. Their average percent of increase based on the retention scores is also 67%. P4 had a 950% increase in addition fact knowledge as demonstrated on the follow-up assessment. This analysis concluded that the knowledge and recall of addition facts of students with disabilities used as peer tutors increased by at least 67%.

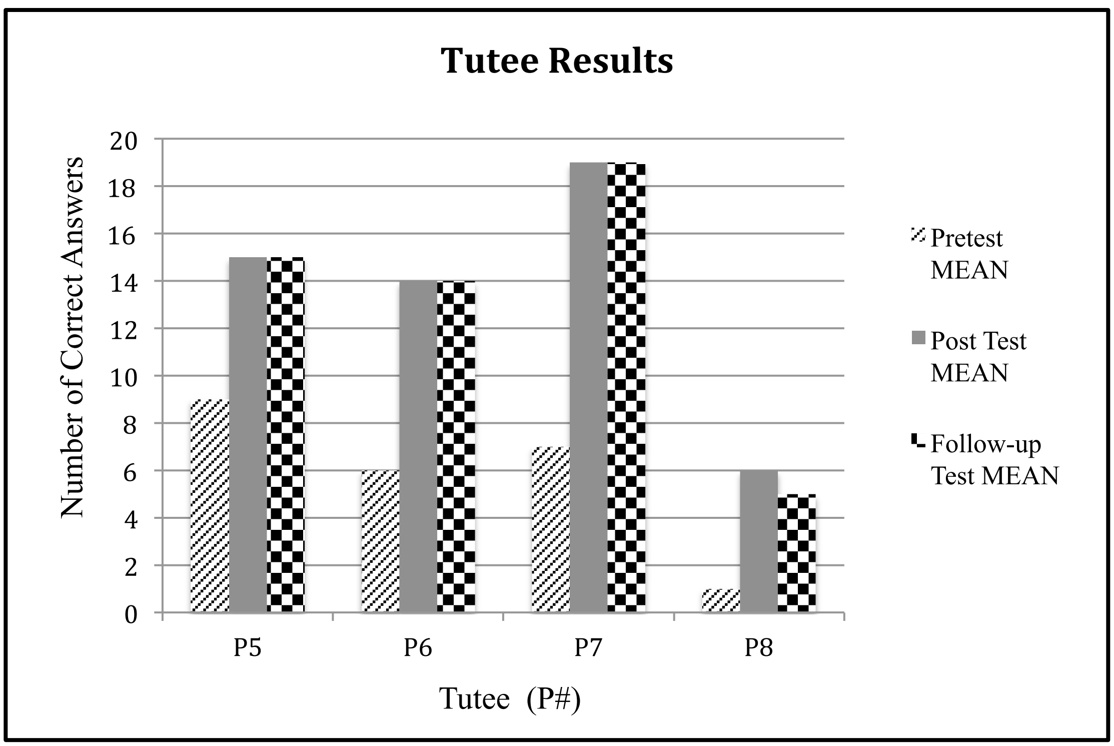

Figure 10. Tutee Pre and Post Addition Fact Assessment Scores with Means

The figure above represents the tutees' collective results, showing the effectiveness of the tutoring sessions on their math fact knowledge and rapid recall. The pre and post test means are determined by the administration of three identical math probes given prior to the intervention and then again at completion. The same probes were administered three weeks after completion of the intervention to gauge retention of skills. The results for these probes is noted as the follow-up test mean. All the probes were timed. Students were asked to answer as many problems as possible within two minutes. There is one outlier (P8) among the tutees, with extreme data points. Based on the three remaining tutees, the average percent increase in math fact knowledge based on the post assessment scores is 87%. Their average percent of increase based on the retention scores is 79%. P8 had a 400% increase in math fact knowledge as demonstrated on the follow-up assessment. This analysis concluded cross-age peer tutoring increased the knowledge and recall of multiplication facts of the tutee by at least 79%.

Chapter 5

Discussion

The purpose of this study was to determine whether cross-age tutoring with a constant time delay improved the math fact automaticity of students with disabilities acting as tutors. Specifically, the study focused on the effects on the older students' knowledge of addition fact families when they tutored others. Cross-age tutoring is a highly effective intervention strategy and involves an older student tutoring a younger student to review academic or behavioral concepts. Basic math skills involve mastering addition, subtraction, multiplication and division. The ability to automatically recall basic math facts is essential for students. Literature supports the premise that proficiency in these foundational skills is a precursor to success in higher order math concepts. There is a lack of research, however, on the effectiveness of peer tutoring when students with disabilities act as the expert. Students with disabilities are often not used in the role of tutor.

Summary of Results

All the students who participated in the study were special education students with individualized education plans (IEPs). The target students, the four fourth-graders, included three girls and one boy - three classified as specific learning disability and one classified as other health impaired. The results of the study indicate that after only fifteen peer tutoring sessions, both the tutors and the tutees greatly improved their math fact knowledge and recall, with the largest increase coming from the younger, tutee group. Both tutors and tutees demonstrated retention of their addition facts when reassessed three weeks after the intervention concluded. At that point, the target group showed no change in their addition fact knowledge, while the tutee group had a slight decrease in their proficiency.

Both groups (tutor and tutee) had students who showed tremendous improvement in their skills. In the tutor group, subject P4 is classified as Specific Learning Disability. His strengths include oral expression and listening comprehension, both of which are used significantly in peer tutoring situations. Student P8, the higher scorer for the tutee group, is classified as Other Health Impaired. He has difficulty in the classroom and will often withdraw by curling up under a table or desk. He benefits from a multi-sensory approach to learning that emphasizes auditory input and visual aids, perfect for peer tutoring. He is also the youngest of those in our study, but shows proficiency for math when he joins in classroom activities.

Previous Research

Earlier research indicates a strong, positive correlation between proficiency with basic math facts and success with more advanced concepts. A student's ability to master basic math in a timely manner is a good predictor of success in secondary grades, post-secondary arenas, and of expected future earnings (Belyavskava, 2014). Recalling these facts automatically permits a student to tackle higher-order math without being bogged down by simple calculations (*Signs of a Math Disability*, 2012). According to Holecek (2012), the skills reduce frustration and foster higher levels of interest in learning.

There is also strong evidence that peer tutoring is an effective and time-efficient strategy to boost many academic concepts. Since explaining a concept to another student helps extend one's own learning, peer tutoring gives both the tutor and the tutee the opportunity to better understand the material being presented (Steedly et al., 2012). The tutor's own skills improve through the process of formulating an explanation of the problem for the tutee. Daggett and Pedinotti (2011) reported on several peer tutoring programs implemented successfully in several schools. One had a very large at-risk population. They found that in addition to building confidence and academic competence, the programs reduced students' math anxiety. Their data showed that the achievement gap between the at-risk and the non at-risk students closed dramatically through the use of peer tutoring. In 2012, Holecek's study of peer tutoring involving students with disabilities found that the students had more time on task and fewer disruptive behaviors during the peer tutoring sessions. The results of our study supported the conclusions made by these studies. Our students were successfully learning the math concept and exhibiting good learning behavior.

Limitations

The goal of the present study was to accurately measure the learning and retention of math facts as a result of participation in peer tutoring. However, the study did not account for the continued exposure of the students to math facts in the course of the regular school day after the intervention ended. It is possible that the retention as measured three weeks after the conclusion of the peer tutoring was due to not just the tutoring, but also to what was being done in their regular math classes between the time that the intervention ceased and the three-week probes were given. I did account for the practice of math facts during the course of the intervention. Classroom teachers agreed ahead of time to use math drills with their classes during the time that our participants were out of the room to negate the effect of these drills on our results, and students agreed not to practice their addition facts outside of the peer tutoring. Future studies might be designed to account for further exposure after the intervention ends by assessing students not participating in the tutoring sessions as a control group. Our results showed noticeable improvement immediately following the intervention and at the three-week mark.

Implications for Classroom Use

Previous studies have emphasized the importance of thoroughly planning and overseeing peer tutoring activities. According to Steedly et al., (2012), successful peer tutoring must involve several key features: comprehensive training for both the tutor and the tutee before beginning the intervention, highly structured and strictly followed routines during the intervention, systematic teaching materials, and continuous monitoring and feedback to the students. Certainly a benefit of peer tutoring is the one-on-one learning that takes place. Once properly established, this type if intervention turns the learning over to the student and the teacher takes on the role of facilitator or supporter. But for students to stay invested and work effectively, the training before implementation is vital. In talking to teachers who have already used peer tutoring, this is one step that is frequently abbreviated. The other aspect often overlooked is the necessity for close monitoring of the students as they participate and then actively providing feedback to correct inconsistencies.

During the present study, tutors filled out the Tutoring Score Sheet (Appendix B) recording the number of correct answers the tutee gave during that session. Interestingly, during most of the sessions, tutees routinely scored 90 or 100 percent. I was suspicious of this at first, but close monitoring showed this to be accurate. I also implemented two Observer Checklists (Appendices E and F) to consistently monitor the behavior of the tutor. The teacher filled these out. Several times this was helpful in pinpointing what behaviors needed to be fine-tuned. One problematic issue that turned up early in our sessions was the three-second time limit for the tutee's answer. The tutors seemed to have trouble consistently and accurately counting the three seconds. After brainstorming with them apart from the tutees, I came up with a solution - they would watch the second hand on a clock to more accurately count the three-second time limit. Tutors also filled out the Coach Integrity Checklist (Appendix D) at the end of each session and left it in their folders. These specific questions acted as a reinforcement of the steps in the process, and while the students answered "Yes" to each question at each session, seemed to add validity in the students' eyes to the intervention.

Understanding Students with Disabilities

Although this is not quantifiable in this study, the target group exhibited behaviors consistent with a mentor or teacher. The older students redirected the behavior of their younger counterparts when necessary, and seemed invested in the collaborative work. They made suggestions about seating arrangements to better focus the younger students. In addition, the tutors did not display any negative behavior during the tutoring sessions. They did not become distracted during the sessions nor complain when taking the repetitive probes. They seemed to be putting forth their best effort, and became frustrated when the younger students did not cooperate or were inattentive. In a previous study by Daggett and Pedinotti (2011), they state that the goal of peer tutoring is to teach students to self-regulate and control their own learning, to move from being student to being teacher. This is certainly something that we witnessed while the tutors worked. This demonstrated to us that students with disabilities, with proper support and training, are able to take on leadership roles successfully, improving their own self-image and the perception of others.

Conclusion

The purpose of this study was to determine whether cross-age tutoring with a constant time delay improves the math fact automaticity of students with disabilities acting as tutors. I hypothesized that both the tutee and the tutor would exhibit increased math fact automaticity, improved engagement and enhanced self-concept. I sought to validate students with disabilities as leaders in teaching situations and show that students with disabilities could facilitate the learning of others. I found this to be true. The math fact knowledge of both the tutees and the tutors increased markedly.

The students with disabilities in this study made excellent tutors and were able to handle the leadership role with proper support. I found that the academic performance and learning potential of the students was enhanced when they taught other students in a controlled and active environment. Peer tutoring is an effective intervention that has been proven through this study and previous research to be engaging and successful for many types of learners. Teachers that take the time to implement peer tutoring in the classroom empower their students to take charge of their learning and facilitate the learning of others.

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Appendix A

Sample Math Fact Card

Front

$$\begin{array}{r} 9 \\ +\ 7 \\ \hline \end{array}$$

Back

Answer

16

Appendix B

Tutoring Score Sheet

Tutor 'Coach': ________________________ Tutee 'Player': ________________________

Directions to the Tutor: Write down the number of math-fact cards that your partner answered *correctly* and the number answered *incorrectly*.		
Date:	Cards Correct:	Cards Incorrect:
Date:	Cards Correct:	Cards Incorrect:
Date:	Cards Correct:	Cards Incorrect:
Date:	Cards Correct:	Cards Incorrect:
Date:	Cards Correct:	Cards Incorrect:
Date:	Cards Correct:	Cards Incorrect:
Date:	Cards Correct:	Cards Incorrect:
Date:	Cards Correct:	Cards Incorrect:

Appendix C

Tutoring Script

1. SIT across from the player and lay the cards face down between you.
2. PICK up the 1st card with the equation facing the player.
3. SAY the equation _____ + _____ . Do not say the answer.
4. COUNT 3 seconds.
5. CHECK the player's answer with the answer on the back of the card.

   RIGHT: say "Yes, great!" or "Yes, good job."

   WRONG: or they don't answer, say "No. _____ + _____ is _____. What is _____ + _____?"

Appendix D

Coach Integrity Checklist

Coach ____________________ Date ________________

Correctly Carried out?	Step	Tutor Action
__ Y __N	1	At the start of the timer, did you immediately present the first card?
__ Y __N	2	Did you wait three seconds for each answer?
__ Y __N	3	When the Player responded correctly, did you acknowledge the answer? When the Player responded incorrectly or took longer than 3 seconds, did you give the correct answer and have the Player repeat it?
__ Y __N	4	Did you praise the Player immediately after a correct answer?
__ Y __N	5	When all the cards in the pile have been reviewed, did you shuffle the cards before beginning again?
__ Y __N	6	Did you continued to immediately present cards until the timer rang?
__ Y __N	7	Did you present each card to the Player for 3 seconds during the assessment phase?
__ Y __N	8	Did you provide feedback or talk during the assessment phase?
__ Y __N	9	Did you sort the fact cards into correct and incorrect piles based on the Player's answers?
__ Y __N	10	Did you count the number of correct and incorrect answers and accurately fill out the Score Sheet?

Appendix E

Observer Checklist for Tutoring Sessions

Observer:

Tutoring Pair:

Directions: Observe the tutor and tutee for a full intervention session. Use this checklist to record whether each of the key steps of the intervention were correctly followed.			
Correctly Carried Out?	Step	Tutor Action	NOTES
___ Y ___ N	1.	**Promptly Initiates Session.** At the start of the timer, the tutor immediately presents the first math-fact card.	
___ Y ___ N	2.	**Presents Cards.** The tutor presents each card to the tutee for 3 seconds.	
___ Y ___ N	3.	**Provides Tutor Feedback.** [When the tutee responds correctly] The tutor acknowledges the correct answer and presents the next card. [When the tutee does not respond within 3 seconds or responds incorrectly] The tutor states the correct answer and has the tutee repeat the correct answer. The tutor then presents the next card.	
___ Y ___ N	4.	**Provides Praise.** The tutor praises the tutee immediately following correct answers.	
___ Y ___ N	5.	**Shuffles Cards.** When the tutor and tutee have reviewed all of the math-fact carts, the tutor shuffles them before again presenting cards.	
___ Y ___ N	6.	**Continues to the Timer.** The tutor continues to presents math-fact cards for tutee response until the timer rings.	

Appendix F

Observer Checklist for Assessment Phase

Observer:

Tutoring Pair:

Directions: Observe the tutor and tutee during the progress-monitoring phase of the session. Use this checklist to record whether each of the key steps of the assessment were correctly followed.			
Correctly Carried Out?	Step	Tutor Action	NOTES
___Y___N	1.	**Presents Cards.** The tutor presents each card to the tutee for 3 seconds.	
___Y___N	2.	**Remains Silent.** The tutor does not provide performance feedback or praise to the tutee, or otherwise talk during the assessment phase.	
___Y___N	3.	**Sorts Cards.** The tutor sorts cards into 'correct' and 'incorrect' piles based on the tutee's responses.	
___Y___N	4.	**Counts Cards and Records Totals.** The tutor counts the number of cards in the 'correct' and 'incorrect' piles and records the totals on the tutee's progress-monitoring chart.	