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Peer-assisted learning strategies and their impact on the math fluency and social skills of students with autism

Melissa Woodward

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**PEER-ASSISTED LEARNING STRATEGIES AND THEIR IMPACT ON THE
MATH FLUENCY AND SOCIAL SKILLS OF STUDENTS WITH AUTISM**

by
Melissa L. Woodward

A Thesis

Submitted to the
Department of Language, Literacy, and Special Education
College of Education
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For the degree of
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At
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Thesis Chair: S. Jay Kuder, Ed.D.

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Dedication

I would like to dedicate this thesis to my nana, Clara, and my mother, Stephanie. They have always inspired me to go after my dreams and without them I wouldn't be who I am today. Also, I would like to dedicate this to my husband, Adam who gave up endless hours of time with me so that I could get this project completed. Thank you all for everything.

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Abstract

Melissa L. Woodward

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2013/14

S. S. Jay Kuder, Ph.D.

Master of Arts in Special Education

The purpose of this study was to determine if peer-assisted learning strategies (PALS) could increase students with autism's math fluency skills as well as enhance their social skills. All students involved in the study began their math fluency at a basic addition subtraction level 1 on the Morningside Math Fluency program. Also at the beginning of the study the students completed a How I Feel Toward Others survey and it was determined that they were either indifferent toward others or disengaged. The eight students involved in the study were engaged in PALS a minimum of three times per week over a ten week time period. The independent variables were the use of PALS. The dependent variable was the measure of the student's math fluency skills and feelings toward others. Overall, the study showed that peer-assisted learning strategies could be an effective intervention to increase students with autisms' math fluency skills. It did however show no significant impact on enhancing these students' social skills. PALS provides explicit instruction to enhance student learning and allows them to work in small groups with students who share similar skills.

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Chapter 1

Introduction

Autism spectrum disorder is a range of complex neurodevelopment disorders, characterized by social impairments, communication difficulties, and restricted, repetitive, and stereotyped patterns of behavior ("Autism fact sheet," 2013). Social impairments are one of the most defining features of ASD (Sperry, Neitzel & Engelhardt-Wells, 2010). Teaching students on the Autism spectrum can be challenging but there are evidence based methods that can have an impact on their learning.

Peer assisted learning systems are an evidence based intervention that can improve the academic and social skills of students on the autism spectrum. Peer assisted learning systems are done within a classroom setting. Students work with their peers to enhance their learning. They are trained on the correct methods and then grouped according to levels; higher students are placed with lower students. Research has shown that cross-age tutoring, a peer-assisted learning technique, has increased both tutor and tutee achievement, improved self concept, fostered positive peer relationships, increased locus of control, and decreased truancy (Utay & Utay, 1997). Peer assisted learning systems can be used in a wide variety of settings and a variety of subject matters.

Students with autism may present with difficulties in academics as well as socialization. One of the academic areas that students with autism present with difficulties is mathematics. Their difficulties may develop during early education with simple mathematical processes of addition and subtraction while other difficulties may not develop until more abstract mathematics. Basic mathematical processes like addition,

subtraction, multiplication, and division often require the ability to memorize. For some children memorizing facts is easy while for others it can be complicated. If the basics of addition, subtraction, multiplication, and division are not memorized mathematics becomes difficult for students as they progress through school. This rote memorization is known as math fluency. Being fluent in math implies that you are able to recall math facts quickly and accurately. For many children with autism rote memorization is difficult. Their processing skills are sometimes much slower which then makes recalling the facts quickly near impossible. Being fluent in math makes the more abstract mathematical processes easier. When you can recall the basic facts quickly and accurately you are able to spend more time on the other parts of the formulas. In general the more fluent a person is in mathematics the less likely they will struggle later on.

This study will involve a high school class at a private school. There are ten children in the class. The level of mathematics that they are learning is life skills math. The curriculum for this math includes counting calories, math in sports, comparing prices, buying goods, paying bills, making money, etc. The purpose of the class is to teach the students the basic principles of math in order to use it for everyday use. There are seven males and three females in the class. Three of the students are in tenth grade and seven of them are freshman. All of the students are classified autistic and are cognitively lower functioning. The students in this class prefer to work independently and are against working in pairs. Some of the students feel that they do not belong in this class and believe that they are too smart for this class.

These students are presenting with difficulty in basic math fluency. Peer assisted learning systems can help these students develop their rote memorization of addition and

subtraction problems. By using peer assisted learning systems these students may also further develop their socialization skills. The purpose of this study is to determine if students who are on the autism spectrum can improve their math fluency using peer-assisted learning systems. The goal is to determine if students on the autism spectrum who have difficulty with socializing can benefit from peer-assisted learning systems in mathematical terms and socialization.

In class the students will be working in pairs. They will first be trained on how to properly perform certain tasks with their pairs. The first tasks they will be trained on are how to use the flash cards and tracking chart. Students will start out with simple addition and subtraction problems on 3x5 flash cards. One student will be designated the instructor and the other will be the student. The instructor shows the student the problem and the student must answer within ten seconds. If the student takes longer than ten seconds or answers incorrectly the instructor marks it on the tracking sheet. This continues until all flash cards are complete. Then roles switch. Each student takes two turns being the instructor. Once the students have mastered this form of peer-assisted learning systems they will progress to using an iPad for the same process. The students will spend sixty minutes a week using peer-assisted learning systems. With the frequent drills their math fluency rates should increase and they will be spending more time interacting with peers.

When teaching children fluency in any area there are steps that must be taken in order for the process to be successful. These steps include; choosing a target skill, defining the goal, teaching the skill, and selecting a fluency target rate. For this group of students their targeted skill is math fluency of addition and subtraction facts.

The goal is to be able to answer as many problems as possible with speed and accuracy. The skill will be taught using peer assisted learning systems and the fluency target rate is fifty problems in one minute. When teaching fluency to children with autism it is important to be consistent and follow a schedule. The children need to be aware of measurable goals and standards need to be set for them. Having this amount of structure helps them become more successful. Also when teaching children with autism mathematics it is important to use manipulatives. Many children on the spectrum are incapable of abstract thinking. Math can be very abstract at times and it helps to use manipulatives.

In this study a consistent schedule is used that provides students with a structured environment. The students are taught specifically how to perform the tasks associated with peer-assisted learning systems and then are frequently monitored while performing in pairs. This research will provide a guide on how to present peer-assisted learning systems to students and how to help them use it. By following a consistent method and schedule the goal is for children to be as successful as possible. Using peer-assisted learning systems may also help the students enhance their socialization skills since they are required to work in pairs to complete the tasks. The results from this research will show that peer-assisted learning systems can be an effective method to teaching math fluency to children on the autism spectrum and to enhancing their socialization skills.

Chapter 2

Review of Literature

Mathematics Instruction for Students with Learning Disabilities

Mathematics is an area of difficulty for many students with disabilities. Due to state standardized testing, most students with disabilities are held to the same standards as general education students. In 2001 a study was done to look at data across the country and determine what implications existed for standards and programming (Cawley, Parmar, Foley, Salmon, & Roy, 2001). The article described arithmetic performance of students with disabilities and general education students based on the Arithmetic Appraisal Battery. The study samples 937 general education students and 137 special education students. The locations of these students ranged from the Northeast, South, and Central states. The students' socioeconomic statuses varied as well with 38% living in urban settings, 42% suburban settings, and 20% living in rural settings. The goal of this study was to determine if there was a discrepancy between the desire for higher standards and meeting the needs of students with disabilities. The data shown in this study provides a basis for discussion between policy makers and those familiar with students with disabilities in order to set better standards for progression and graduation. The results showed that the levels of expectations and performance in math needs to be raised for both general education students and students with disabilities. The mean for the 64 Grade 8 general education students who took subtest 8 of the computational proficiency component was 6.4 but the mean of the entire sample of 109 students was 3.76. When reported, the results showed there is a discrepancy because the tables only show the data of students who met the criterion on one subtest and progressed instead of the entire

sample group. This causes the scores to be inflated. The results on the vocabulary tests showed a nonlinear incremental growth pattern for students with mild disabilities. There was a mean of 62.5 at Grade 3 and a mean of 75.7 at Grade 7. For general education students the means were 69.5 at Grade 3 to 86.3 at Grade 8. These results showed that students with disabilities reading skills need to be better developed in order for better math results. The study also presented the implication of socioeconomic status having a more positive or negative effect than an actual disability. It suggested that more focus needs to be put on reforming and supporting math programs in lower socioeconomic districts. Ultimately, if nothing is done at the national level, high levels of math standards for both general education students and students with disabilities is unlikely.

In 2005 Lynn S. Fuchs and Douglas Fuchs looked at three different interventions that can enhance mathematical problem solving for students with disabilities. According to studies they researched, approximately 5% of the school-age population experiences mathematics disabilities. However, due to the increase in awareness of reading disabilities there is a smaller focus on studies involving math disabilities (Fuchs & Fuchs, 2005). This article specifically looked at how math disabilities affect students' problem solving abilities. There is a belief in a hierarchical math sequence, which proposes that the mastery of fundamental skills is a requirement to proceed to more complex math instruction. The problem that occurs when this sequence is followed is students with math disabilities then miss out on instruction on complex problems and some never achieve mastery on the basic skills. This ultimately leaves them unprepared for real life situations where math skills are required. Fuchs & Fuchs looked at the Center on Accelerating Student Learning's program where they introduce the more complex math skills even

before the basic skills are mastered. Three types of interventions were looked at; Schema-Based Instruction, Self-Regulated Learning Strategies, and Delivering Schema-Based Transfer Instruction in Small Groups.

During the Schema-Based Instruction all of the students receive the same base treatment. The base treatment consists of a basal text and the district curriculum. Four problem types were chosen from the curriculum. For six of the classrooms instruction addressed one problem at a time and the teachers relied primarily on the basal. Instruction focused on the problem type and taught with explicit steps for arriving at solutions for the problems. The other classes used experimental designed instruction on problem-solution rules. There was no explicit attempt to develop broader schemas to enhance mathematical problem solving (MPS). The experimental instruction was 32 sessions, divided into five 3 week units, with two lessons per week. This interventions findings showed that students with disabilities needed to develop a stronger foundation in problem-solving rules before instruction designed to promote transfer can contribute to learning (Fuchs &Fuchs, 2005).

For Self-regulated Learning Strategies there was a control group to reflect conventional classroom instruction of math problems. The self-regulated learning strategies were then incorporated into the schema-based instruction classes. The students in this group had to score their own problems using an answer key and charted their daily scores on an individual thermometer. This intervention showed growth on immediate transfer and proved to be an effective method for both typically developing children and children with disabilities.

The third type of intervention used schema-based instruction in small groups instead of whole class. This was to intensify instruction. The lessons in this study were

identical to those in the first study. This intervention showed that by combining explicit instruction on rules for problem solution and schema-based transfer instruction students with a math disability could show understanding at a significantly higher rate. The study showed that students with disabilities can improve their problem solving skills with proper interventions and that more than one intervention may be required to show the amount of growth that is idea.

When learning math, it is crucial for a student to be able to transfer their knowledge across skills. A study explored methods to enhance mathematical problem solving for students with mathematics disabilities (Fuchs, Fuchs, Hamlett, & Appleton, 2002). They designed a system to explicitly teach transfer to students with disabilities since it is an area of great difficulty for them. The study utilized small-group tutoring and in order to create a test of efficacy they contrasted the small-group tutoring with a computer-assisted practice. Sixty-two students were chosen for the study and were given the Test of Computational Fluency. There were 40 students who scored 1.5 standard deviations below a regional norm and they were the students who were included in the actual study. There were four conditions set in place; problem-solving tutoring with computer-assisted practice, computer-assisted practice, problem-solving tutoring, and control. The students were split evenly into groups of 10 for each group. The students' progress was based on three measures; story problems, transfer story problems, and real-world problem solving. There were no significant effects shown on the pretreatment scores when ANOVAs was conducted. Results showed that the students with tutoring in the computer-assisted practice groups and in the tutoring group without computer assisted practice outgrew the students without tutoring for story problems and transfer story

problems. However, overall it was determined that the small sample sizes was a limitation and the results did not indicate any significant improvement for the students. It was also determined that many of the students in the study also had a reading disability and without that being addressed simultaneously growth was unlikely.

When teaching students with disabilities, specifically students on the autism spectrum, applied behavior analysis methods are often used. In using this specific method of instruction most teachers try to use things that are of preference to the students. A study done in 2007 was done to determine if there was a relationship between math preference and mastery for five middle school students with autism spectrum disorder (Banda, McAfee, Lee, & Kubina Jr., 2007). The study wanted to determine if children are more likely to master a skill if it is of their preference. During this study these five students were presented with different addition and subtraction problems in different formats. Using these samples the students' preferences were determined as well as their mastery level. Student one mastered 88% of preferred material, student two mastered 66%, student three mastered 16%, students four mastered 25%, and student five mastered 50%. The study decided that there was no direct correlation between preference and mastery for these five students. They preferred the mastered items about half the time. Ultimately it was determined that for students on the autism spectrum, specifically those five students, there may be outside contributing factors that are beyond one's control that influence the result in a study like this. Students may be reinforced for attempting the more difficult problems therefore making it a preference of theirs. While in most cases ABA is correct in the idea that children will work better under conditions where there preference is present this study shows that, that is not always the case. Based on this

study one can infer that whether children prefer specific material or not they may not always be successful and therefore using different types of interventions is necessary.

Socialization in the Classroom with Students with Autism Spectrum Disorders

Students with disabilities face many different challenges in the classroom.

Children on the autism spectrum tend to face many of the same challenges academically and have the added challenges of poor social skills. Their poor social skills can contribute to poor academic skills when students are asked to learn from their peers. There are many different evidence based interventions to help these students both academically and socially. A study done in 2005 examined the influence of a class wide peer-tutoring reading program on the quality of social relationships of elementary school children (Dion, Fuchs & Fuchs, 2005). They specifically used Peer-Assisted Learning Strategies (PALS). These researchers have used this system many other times to show that students can make progress in reading. For this particular study in order to determine what the social acceptance and friendships were like among the students who participated in the study the students were given the How I Feel Toward Others (HIFTO) evaluation. Each child is required to rate each participating classmate in terms of how much he or she likes them. They are presented with a list of the peers and are asked to fill in the bubbles accordingly. From the test results two scores were calculated for each child; one being their social preference and the other being the percentage of friends. After approximately 10-12 weeks of PALS the students completed another HIFTO to determine if their feelings changed after working with peers regularly. There was no overall reliable effect on the mean quality of social relationships but there was differential effectiveness based on the statistics. The researchers hypothesized that the PALS was not that effective in

building the social relationships because the skills were not carried over into other areas of the school day. This therefore suggests that the social interaction that occurs during the PALS session should be reinforced and encouraged in various settings throughout the school day.

In 2012 a study was done to determine if the UCLA PEERS Program could enhance students with autism spectrum disorders socialization skills (Laugeson, Frankel, Gantman, Dillon & Mogil, 2012). The PEERS Program is a parent assisted social skills group that was developed for high-functioning adolescents on the spectrum. The study included twenty-eight students ranging from 12 to 17 years of age. Each child was diagnosed with ASD minimally. They used both parent and teacher questionnaires to gather information about the students socialization skills prior to training. The Social Responsiveness Scale (SRS) was also used to determine the severity of autism spectrum symptoms. Many other tests were used to measure these students skills prior to intervention. During the intervention the students participate in fourteen 90-minutes sessions. The parent and teen attended the sessions concurrently and one parent was responsible for assisting the teen with weekly socialization assignments and coach them through situations when necessary. Ultimately the program proved to be successful. With both the teen and the parent receiving training needed to implement the skills in the real world the children were successful. While most parents strive for their students to become more social many do not know how to help them. This program provides the proper instruction for helping students with ASD to better their socialization skills. This program is similar to peer-assisted learning systems in the sense that persons involved are

trained on how to complete the tasks and the skills are frequently practiced and reinforced.

Peer-Assisted Learning Strategies

Peer-Assisted Learning Strategies was originally created as a peer-tutoring program for use in elementary school classrooms to improve student proficiency in reading. This program was developed for students with many different needs in the classroom and as it became successful for those students it was used for English language learners. The U.S. Department of Education's What Works Clearinghouse completed a review of PALS in August of 2012. According to the WWC only one of the four studies they reviewed met their criteria. The one study that did meet the criteria presented with positive results for PALS. This study specifically focused on PALS impact on English language learners as well as only reviewed four studies.

Douglas Fuchs and Lynn S. Fuchs were two of the first educators to work with PALS. In 2000 they completed a study that contributed to their many previous studies about the impact PALS has on students with disabilities reading abilities. While working at Vanderbilt University Fuchs & Fuchs collaborated with several local school districts to develop PALS in reading and math (Fuchs, Fuchs, & Burish, 2000). When they developed PALS they created structured activities that require students to engage in frequent interaction and provide immediate feedback. The program requires training for the staff and students. Once everyone was properly trained the sessions were to be completed multiple times per week. They have continued to complete these studies to determine what things must be changed to properly accommodate the students' needs. From this specific review of PALS two flaws were discovered. The first flaw was that

some students were not recognizing when their partner made a mistake and the second was that the correction procedures and point reward structure moved too quickly for some students. This knowledge assisted the researchers in developing better techniques for this process. The findings of this study also found that PALS is not very effective in the area of reading fluency. Studies are consistently done on PALS to determine its effectiveness and modify it to accommodate the needs of many different learners.

In 2001 No Child Left Behind was passed and has since then required all students to meet rigorous standards of knowledge and skill (McMaster, Fuchs, & Fuchs, 2007). This included students with disabilities. Educators were being held accountable for the academic outcomes of all students whether they have disabilities or not. At that point teachers were looking for any way possible to help students. Fuchs & Fuchs had spent years working on PALS and joined with Kristen L. McMaster to determine the promises and limitations of PALS in reading. One of the limitations they found included the small proportion of students who had not made any significant progress in reading despite participating in a program that uses PALS. Researchers also found that teachers have difficulty making PALS a regular part of the classroom schedule. They struggle with finding ways to implement it on a regular basis and this impacts its effectiveness. In order to better assist educators in PALS McMaster, Fuchs and Fuchs composed an informational piece that was published in *Learning Disabilities: A Contemporary Journal* in 2007. This specific article discusses PALS research and activities. It provides specific activities that teachers can use in order to better incorporate PALS into the classroom, such as Paragraph Shrinking. Not only does the article provide suggestions for elementary age students but high school students as well. Partner Reading, Paragraph

Shrinking, and Prediction relay are all activities that can be used at any level of school. This specific article emphasizes that PALS is a growing intervention that can be shaped and molded to best fit the needs of the students and when used with the right students it can be an effective intervention.

When teachers are presented with students who have given up on themselves it becomes their mission in life to real those students back in. In a study published in 2006 Stephen D. Kroeger and Beth Kouche looked at a class where two teachers were in this exact predicament. They had students who felt they would never be successful in math, they have given up on themselves. The two teachers in this study sought out a strategy that would increase student response to intervention in mathematics (Kroger & Kouche, 2006). These two teachers chose to use PALS and were pleased with the results. The study took place in a large middle school in the Midwest and a team of 150 seventh grade students participated. These students had many diverse math abilities. PALS was not the only instructional method used in the classrooms. While using PALS teachers found that students' negative attitudes towards math decreased and the learned helplessness they were presenting with prior to intervention was diminished. The students in the study expressed their like for the intervention and enjoyed feeling helpful towards their peers. Overall the students in this study improved their math skills, and use of appropriate social skills in a natural setting.

Peer Assisted Learning Strategies in Mathematics

Peer-Assisted Learning Strategies are most commonly used in elementary reading classes. In 2004 a study was published in which PALS was being used in math in an elementary school. The study was done with general education teachers on students with

and without disabilities. PALS was to be used twice a week and done as a class-wide intervention. This specific study not only looked at PALS impact on the students but the teachers perceptions of its utility and sustained use as well (Baker, Gersten, Dimino, & Griffiths, 2004). Often times teachers will participate in research studies for interventions and once the study is completed the teachers will no longer use that intervention. This study specifically looks at whether or not teachers sustain the use of PALS even after the original study is completed. It also looks at whether the teachers who were sustaining PALS use were doing so according to how they were originally trained or did they adapt it to fit their style. Through questionnaires and observations information was gathered to determine the sustained use and effectiveness. When the teachers were asked to report on their use of PALS all eight teachers reported that they use it regularly at least twice a week and have not made any modifications to their original training. Through observations and the gathering of data all eight teachers were found to have actually sustained use and for it to continue to have positive impact on their students. This study shows that when PALS is implemented on a consistent basis and is done correctly it can be successful in elementary math as well as elementary reading.

As an educator in today's society is important to remember that the needs of all students must be met one way or another. Students with disabilities are being held to the same standards as neuro-typical children today due to No Child Left Behind. This has present problems for teacher specifically in mathematics. Children will make it to the secondary level and have disabilities and struggle in math. When a child with a disability ends up in an educators classroom that educators job is to begin looking for an intervention that will work for that student. In 2003 Mary Beth Calhoon and Lynn S.

Fuchs joined together to examine the effects of PALS and curriculum-based measurements (CBM) on mathematics performance of secondary students with disabilities (Calhoun & Fuchs, 2003). The study included 92 students split between ten classes. These students were in 9th through 12th grade. All of these students were receiving math instruction in a self-contained resource room and were below grade level. The classes were randomly assigned either PALS/CBM or the classroom math program. PALS was practiced twice a week and CMS was completed weekly for 15 weeks. The *Math Operations Test-Revised*, *Math Concepts and Applications Test*, and *Tennessee Comprehensive Achievement Test* were all used to determine the students' understanding of math skills at all levels. Teachers and students were trained on how to properly use PALS and were provided with the tools to complete the tasks. In order to determine comparability of condition a one-way ANOVA was run on the three pretreatment mathematics test scores, but not significant difference was found. To determine the difference post treatment one-way ANOVAs were run PALS/CMB vs. control and a significant difference was seen between the groups. Concepts/applications and TCAP skills showed that both groups increased while the PALS/CBM group did significantly better than the control group on computation scores. Overall growth was shown with both groups but in many cases the PALS/CBM groups showed a greater improvement on computation skills. Based on the results from the questionnaires the students and staff enjoyed PALS/CBM. The students felt it helped them improve their math skills and made them work harder in math. The teachers believed it was beneficial to the students and provided a lot more information when writing students IEPs and individualizing math instruction. While this study proved that PALS/CBM can be beneficial for increasing

students computational skills it fell short on improving students development of concepts/application skills. When teaching math, many believe it is important to ensure that the basic computational skills are mastered prior to moving on to the concepts/application skills. Research has shown PALS can be beneficial to helping move this process along, especially for students with disabilities.

Summary

Studies have shown that Mathematics is an area of difficulty for students with disabilities. Students with Autism have difficulty with many areas both academically and socially. For some students with Autism math can be very easy while for others it can be difficult. This can also be said of any student, but for students with Autism the added pressure of learning in a social environment makes retaining information more challenging . Research has been done on Peer-Assisted Learning Strategies (PALS) in order to determine if students with disabilities can benefit from its use both academically and socially. Most research on PALS has been done in the academic area of Reading and has been found to improve students skills.

In order for PALS to be successful for students in the academic and social area staff must be properly trained on using PALS and the practices must be used across the board. By the skills being carried over into other areas the students learn to generalize the skills and maintain their improvements. Douglas and Lynn Fuchs have spent many years developing PALS and testing it in many different locations around the U.S. As they complete studies they determine the flaws and modify the program to fit the needs of students. They emphasize the importance of properly trained staff and students as well as consistency. The research that Lynn Fuchs has done on using PALS with math

instruction has shown that it can improve basic math computational skills and that PALS can be enjoyable for both students and staff (Calhoon & Fuchs, 2003).

The purpose of this study is to determine if using Peer-Assisted Learning Strategies can improve students with Autism's math fluency skills as well as their social skills. The students in this study have difficulty completing basic addition and subtraction problems in a timely manner. They also prefer to keep to themselves and do not engage with peers regularly. By implementing PALS these students will have to work in pairs in order to review their basic math skills. This study will look at how effective PALS is in increasing their math fluency based on the Morningside Math program. It will also use the How I Feel Toward Others evaluation to determine PALS effectiveness on increasing their socialization.

Chapter 3

Methodology

Settings and Participants

This study examined the effect of Peer-Assisted Learning Strategies on the math fluency and social skills of high-school age students with developmental disabilities

The study took place in a private school for children with special needs. The school is located in southern New Jersey. The school serves students from districts all over the state of New Jersey. It houses grades K-12 and includes a post-graduation program for students up to the age of 21. All of the students that attend the school are classified as eligible for special educational services and have been placed in the school by their home districts. No class exceeds twelve students during instructional periods. Each class has a minimum of one teacher and one teacher's assistant.

This study was conducted in a Life Skills Math class. The students in the class were in grades 9, 10, and 12. The class contains eleven students. There were three girls and eight boys. All students are classified as eligible for special education. Six are classified Autistic and five are classified multiply disabled. Some of the other disabilities include; specific learning disabled, ADHD, and cerebral palsy.

Eight of the eleven students are required to participate in the school's Morningside Math Facts program (Morningside Press). Five of the eight students began on addition and subtraction level 1. Three students began on addition and subtraction level 2. Upon being able to answer 50 questions in one minute's time the student is permitted to move up to the next level. The eight students who are required to complete the math fluency were chosen to participate in the study.

The Morningside Math Facts was used to gauge the students' math fluency abilities. In this program the students are required to answer 50 addition, subtraction, multiplication, or division questions in one minute. The program is split up into addition/subtraction and multiplication/division. Each set of operations is split up into 16 levels. Each level is then broken down into 5 different slices. When a student is able to answer 50 problems in one minute they are permitted to move on to the next level. Once they have completed all 16 levels in both addition/subtraction and multiplication/division they are exempt from participating in the program. In order to determine if a student must participate in the program they are given the Orleans-Hanna Algebra Prognosis Test (Gerald S. Hanna/Pearson).

Subjects

Student one is a 14 year 6 month old Caucasian male. He is classified as Autistic and is in an out of district placement. His math placement is Life Skills Math. Student one struggles with recognizing social cues and maintaining conversations. His socioeconomic status is in the middle range.

Student two is a 14 year 10 month old Caucasian male. He is classified as Multiple Disabled with Autism and Specific Learning Disability. His is in an out of district placement and his math placement is Life Skills Math. He often refuses to socialize in any way. His socioeconomic status is in the upper middle range.

Student three is a 14 year 9 month old Caucasian female. She is classified as Multiple Disabled with Autism and Mildly Cognitively Impaired. She is in an out of district placement and her math placement is Life Skills Math. She speaks very softly and shows no confidence in social situations. Her socioeconomic status is in the lower range.

Students four is a 14 year 10 month old Caucasian female. She is classified as Autistic. She is in an out of district placement and her math placement is Life Skills Math. She often times has one sided conversations with peers only focusing on her own interests and does not pick up on social cues. Her socioeconomic status is in the middle range.

Student five is a 16 year 4 month old Caucasian male. He is classified as Multiple Disabled with Autism and Specific Learning Disability. He is in an out of district placement and his math placement is Life Skills Math. He does not understand social cues and often time becomes very anxious when someone does not share the same opinion as him. His socioeconomic status is in the upper middle range.

Student six is a 15 year 9 month old African American female. She is classified as Multiple Disabled with ADHD (other health impaired) and Specific Learning Disability. She is in an out of district placement and her math placement is Life Skills Math. She struggles with accepting others' differences and gets frustrated very easily. Her socioeconomic status is in the lower range.

Student seven is a 15 year 6 month old Caucasian male. He is classified as Autistic. He is in an out of district placement and his math placement is Life Skills Math. He prefers to stay away from peers and becomes very anxious when required to work with them at all. His socioeconomic status is in the upper middle range.

Student eight is an 18 year 3 month old African American male. He is classified as Multiple Disabled with Autism and Specific Learning Disability. He is in an out of district placement and his math placement is Life Skills Math. He struggles with

maintaining conversations with peers and controlling anger when frustrated. His socioeconomic status is in the middle range.

Method

Peer-Assisted Learning Strategies (PALS) have been used by educators to enhance student learning. PALS allows students to work together in order to learn new material and practice skills. The use of PALS requires proper training for both staff and students. When students are participating in PALS they get to learn from one another and receive feedback from their peers. By using PALS educators have the opportunity to enhance students' learning and social skills.

The eight students who participated in this study were separated from the other three students so they could use Peer-Assisted Learning Strategies (PALS). The three students who were not required to complete math fluencies were sent to another classroom with a teacher's assistant and reviewed on-going lessons. The eight students who were chosen to participate in PALS were chosen due to their IEP requirement of Math Fluency. Prior to beginning the use of PALS the students were asked to complete a How I feel Toward Others survey. The survey was used to determine whether or not the students were comfortable with their peers. Then the eight students who were required to complete math fluencies were placed in pairs according to levels and abilities. Once the students were paired they were trained on how to properly perform the activities using PALS. After the students were trained they used PALS twice a week for 30 minutes a period and once a week for 15 minutes. Students and staff kept track of students' progress on progress charts that were teacher created and supplied.

The use of PALS on a weekly basis began December 9, 2013. Training took place the week of December 2, 2013. During the time that PALS was used the days that instruction took place needed to be changed due to students being taken from class in order to attend related services. Some days were missed due to school closings from weather and student absences. These factors impacted the outcome of the study.

Materials and Instruments

In order to gauge the students' math fluency skills, Morningside Press's math facts were used. These are worksheets that contain 100 math problems that are either addition/subtraction or multiplication/division. During instruction using PALS, the students used simple flash cards at first. The flash cards were 3x5 note cards that were teacher made. Each pair was supplied with addition and subtraction problems using numbers 1 through 20. On one side of the card was the problem and the other side had the answer. When iPads were available from the computer lab, students used the Math Drills app. The app was created by Instant Interactive. It allows students to answer questions varying in addition and subtraction. They can review and practice the math facts. Whether using the flashcards or the app the students are responsible for keeping track of each other's progress on progress sheets that were teacher created. Using the students' progress sheets staff then tracked their progress on charts and graphs. The students were also asked to complete the How I feel Toward Others survey twice during the process to gauge how they feel about working with their peers.

Procedure

Beginning the week of December 2, 2013 the students were trained on how to use PALS. Prior to the training beginning the staff administered the How I Feel Toward

Others survey and then determined what students would be paired together during instruction using PALS. Once the pairs were decided training began. Staff spent three days that week training the pairs on how to properly perform the PALS. First the staff would model the process. One staff would play the role of the student and the other would be the instructor. The instructor would present the student with a flash card. The flash card would contain an addition or subtraction problem. The instructor would say the problem out loud to the student. If the student responded correctly within 5 seconds a check was placed in the 5 second column on the progress sheet. If the student took longer than 5 seconds to respond to the question a check was placed in the correct column. If the students response was wrong no matter how long it took a check was placed in the incorrect column. The progress sheet contained all of the math problems that were present on the flash cards. It was used to determine which problems the students knew fluently and which problems the students still struggled with.

After the students observed the staff modeling the process the students practiced the process. Each student would take turns going through the set of cards once. After the students practiced the process for three days it was determined they were prepared to use PALS as an instructional method in class. PALS were implemented on Mondays and Wednesdays for 30 minutes each day. On Fridays PALS were implemented for 15 minutes. Also on Fridays the students were given the level and slice they were on for Morningside Math Facts. The scores they received on the Morningside Math Facts were recorded on charts in order to track their overall progress.

During instruction with the use of PALS the students took turns being the student and the instructor. During the thirty minute sessions each student performed each role for

at least 15 minutes. During the fifteen minute sessions each student performed each role for at least 7 minutes. Each student was responsible for recording their partner's responses when they were the instructor. When iPads were available for use the instructor recorded the number of questions correct and the number of questions incorrect at the bottom of the progress sheet in the designated iPad area. On a daily basis staff collected the progress sheets and reviewed student progress. Students' Morningside Math Facts scores were also review to determine if the students were moving up in levels. After using PALS for 10 weeks the students' progress was graphed and analyzed. After the 10 weeks students were also given another How I Feel Toward Others survey and their opinions about working with others was gauged after spending all that time working in pairs. Results were compiled and data was then analyzed to determine the success of the study.

Chapter 4

Results

Summary

In this study the results of using Peer-Assisted Learning Systems with students on the Autism Spectrum in math fluency were examined. The research questions to be answered were:

Can students on the autism spectrum improve their math fluency using peer-assisted learning systems?

Can peer-assisted learning systems enhance socialization among students on the autism spectrum?

The students' math skills were assessed in October 2013 using the Orleans Hanna Algebra Prognosis Test. Based on their scores the students were then assigned math fluency as an IEP goal. Students' participated in Peer-Assisted Learning Systems twice a week for 30-minute periods. Intervention took place on Mondays and Thursdays. Students were tested on their math fluency skills on Tuesdays and Fridays. All students began on slice 1 of the Morningside Math Fluency program. The program is split into 16 slices with 1 being the beginning and 16 being the end. The raw score is out of a total of 50 problems. In order for students to move up in levels they must be able to correctly answer 50 problems in one minute. All math fluency scores are based on one-minute timings. Students were also asked to complete a How I Feel Toward Others survey during the baseline period.

Math Skills

Table 1 shows the students' raw scores from slice 1A of the Morningside Math Fluency program during baseline. During baseline all students were on slice 1 addition/subtraction of the Morningside Math fluency sheets.

Table 1. Baseline on Slice 1A of Morningside Math Fluency program

Student	Baseline 1	Baseline 2	Baseline 3	Baseline 4	Baseline 5	Baseline 6	Baseline 7	Baseline 8	Mean Score
1	31/50	30/50	28/50	32/50	32/50	33/50	27/50	31/50	31/50
2	16/50	19/50	15/50	12/50	19/50	21/50	14/50	19/50	17/50
3	10/50	14/50	12/50	15/50	16/50	14/50	18/50	19/50	15/50
4	10/50	10/50	9/50	13/50	12/50	16/50	16/50	15/50	13/50
5	17/50	23/50	18/50	20/50	24/50	26/50	30/50	24/50	22/50
6	33/50	35/50	35/50	34/50	29/50	37/50	31/50	35/50	33/50
7	15/50	17/50	15/50	13/50	20/50	18/50	14/50	21/50	17/50
8	23/50	22/50	22/50	19/50	17/50	21/50	23/50	23/50	21/50

Students 1 and 6 were close to achieving mastery of slice 1 prior to intervention. Students 3 and 4 struggled significantly at the beginning of baseline. Students 2,5,7, and 8 were all doing moderate to moderately well on slice one during baseline. After training on PALS was complete the students began participating in PALS twice a week. The students scores were tracked based on what slice they were on once intervention began. Tables 2, 3 and 4 show the students raw scores from math fluencies during intervention. During intervention Students 1 and 6 progressed on to slice 3 and Students 2, 5, 7 and 8 progressed on to slice 2. This indicates that 75% of the students were able to successfully meet the criteria in order to move up in levels. Students 3 and 4 were both on level one at the end of the intervention period but Student 3 was only eight problems short of meeting the criteria and Student 4 was twelve problems short. At the beginning of baseline

Student 3 was at a raw score of 17/50 and Student 4 was at a raw score of 12/50. That is a 50% or higher increase for both students.

Table 2. Intervention Slice 1 of Morningside Math Fluency Program

Trial	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7	Student 8
1	33/50	20/50	17/50	12/50	20/50	34/50	18/50	20/50
2	33/50	19/50	17/50	10/50	28/50	39/50	24/50	20/50
3	42/50	21/50	19/50	15/50	29/50	37/50	19/50	18/50
4	41/50	24/50	23/50	18/50	31/50	43/50	24/50	23/50
5	43/50	24/50	23/50	16/50	29/50	48/50	25/50	27/50
6	50/50	24/50	25/50	23/50	33/50	50/50	27/50	25/50
7		30/50	26/50	23/50	38/50		23/50	29/50
8		35/50	26/50	21/50	44/50		28/50	28/50
9		35/50	26/50	24/50	50/50		34/50	33/50
10		42/50	31/50	29/50			29/50	32/50
11		43/50	30/50	28/50			36/50	36/50
12		50/50	29/50	32/50			40/50	35/50
13			33/50	29/50			42/50	39/50
14			34/50	31/50			42/50	44/50
15			35/50	34/50			50/50	48/50
16			35/50	33/50				50/50
17			35/50	35/50				
18			44/50	34/50				
19			42/50	38/50				
Mean Scores	40/50	31/50	29/50	26/50	34/50	42/50	31/50	32/50

Table 3. Intervention Slice 2 of Morningside Math Fluency Program

Trial	Student 1	Student 2	Student 5	Student 6	Student 7	Student 8
1	21/50	16/50	16/50	19/50	12/50	15/50
2	28/50	15/50	15/50	17/50	16/50	14/50
3	28/50	15/50	21/50	20/50	17/50	17/50
4	30/50	18/50	18/50	28/50	15/50	
5	31/50	20/50	23/50	31/50		
6	36/50	21/50	25/50	31/50		
7	36/50	18/50	22/50	37/50		
8	40/50		24/50	35/50		
9	42/50		27/50	44/50		
10	49/50		26/50	49/50		
11	50/50			50/50		
Mean Scores	36/50	18/50	22/50	33/50	15/50	15/50

Table 4. Intervention Slice 3 of Morningside Math Fluency Program

Trial	Student 1	Student 6
1	17/50	20/50
2	15/50	23/50
Mean Scores	16/50	22/50

Social Skills

During the baseline period students were given a How I Feel Toward Others survey. It was given to gauge the students' feelings and compassion toward others. Students answer questions based on a scale of 1-5. Each question falls into a specific category. Based on their score in that category you then calculate their scores to determine which category they scored the highest and the lowest. The categories were; kindness, common humanity, mindfulness, indifference, separation, and disengagement. Students 1, 6, and 8 scored indifferent. Students 2, 3 and 5 scored separation. Students 4 and 7 scored disengagement. These scores show that each of the students show little to no compassion towards others and would prefer to work alone. At the end of intervention the students were given the same survey. All of the students' scores remained within the same range except for Students 1 and 6. Students 1 and 6 scored mindfulness upon taking the second survey. Based on the scores there was no significant improvement in the students' feelings towards their peers after PALS was implemented.

Chapter 5

Discussion

Review

This study examined the effect Peer-Assisted Learning Systems (PALS) had on math fluency and social skills of students in high school on the Autism Spectrum. The study took place at a private school in southern New Jersey. There were eight participants in this study. Based on their scores on the Orleans Hanna Algebra Prognosis test these eight students were below grade level in math. Since the students were below grade level and scored so low on the assessment the eight students were required to complete the Morningside Math Fluency program. This study utilized a single group, pre-post design and the students' achievement was assessed based on their progress in the Morningside Math Fluency Program.

The results indicate that Peer Assisted Learning Systems was an effective method of intervention for the student's math fluency skills. Six of the eight students were able to move up at least one level in Morningside program. The two students who did not move up any levels did show a minimum of 50% increase on overall raw scores.

The use of PALS did not prove to be effective in increasing the students' positive feelings or compassion towards their peers. Based on their scores on the How I Feel Toward Others surveys there was no significant difference in how the students felt towards one another even after working with peers twice weekly.

The hypothesis was that the use of PALS would increase both math fluency skills and social skills. The hypothesis was determined based on prior studies that

showed PALS has been an effective tool to enhance student learning. Since PALS requires students to interact in a more educational manner than social manner the hypothesis that it would help to enhance social skills through inadvertently allowing them to socialize was developed. The findings of this study were similar to studies done by Fuchs and Fuchs in finding that PALS is an effective intervention to increase students' academic skills. In 2005 Lynn S. Fuchs and Douglas Fuchs performed a study to determine if PALS could enhance mathematical problem solving for students with disabilities. Ultimately the study proved that PALS was an effective tool to improve students' problem solving skills. In August of 2012 What Works Clearinghouse completed a review of Peer-Assisted Learning Systems and found that it does have a positive impact on students' learning. Based on this study PALS did increase math fluency skills but did not have an impact on social skills. Overall these studies show that PALS is an effective intervention tool.

Limitations

The Peer-Assisted Learning Systems strategy was first introduced and implemented for the 2012-2013 school year. Staff was not given any formal training on PALS and were instructed to use it in Social Studies classes. The lack of proper training created a limitation to its effectiveness. In August of 2013 staff were provided a two-hour training session on how to use PALS effectively in the classroom. Staff was then instructed to use it in math classes for the 2013-2014 school year. Even though PALS was successful in increasing math fluency skills for these students limited training could present as a limitation for future studies.

In addition to training, another possible limitation to this study was the sample size. This study included only eight students, which is a very limited number of participants. This small sample of students provided a limited amount of data to accurately determine the true effectiveness of PALS. Increasing the sample size across multiple grade levels could have been helpful in collecting more accurate results.

The amount of time in order to conduct this study was also a limitation. There was only 10 weeks to provide intervention and track data. During that ten-week time period the students had three snow days. Two of those snow days occurred on days when intervention was supposed to take place. Even though intervention did not occur on those days as per IEP requirements the students were still required to complete the math fluency sheets. The time constraints of this study did not provide a complete picture in order to prove PALS true effectiveness.

Even though the number of students in this study was small their backgrounds varied. Out of the eight students two were African American and their ages ranged from 14-18 years old. All of the students in this study were classified Autistic at minimum. Some of the students were classified as Multiple Disabled. Their classification was key to the basis of the study since the study was determining whether or not PALS was an effective intervention for students on the Autism Spectrum, however it was a small sample size.

Implications

The students in this study received math intervention through the Peer-Assisted Learning Systems method. Based on the results the intervention

proved to be an effective method in enhancing students with autism spectrum disorders' math fluency skills. Students were able to recall simple addition and subtraction facts at a much higher rate of time after participating in PALS. The study was also used to determine if PALS could be an effective tool to enhance the social skills of students on the autism spectrum. Most students on the autism spectrum prefer to be left alone and are uncomfortable in social situations. While the data shows that the students feelings towards other did not change the students did participate regularly in class. In most cases students with autism prefer to work independently and even though their feelings towards others did not change they were successful using PALS. The students were engaged in using PALS on a weekly basis and some looked forward to the sessions. The students displayed more confidence in their skills when working with their peers and staff reported the students taking pride in their work. The increase of math fluency skills carried over into regular math instruction. The students were then able to transfer their math fluency skills into regular classroom instruction. This transfer allowed some of the students to receive higher test scores on chapter tests. In order to PALS to be an effective intervention staff and students must be trained properly. Data must also be tracked regularly and there should be frequent checking for progress. If based on data collected students are making no progress intervention methods should be changed.

Future Studies

Continued research should be done to determine the effectiveness of Peer-Assisted Learning Systems on students with disabilities. Prior studies have

been done primarily at the elementary level in reading classes. Future studies should include high school students and a larger sample of students with learning disabilities. Studies using PALS with students on the autism spectrum would also be beneficial. Students with autism can benefit from working with peers even though one of their biggest weaknesses is socializing. In order for future studies to be successful staff and students should receive proper training. With proper training and a larger time sample future studies will be able to determine if Peer-Assisted Learning Systems is an effective intervention to enhance student learning.

Conclusion

In this study two questions were asked. The first question was whether or not Peer-Assisted Learning Systems would increase the math fluency skills of students on the autism spectrum. The second question was whether or not Peer-Assisted Learning Systems would enhance the social skills of students on the autism spectrum. After reviewing the student data, math fluency skills for all students increased. Even though two of the students were still on slice 1 at the end of the ten-week intervention they showed a 50% or more increase in accuracy. The student data did not show any significant change in the student social skills. Six of the eight students feelings towards others did not change at all. Two of the students only became a bit more mindful of their peers. Prior to the use of PALS the students in this study were struggling with being able to recall simple addition and subtraction facts quickly. After the intervention their accuracy rates had increased and the skills were transferred into their regular math instruction. Students overall math grades increased and the students' confidence in their math abilities

increased. While PALS is not proven to be an effective intervention for social skills, it is an effective intervention for math fluency skills and this study has proven its effectiveness in a small group setting for students with autism.

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