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The effects of peer mediated instruction on students' knowledge of basic math facts

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THE EFFECTS OF PEER MEDIATED INSTRUCTION ON STUDENTS' KNOWLEDGE OF BASIC MATH FACTS

By

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Dedication(s)

I would like to dedicate this thesis to my family and friends. Thank you for all the love, support, and encouragement throughout this process.

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I would like to acknowledge Dr. Amy Accardo for all her guidance and support throughout this research.

Abstract

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THE EFFECTS OF PEER MEDIATED INSTRUCTION STUDENTS KNOWLEDGE OF BASIC MATH FACTS
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The purpose of this study was to: (a) to examine the effectiveness of peer mediated instruction (PMI) on student knowledge of basic math facts, (b) explore how PMI effects the on task behavior of students, and (c) evaluate how students' satisfaction with using PMI as a learning strategy in a mathematics classroom. Three second grade students, two males and one female, with IEPs participated in the study. A single subject ABAB design was used. The study examined if PMI can be utilized to assist students in increasing their knowledge of basic math facts as opposed to utilizing traditional ways of teaching. During the baseline phases students were taught using traditional lecture style of teaching. During the intervention students used PMI to teach their peers basic math facts. Throughout each phase data was collected on student progress in their knowledge of math facts as well as their on task behavior. At the end of the study students were given a satisfaction survey. The results found that PMI increased student knowledge of basic math facts and the on task behavior of students improved as well. The satisfaction survey suggested that student enjoyed using PMI in mathematics and believed that it aided them in understanding math facts.

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Chapter 1

Introduction

In order to become successful in math students must have the right foundation of mathematical knowledge. Students who begin their academic career behind in mathematics usually stay behind in their studies (Geary, 2013). One way for students to become successful in math is to increase their knowledge of basic math facts (Hoelscher, 2016). Having knowledge of basic math facts helps students to attend to more difficult tasks because they do not have to assert as much cognitive effort as they would if they had no knowledge of math facts (Poncy, Skinner, & Jaspers, 2007).

All students regardless of their abilities or disabilities can benefit from exposure to different teaching or learning strategies. Peer mediated instruction (PMI) is one strategy that can be used to teach math facts. PMI is different from the traditional method of teaching in that it helps students receive more individualized instruction (Webster, 2005). In prior studies, students who have engaged in PMI have demonstrated immediate improvements in math fluency (Maheady & Gard, 2010). Once students become familiar with the process PMI can benefit the entire classroom (Webster, 2005).

Students with learning disabilities, ADHD or issues with keeping focus during whole group instruction have also been found to benefit from PMI. PMI has been said to help create learner friendly instructional environments in which students increase on task behavior and are provided with more positive and corrective feedback (Maheady, Harper, & Mallette, 2001). Working with other students can help to encourage positive peer interactions which in turn can foster desired behaviors (Fiers, 2017).

This study will investigate the effect of PMI in a mathematics classroom. Educators are consistently looking for different methods to increase student knowledge. Sometimes student learning does not have to come from the teacher. Children can be powerful instructional resources for one another because the way they communicate with one another is different than how a teacher may communicate with them (Maheady et al. 2001). Therefore students may be more open to the feedback of their peers.

Statement of Problem

Math sets the foundation to learn higher level and more complex math skills (Hoelscher, 2016). Many times a typical math lesson may use direct instruction as a strategy to teach students math content. However, some students, depending on their learning styles or abilities, may need different types of instruction to succeed. PMI can be a way to increase student achievement in mathematics. Many students, as young as 5 years old, can experience math anxiety, which can lead to negative feeling about learning mathematics (Ramirez, Gunderson, Levine, & Beilock, 2013). With the use of different strategies, such as PMI, there is a chance that those anxieties can be lessened and students show more academic growth.

According to the US Common Core Standards, one goal included in every grade level is students must have fluency with basic math facts (2010). Starting in kindergarten students begin learning how to add and subtract with fluency (Common Core Standards, 2010). If students do not reach the expected level of fluency for their grade level then it may cause students to fall behind. Therefore, it is important for students to become familiar with math facts in order to move on to more complex skills (Hoelscher, 2016). Studies have shown that PMI can lead to greater student achievement and confidence in

math, as well as contribute to a deeper understanding of math problem solving (Webster, 2005).

Significance of the Study

This study will add to the existing research on strategies that can be used to teach mathematics. PMI is used in a lot of different subject areas such as social studies and language arts. There are many studies that focus on PMI's effects in subject areas such as language arts (e.g. Mathes & Fuchs,1993; Hofstadter-Duke & Daily, 2011; Tzoneva, 1997). However, there are few studies that focus on using PMI to increase knowledge of basic math facts. This study will investigate the effects of PMI on students with ADHD as well as students who have learning difficulties in mathematics. Although there are many studies on peer tutoring and its effects on math performance in self-contained or remedial math classrooms such as the studies (e.g., Fiers, 2017; Webster, 2005), there is a lack of research on its effects in a second grade mathematics inclusion classroom.

Purpose of the Study

The purpose of this study is to examine the effectiveness of PMI on student knowledge of basic math facts in a second grade inclusion classroom. This study will investigate how well students are able to recall addition and subtraction math facts when direct instruction is not being used. Also, this study will explore how PMI's effects student's on task behavior. Earlier research has shown that PMI can have positive effects on student behavior (Locke & Fuchs, 1995). Lastly, students will be asked whether they were content with the use of PMI in the classroom. Taking into consideration how students feel about the learning strategy used in the classroom shows them that they have the ability to take charge of their education (Webster, 2005).

Research Questions

1) Will PMI increase students' knowledge of basic math facts?

2) Will PMI instruction increase students' on task behavior?

3) Are students satisfied with the use of PMI as a learning strategy in a mathematics classroom?

Key Terms

For the purpose of this study:

PMI will be defined as an instructional method in which students assume the role of instructional assistant to their classmates. The teacher takes on the role as the facilitator rather than the instructor (Maheady et al., 2001).

Math fluency will be defined as the ability to recall math facts accurately and with little effort (Poncy et al., 2007).

Chapter 2

Review of Literature

Students with disabilities may encounter difficulties in areas such as basic academic skills, academic behaviors, and social interactions with their peers (Maheady, Harper, & Mallette, 2001). In order to address those areas of difficulty educators and other school professionals implement interventions and strategies. Some studies have used strategies such as drill memorization and timed practices as a way to teach basic math facts (Hoelscher, 2016). However, other studies have shown that since math anxiety can be present in students as early as in elementary school strategies such as timed tests may not be very effective (Ramirez, Gunderson, Levine, & Beilock, 2013). PMI has been identified as a teaching strategy that has positive effects on student progress in mathematics (Fiers, 2017). Mathematics is a subject that can be very challenging for students if they do not have the right foundation. Math is a challenging subject area because it relies heavily on in school learning as opposed to other subjects, such as language arts, that are influenced by a student's culture or environment (Bodovski & Farkas, 2007). In order to set a solid foundation for learning complex or multi step math problems students need to know their basic math facts (Hoelscher, 2016). In a study conducted by Bodovski and Farkas (2007) the researchers studied the progress of students starting in Kindergarten and tracked their progress in mathematics for four years. They concluded that in order for students to make significant gains in mathematical knowledge they must begin with a higher level of mathematical knowledge. In order to

set students up for success teachers must implement the most appropriate strategies to help them gain the knowledge that they need.

This chapter discusses literature related to classrooms using PMI as a strategy in mathematics. Studies have reported that PMI increased student fluency of basic math facts (Greene, Tiernan, & Holloway, 2018). Other studies have reported PMI increasing the on task behavior of students (Locke & Fuchs, 1995).

PMI as a Teaching Strategy

PMI is a teaching strategy that can have different benefits for students. PMI is an effective strategy that has been shown to aid students in increasing fluency of basic math facts (Fiers, 2017). One reason behind PMI being an effective strategy is students are able to receive immediate feedback from peers as opposed to waiting for a teacher to check and grade their work (Maheady, Harper, & Mallette, 2001). Studies have shown that PMI can increase student achievement, social interaction, and confidence in math (Sperry, Neitzel, & Engelhardt-Wells, 2010; Webster, 2005). In a study conducted by Greene, Tiernan, and Holloway (2018) the researchers used peer tutoring for 41 elementary students between ages 8 and 12 to increase their fluency with addition and subtraction computation skills. The researchers divided their students into 3 groups. One group of 14 students was the control group who received typical math instruction and did not participate in peer tutoring. A group of 15 students were designated the experimental group who were the ones who were tutored. The last group of 12 students were designated the Tutor Condition group who were the ones that tutored the students in the experimental group. The tutoring sessions were completed 3 days a week, 30 minutes each day for 8 weeks. The study found that peer tutoring did help students who were

tutored make significant gains in math fluency. However, there was not much difference in progress between the control group and tutor group. The researchers attribute the little progress of the tutor group to the fact that the tutors were provided answers to math facts, which did not give them an opportunity to learn.

In another study conducted by Fiers (2017) the researcher used peer tutoring in a self-contained classroom to increase student's math fact fluency. Four students, ages 7 to 10 years old, participated in the study. The peer tutoring sessions were conducted during center rotations in the student's math classroom. Students worked in teams, while one held up flashcards and the other answered. The cards that were answered correctly earned the team a point. The tutor and tutee would switch roles after 3 minutes. The results of the intervention showed that peer tutoring had positive effects on student's math fluency. Every student's average points during the intervention was higher than the points they scored during their baseline sessions. Not only did the student's math fluency increase, their feelings toward math at the end of the study was more positive than they were at the beginning.

In a study conducted by Webster (2005), the researcher studied the effects of peer tutoring on the confidence and academic achievement of students in a remedial mathematics classroom. The participants of the study were 19 seventh grade students who were place in a remedial mathematics class, called Math Booster, due to their low scores on state testing. Students received three days of training on how to properly implement peer tutoring then were split into three groups. Within each group each student wrote three problems they needed help with. Then the group members decided which student should go first based on who needed the most help. Once the students decided

which problems to work on first the tutors would only ask questions to help guide the student to the correct answer on their own. To obtain data from the study Webster used a pre and post test that was comprised of fractions, decimals, percentages and two-step word problems. A math confidence survey was also used to measure student's attitude towards math. The entire study lasted nine weeks. The results of the study showed an increase in mathematics performance as well as an increase in student's confidence in math. The average score on the pretest was 7.1 while the average score on the posttest was 15.8. Also, on the pre survey students had a confidence average of 66% and on the post survey student's confidence average increased to 84%. This data adds to the literature that peer tutoring is an effective strategy that can be used to increase student performance in mathematics.

Studies have shown that PMI has positive effects on students with learning disabilities as well as those who are at risk for mathematics disabilities (Kunsch, Jitendra, & Sood, 2007). If implemented properly PMI has the potential to increase student's fluency rate of math facts as well as change their attitude toward mathematics (Maheady & Gard, 2010).

PMI's Effects on On Task Behavior

It is important for students to be engaged in the classroom in order for any intervention or strategy to be effective. If students are engaged in learning then there will be a decrease of disruptive behavior (Fiers, 2017). PMI is an intervention that can be used to increase student's on task behavior in the classroom. In one study researchers Locke and Fuchs (1995) studied the effect of PMI on on task behavior of students with EBD. The students who participated in the study were three fifth and sixth grade boys. In a self-

contained classroom of 20 students the authors chose to use PMI during reading instruction to study student's on task behavior. The study lasted for 20 days with four days being used to teach students how to implement PMI and give positive corrective feedback to their peers and the rest of the days were divided between baseline, intervention, and withdrawal periods. The researchers defined on task behavior as "a student (a) appropriately directing eyes toward task, teacher, or peer; (b) remaining in seat; and (c) keeping hands to self" (Locke & Fuchs, 1995 p. 95). When students were observed exhibiting on task behaviors the observers recorded a plus sign. When students were not on task the observers recorded a line. The observers calculated the percentage of intervals where on task behavior occurred each day. The study found that PMI had a positive effect on the student's on task behavior. One student's data showed that his on task level was 56% during the baseline then 87% during PMI. The authors concluded that PMI had a positive effect on the behaviors and social interactions of their students.

In the research study conducted by Maheady and Gard (2010) the researchers chose to implement classwide peer tutoring because of the off task, disruptive behaviors that their students were displaying. The students also had a negative attitude towards math and would express those attitudes to their teachers. The study was conducted in a fifth grade remedial math class that consisted of 8 students. It lasted the entire school year from September to June. The students focused on division and multiplication during their tutoring sessions. Students were split up into teams where each student took a turn being the tutor and tutee for 10 minutes each. The tutors would show flashcards to the tutee who would then provide a solution to the problem. Teams were awarded points based on how well they worked, their ability to give correct answers, and the tutors' ability to

provide positive corrective feedback. The researchers noted that at first students were slow to earn points but as weeks progressed teams would compete to earn as many points possible. At the end of each week the team with the most points would receive a team of the week certificate. By the end of the study the researchers found that students were participating much more than they had at the beginning of the study. Students' off task behavior also decreased significantly.

In contrast Greene, Tiernan, and Holloway (2018) found that PMI had no significant effects on behavior or social interactions. The data they collected included a wide range of results from the pre and post tests. Some student behavior increased while others decreased and the researchers did not see a trend in student behavior when the intervention was introduced. The researchers concluded that the data collected may not have been as accurate as it could have been because of the survey used being subjective. For possible future research, the researchers suggested using more objective measures or including both teacher observations and self-reporting surveys to measure student behavior.

Attitude Towards Math

A student's ability to recall, with both speed and accuracy, basic math facts will help them develop and master more advanced math skills (Poncey et al., 2007). However, if students do not have the foundational knowledge they need to succeed then they may become reluctant to engage in a subject area such as mathematics. Ramirez, Gunderson, Levine, and Beilock (2013) researched how math anxiety was related to math achievement. The participants of the study were 154 first and second grade students. The researchers measured students' math achievement, math anxiety, and working memory

through different assessments and questionnaire. It was found that there is a correlation between math anxiety and math achievement. Those students with a higher working memory, who were more aware of their difficulties with math, did not perform well in mathematics. These student's knowledge of their own challenges made them more nervous when completing math assessments, which resulted in a lower performance. Therefore, knowing that student's as young as at the elementary level can experience such negative feelings about their academic performance leads us to believe that providing students with strategies to increase their mathematics knowledge will lessen their anxiety and increase their performance as they progress.

Researcher Tsuei (2011) used an online peer tutoring system called G-Math to implement peer tutoring among eighty-eight 10-11 year old elementary students. This type of peer tutoring is different from the traditional peer tutoring in that all student interaction is done through a computer. The study lasted two semesters with students meeting three times per week with each session being 40 minutes long. Students were split into two groups, a control group and an experimental group. The control group used a cooperative learning strategy while the experimental group used an online peer tutoring system. The control group included pairs of students who would work collaboratively to solve a problem then once the problem was solved they would explain how they solved it to the class. Students in the experimental group used the G-Math system to communicate to one another while solving math problems. The system helped to guide the tutor and tutee relationship by providing prompts or guides for the students to communicate. The system would provide the students with sentence starter such as "I don't understand your answer. Please show me again" or "this is a very important step". The system's suggested

feedback and task coordination helped to keep the tutor-tutee relationship positive and constructive. The results of the study showed that students in the experimental group had a significant difference in their attitude towards math than the control group. Students in the experimental group reported more positive attitudes towards math. These students felt more comfortable solving math problems than they did at the beginning of the study and their overall enjoyment of math class increased. Their fear of failure had decreased significantly as well. The students who used G-Math also showed significant progress in their overall math scores. This study is an example of how a student's attitude towards math can have significant effects on their overall learning. It is possible to believe that there could be a correlation between student's attitude toward math and their mathematical achievement. Peer mediated instruction was able to help the student's in the study to increase both (Tsuei, 2011).

Summary

The review of literature suggests the PMI can be an effective strategy that increases achievement and confidence in math as well as improve on task behavior (Webster, 2005; Locke & Fuchs, 1995). PMI has shown to have positive effects on the overall performance of students in a mathematics class. Students such as those in the Maheady and Gard (2010) study had shown enough improvement that all students who participated in peer tutoring were reclassified from needing intensive intervention to strategic intervention. Results such as these demonstrates the effectiveness that PMI can have on academic performance.

Both on task behavior and positive attitude towards math are needed to aide in student's growth in mathematics. PMI has shown that it can have an influence on both of

these factors. A student's attitude towards math can develop as early as elementary school (Ramirez, Gunderson, Levine, & Beilock, 2013). If students have a bleak outlook on their future academic performance, which will lead them to say thing such as they "hate math" or that they are "too stupid to do math" then they will lack the motivation they need to succeed (Maheady & Gard, 2010). PMI is a strategy that will help lessen that anxiety and increase their motivation so that students will feel more confident in solving problems that were once seen as being too difficult for them (Webster, 2005). Also, since it has been found that on task behavior is associated with academic growth PMI has been chosen by some researchers to improve both of these factors in their students (Locke & Fuchs, 1995). Literature has shown that PMI can increase student participation and help them focus more on their own academic progress (Maheady & Gard, 2010).

The present study seeks to add to the literature of the effects of PMI in mathematics. The goal of the study is to show that PMI can be an effective strategy in a second grade inclusion mathematics classroom. The hypothesis for the present study is that student knowledge of basic math facts will increase after PMI is introduced and student's on task behavior will increase during the intervention period.

Chapter 3

Methodology

Setting

School. This study was conducted in a public elementary school in a southern New Jersey school district. The school district includes a total of 5 elementary schools with this school being the newest. There are approximately 190 students being served at this school. After baseline assessments at the beginning of the academic year the school reorganized classroom schedules to include a 45 minute period where students receive extra practice with math and language arts. This was done in order to better serve students and give them the help they need to progress in those subject areas.

Classroom. This study took place in a second grade inclusion classroom. The classroom has a total of 20 students who vary in academic ability. There is one teacher and one paraprofessional in the classroom throughout the day. The classroom utilizes flexible seating, where some students sit at tables or desks, others may sit on a pillow on the rug in the classroom. The tables are arranged in a semicircle with the rug in the middle. The tables face the smartboard where most of the teaching in the classroom takes place on a daily basis. The study was conducted at the end of the day during the 45 minute period that the school uses for math or language arts practice.

Participants

Participant 1 is a 7 year old male. This student has speech difficulties that often get in the way of his ability to communicate clearly. One of his strengths is his enthusiasm to learn new things and his ability to catch on to new ideas and concepts quickly. Participant 1 often has difficulty working collaboratively with other students due

to his desire to demonstrate leadership in small groups. Outside of school this student loves video games and often talks about watching football on TV with his family. Participant 1 seems very close with his family and loves to spend time talking about what he does with his family when he's home. There are times when he expresses that he misses his family, which results in him stopping what he is doing and not completing work in class.

Participant 2 is a 7 year old male. He has been diagnosed with autism and generally keeps to himself in the classroom. Participant 2 does not speak much during the school day. This student needs one on one attention in order to complete assignments during class and if he does not have the aid of another teacher he tends to not complete the assignments given. One of this student's strengths is his positive attitude towards school. He does his best to follow directions to the best of his ability and gives help to others when he is asked. Participant 2 has difficulty expressing himself in class which he himself has said is due to not wanting to say the wrong thing or get in trouble.

Participant 3 is a 7 year old female who pushes into the inclusion second grade classroom throughout the day. This student has a learning disability and spends most of her day in a self-contained classroom. Some of her strengths include her outgoing personality and her willingness to help classmates when they need it. A weakness that this student has is her tendency to become frustrated when presented with a challenging problem. This student has expressed her dislike of mathematics because she feels like she will get the answers wrong if she tries. She is very talkative and energetic when in a small group setting, however when in a room with a larger group of students she mostly keeps to herself.

Table 1

General Information of Participants

Student	Age	Grade	Classification
Participant 1	7	2	Speech/ Language
Participant 2	7	2	ASD, Speech/Language
Participant 3	7	2	SLD

Research Design

This research study utilized a single-subject ABAB design. During Phase A students received traditional teacher-led math instruction. Also students took a basic math facts assessment that tested them on their knowledge of basic addition and subtraction math facts. The on task behavior of students was recorded during Phase A in order to establish a baseline for behavior. After the initial Phase A students were instructed on how to implement peer mediated instruction through direct modeling. Students learned and practiced peer mediated instruction for two weeks. During Phase B of the intervention students used peer mediated instruction to practice both addition and

subtraction math facts. Also, during this phase students on task behavior was observed and recorded. Students were given a basic math facts assessment as well. Phase B took place for two weeks. After Phase B the intervention was removed and students were administered the same assessments as given during the initial Phase A. Peer mediated instruction was reintroduced during the final Phase B and the same assessments was conducted. After the final Phase B students were given a Likert survey to share their feelings about peer mediated instruction.

Procedures

The study took place over 9 weeks. During week 1 and 2 baseline data was collected on students' mean score on addition and subtraction assessments. Baseline data was also collected on the amount of time that students were on or off task. At the beginning of week 3 students were introduced to peer mediated instruction. Weeks 4 and 5 were intervention weeks where students used peer mediated instruction to teach each other math facts using flash cards. Week 6 and 7 returned to traditional classroom teaching of strategies students can use to remember math facts. Finally weeks 8 and 9 reintroduced students to peer mediated instruction. At the end of week 9 students took a survey on their attitude towards PMI. Each phase also included teacher observation of student on task behavior. For 30 minutes the teacher observed the students every 3 minutes and marked whether the student was on or off task.

Materials

Math facts flashcards. Students used teacher created flashcards to practice basic math facts. One side of the card had either an addition or subtraction problem while the other side had the answer. These flashcards were only used during intervention phases.

On task behavior chart. The teacher utilized an on task behavior chart to record behavior data. Every 3 minutes over a period of 30 minutes the teacher recorded whether or not a student was on task by either writing a (+) or (-). The teacher recorded behavior data every other day.

Math survey. At the end of the final Phase B students filled out a survey on how they felt about peer mediated instruction. The survey included a scale of 1-5 with 5 representing strongly agree and 1 representing strongly disagree. The survey included phrases such as "peer mediated instruction helped me learn math facts" and "I would like to use peer mediated instruction again." The purpose of the survey was to gauge student's attitudes towards peer mediated instruction.

Basic facts math assessment. During each phase of the study students were given an assessment that took approximately 10-20 minutes where they had to solve basic addition and subtraction problems. The assessment was used as a baseline as well as to monitor student progress with and without intervention.

Measurement Procedures

Basic math facts. Students were assessed on their knowledge of math facts after each phase of the study. Student scores were calculated by finding the percentage of problems that were correct. Student progress was monitored using math warm ups during the phases.

On task behavior. Student on task behavior was observed by the teacher for 30 minutes every other day. The teacher used a behavior chart to keep track of student behavior. Every 3 minutes during the 30 minute period the teacher observed if the student was on or off task. If the student was on task, participating and completing assigned work, the teacher placed a plus sign on the chart. If the student was off task, not involved in the activity or not completing the task given to them, then the teacher placed a minus sign on the chart.

Survey. At the end of the last phase students took a survey to convey their attitudes toward PMI. The survey consisted of various statements about PMI. For each statement students circled a number from 1 to 5; 1 representing strongly disagree, 2 representing disagree, 3 representing neutral, 4 representing agree, and 5 representing strongly agree.

Data Analysis

Students were assessed after each phase of the study. Student scores were converted into percentages. Average scores of the baseline were compared to average scores of the intervention to determine the effectiveness of the intervention for each individual student. On task behavior means during baseline and intervention phases were also compared. Assessment data for each phase was displayed using a line graph and analyzed visually for patterns. Mean scores between intervention phases and baseline phases were compared using a bar graph. Survey data was displayed using a stacked bar chart.

Chapter 4

Results

Summary

In this single subject design the effects of PMI on knowledge of basic math facts and on task behavior were examined with three students from a 2nd grade inclusion classroom. The research questions to be answered were:

1. Will PMI increase students' knowledge of basic math facts?
2. Will PMI instruction increase students' on task behavior?
3. Are students satisfied with the use of PMI as a learning strategy in a mathematics classroom?

The students were assessed at the beginning of the study using a teacher created addition and subtraction assessment. This assessment was used to obtain baseline information for students' knowledge of math facts. Students were assessed during each phase of the study to track their progress. The teacher observed students during each phase for 30 minutes every other day. Every 3 minutes the teacher marked whether the student was on or off task.

Group Results

Figure 1 shows the mean of the participant's baseline scores for their math fact knowledge. Baseline assessments showed that the three participants had an average score of 68%. After the end of phase 2 the student's mean increased to 71%. During the second baseline phase the group's mean increased to 73%. Finally, during the last phase of the study the group's mean score increased to 75%.

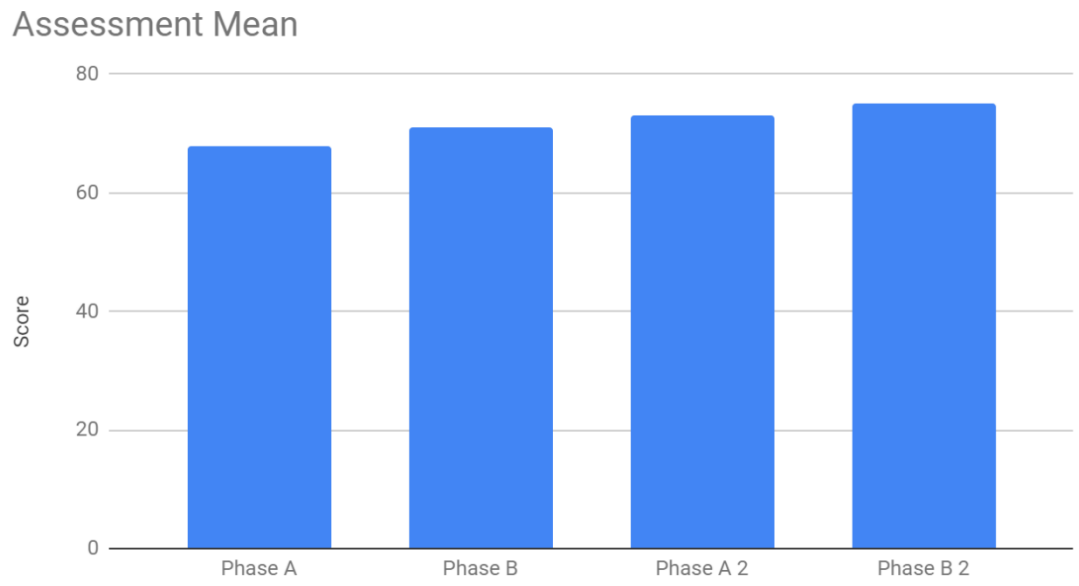

Figure 1. Mean Group Scores of Baseline Assessments

Figure 2 shows the mean of the groups on task behavior during each phase of the study. During week 1 of interventions participants had an average on task behavior of 51.1 % during the 30 minute periods they were observed. Week 2 displays an increase to 58.3% on task behavior. Then during week 3, which is when the intervention was introduced, on task behavior increased to 69.4%. Week 4 saw an increase to 70 %. However, during week 5 the group's on task mean dropped to 58.9% but increased to 67.8% during week 6. The group's mean continued to increase during week 7 to 73.3%. Then there was another increase during week 8 with a mean of 75.6%.

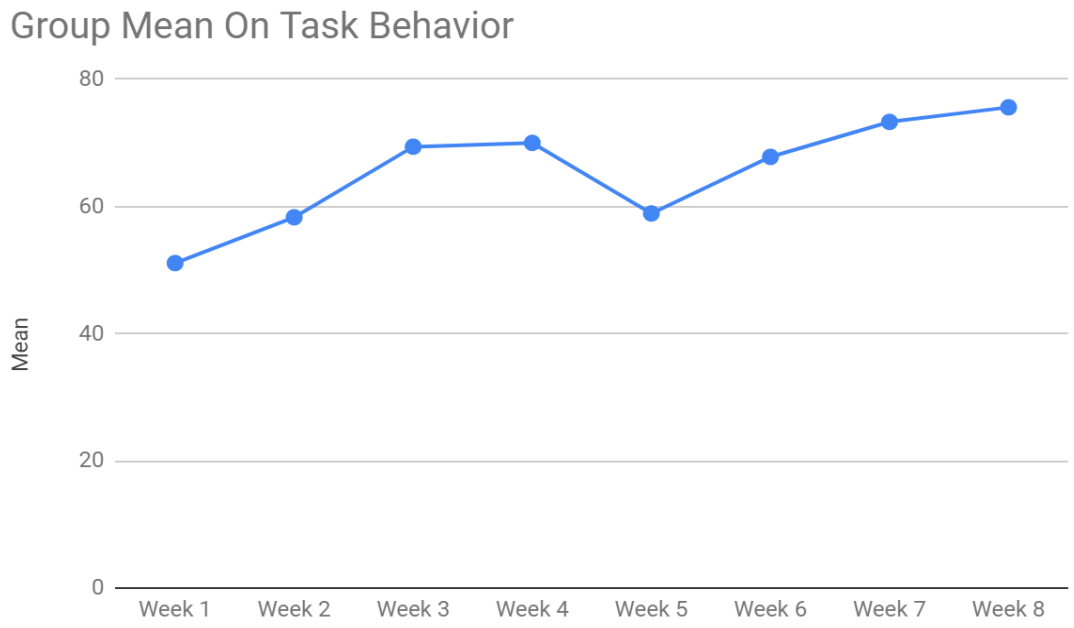

Figure 2. Group On Task Behavior

Figure 3 displays the mean of the group's weekly assessments. During week 1 the group had a mean of 56.7%. Then there was an increase to 63.3% in week 2. Week 3 saw another increase to 66.7. Then in week 4 the mean decreased back to 63.3%. In week 5 the groups mean increased to 70 % and in week 6 there was another increase to 73.3%. During week 7 there was a decrease to 63.3% for the groups weekly assessment score. Finally, in week 8 the groups score increased to 73.3%.

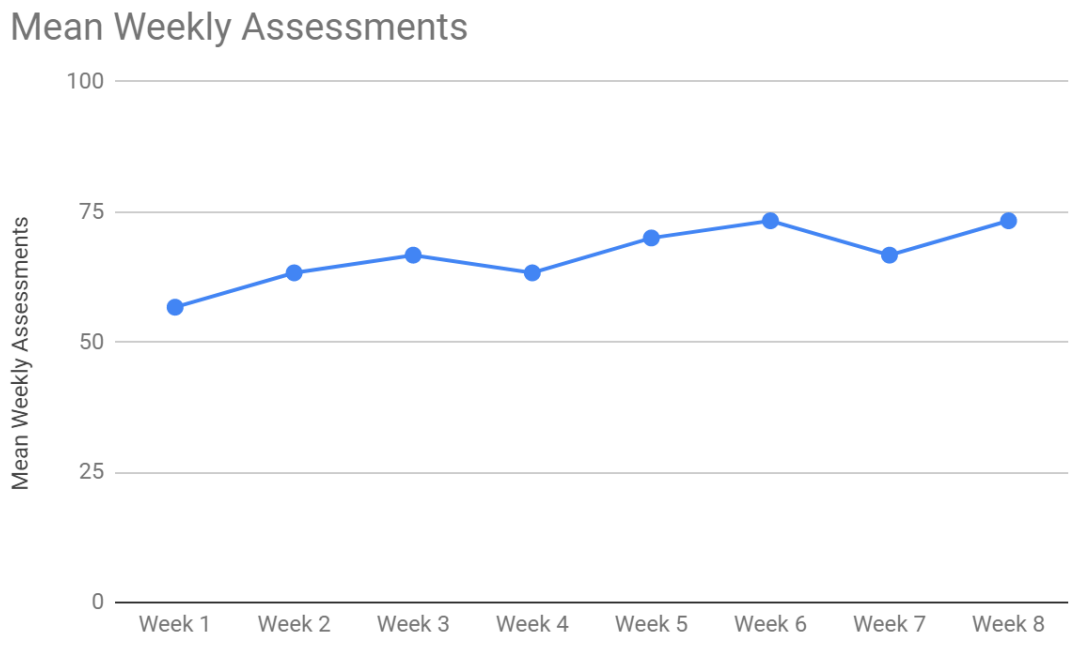

Figure 3. Group Mean Weekly Assessment Scores

Individual Results

Figure 4 displays the math fact assessment scores of Participant 1 throughout the ABAB phases. During the first base line participant 1 scored 75%. Then during the first intervention Participant 1 scored 75% with no change in scores. Participant 1's score increased to 80% during the second baseline phase. Then during the last intervention phase Participant 1 scored 85%.

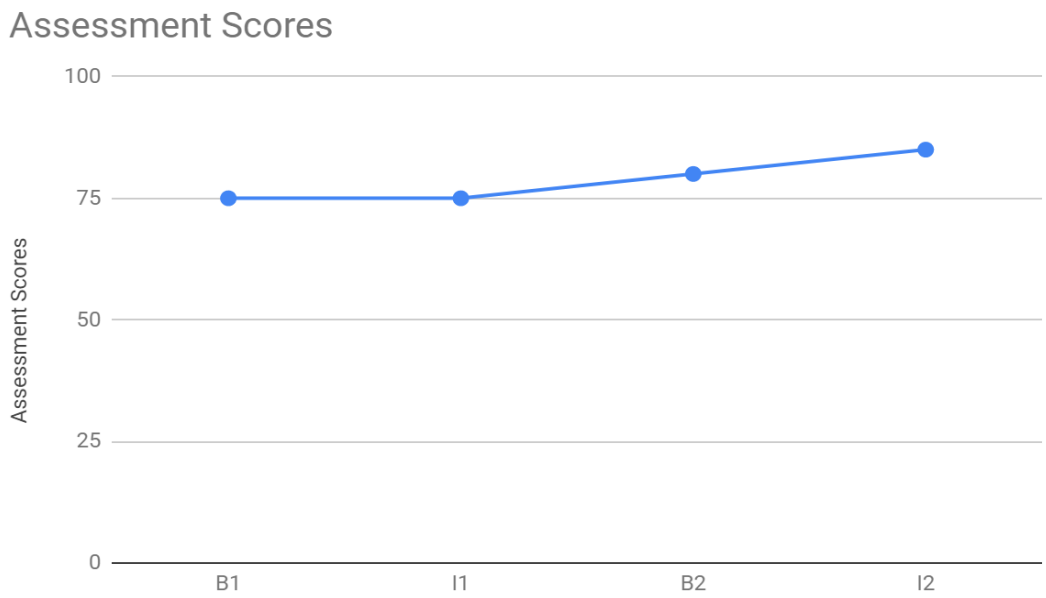

Figure 4. Baseline Assessment Scores of Participant 1.

Figure 5 displays the math fact assessment scores of Participant 2 throughout the ABAB phases. During the first baseline participant 3 scored an 80%. During the first intervention participant 2's score increased to 85%. During the second baseline phase Participant 2 scored 88%. For the last baseline assessment Participant 2 score 90%.

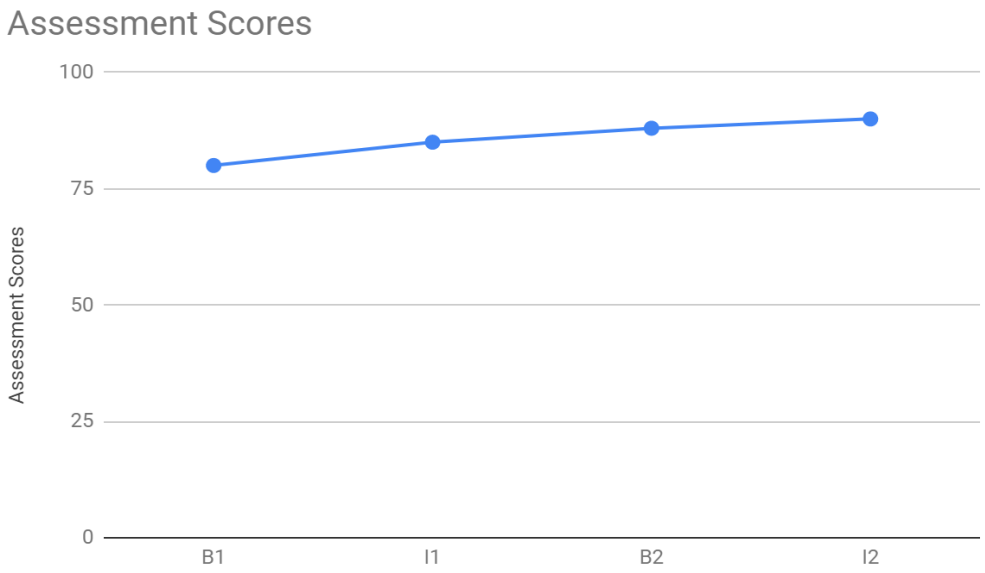

Figure 5. Baseline Assessment Scores of Participant 2

Figure 6 displays the math fact assessment scores of Participant 3 throughout the ABAB phases. During the first baseline participant 3 scored 50 % on the baseline assessment. During the first intervention phase participant 3's score was a 55%. Participant 3 then scored 50 % during the second baseline assessment. Participant 3's score increased to 55% for the last baseline assessment.

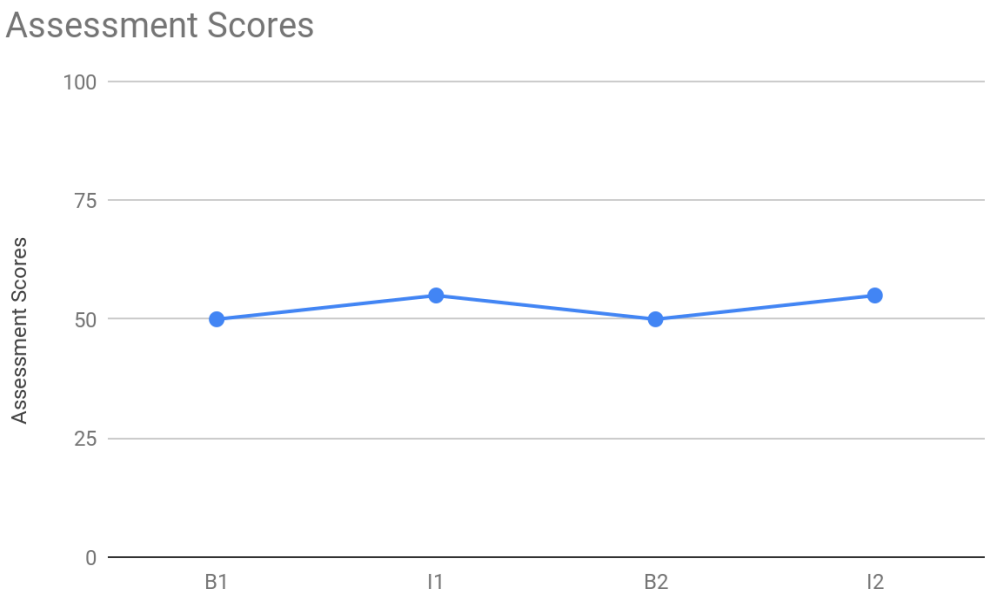

Figure 6. Baseline Assessment Scores of Participant 3

Weekly Assessment Scores

Table 2 shows the mean weekly assessment scores of participants throughout the phases of the study. Participant 1's mean score during the first baseline phase was 65% and did not change during the first intervention phase. However, during the second baseline phase participant 1s mean score for weeks 5 and 6 increased to 80%. During last phase of the study participant 1s mean score stayed at 80%

Participant 2's mean weekly assessment score for the first baseline was 75% then increased to 85% during the first intervention phase. Participant 2's mean score stayed at 85% during the second baseline phase. During the last phase of the study Participant 2's score stayed at 85%.

Participant 3's mean weekly assessment score during the first baseline was 40% then increased to 45% during the first intervention phase. In the second baseline Participant 3's mean score increased to 50%. However, during the last phase of the study participant 3's mean score decreased to 45%.

Table 2

Mean Scores of Weekly Assessments

	Baseline 1		**Intervention 1**		**Baseline 2**		**Intervention 2**	
Student	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 7**	**Week 8**
Participant 1	60	70	70	60	80	80	80	80
Participant 2	70	80	80	90	80	90	80	90
Participant 3	40	40	50	40	50	50	40	50

On Task Behavior

Figure 7 illustrates the engagement scores of Participant 1 throughout each phase. During the first baseline participant 1 had a mean score of 53.3%. During the first intervention participant 1 had a mean on task behavior score of 65.8%. Participant 1's average on task behavior decreased during the second baseline phase to 61.2%. Then during the second intervention phase it increased to 76.7 %.

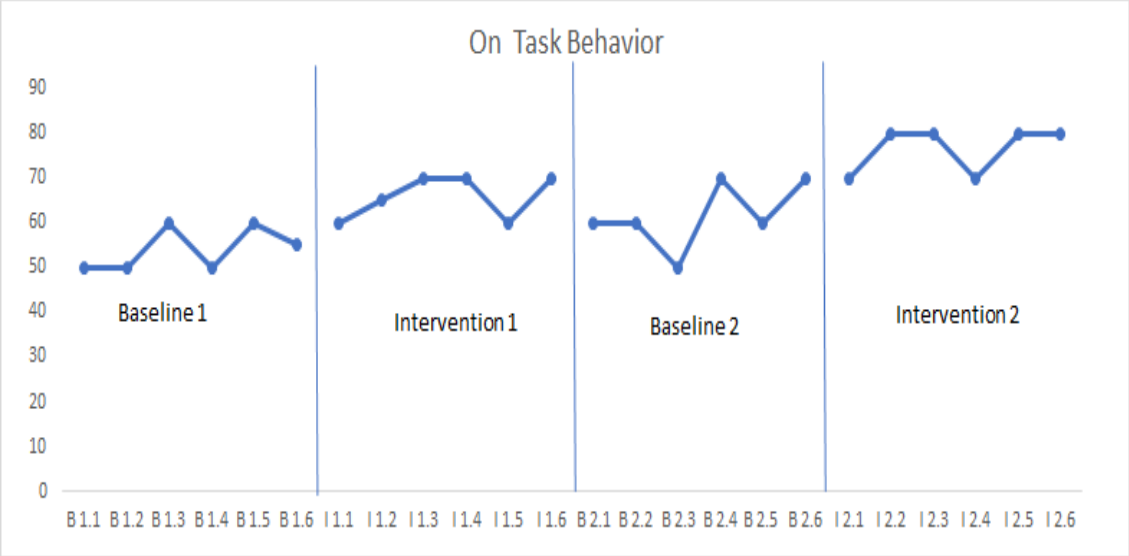

Figure 7. Participant 1 On Task Behavior Scores

Figure 8 illustrates the engagement scores of Participant 2 throughout each phase. During the first baseline phase Participant 2 had a mean on task behavior score of 56.7%. Participant 2's on task behavior mean increased to 68.3% during the first intervention

phase. During the second baseline the mean on task behavior decreased to 66.7%, then increased during the second intervention phase to 70%.

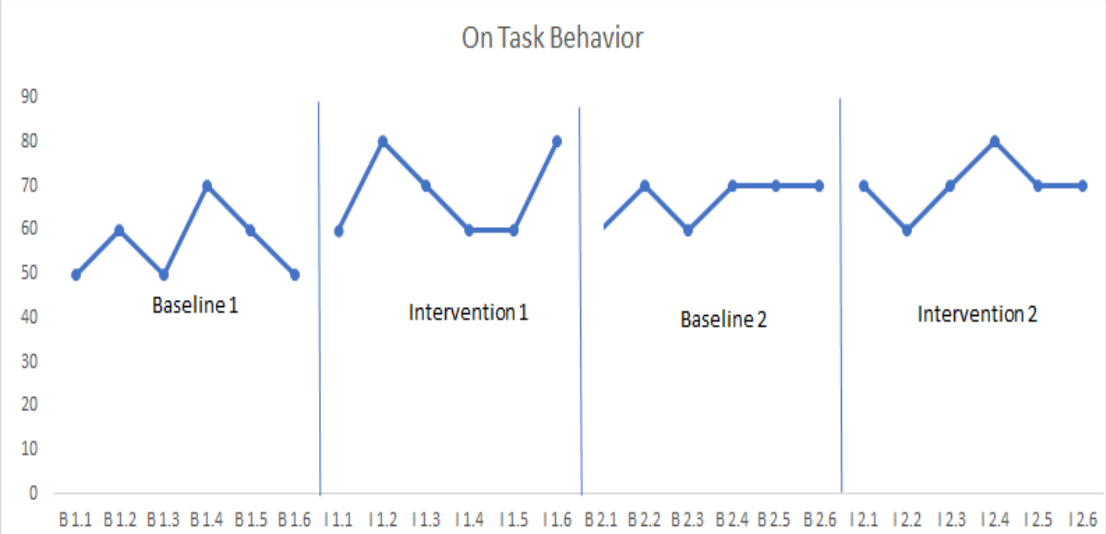

Figure 8. Participant 2 On task Behavior

Figure 9 illustrates the engagement scores of Participant 3 throughout each of the phases. During the first baseline Participant 3 had a mean on task behavior score of 53.3%. Then during the first intervention Participant 3's mean increased to 75%. The second baseline phase saw a decrease of on task behavior to 61.7%. The mean on task behavior of participant 3 increased to 76.7% during the second intervention phase.

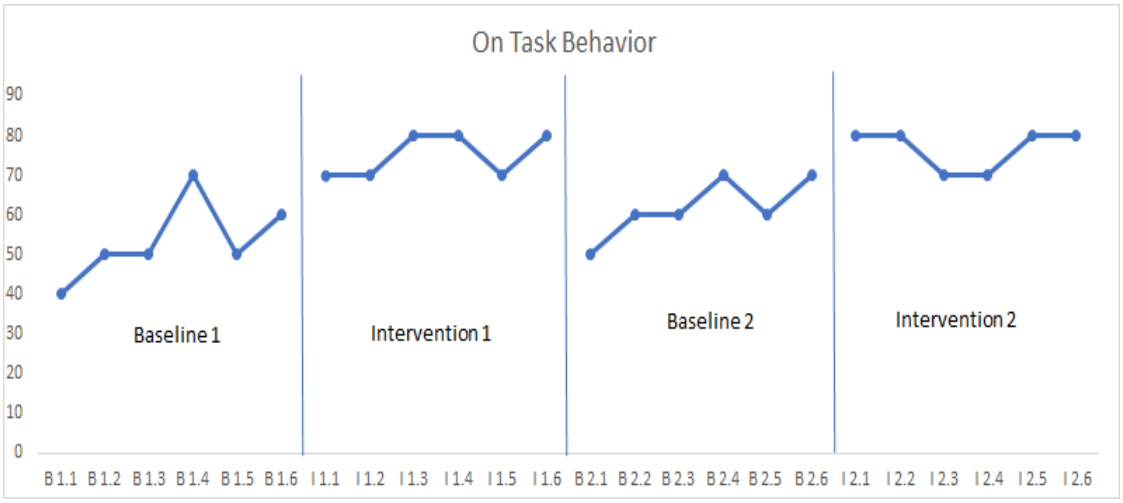

Figure 9. Participant 3 on task behavior

Survey Results

Table 3

Student Satisfaction Survey Percentage Results

Statements	Strongly Agree (%) 5	Agree (%) 4	Undecided (%) 3	Disagree (%) 2	Strongly Disagree (%) 1
1. I like using peer mediated instruction in math.	67	33	0	0	0
2. Peer mediated instruction helped me learn math facts.	0	100	0	0	0
3. Peer mediated instruction helped me stay on task.	67	0	0	33	0
4. I would like to use peer mediated instruction again.	33	33	33	0	0
5. I would like to use peer mediated instruction in other subjects.	33	33	0	33	0
6. I received good grades in math class as a result of peer mediated instruction.	0	67	0	0	33

As seen in Table 3 a score of 4 or 5 meant that the participants agreed or strongly agreed with the statement. A score of 3 meant that they were undecided on the statement. A score of 1 or 2 meant that the participants either disagreed or strongly disagreed with the statement. Table 3 shows that all participants either agreed or strongly agreed that they liked "using peer mediated instruction in math". All participants agreed that "peer mediated instruction helped me learn math facts." A majority of the participants strongly agreed that "peer mediated instruction helped me stay on task," while one disagreed with the statement. Two of the three participants either agreed or strongly agreed that "I would like to use peer mediated instruction again," while one participant was undecided. The majority of participants agreed or strongly agreed that "I would like to use peer mediated instruction in other subjects," however one participant disagreed. Finally, the majority of participants agreed with the statement "I received good grades in math class as a result of peer mediated instruction," while one participant strongly disagreed.

Chapter 5

Discussion

The purpose of this study was to determine the effectiveness of PMI on student's knowledge of basic math facts as well as its effects on the on task behavior of students. At the end of the study students were asked to complete a satisfaction survey to assess their feelings on the use of peer mediated instruction in the classroom.

Findings

Research has suggested that PMI increases student achievement in mathematics (Webster, 2005). The results from the present study support Webster's findings as each participant in the study showed progress in math fact fluency. Also, the results from the present study validate the finding of Locke and Fuchs (1995) that PMI has a positive effect on the on task behavior of students. Participants' on task behavior increased when the intervention was introduced. Participants took a voluntary satisfaction survey that communicated their attitude towards the use of PMI as an intervention in mathematics. The participants' responses align with the responses of those in a study conducted by Greene et al. (2018) where students expressed positive feedback to PMI.

The results of the present study support the findings of Webster (2005). The participant's baseline assessment scores increased throughout the study. Participant 1 started with a baseline score of 75% then progressively increased until the last assessment where they scored 85%. The same happened with Participant 2 where they started with a baseline score of 80%. Through each phase the score increased until the last assessment where Participant 2 scored 90%. The pattern in Participant 3's scores differed from the other participants in that scores during intervention phases were higher than the baseline

phases. In both baseline phases Participant 3 scored 50% whereas in both intervention phases the score had a slight increase to 55%.

When looking at the on task behavior of students, the present study also aligns with the findings of Maheady and Gard (2010). The participants of the present study were more engaged during intervention phases than baseline phases where the intervention was taken away. During the first and second baseline phases Participant 1 had a mean on task behavior score of 53.3% and 61.2%, respectively. On task behavior was significantly higher during the intervention phases. The first intervention phase Participant 1 was on task 65.8% of the time and during the second intervention phase on task behavior increased to 76.7%. Other participants displayed similar results with on task behavior increasing during periods of intervention. Participant 3 scored a mean of 53.3% during the first baseline then increased to 75% during the first intervention phase. On task behavior decreased to 61.7% during the second baseline then once again increased during the second intervention to 76.7%. The present study shows that PMI has a positive effect on students' on task behavior. Students were much more engaged and participated more when the intervention was introduced then when it was taken away.

Also, the present study reinforces the findings of Greene et al. (2018) in which a majority of the students enjoyed using the intervention and expressed their willingness to participate in the intervention again. In the present study, all participants either agreed or strongly agreed that they liked using PMI in mathematics. A majority of the participants also agreed that they would like to use PMI again. This shows that PMI is an intervention that can allow students to enjoy learning.

Limitations

The present study had a few limitations that could have affected the results. One limitation of the study is the time spent completing the study. If the phases of the study lasted longer than two weeks than the data may have been stronger in showing PMI's effects on students' academic success. Although the students did show some progress the amount of progress may have differed if more time was spent using the intervention.

Another limitation to the study is that once the intervention was introduced the participants demonstrated better understanding of math facts, but continued to show that understanding once the intervention was taken away. The participants made more progress once the intervention was reintroduced, however it was difficult to see how much of an impact PMI had on student's knowledge if they were retaining the information once it was introduced the first time when using an ABAB design.

The study included a small number of participants, which makes it difficult to generalize the results to a large population of students. The results showed that PMI worked well with these particular second grade students but it does not show if it will work well with all second grade students. The results could have been stronger if more students were used in the study like that of Greene et al. (2018) who used forty-one elementary aged students to study the effects of PMI on student achievement in math fact fluency.

Implications and Recommendations

Despite the limitations of the present study, the results show that PMI has a positive effect on the students' knowledge of basic math facts and their on task behavior. The participants of the study demonstrated a better understanding of basic math facts

once PMI was introduced. This shows that perhaps special education students retain information better when they are actively participating in the learning process rather than listening and learning in a traditional way. Through PMI students were able to take more control of their learning and had to be more accountable because they were working with another student.

The data collected also shows that PMI increases student on task behaviors in the classroom. Previous studies, such as one done by Locke & Fuchs (1995), concluded that PMI increases on task performance and creates more positive social interaction among students. PMI should be looked at as a possible intervention for educators to use to as a way to increase student participation and decrease disruptions in the classroom. When students increase on task behavior in turn there becomes more learning opportunities available to them.

Survey results indicated that the majority of participants enjoyed using PMI and that they would like to use it in other subject areas. Further research should be conducted to find if PMI can be effective in other areas of mathematics. The present study provides evidence that PMI can be useful in the acquisition of knowledge in basic math facts. Other studies can be conducted to find if PMI can be effective in areas such as geometry or algebra.

Conclusions

Overall, PMI is an intervention strategy that can have positive effects on student achievement. Students' knowledge of math facts increased as well as their on task behavior. Furthermore, students expressed their enjoyment with using PMI in mathematics and a majority felt as though they received better grades as a result of

participating in the intervention. Further research is needed to study the effects of PMI on student achievement in different subject areas. Future research should also include a larger number of participants so that the results could possibly be generalized to a larger population.

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