THE EFFECTS OF A MATH FACT INTERVENTION WITH THE USE OF AN I-POD AND PROGRESSIVE TIME DELAY WITH REGULAR EDUCATION STUDENTS AND STUDENTS WITH ATTENTION DIFFICULTIES

by

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ABSTRACT

This study examined the acquisition of math multiplication facts using a progressive time-delay intervention with an I-Pod. A single-subject multiple baseline design was used across 6 participants. Three participants were students receiving only regular education services and scoring below 55% correct on a baseline math multiplication probe. The other 3 participants also scored below 55% correct on a baseline math multiplication probe, were receiving regular education services, but also met criteria for inattention. During intervention, all participants had items presented to them via I-Pod with three time delays per 15-item worksheet (1s, 2s, 4s). Each of the 3 worksheets had a track with a differing time delay between the presentation of the math problem and the presentation of the answer. The first time delay was 1s in order to prevent practice errors. Next, students completed the worksheet with the 4s delay in order to provide more time for recall. Lastly, students completed the task with a 2s time delay in order to promote automaticity and fluency. Once a participant reached mastery (80% correct or better on two sessions in a row) on a 2s time delay worksheet, the student moved to a new set. A generalization probe consisting of all multiplication facts from 2-9 was administered directly after the intervention phase. The same probe containing all facts from 2-9 was administered as a follow-up, 2 weeks and 4 weeks after the intervention was complete in order to assess maintenance. The intervention phase lasted

between 7 and 12 weeks, depending on how quickly participants reached mastery. Effect sizes were calculated using accuracy rates to determine the effectiveness of the intervention. Large effect sizes were demonstrated across all participants, ranging from 2.84 to 30.67. Improved accuracy rates were also maintained at follow-up, suggesting that the intervention used in this study was successful at increasing multiplication fact fluency for students with attention difficulties as well as those without.

TABLE OF CONTENTS

Appendix

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

With the emergence of Response to Intervention (RTI), it has become more important to use effective evidence-based interventions when trying to implement change in students' academic performance. The ultimate aim of RTI is to improve learning for all students and provide specially designed instruction for those students who may need additional support. This specialized instruction is meant to help individual students learn and keep them from falling behind academically (Rathvon, 2008). One area that many students fall behind in is mathematics. If students do not master basic math facts, higher-level math becomes very difficult, if not impossible, for them. This makes it imperative to develop effective and efficient ways to help students who struggle to learn basic math facts (Poncy, Skinner, & Jaspers, 2007).

Response to Intervention (RTI)

RTI is a "proactive approach designed to identify students with academic or behavioral difficulties as soon as they begin to struggle" (Rathvon, 2008, pp. 6-7). An RTI model requires the use of evidence-based interventions with services matched for each student to meet individual academic and behavioral needs. RTI uses a multitiered approach, usually with three tiers: Tier 1, Tier 2, and Tier 3. Tier 1 refers to quality core curriculum that all students receive. One-hundred percent of students should receive Tier 1 instruction that involves universal screenings, evidence-based instruction, and tri-yearly progress monitoring. About 15% to 20% of students require Tier 2 instruction. This group is comprised of those students deemed to be "at risk" based on data from ongoing monitoring of all students in Tier 1. Tier 2 instruction typically involves standardized interventions with small groups with interventions matched to student needs. For those students who do not respond to Tier 2 interventions based on data obtained from more frequent ongoing monitoring, Tier 3 interventions can be considered. Tier 3 involves services for about 5% of the student population and consists of intensive and individualized instruction (Jimerson, Burns, & VanDerHeyden, 2007). With the RTI model, approximately 80% of students should be successful with only Tier 1 instruction. However, about 20% of students are estimated to need more focused, individualized academic instruction.

Changes in standards for student performance were impacted by the No Child Left Behind Act (NCLB) in 2002 and the Individuals with Disabilities Education Improvement Act (IDEIA) in 2004. These mandates were meant to support students and focus on meeting the standards of increasingly diverse student populations. IDEIA 2004 supports local education agencies to use federal funds to provide "early intervention strategies" such as those described in an RTI model, as well as permits local education agencies to use an RTI model for eligibility determination for special education instead of, or in addition to, the old ability-achievement discrepancy model (Rathvon, 2008). NCLB sets proficiency standards that all students must reach. Because of these mandates, schools are permitted to use an RTI model that incorporates evidence-based interventions and instruction in order to help reach standards set by NCLB. Because of these high standards, it is important to use interventions that are effective in an RTI framework (Rathvon, 2008). Teachers need strategies that improve learning on a classwide basis as well as for individual students who need additional educational support to succeed. Using Evidence-Based Practice (EBP) or Evidence-Based Interventions (EBI) is an important standard to include within an effective RTI model.

Evidence-Based Interventions

According to Rathvon (2008), Evidence-Based Interventions (EBIs) are "strategies, practices, and programs for which research is available documenting their effectiveness" (p. 5). A more in-depth definition is provided by Hoagwood and Johnson (2003): The term "evidence-based practice" (EBP) refers to a body of scientific knowledge, defined usually by reference to research methods or designs, about a range of service practices such as referral, assessment, case management, student support services, etc. The knowledge base is usually generated through application of particular inclusion criteria (e.g., type of design, types of outcome assessments) and it generally describes the impact of particular service practices on child, adolescent, or family outcomes. Due to the fact that evidence-based interventions are essential for student success, a Task Force on Evidence-Based Interventions (EBIs) in School Psychology was started (Kratochwill & Shernoff, 2004). The purpose of the Task Force was to identify and review interventions for psychology and education for behavioral, emotional, and academic problems. The target population for intervention review included school-aged children and their families.

A principal goal of the Task Force on Evidence-Based Interventions has been to improve knowledge of evaluation criteria for EBI's and disseminate this information to professionals in the field. However, the Task Force faces many obstacles when trying to transport the use of EBIs to practice. For example, in order for interventions to be evidence-based and backed by research, interventions need to be standardized. This means that some treatments may be manual-based. Some practitioners may have theoretical beliefs that go against the procedures of manual-based treatments. Also, many believe that it should be the responsibility of practitioners alone to come up with EBIs. However, it is the opinion of the Task Force that the search for EBIs needs to be a combined effort between researchers, trainers, and practitioners (Kratochwill & Shernoff, 2004). Without collaboration, researchers may develop an intervention that works in a clinical setting but is not practical in an educational setting. Educators and school psychologists often face administrative and practical barriers that keep them from using an intervention that has proven successful elsewhere. In order to successfully implement EBIs, the Task Force lists 5 assumptions that should help with this effort. These assumptions include the need for shared responsibility, evidence-based practice guidelines, enhanced practice guidelines to ensure efficacy, professional development, and a scientist-practitioner training model. Ultimately, the Task Force promotes the importance of EBIs in practice and encourages the collaboration of professionals to expand the effort (Kratochwill & Shernoff, 2004).

Having a body of scientific knowledge regarding interventions would allow educators to know which interventions might be effective to implement with their students. It is imperative, especially in the field of school psychology, to be able to access EBIs to match with students' educational needs. This would allow school psychologists, as part of an RTI problem-solving team, to implement effective interventions in order to prevent students from falling behind. Windingstad, Skinner, Rowland, Cardin, and Fearrington (2009) discuss how developing and validating effective interventions plays an important part in preventing learning deficits. It is essential to know whether an intervention is effective so that students use only the most effective interventions that can significantly improve their skills. It is also imperative that interventions focus on basic skills in order to help students build a foundation for higher-level learning. Windingstad et al. (2009) also assert that interventions need to be effective, efficient, and applicable on a classwide basis. Time efficiency is especially important in the school setting. Instructional time is limited, thus finding an efficient intervention that does not require a lot of time and can benefit a large number of students is advantageous (Windingstad et al., 2009).

In order to help students be successful, educators need to know which academic interventions are evidence-based and to be familiar with the research demonstrating this evidence. It is also important to identify each individual student's specific academic needs. According to Burns, Codding, Boice, and Lukito (2010), 20% of students in elementary schools require additional academic support beyond regular classroom instruction. Because each student is different in terms of academic needs, it is important to gather more information to better analyze an individual student's struggles. This would facilitate selection of interventions that have the greatest likelihood of success. In the area of mathematics, for example, it is important to identify whether students are in the acquisition or fluency phase. If students are in the acquisition phase, they are learning the initial concepts of a task. Interventions focused on acquisition should include relevant concepts and procedures that are modeled and specifically taught. Examples of acquisition-phase interventions in mathematics are Cover, Copy, and Compare (CCC), use of manipulatives, and flashcard drills (Burns et al., 2010). If students are in the fluency phase, students have already been taught the basic concepts and procedures of a task. At this point, students can complete the task, but are likely to need more rehearsal and practice to become more proficient and swift in their response. Examples of fluency interventions are Taped Problems (TP), explicit timing, and independent practice (Burns et al., 2010). Matching an intervention that meets the student's phase of learning (acquisition vs. fluency) is critical. Research by Burns et al. (2010) demonstrated that by collecting initial assessment data and further analyzing the learning of a student increases the likelihood that the intervention chosen will be successful.

Although it is important to know whether an intervention is evidence-based, it is also important to know which components make an intervention successful. In mathematics, several important components make an intervention successful when targeting fluency and automaticity (Poncy et al., 2007). First, it is important to provide the student with opportunities for high rates of academic responding. This can improve both speed of response and maintenance. Moreover, the intervention should not only encourage speed, but accuracy as well. In order to facilitate this, immediate feedback is necessary. Immediate feedback decreases practice errors and increases accurate responding. Students need to be given the correct answer immediately so they do not have time to learn or memorize any incorrect facts. High rates of opportunities to respond and immediate feedback are two vital components necessary for a successful math fluency intervention (Poncy et al., 2007).

Prevalence Rates of Math Difficulties

It is important to consider the student's needs, as well as whether an intervention is evidence-based, when implementing interventions in mathematics. Many students struggle specifically with learning math skills (Poncy et al., 2007); approximately 64% of fourth-grade students and 70% of eighth-grade students are not meeting grade-level standards for math competency. Although this number is shockingly high, math deficits and math learning disabilities were once thought of as uncommon. However, now there is general agreement that approximately 6% of students have a learning disability in math (Fleischner & Manheimer, 1997). Typically, teachers have significantly more information and resources on how to teach students reading and language arts skills than math skills (Fleischner & Manheimer, 1997). Although mastering basic math facts is an essential skill for students to attain, many teachers and professionals do not have the information required to facilitate math facts acquisition (Fleischner & Manheimer, 1997). Accurate responding must be mastered before generalization, maintenance, and adaptation can be accomplished (Poncy et al., 2007). Without basic math facts, higher level math concepts are difficult to learn. The more fluent a student is with math facts, the more that student can participate in higher-level math activities. Also, the faster students are able to complete basic math facts, the faster they will be able to perform more complex math tasks. Fluency also means that students will get more practice and experience (Skinner, Fletcher, & Henington, 1996). Repeated practice has been shown to increase both automaticity and maintenance. For this reason, it is necessary to utilize interventions that focus on teaching basic math facts efficiently and effectively, and use interventions that allow for repeated practice. It is also important to find highly effective interventions that are successful with many different student populations (Skinner et al., 1996).

Currently, developing math instructional strategies and measuring student outcomes is based on recommendations set by the National Council of Teachers of Mathematics (NCTM, 2000). The NCTM standards list 5 goals that they would like students to achieve: (1) problem solving, (2) reasoning and proof, (3) communication, (4) connections, and (5) representation (NCTM, 2000). These goals are designed so that students learn to communicate mathematically, become problem solvers, and learn to reason mathematically (Fleischner & Manheimer, 1997). According to Cooke and Buckholz (2005), to achieve these goals, teachers must have knowledge of student performance in many different areas of mathematics. Also, in order to become confident in their mathematical abilities and develop higher-level skills, it is important for students to learn and be proficient with their basic math facts. Erenberg (1995) found that students with learning disabilities were more likely to rely on elementary strategies such as counting when computing basic facts. Instead, they should be relying on recall strategies in order to promote automaticity and fluency. Erenberg (1995) demonstrated that improved strategies can occur following extended practice on multiplication or addition facts by learning disabled students (as cited in Fleischner & Manheimer, 1997).

Insufficient math skills are common, with approximately 6% of students demonstrating severe math deficits (Burns, VanDerHeyden, & Jiban, 2006). Some of the students that tend to struggle in academic areas such as math are those diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) or those with attention problems. They may not keep up with the general curriculum, placing then in the at-risk group, thus making a Tier 2 intervention necessary. ADHD often leads to many negative consequences in the school environment. Because students with attention problems have difficulty attending during class, they may miss out on learning the material at the same rate as their peers (Bowen, Jenson, & Clark, 2004). This may require extra exposure and repetition outside of the general education curriculum in order to reach mastery. Due to their attention deficits, such students are at risk for chronic academic achievement struggles, which makes supplemental interventions, in addition to the general education curriculum, critical. Furthermore, due to inattentive students having a higher risk of deficits in math, using interventions that are effective for this population of students is vital (DuPaul & Stoner, 2003).

Math Fact Interventions

One intervention shown to be effective for math fact acquisition is called the Taped Problems Intervention, a technique adapted from a Taped Words Intervention developed by Freeman and McLaughlin (1984). This intervention is gaining a significant amount of research demonstrating its effectiveness, and its potential success in an RTI framework. The Taped Words Intervention involved having the student read lists of words along with an audiotape. The Taped Problems Intervention for math facts is slightly different in that the student does not read the math problems along with the audiotape. Instead, the student listens to an audio-taped presentation of a math problem followed by the answer after a short delay. During the delay between problem and answer, students are instructed to try and write down the answer on an accompanying worksheet before they hear the answer on the audiotape. This intervention has been shown to be successful through several studies. McCallum, Skinner, and Hutchins (2004) developed the Taped Problems Intervention and were the first to test its effectiveness with a fourth-grade student. They investigated the effects this intervention had on the acquisition and fluency of division facts employing a progressive time delay technique. The student was first exposed to the audiotape with questions and answers presented with a 1s time delay. Next, the audiotape had a 5s time delay, followed by a shorter delay to increase automaticity. A multiple probes across tasks design was used. Results of the study showed a significant increase in digits correct per minute. Increases occurred rapidly and were also sustained over time (McCallum et al., 2004).

Another study investigating the effectiveness of the Taped Problems Intervention was conducted by McCallum, Skinner, Turner, and Saecker (2006), who used the intervention to teach basic multiplication facts to a third-grade classroom. Participants were 18 students from a general education classroom. All students were given a list of multiplication problems. The problems corresponded to a list recorded on the tape player. Students were instructed to try and write down the answer to the problem before the tape player revealed the answer. A progressive time delay procedure was employed. Students started with no delay, then transitioned to a long delay, and finished with a shorter delay. After the intervention was implemented, the researchers found immediate increases in multiplication fact fluency. They also found that these increases were sustained over time. The Taped Problems Intervention demonstrated effective results with immediate and delayed assessment effect sizes of 0.99 and 0.95 respectively (McCallum et al., 2006).

The Taped Problems Intervention has also been compared with other interventions for math fluency and memorization. For example, Poncy et al. (2007) compared the Taped Problems Intervention with another empirically validated intervention meant to increase math fact accuracy and fluency: Cover, Copy, and Compare (CCC). CCC differs from Taped Problems in that students look at a problem and its answer, cover it, write down the problem and the answer, and compare it to the original one to make sure it is correct. However, the interventions are similar in that they allow for both high rates of responding and immediate feedback. The participant in the Poncy et al. study was a 10-year-old girl receiving special education services. She had an IQ of 44 and a diagnosis of mild mental retardation who, according to her teacher, struggled with accuracy and fluency of basic addition facts. Baseline and intervention data were collected via addition probes constructed by the researcher. The student participated in three conditions: control (no intervention), CCC, and Taped Problems (TP). Each intervention session consisted of a packet with three pages. The first was the CCC or TP sheet, the second was a practice probe containing the problems for each set, and the third was an assessment probe for the purposes of data collection. An alternating treatments design combined with a multiple probe design was used in order to compare the two treatments and the control condition. The TP intervention increased the student's accurate responding to 100% almost immediately and this was maintained throughout the intervention phase. The CCC intervention immediately increased accurate responding to 90% and remained high (between 89% and 100%) for the duration of the intervention.

Follow-up data indicated that the participant continued to demonstrate 100% accuracy on all intervention problems. These data show how both interventions can be effective in improving accuracy on basic addition facts with a student with significant cognitive difficulties. However, the Taped Problems Intervention resulted in a higher accuracy rate and took the student 30% less time to complete, making this the intervention of choice in comparison to CCC.

More recently, a study was conducted by Todd (2010) that involved teaching multiplication facts to four regular education students in the third grade. The Taped Problems Intervention was used, but an I-Pod was substituted for the cassette player. A progressive time delay was also implemented with 1s, 4s, and 2s delays. The intervention demonstrated success as 3 out of the 4 participants reached mastery (80% correct) on all four multiplication fact worksheets. Research results also demonstrated that the students enjoyed using the I-Pod to learn their math facts.

Although several studies have shown the effectiveness of the Taped Problems Intervention, more research is still needed. McCallum et al. (2004) suggest that more research is needed across students with different characteristics (e.g., students with learning disabilities). Also, with technology on the rise, audiotapes are becoming outdated while newer technological devices such as I-Pods are rapidly gaining popularity. McCallum et al. (2004) suggested that technology such as computers and software may be helpful to use with the Taped Problems Intervention in the future. Therefore, this study involved the use of an I-Pod to investigate the effectiveness of a Taped Problems Intervention with a specific group of students, those with attention difficulties.

Statement of Purpose

The purpose of this study was to examine the acquisition of math multiplication facts using a progressive time delay intervention with an I-Pod among students with attention difficulties. It was hypothesized that this intervention would provide students with adequate practice and feedback necessary to memorize and become fluent with multiplication facts. A previous study by Todd (2010) examined the effects of this intervention only with regular education students. The present study was designed to further the knowledge base on this intervention by also examining the effectiveness of the intervention with inattentive students as well as with student in regular education without attention difficulties. In addition, this study assessed the acceptability of this intervention to students and teachers.

Research Questions

1. Do students become more accurate in their completion of multiplication facts with the use of a progressive time delay intervention with an I-Pod?
2. Do gains on intervention probes generalize across multiplication facts?
3. How many sessions does it take for participants to reach mastery criterion for each set of math facts?
4. Is there any difference between multiplication fact learning rates of regular education students compared with those with attention differences?
5. Are participants able to maintain multiplication fact accuracy at 2 weeks and 4 weeks follow-up?

6. Do teachers find this procedure acceptable as an intervention to teach multiplication facts?
7. Do regular education or inattentive students find this procedure acceptable as an intervention for learning math facts?

CHAPTER 2

METHODS

Participants

The target participants for this study attended an elementary school within a small suburban district located in a state in the intermountain west. The participants were recruited at the beginning of spring semester during the 2010-2011 school year. Screening was conducted during the after-school program to determine a pool of students who met the initial criteria to participate in the study. Third-, fourth-, and fifth-graders in the after-school program were targeted, as these are the grades in which students are typically learning their multiplication facts.

Students who scored below 55% correct on a baseline multiplication probe (see Appendix A) initially qualified for possible participation. The baseline probe included all multiplication facts from 2-9 (64 problems total). Once a limited list of potential participants was identified, a letter was sent home in order to solicit parental consent. The letter described the basis for the study and the services the student would receive if selected as a participant. The students were also given an assent form about the study and had to give their own assent to participate. For those students who met baseline criteria on the math probe and parental consent and student assent were obtained, their classroom teachers or afterschool teachers were then approached to solicit their consent for participation. Eight teachers participated in this study: 3 third-grade teachers, 2 fourth-grade teachers, 1 fifth-grade teacher, and 2 afterschool teachers. Teachers who provided consent completed a Conners' Teacher Rating Scale-Revised: Short Version (CTRS-R: S; Conners, 2008) regarding the selected students' classroom behavior. The researcher also conducted a classroom behavioral observation of all possible participants, using an on-task/off-task time sampling behavior observation form (see Appendix B). The observation was completed during a 15-minute period of math instruction in the participant's classroom. The CTRS-R: S was completed by each student's teacher (either classroom or after-school teacher), and the classroom observation of attention during math instruction was conducted by the researcher.

Exclusion criteria for students in the regular education group dictated that participants could not have attention difficulties according to the subscale scores on the CTRS-R: S (< T-score of 60) and according to the behavior observation (above 60% on-task rate). Also, students in the regular education and inattentive groups could not be receiving any special education services. Exclusion criteria for all students also stipulated that participants could not have an identified learning disability in math. Three students were chosen at random from those who met inclusion criteria for the regular education setting. Three other students were chosen randomly from those who met the baseline criteria but who also met criteria for inattention. Criteria for inattention required a T-score of 60 or above on the Cognitive Problems/Inattention subscale of the CTRS-R: S and 60% or below on-task behavior during an in-class observation of math instruction. Participants 1-3 were in the regular education group (with no attention difficulties), and Participants 4-6 were in the inattentive group. Table 1 lists the demographic

Table 1. Demographic Characteristics for Participants in Regular Education Group

Characteristic	Participant 1	Participant 2	Participant 3
Sex	Female	Male	Female
Age	9	9	8
Grade	4th	3rd	3rd
CTRS-R: S subscales:			
Oppositional	T-Score: 47	T-Score: 45	T-Score: 47
Cog Problems/Inattention	T-Score: 44	T-Score: 54	T-Score: 44
Hyperactivity	T-Score: 54	T-Score: 58	T-Score: 51
Conners' ADHD Index	T-Score: 46	T-Score: 68	T-Score: 45
Behavior Observation	On-task rate: 90% Peer: 88%	On-task rate: 62% Peer: 95%	On-task rate: 83% Peer: 78%

characteristics for each participant in the regular education group. Table 2 lists the same demographic characteristics for participants in the inattentive group.

Participant 1 was a 9-year-old girl in the fourth grade, and in the regular education group for this study. Participant 1 was described as a "model student" by her teacher. During the intervention, Participant 1 was highly motivated to learn and get answers correct. However, Participant 1 often tried to "cheat" and write the answer after it was given on the I-Pod. Participant 2, also in the regular education group, was a 9-year-old male in the third grade. Although Participant 2 did not qualify for the inattentive group, he displayed considerable off-task behavior during the intervention phase. Participant 2 tended to answer impulsively as evidenced by his quick responding. Participant 2 often wrote down more than one answer per problem and required frequent redirection from the researcher. Participant 3 was an 8-year-old female in the third grade, and in the regular education group for this study. Participant 3 was described by her teacher as "very sweet" and willing to learn. During the intervention, Participant 3 was always on-task and ready to go.

Participant 4 was an 8-year-old male in the third grade, and in the inattentive group for this study. He expressed excitement about using the I-Pod and seemed motivated by the one-on-one attention given to him by the researcher. Participant 4's teacher described him as off-task and hyperactive in the classroom. Participant 4's teacher also reported that he has a diagnosis of ADHD and often cannot control his emotions at school. Participant 5 was a 9-year-old male in the fourth grade and also in the inattentive group. During the intervention, Participant 5 seemed to work hard and expressed excitement about completing the intervention. However, he often became

Table 2. Demographic Characteristics for Participants in Inattentive Group

Characteristic	Participant 4	Participant 5	Participant 6
Sex	Male	Male	Female
Age	8	9	10
Grade	3rd	4th	5th
CTRS-R: S Subscales:			
Oppositional	T-Score: 85	T-Score: 87	T-Score: 68
Cog Problems/Inattention	T-Score: 71	T-Score: 73	T-Score: 62
Hyperactivity	T-Score: 78	T-Score: 74	T-Score: 70
Conners' ADHD Index	T-Score: 76	T-Score: 75	T-Score: 89
Behavior Observation	On-task rate: 60% Peer: 83%	On-task rate: 47% Peer: 80%	On-task rate: 53% Peer: 88%

frustrated if he did not get enough answers correct. It is not known if Participant 5 has a diagnosis of ADHD. Lastly, Participant 6 was a 10-year-old female in the 5th grade and in the inattentive group. During the intervention, Participant 6 seemed excited to learn her math facts, but often became off-task. Participant 6 frequently drew on worksheets in between math facts, instead of looking ahead and anticipating the next problem. However, it is not known if Participant 6 has a diagnosis of ADHD.

Materials

The materials for this study included an I-Pod with recorded tracks on it for the multiplication facts intervention, a splitter, two headphone sets, worksheets that corresponded with the tracks on the I-Pod (see Appendix C for sample math worksheets), and a writing utensil. For each set of math facts, there were 3 worksheets and 3 recorded tracks. Each track had a different delay between the presentation of the math problem and the presentation of the answer (1s, 4s, 2s). Four sets of math facts (Worksheets A-D) included a random assortment of 15 multiplication facts ranging from 2-9. Also, the Conners' Teacher Rating Scale-Revised:Short Version (CTRS-R: S; Conners, 2008) was used for this study to assess inattentive symptoms of participants. The CTRS-R: S examines 4 areas of behavior: Oppostitional, Cognitive Problems/Inattention, Hyperactivity, and Conners' ADHD Index. The CTRS-R: S has excellent reliability and validity scores (Conners, 2008). The CTRS-R: S reports 2- to 4-week test-retest reliability coefficients of 0.70 and 0.94. Also, interrater reliability coefficients range from 0.52 to 0.94. It is also reported that statistical analyses strongly supported the discriminative validity of the CTRS-R: S (Conners, 2008).

Dependent Variable

The dependent variable for this study was the percent of correct answers on the math worksheets. Each worksheet had 15 problems, and the percent correct was calculated for each worksheet. To determine mastery of multiplication facts, the percent correct was recorded for the 2s delay worksheets. Also, a generalization probe and follow-up probes were completed in order to determine the extent of generalization and the maintenance of treatment gains over time. These probes used the same worksheet used at baseline containing all multiplication facts from 2-9.

Procedures

Following the selection of participants, the baseline phase began. Every participant was given the first baseline measure during screening. The baseline probe included all multiplication facts between 2 and 9 (64 problems total); multiplication facts of 0 and 1 were excluded. Students were given 4s per multiplication problem during the baseline phase. At this rate, students had approximately 5 minutes to complete the baseline probe. Students were instructed to try and answer as many multiplication problems on the worksheet as they could until they were told to stop and to skip a problem and go on to the next one if they did not know the answer. A minimum of 3 baseline probes were administered. After a minimum of 3 baseline probes were completed and baselines were found to be stable or decreasing, the intervention phase began. If the third baseline data point showed a large increase, a fourth baseline probe was administered to ensure there were no increasing baseline trends before the intervention phase was started.

The intervention phase consisted of using the TP intervention with an I-Pod and progressive time delay to assist in the learning of multiplication facts. Four different 15-item sets of random multiplication facts between 2 and 9 were used. This intervention took place during the after-school program of an elementary school, which met Monday through Thursday. Four days a week, the students completed a set of 3 worksheets containing the same multiplication facts. Every set consisted of 15 problems and each worksheet contained the same 4 facts in a different sequence so students could not memorize the facts by order. Each set of worksheets had recorded tracks that corresponded to the I-Pod. A progressive time delay procedure was employed. This means that each of the three worksheets had a corresponding I-Pod track with a differing time delay between the presentation of the math problem and the presentation of the answer. The first time delay was 1s in order to prevent practice errors. Next, students completed the worksheet with the 4s delay in order to provide more time for recall. Lastly, students completed the task with a 2s time delay in order to promote automaticity and fluency. For each day of intervention, participants continued to work on the first set of four facts until they reached mastery (at least 80% correct for 2 sessions in a row on the 2s worksheet). Then they moved on to the next set and repeated the same procedure until they had completed all 4 sets (A-D) of multiplication facts at mastery levels or reached the stop criterion (5 days of intervention working on the same set of facts).

The first day of the intervention, students had the procedure described to them. The researcher ensured that the participants knew how to use the I-Pod and knew how to use the I-Pod along with the worksheets. Participants were told that the recording would state the multiplication problem and after a short delay, the answer would be given.

Participants were encouraged to try to write down the answer before the answer on the I-Pod was heard; the goal was to "beat" the I-Pod. If students did not have the answer written down before the answer was stated on the I-Pod, they were instructed to leave it blank; that multiplication fact was then counted as incorrect.

To make sure students performed the task correctly, a splitter was used. This allowed the researcher to listen to the I-Pod along with the student. The researcher was able to tell if the student tried to write down the correct answer after the answer was heard. It was observed in this study that the splitter is a necessity if one needs to know the accurate progress of a student. Students were often tempted to write the answer down after it was already provided on the I-Pod. Several times during the intervention, students wrote down the answer after it was heard on the I-Pod and checked to see if the researcher had noticed. The researcher took note of these instances so the facts would not be counted as correct, thus ensuring data accuracy. Also, treatment integrity checks were conducted 6 times throughout the study. The lead teacher in the after-school program completed the integrity checks to make sure that the intervention procedure was conducted correctly and consistently across participants. A checklist of intervention procedures was used during each check to help assess treatment integrity (see Appendix D). Treatment integrity checks were completed once per participant.

After a student reached mastery or the stop criterion on the fourth set of 2s delay worksheets, the intervention phase ended. The intervention phase was intended to last for 5 weeks unless a student reached mastery more rapidly. However, due to frequent absences and schedule changes, the intervention phase took longer than 5 weeks to complete. As stated above, 5 days was used as the stop criterion for a set of worksheets in this study. This was based on Todd's (2010) research on math fact acquisition, in which the average number of days until participants reached mastery was 1.98 days. To be certain that students would have enough time to reach mastery, 5 days was used for the present study's stop criterion.

A generalization probe was given directly after the intervention phase, on the same day the intervention phase ended. The generalization probe was the same probe used in the baseline phase containing all multiplication facts from 2-9. The same probe was also used as a follow-up measure given 2 weeks and again 4 weeks after the student reached the end of the intervention phase. During generalization and follow-up, participants were given the same directions and the same amount of time to complete problems as they were during the baseline probe.

Design

A single subject multiple baseline design across participants was used for this study. Single subject design research uses scientific methodology to document the functional relationship between independent and dependent variables both within and between subjects through systematic replication. A single subject design was used for this study due to its usefulness in documenting the effect of the independent variable (Taped Problems intervention using a progressive time delay via an I-Pod) on the dependent variable (accuracy in multiplication math facts) in order to provide further support for this intervention's effectiveness with individual learners (Horner et al., 2005).

Data Analysis

Results were analyzed using visual analysis of graphs for individual participants and calculated effect sizes. The effect sizes were calculated using the following equation from Busk and Serlin (1992):

$$\frac{\text{(mean of the intervention phase- mean of the baseline phase)}}{\text{standard deviation of the baseline phase}}$$

This equation was chosen due to empirical evidence demonstrating that it is a reliable measure of effect size for single-subject design research. Data depicted in the participant graphs and data used to calculate effect sizes were taken from the accuracy rates of the baseline probes during baseline, the 2s time delay worksheets during the intervention, the generalization probe directly postintervention, and maintenance probes at 2 weeks and 4 weeks postintervention.

Treatment Acceptability

Treatment acceptability was assessed using both teacher and student acceptability questionnaires (see Appendices E and F). These treatment acceptability questionnaires included questions such as “Learning my multiplication facts with the I-Pod was fun” and “This intervention was an acceptable way to increase student math fact accuracy and speed.” The teacher acceptability rating form is adapted from McCallum, Skinner, Turner, and Saecker (2006) and uses a 6-point Likert scale. The student acceptability rating form is a more simplified version of this same form used by Todd (2010).

CHAPTER 3

RESULTS

The purpose of this study was to examine the acquisition of math multiplication facts using a progressive time delay intervention with an I-Pod. It was hypothesized that this intervention would provide students with adequate practice and feedback necessary to become fluent with multiplication facts, that gains would be maintained after the completion of the intervention, and that both teachers and students would find the intervention acceptable.

Treatment Integrity

During the study, treatment integrity checks were conducted by an independent observer (after-school lead teacher) in order to make sure that the intervention procedures were conducted correctly and consistently across participants. Treatment integrity checks were completed once per participant to determine if each of the 8 steps of the intervention were followed. Across participants, a treatment integrity score of 95.83% was obtained. Only 2 steps out of a total of 48 were missed. The 2 steps that were missed (Step 2 was missed twice) were due to 1 participant not writing his name on all three worksheets. Otherwise, all intervention procedures were done correctly and consistently across participants.

Results by Research Question

Six research questions were developed to assess the effectiveness of the intervention. Results are presented below as they correspond with each research question.

Research Question 1: Do students become more accurate in their completion of multiplication facts with the use of a progressive time delay intervention with an I-Pod?

All 6 participants made substantial gains in their accuracy of multiplication facts during the intervention. Results are presented for all participants and for each of the 6 participants individually in graph form. Table 3 depicts the percent correct during baseline and intervention phases across participants.

Table 3. Mean of Participants During Baseline and Intervention

Participant	Mean Percent Correct on Baseline Probe and Range	Standard Deviation	Mean Percent Correct During Intervention and Range	Standard Deviation
1	41.80 (34.38-54.69)	9.23	68.48 (53.33-100.00)	13.78
2	14.06 (7.81-20.31)	5.71	52.00 (20.00-80.00)	15.69
3	42.58 (31.25-48.44)	7.70	79.56 (46.67-100.00)	18.42
4	24.61 (15.63-31.25)	7.67	74.87 (46.67-93.33)	12.22
5	47.40 (46.88-48.44)	0.90	74.58 (60.00-100.00)	9.18
6	30.73 (23.44-42.19)	10.05	82.05 (66.67-100.00)	11.35

Participant 1

Participant 1 was a 9-year-old girl in the regular education group. During the baseline phase, Participant 1 had a mean percent correct of 41.8%. During the intervention phase, Participant 1 increased her mean percent correct to 68.48%. Participant 1's gains reflect a large intervention effect size of 2.89. Figure 1 depicts baseline data as well as data from the 2s time delay worksheets during the intervention phase for Participant 1.

Participant 2

Participant 2 was a 9-year-old male also in the regular education group. Participant 2 had a mean of 14.06% correct during the baseline phase and a mean correct of 52.0% during the intervention phase. Gains for Participant 2 reflect a large intervention effect size of 6.64. Figure 2 includes baseline data as well as data from the 2s time delay worksheet during the intervention phase for Participant 2.

Participant 3

Participant 3 was an 8-year-old female in the regular education group. Participant 3 had 42.58% correct during the baseline phase, which increased to 79.56% correct during the intervention phase. Participant 3's gains from baseline to intervention reflect an overall intervention effect size of 4.80. Figure 3 depicts the baseline phase as well as data from the 2s time delay worksheet during the intervention phase for Participant 3.

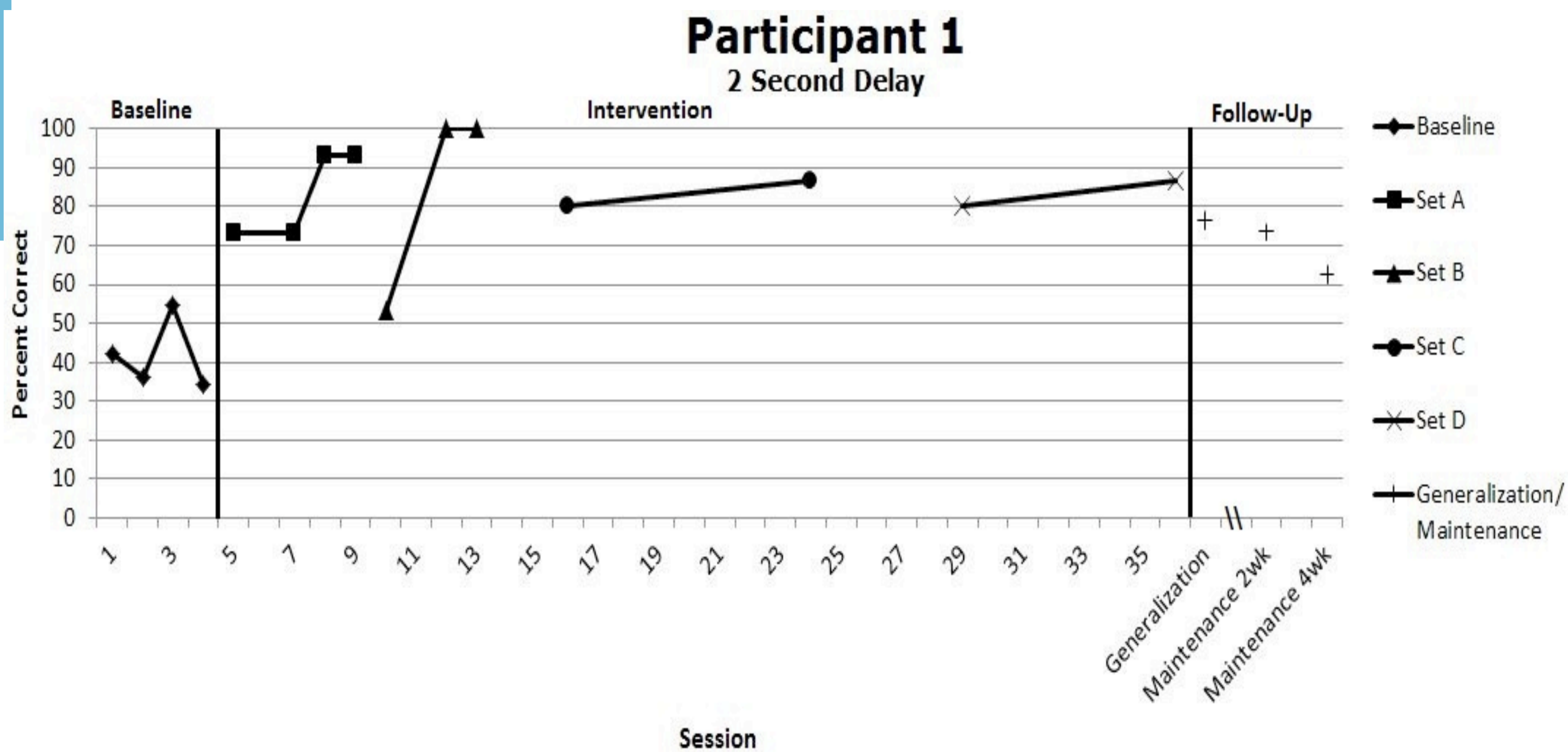

Figure 1. Participant 1 Graph

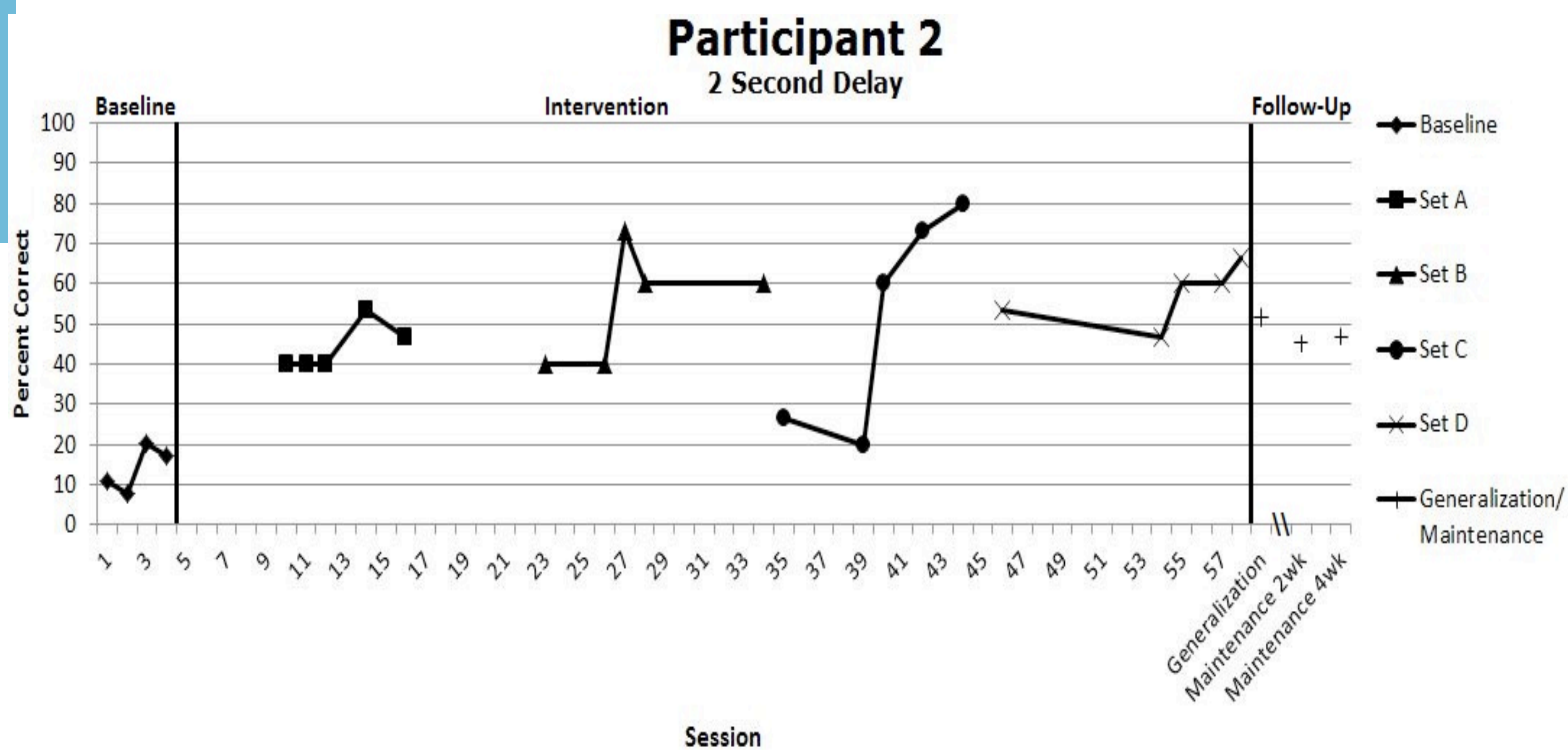

Figure 2. Participant 2 Graph

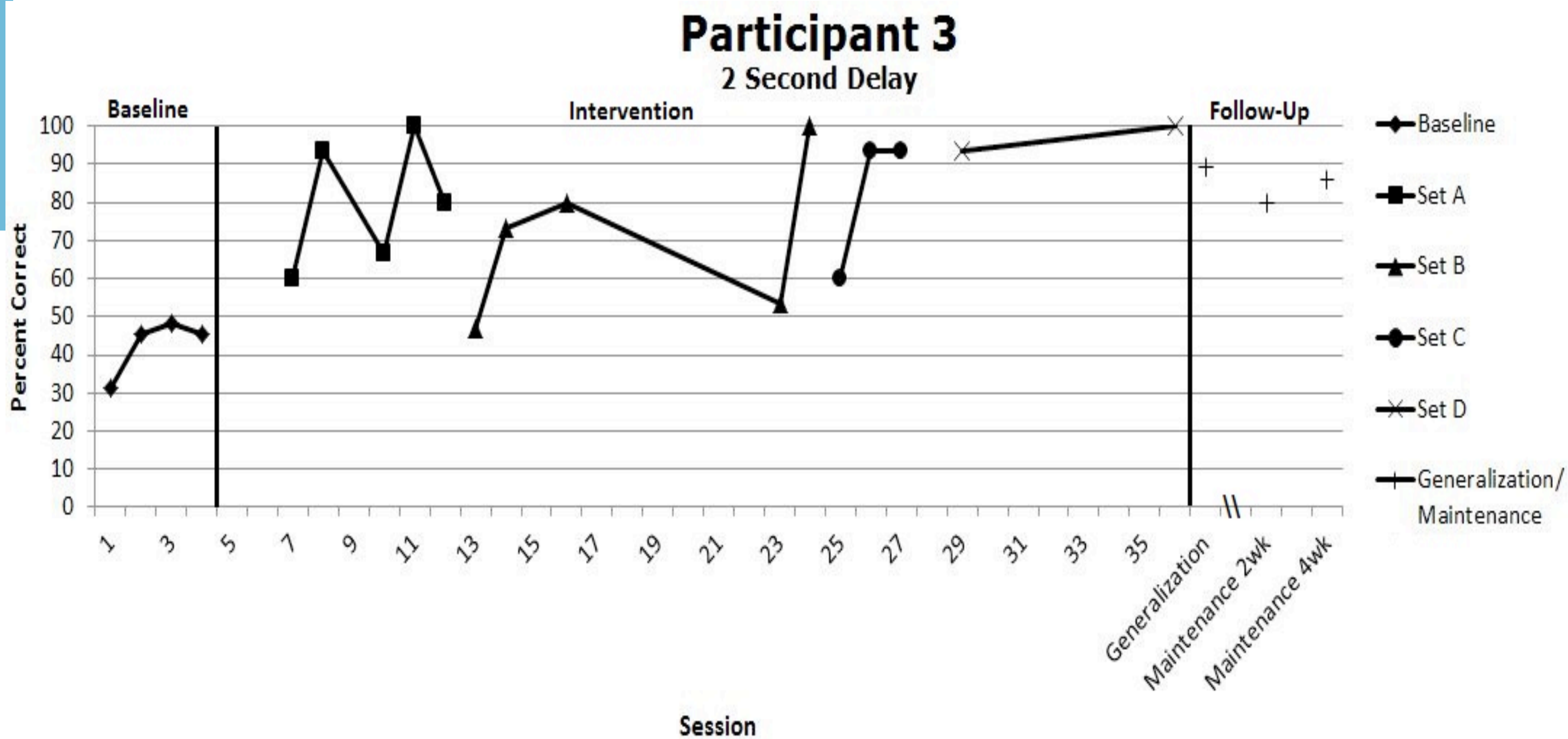

Figure 3. Participant 3 Graph

Participant 4

Participant 4 was an 8-year-old male in the inattentive group. During the baseline phase, Participant 4 had an average of 24.61% correct and during the intervention phase, increased to an average of 74.87% correct. Participant 4 received an overall intervention effect size of 7.67. Figure 4 depicts the baseline phase for Participant 4 and data from the 2s time delay worksheet from the intervention phase.

Participant 5

Participant 5 was a 9-year-old male in the inattentive group. During the baseline phase, Participant 5 had a mean percent correct of 47.4%, while during the intervention phase he increased his mean percent correct to 74.58%. Participant 5 received an intervention phase effect size of 30.20. Figure 4 depicts Participant 5's baseline data and data from the 2s time delay worksheet during intervention.

Participant 6

Participant 6 was a 10-year-old female in the inattentive group. During the baseline phase, Participant 6 had a mean percent correct of 30.73%, while during the intervention phase she increased to a mean percent correct of 82.05%. Participant 6 received a large intervention effect size of 5.11. Figure 6 depicts Participant 6's baseline data and data from the 2s time delay worksheet during intervention.

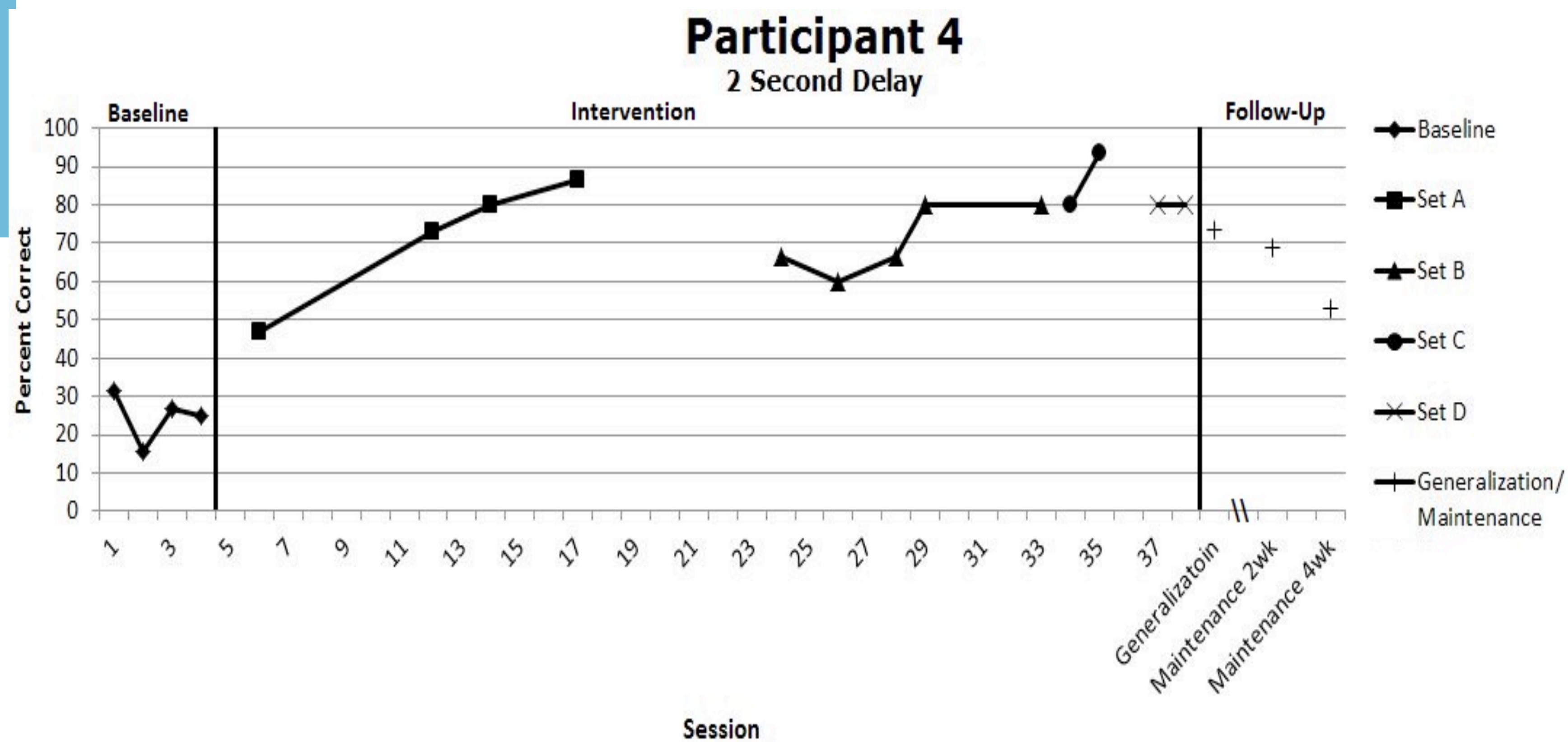

Figure 4. Participant 4 Graph

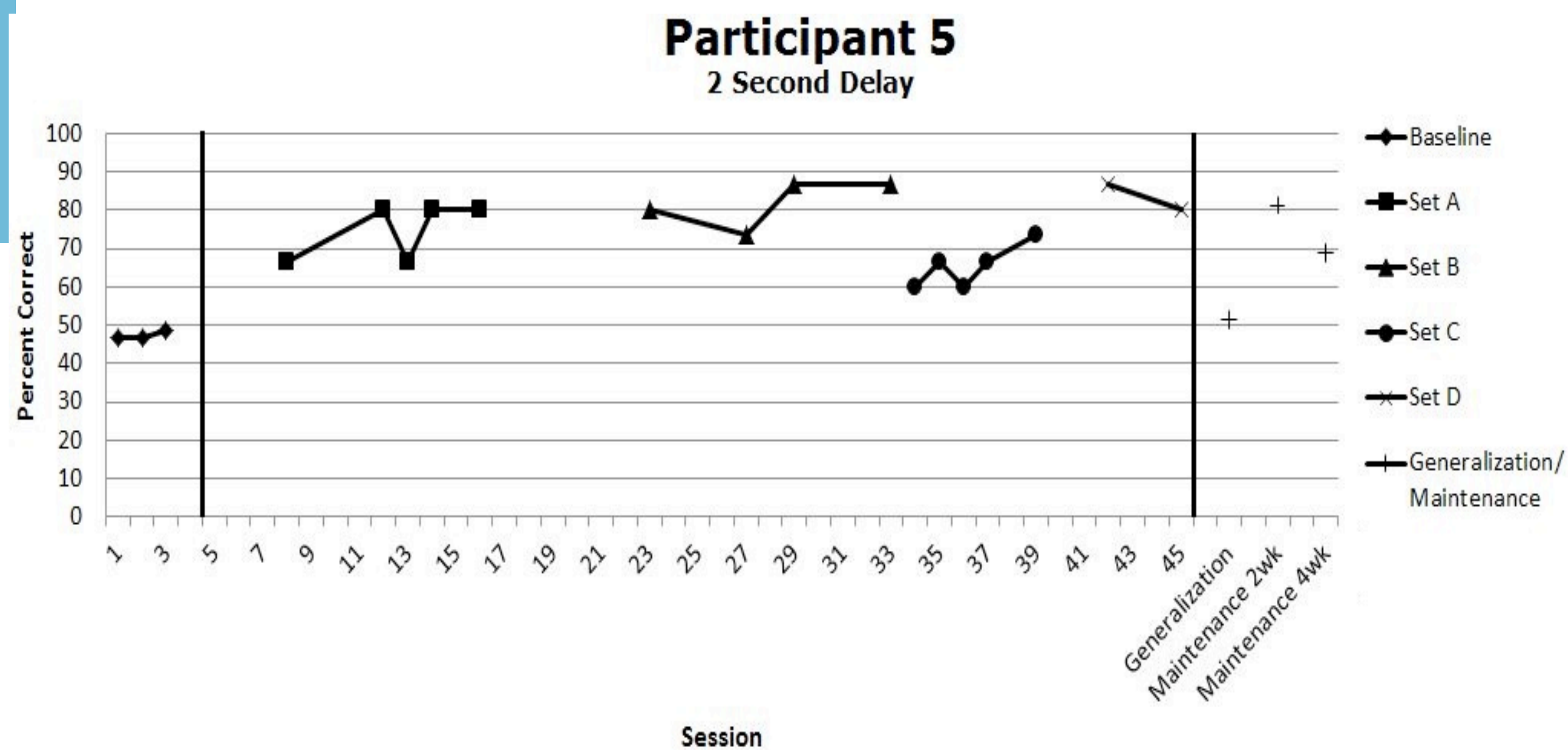

Figure 5. Participant 5 Graph

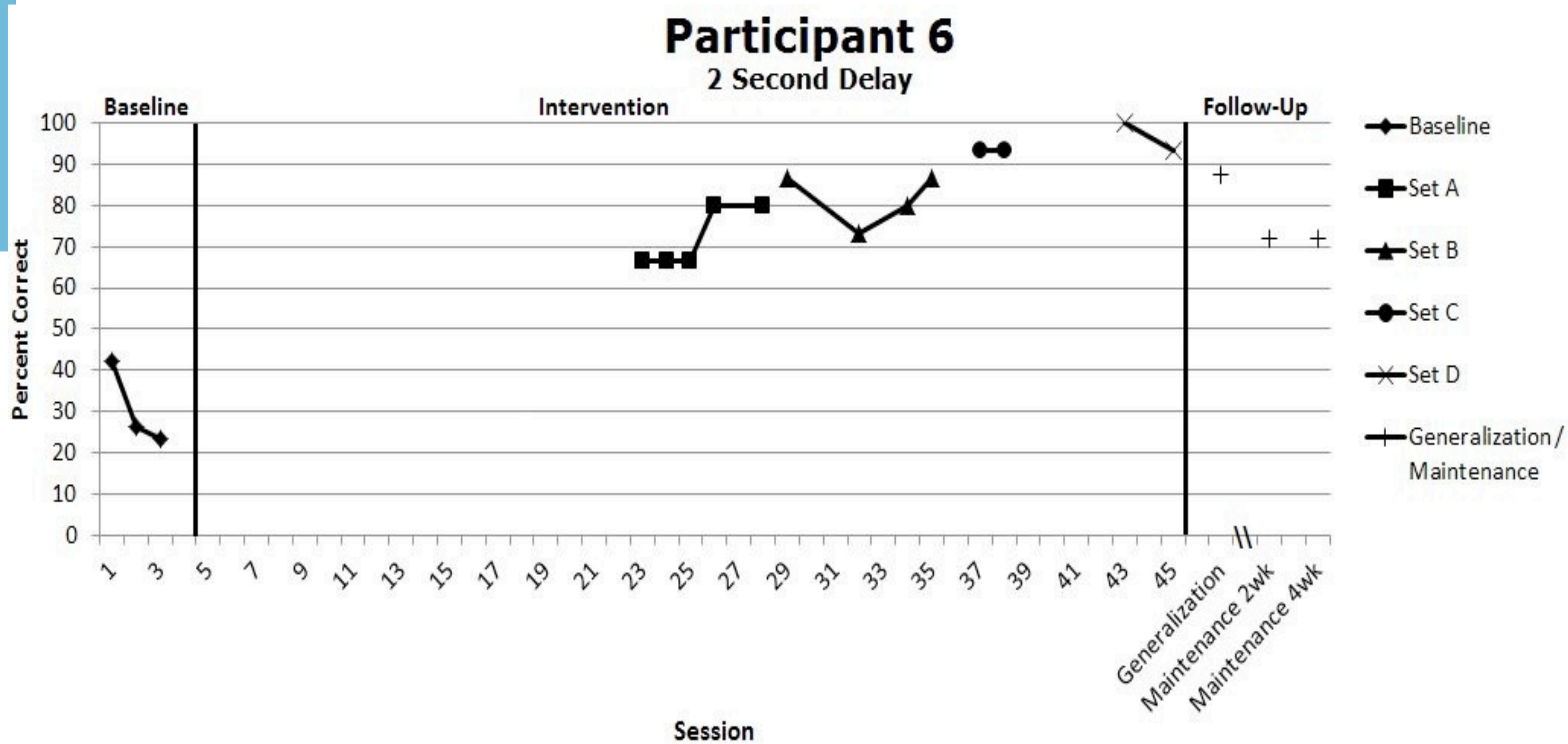

Figure 6. Participant 6 Graph

Effect Sizes

Significant gains in math fact accuracy during intervention were demonstrated by calculated effect sizes for each participant. Effect sizes were calculated using the equation from Busk and Serlin (1992). Effect sizes for each participant are depicted below in Table 3. The mean effect size across participants was 9.55 for the intervention phase.

Research Question 2: Do gains on intervention probes generalize across multiplication math facts?

A generalization probe was also administered directly after the intervention phase. This probe was the same probe given at baseline, with all multiplication facts from 2 through 9. Table 4 depicts the percent correct for baseline and generalization across participants.

Table 4. Mean Percent Correct of Participants During Baseline and Generalization

Participant	Mean Percent Correct on Baseline Probe and Range	Standard Deviation	Percent Correct on Generalization Probe
1	41.80 (34.38-54.69)	9.23	76.56
2	14.06 (7.81-20.31)	5.71	51.56
3	42.58 (31.25-48.44)	7.70	89.06
4	24.61 (15.63-31.25)	7.67	73.44
5	47.40 (46.88-48.44)	0.90	51.56
6	30.73 (23.44-42.19)	10.05	87.50

Across all 6 participants, generalization effect sizes were large (M = 5.69 range 3.77 to 7.46), indicating that the intervention effects were generalized across math facts.

Research Question 3: How many sessions do participants need to reach mastery criterion for each set of math facts?

Participants clearly varied on how long they took to reach mastery criteria for each worksheet. Days to reach mastery criteria ranged from 0 to 3 days. The stop criterion for working on a specific set of facts was 5 days. Because mastery criterion was defined as 80% correct or better on 2 sessions in a row, the minimum number of days a participant could take to reach criterion was 2 days and the maximum number of days a participant could take to reach criterion was 5 days. Beyond 5 days, a participant would not meet criterion for that set. Table 5 depicts the number of days it took each participant to reach mastery for each worksheet (-- means that mastery was not met for that set).

The average number of days participants took to reach mastery steadily decreased as the intervention progressed. The average number of days to reach mastery for Set A was 3.83 days while the average number of days to reach mastery for Set D was 2 days which meant that for Set D, participants reached 80% correct or better in the first 2 days. It should be noted that Participant 2 did not reach mastery on any set of facts before reaching the stop criterion. Participant 2 was often absent and as a result, often had large gaps between intervention sessions. Overall, students took an average of 3.22 days to reach mastery levels; however, these averages may not be wholly accurate since on 6 occasions, mastery was not met, meaning mastery would have taken more than 5 days if the stop criterion had not been used.

Table 5. Number of Days to Reach Mastery for Math Fact Sets A-D

Participant	Days to Criterion Set A	Days to Criterion Set B	Days to Criterion Set C	Days to Criterion Set D
1	4	3	2	2
2	--	--	--	--
3	5	--	3	2
4	4	5	2	2
5	5	4	--	2
6	5	4	2	2
Average	3.83	4.00	2.25	2

Research Question 4: Is there any difference between multiplication fact learning rates of regular education students compared with those with attention difficulties?

Participants 1, 2, and 3 were in the regular education group while Participants 4, 5, and 6 were in the inattentive group. The general education group averaged 3.00 days until mastery was reached. The inattentive group averaged 3.36 days to reach mastery criteria. Although the average number of days to mastery was very similar, the general education group met criteria on average 0.36 days faster. It should be noted that it is difficult to compare days to criteria accurately since several participants did not reach mastery for some of the sets of worksheets due to the 5-day stop criterion. If the researcher had not set a stop criterion, some participants may have taken many more days to reach criteria. However, a stop criterion was necessary due to time constraints as well as the intent to have students not grow tired of the same set of worksheets.

Research Question 5: Are participants able to maintain multiplication fact accuracy at 2 weeks and 4 weeks follow-up?

Table 6 lists the mean percent correct at baseline, percent correct on a generalization probe taken directly after the intervention phase, as well as percent correct at 2 weeks and 4 weeks postintervention follow-up. As seen in Table 6, almost all of the participants' accuracy rates decreased slightly once the intervention was completed (Participants 1, 2, 3, 4, and 5). However, all participants' accuracy rates were still significantly higher during follow-up than during the initial baseline phase. Also, 1 participant went against the logical trend and actually had higher accuracy rates as time progressed (Participant 6). Overall, participants maintained high accuracy rates at both 2 week and 4 week follow-up compared to baseline. Maintenance of accuracy rates is also demonstrated through calculated effect sizes. Table 7 lists effect sizes for the intervention, generalization, and maintenance phases. Across all 6 participants, maintenance effect sizes were large (M = 9.68 range 2.84 to 30.67), indicating that the intervention effects were maintained over time after the intervention was concluded.

Research Question 6: Do teachers find this procedure acceptable as an intervention to teach multiplication facts?

To examine teacher acceptability, the participants' teachers filled out an acceptability questionnaire (see Appendix D). The Teacher Acceptability Rating Form used a 6-point Likert scale, ranging from 1 (strongly disagree) to 6 (strongly agree). Table 8 shows the acceptability questions and mean ratings across 5 teachers.

The questions that received the lowest acceptability ratings by teachers were

Table 6. Math Fact Accuracy at Baseline, Generalization, and Maintenance at 2 Weeks and 4 Weeks Postintervention.

Participant	Mean % Correct at Baseline (sd)	Mean % Correct on Generalization Probe	Mean % Correct at 2-week follow up	Mean % Correct at 4-week follow up
1	41.80 (9.23)	76.56	73.44	62.5
2	14.06 (5.71)	51.56	45.31	46.88
3	42.58 (7.70)	89.06	79.69	85.94
4	24.61 (7.67)	73.44	68.75	53.13
5	47.40 (0.90)	51.56	81.25	68.75
6	30.73 (10.05)	87.5	71.88	71.88

Table 7. Effect Sizes for Intervention, Generalization, and Maintenance

Participant	Intervention	Generalization	Maintenance
1	2.89	3.77	2.84
2	6.64	6.57	5.61
3	4.80	6.04	5.23
4	7.67	7.46	5.55
5	30.2	4.62	30.67
6	5.11	5.65	4.10

Table 8. Teacher Acceptability of Math Fact Intervention

Question	Mean Ratings (and Range)	Standard Deviation
1. This intervention was an acceptable way to increase student(s) math fact accuracy and speed.	5.00 (4-6)	1.00
2. I would recommend this intervention to other teachers.	5.00 (4-6)	1.00
3. I noticed a positive change in my student(s) math fact knowledge.	4.60 (3-6)	0.89
4. I noticed a positive change in my student(s) math fact speed.	4.60 (3-6)	1.14
5. I would be willing to use this intervention again in the future.	4.80 (4-6)	0.84
6. This intervention is appropriate for a variety of students.	5.20 (4-6)	0.84
7. I liked the procedures used in this intervention.	5.00 (4-6)	0.71
8. The intervention will produce lasting improvements in the student(s) math fact skills.	5.00 (4-6)	1.00
9. The student(s) enjoyed the intervention.	5.20 (4-6)	0.84
10. This intervention will not result in negative side effects for the student(s) performance.	5.60 (5-6)	0.55
11. Overall, this intervention was beneficial to the student(s).	5.40 (4-6)	0.89
12. This intervention is a time-efficient way to work on math facts.	5.60 (5-6)	0.55

Question 3 (“I noticed a positive change in my student(s) math fact knowledge”) with a mean rating of 4.60 and Question 4 (“I noticed a positive change in my student(s) math fact speed”) also with a mean rating of 4.60. These 2 mean ratings fell between “slightly agree” and “agree.” These 2 items may have been relatively lower because the teachers may not have noticed positive changes in student math fact knowledge and speed because they were not assessing this specifically on a regular basis. Also, there was a disconnect with the regular classroom teachers because the intervention occurred during the after school program. This would be different in a “real-life” situation in which an intervention was taking place during regular class time with ongoing communication and involvement with the classroom teacher. Question 5 (“I would be willing to use this intervention again in the future”) also had a mean rating that fell between “slightly agree” and “agree” with a mean rating of 4.80. However, 9 out of 12 questions received mean acceptability ratings that fell between “agree” and “strongly agree”, suggesting that overall, the teachers found this intervention to be acceptable.

Question 7: Do regular education or inattentive students find this procedure acceptable as an intervention for learning math facts?

To examine the acceptability of this intervention to students, a student acceptability rating form was used (see Appendix E). The Student Acceptability Rating Form used a 3-point Likert scale ranging from 1 (No) to 3 (Yes). Table 9 depicts the mean ratings for the 2 groups of participants (regular education and inattentive) for each question.

Table 9. Student Acceptability of Intervention for Participants in Regular Education and Attention Difficulties Groups

Question	Regular Education Group Mean (and Range)	Standard Deviation	Attention Difficulties Group Mean (and Range)	Standard Deviation
1. Learning my multiplication facts with the I-Pod was fun.	2.33 (1-3)	1.16	3 (3)	0
2. I became better at my multiplication facts because of the I-Pod.	3 (3)	0	3 (3)	0
3. I get more multiplication answers right now than I did before.	3 (3)	0	3	0
4. I am faster at my multiplication facts now than I was before.	2.67 (2-3)	0.58	2.67 (2-3)	0.58
5. My friends would like to learn math this way.	2 (2)	0	2	0

There were not significant differences between the acceptability ratings of students in both groups. All mean scores were the same except for Question 1, "Learning my multiplication facts with the I-Pod was fun." For this question, students in the inattentive group rated the intervention as being slightly more fun. Questions 2, 3, and 4 received mean ratings of 2.67 or higher demonstrating that students felt that the intervention was successful in helping them learn their multiplication facts and become faster with them as well. The only question that received a low mean score was Question 5, "My friends would like to learn math this way." Every participant gave this question a rating of 2 meaning "maybe." Students did not seem to want to judge what their peers would think of the intervention, only what they personally thought. Overall, ratings indicated that all participating students, regardless of group, felt this intervention was fun and effective.

CHAPTER 4

DISCUSSION

The purpose of this study was to examine the acquisition of math multiplication facts using a Taped Problems (TP) intervention with a progressive time delay delivered via an I-Pod with regular education and inattentive students. It was hypothesized that this intervention would provide students with adequate practice and feedback necessary to become fluent with multiplication facts. It was also hypothesized that students and teachers would find this study acceptable and fun. The study was designed to assess the effectiveness of this intervention with regular education students as well as those with attention problems. A previous study by Todd (2010) examined the effects of this intervention only with regular education students. The present study furthered the knowledge based on this intervention by also examining the effectiveness of the intervention with inattentive students, a group for whom the general curriculum may not provide them with enough practice to learn a skill such as basic math facts due to their difficulty attending to instruction.

To address these hypotheses, this study used a single-subject design to assess the effectiveness of the TP intervention with 3 regular education participants and 3 inattentive students. Participants were in third to fifth grades. Participants were highly motivated to participate in this intervention due to the use of the I-Pod. Because of the new technology, students were excited and ready to learn. Results demonstrated that students did indeed learn.

Intervention Effectiveness

Significant gains in math fact accuracy were observed across participants from baseline to the intervention phase. The graphs depict how each participant made gains as they progressed through the four sets of worksheets. Although not every student reached mastery criteria (80% correct or better on 2 sessions in a row) on each set of worksheets, all students' accuracy increased as they completed more intervention sessions. Also, the percent correct for every participant increased substantially during the intervention phase. The average percent correct across participants during the baseline phase was 33.53. This increased to an average of 71.92 across participants during the intervention phase. This demonstrates that participants received a much higher percent correct during the intervention phase than they did at baseline. The average percent correct across participants during the generalization phase was 71.61. This is only slightly lower than the percent correct during intervention. This demonstrates that students were able to generalize their knowledge of multiplication facts beyond those practiced during the intervention sessions. Percent correct scores also remained elevated on follow-up probes at 2-weeks ($\underline{M}$ = 71.22) and 4-weeks ($\underline{M}$ = 68.44). This demonstrates that participants were able to maintain their knowledge and remember the multiplication facts they learned during intervention up to 4 weeks after finishing the intervention phase.

Effect sizes were also calculated to determine the effectiveness of the intervention. Effect sizes were interpreted using Cohen's (1988) standards. According to

Cohen (1988), a small effect size is about 0.25, a medium effect is about 0.5, and a large effect is about 0.8 or higher. According to these guidelines, effect sizes for all participants during the intervention phase are large effect sizes with a mean effect size of 9.55. Effect sizes for the generalization and maintenance phases were also large with mean effect sizes across participants of 5.69 and 9.68 respectively (Cohen, 1988 as cited in Keppel & Wickens, 2004).

Participant Learning Rates

Overall, participants took an average of 3.22 days to reach mastery. However, due to the established stop criterion (5 days if mastery of 80% on 2 consecutive days was not reached), not every participant was able to reach mastery on all sets, so this average is not wholly accurate. For those participants who did reach mastery, the number of days it took students to reach mastery also decreased as they progressed through the sets of worksheets. This decreasing trend of days to mastery might be explained by students' memorization of more multiplication facts while moving through the intervention phase. It also was noted that more math fact reversals were found on later worksheets. A fact reversal is a fact that appears as 2x9 on one worksheet and 9x2 on another. Students may have had many facts on a worksheet memorized before they even began working on that set. Also, the general education group and inattentive group had slightly different rates of learning. The general education group averaged 3.00 days until mastery was reached while the inattentive group averaged 3.36 days to reach mastery criteria. This means that it took 0.36 days longer for the participants in the inattentive group to reach mastery. However, all participants were not able to reach mastery on all sets of worksheets due to the stop criterion. Participant 2, in fact, did not reach mastery on any set. This may be due to the fact that this participant started out with a lower percent correct. Participant 2's mean percent correct at baseline was only 14.06. Also, Participant 2 was often absent, allowing more time to pass between intervention sessions. In addition, Participant 2 was frequently off task during intervention sessions. He also received an elevated T-score of 68 on the Conners' ADHD Index subscale on the CTRS-R: S, placing him in the clinically significant range. Participant 2's off task behavior also could have impacted his performance. If all participants were able to reach mastery levels, a more accurate depiction of the number of days to reach mastery could have been obtained.

Teacher and Student Acceptability

Results from the teacher and student acceptability questionnaires indicated that both students and teachers generally felt that this intervention was effective. Most teachers indicated that this intervention was an acceptable way to increase student math fact accuracy and speed with a mean score of 5.00 (agree). Most teachers also indicated that they would recommend this intervention to another teacher demonstrated by a mean score of 5.00 (agree). Students generally felt that the intervention was fun and that it helped them know their multiplication facts better and faster. Also, students indicated that their peers may enjoy the TP intervention as well with a mean score of 2.00 (maybe) on Question 2 ("My friends would like to learn math this way"). The positive feedback on the acceptability survey suggests that students with a variety of characteristics find this intervention an acceptable way to learn multiplication facts. In conclusion, the current research project suggests that the intervention is acceptable to both students and teachers.

Implications for Practice

These results advocate for the use of the TP intervention with a progressive time delay and the use of an I-Pod as an effective tool for learning multiplication math facts among students in regular education as well as among students with attention difficulties. The simplicity of the intervention lends itself for inclusion within a Response to Intervention (RTI) framework. In an RTI model, interventions need to be used in Tier 1 (classwide instruction), which is instruction that all students receive. Interventions also need to be used in Tier 2 (small group instruction) in which students who are at-risk are grouped by ability and receive an intervention that meets their learning needs. Lastly, interventions need to be used in Tier 3 (individualized for each student) in which only a select few students receive more individualized intensive intervention. The TP intervention with a progressive time delay via an I-Pod could easily fit into each of these three tiers. If needed, this intervention can be tailored to the student in order to be successful in different Tiers of RTI. In Tier 1, the intervention could be used classwide so all students would receive this instruction. In Tier 1 instruction, the TP intervention could be used as an activity during center time. All students could take turns rotating through the center with the I-Pod. In Tier 2, the intervention could be used for different groups of students. Depending on the need, different math facts could be used for each group. Students with similar needs could be placed in a group. Students could all listen to one I-Pod together and have their own worksheets. Newer model I-Pods have speakers in which head phones are not necessary. Also, if several I-Pods are available, each student could use their own. Lastly, in Tier 3, worksheets could be made specifically for individual students depending on the need. For Tier 3 instruction, sets of facts for the I-Pod could be made depending on what facts the individual student is struggling with. The student would then use the I-Pod to listen to the tracks made specifically for them. In order for this intervention to be used effectively in an RTI model, progress monitoring would need to be implemented in order to assess the interventions impact. This study required close one-on-one supervision in order to acquire accurate results. However, progress monitoring for this intervention in an RTI framework would not need to be so closely monitored. Progress monitoring could easily be accomplished through self-monitoring. Students could be trained on when they are to write the answers in and how they add up the number of correct answers. A teacher or teacher aide could still monitor students in a class or group to provide supervision. This would increase the likelihood that students would not write in an answer when they were not supposed to. Taking these steps would provide adequate progress monitoring that could be taken every day of the intervention.

Mean effect sizes across participants for the generalization phase was 5.69, demonstrating a large effect. Maintenance data also demonstrated a large effect with a mean effect size across participants of 9.68. Generalization and maintenance data from this study indicate that this intervention was effective in generalizing the multiplication fact knowledge across all multiplication facts and by maintaining this knowledge over time. Also, students and teachers found this intervention an acceptable way to learn multiplication facts. Generalizing knowledge, maintaining knowledge, and acceptability are characteristics that make an intervention useful and appropriate in an RTI model.

Limitations

This study had several limitations. To begin, there were a limited number of potential participants. Because the research was conducted during an after-school program, there were a limited number of third-, fourth-, and fifth-graders available as potential participants. Once the initial baseline probe was administered, only 17 students qualified for participation in the study based on the targeted inclusion criteria of ≤55% correct on the baseline probe of multiplication facts (2 to 9). Once these participants were initially identified as qualifying for participation in the study, a parent permission form was sent home. Out of the 17 permission forms that were sent home, only 8 were returned. Because this study targeted 6 participants, this did not leave a lot of flexibility. This led to one of the participants not fitting into the regular education category as clearly as anticipated. For example, Participant 2 in the regular education group obtained the following T-scores on the CTRS-R: S: Oppositional subscale: 45, Cognitive Problems/Inattention subscale: 54, Hyperactivity subscale: 58, and Conners' ADHD Index subscale: 68. Although the criteria for the regular education group only required an average T-score (< T-score of 60) on the Cognitive Problems/Inattentive subscale, it was not ideal for a participant in this group to have a score on the Conners' ADHD Index subscale in the clinically significant range. Also, Participant 2 was on task only 62% of the time during the in-class observation. Although he met the established cut-off (above 60% on-task rate), this is still a low on-task rate.

Another limitation of this study was that the participants were frequently absent. This problem was not anticipated when beginning the study. However, because the attendance of students in the after-school problem was voluntary and not required as it was during regular school hours, students were often absent. This led to several days lapsing between intervention sessions. As a result, students took longer to reach mastery and to finish the intervention. It is believed that this intervention may have been more effective if the students completed intervention worksheets on a more regular basis and closer together in time. The intervention may have taken less time and also may have generated more significant results.

An additional limitation of this study was that a small sample was used. Because a single subject design was used, only a few participants were required to participate in the intervention. Even though 6 participants were used, only 3 of them met criteria for inattention. The remaining participants were used as a comparison group. Although the present study found the intervention to be successful with both typical students and inattentive students, the same effects need to be demonstrated with additional students who struggle with attending. It may be beneficial to replicate this study with more inattentive participants.

Furthermore, in order for a participant to qualify for the inattentive group, they simply needed to have an elevated score on the Cognitive Problems/Inattentive subscale on the CTRS-R: S and a low rate of on-task behavior during one 15-minute observation of math time. It was not required for participants to have a diagnosis of ADHD. Participant 4 had a diagnosis of ADHD while Participant's 5 and 6 diagnoses are unknown. This is a limitation of the study because results may differ for participants who have a diagnosis of ADHD. There may be a difference between behaviors and symptoms of individuals with a diagnosis of ADHD compared with individuals who simply have attention problems.

The fact that this intervention was implemented on an individual basis is also a limitation of this research study. Many students, especially those with attention difficulties, would benefit from one-on-one attention. They may need frequent redirection and monitoring. Because this research was implemented one-on-one, each student essentially received individual attention from the researcher. Students were able to be redirected or reminded when necessary. All participants, especially those in the inattentive group, may not have achieved such substantial improvement from this intervention if a small group or whole class format were used. Potential success using other implementation formats is unknown. Furthermore, due to the one-on-one nature of the intervention, students gained a close relationship with the researcher as the study progressed. Students began to want to do well to please or impress the researcher, which may have been a motivator for some students and increased the success of the intervention. This one-on-one format, however, was necessary to monitor data at the level needed for this research study. Students needed to be monitored to make sure an accurate percent correct for each worksheet was calculated. This same results noted in this research study may not be generated in a format other than one-on-one.

Lastly, a limitation of this study was that a compressed time was available to complete the study. Even though the research began directly after the school district's winter break, there was limited time to complete the intervention before school was dismissed for the summer. To ensure students' completion of all 4 sets of facts, a stop criterion was used. The stop criterion selected for this study was 5 days. This stop criterion was chosen based on Todd's (2010) research on math fact acquisition which found that the average number of days until participants reached mastery was 1.98 days. To be certain that students would have enough time to reach mastery, 5 days was used for this intervention's stop criterion. This was also employed to keep students from becoming frustrated from working on the same facts worksheets too long. However, if students were allowed to continue working on a set until they reached mastery with no limitation, valuable information could have been gathered. Exactly how long it took each student to reach mastery levels could have been determined if a stop criterion had not been used. In this study, several participants did not reach mastery on sets of facts because of the stop criterion. It is unknown how much longer they would have had to work in order to be successful.

Future Directions

Although the present study has some limitations, the findings suggest that the TP intervention with a progressive time delay delivered via an I-Pod was very effective with both inattentive students and students in regular education. These results also lead to areas where further research is needed. A significant amount of research still needs to be done on the effectiveness of the TP intervention on various populations of students. To begin with, this is the first documented study conducted with inattentive students. Because this research used a single-subject design model with only three inattentive participants, additional participants with attention difficulties are needed to fully establish the effectiveness of this intervention with this population of students. Also, as mentioned above, this research focused only on the effectiveness of the TP intervention with inattentive students in a one-on-one format. Investigating the usefulness of this intervention for inattentive participants with small group or whole class instruction would be beneficial to expand its utility.

Furthermore, with technology progressing so quickly, it is important to keep up with the latest developments. Students become bored with the use of older technology and more excited and motivated over the latest and greatest gadgets. Although students were still excited and motivated to use the I-Pod in the current study, it is believed that students would be even more eager to use more updated technology such as an I-Pad. This is the latest technology that many students are excited about. In fact, at the beginning of the study, one student thought an I-Pad was being used for the current study. When they found out that a “meager” I-Pod was being used instead, the student was disappointed. I-Pads are becoming widely used in schools with many different educational applications. Adding tracks for the TP intervention would be simple and could be used easily just as the I-Pod was. The benefit of using the I-Pad would be to keep up with technology and keep students eager and motivated to learn. Expanding the TP research to include the use of I-Pads would also add to the knowledge base for this intervention.

In addition, although the current research study focused on inattentive students, most research conducted on the TP intervention has been done with regular education students without identified learning difficulties. Only a handful of research examines the effects with disabled students. Historically, research on the TP intervention has either used different methods (classwide, individual student) or different technology (audio tape player, I-Pod), but primarily with regular education students. Assessing the effectiveness of this intervention with different populations would allow educators to use this with a variety of students knowing that they were using evidence-based practice. Poncy et al. (2007) found the TP intervention to be effective with a student diagnosed with a mild intellectual disability. McCallum et al. (2004) used the TP intervention to effectively teach a fourth grade student division. This fourth-grade student had a mathematics learning disability, yet the TP intervention still increased division-fact fluency (Windingstad et al., 2009). These successes give more reason and motivation to complete and expand further research. The TP's intervention success with more students with a variety of learning difficulties should be investigated. For instance, students with a learning disability in math will most likely have struggles with learning their multiplication facts as well as other basic math facts. The TP intervention may be a very effective intervention for this population.

Another population that should be investigated further is older students. Among middle school students, memorization of basic math facts, such as multiplication, is not necessarily mastered in elementary school for all students. There are students in upper grades who either never learned their math facts or have since forgotten them. It is imperative that students know their basic math facts in order to complete and be successful with higher-level math concepts. It would be beneficial if the TP intervention could be established as a successful way for older students to learn their basic facts as well. Most research on multiplication fact acquisition has been conducted with third-grade students, as this is the grade in which students are first learning multiplication facts. However, there are still many students in need of basic math fact instruction in higher grades. It is possible that older students may find learning basic math facts too repetitive or elementary. It would be interesting to see if introducing math facts using progressive time delay using new technology such as I-Pods or I-Pads could motivate these students as well and provide further support for the TP intervention as a successful intervention. It is recommended that the acquisition of multiplication facts with the use of the TP intervention be investigated with middle school and high school students in need of additional instruction.

Conclusions

Previous research on the TP intervention has shown that it is effective with a variety of math facts and in a variety of environments. Previous research has also begun to examine the effectiveness of the TP intervention with a variety of different populations. This study has added to the research on the TP intervention by using advanced technology (an I-Pod) in implementing this intervention. The current research has also added knowledge on the effectiveness of this intervention across different student populations, specifically those with attention difficulties. The current study found that the TP intervention was effective for both regular education and inattentive participants. The results also demonstrated that students and teachers found this intervention to be an acceptable and fun way to learn multiplication facts. In the end, the results from this study add to current knowledge on the use of evidence-based interventions for multiplication fluency.

APPENDIX A

BASELINE PROBE

Baseline Probe *Name*: ________________

2 x 4	9 x 8	3 x 6	9 x 2
4 x 5	7 x 7	4 x 7	5 x 4
6 x 3	4 x 2	6 x 7	4 x 6
4 x 3	7 x 2	8 x 5	2 x 6
5 x 5	3 x 9	6 x 6	2 x 7
4 x 8	8 x 6	3 x 7	4 x 4
2 x 3	7 x 4	8 x 7	9 x 6
3 x 3	5 x 7	8 x 2	4 x 9

5 x 3	7 x 6	8 x 4	9 x 9
7 x 9	8 x 3	3 x 2	2 x 5
3 x 8	7 x 5	3 x 4	2 x 2
6 x 5	8 x 8	9 x 4	8 x 9
5 x 2	6 x 9	3 x 5	2 x 9
6 x 4	5 x 9	9 x 3	2 x 8
9 x 7	7 x 3	6 x 2	5 x 8
9 x 5	6 x 8	5 x 6	7 x 8

APPENDIX B

TIME SAMPLING BEHAVIOR OBSERVATION FORM

SpEd 14 1005

BEHAVIOR OBSERVATION REPORT

Student _________________________ Grade __________ Teacher ______________________________
Date_________________ Time _________ Observer ____
Subject/Activity ____

ENVIRONMENT
__ Teacher-directed lesson, small group __ Independent practice
__ Teacher-directed lesson, whole class __ Small group cooperative work
__ Other: ________________________

General description of classroom environment:

____

Time sampling: Record student's behavior by code outlined below at the end of each 15-second interval over a 15-minute observation period. Calculate % of time on task.

Target student:												Comments:

% of time on task: __________

Control student:												Comments:

% of time on task: __________

Behavior pinpoints code:

A = attending to expected task
D = distracted
M = excessive movement
T = talking inappropriately
O = out of seat
+ = teacher intervention
# = other: ____
* = other: ____

Comments and summary:

____
____

APPENDIX C

MATH WORKSHEETS

Set A: Track 1 *Name*: ____________________

2 x 6	9 x 7	3 x 4	5 x 6
6 x 4	7 x 8	7 x 5	3 x 8
4 x 7	2 x 4	5 x 9	6 x 6
8 x 2	4 x 9	8 x 9	

<u>Set B: Track 1</u> *Name*: ________________

2 x 3	9 x 8	3 x 3	5 x 2
4 x 4	7 x 3	5 x 7	8 x 4
4 x 3	3 x 6	6 x 7	4 x 6
9 x 3	7 x 4	6 x 8	

<u>Set C: Track 1</u> *Name*: ____________________

9	6	9	7
x 2	x 3	x 5	x 6

8	6	6	3
x 7	x 9	x 2	x 9

4	7	4	8
x 8	x 7	x 2	x 8

9	2	5
x 9	x 5	x 8

Set D: Track 1 *Name*: ___________________

9 x 4	8 x 3	3 x 7	4 x 5
7 x 9	5 x 4	6 x 5	9 x 6
8 x 6	3 x 2	2 x 7	3 x 5
2 x 9	2 x 8	5 x 5	

APPENDIX D

TREATMENT INTEGRITY CHECKLIST

Treatment Integrity Checklist

	Yes	No
1. Student selected correct worksheets		
2. Student wrote name and date on worksheet		
3. Student selected correct track on I-Pod first trial		
4. Student selected correct track on I-Pod second trial		
5. Student selected correct track on I-Pod third trial		
6. Student responded within interval (1, 4, or 2 seconds)		
7. Student completed all 3 time trials		
8. Accurate number of correct responses were calculated		

Rater: ______________________

APPENDIX E

TEACHER ACCEPTABILITY RATING FORM

Teacher Acceptability Rating Form

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
1. This intervention was an acceptable way to increase student(s) math fact accuracy and speed.	1	2	3	4	5	6
2. I would recommend this intervention to other teachers.	1	2	3	4	5	6
3. I noticed a positive change in my student(s) math fact knowledge.	1	2	3	4	5	6
4. I noticed a positive change in my student(s) math fact speed.	1	2	3	4	5	6
5. I would be willing to use this intervention again in the future.	1	2	3	4	5	6
6. This intervention is appropriate for a variety of students.	1	2	3	4	5	6
7. I liked the procedures used in this intervention.	1	2	3	4	5	6
8. The intervention will produce lasting improvements in the student(s) math fact skills.	1	2	3	4	5	6
9. The student(s) enjoyed the intervention.	1	2	3	4	5	6
10. This intervention will not result in negative side effects for the student(s) performance.	1	2	3	4	5	6
11. Overall, this intervention was beneficial to the student(s).	1	2	3	4	5	6
12. This intervention is a time-efficient way to work on math facts.	1	2	3	4	5	6

APPENDIX F

STUDENT ACCEPTABILITY RATING FORM

Student Acceptability Rating Form

	No	Maybe	Yes
1. Learning my multiplication facts with the I-Pod was fun.	1	2	3
2. I became better at my multiplication facts because of the I-Pod.	1	2	3
3. I get more multiplication answers right now than I did before.	1	2	3
4. I am faster at my multiplication facts now that I was before.	1	2	3
5. My friends would like to learn math this way.	1	2	3

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