PEER-MEDIATED ACADEMIC INSTRUCTION: A META-ANALYSIS AND SINGLE CASE EXPERIMENT

A Dissertation

by

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ABSTRACT

When students with autism demonstrate deficits in social skills, academic instruction is sometimes relegated to secondary priority. A handful of studies focusing on academic skills show students with ASD in inclusive settings performed better academically than those in other setting. Other studies show that students' academic competence influences social competence from year to year, and a focus on academic skills training show greater benefits to academic and social outcomes compared to only social skills training. Prior research has found that students taught by peers improve social and academic outcomes simultaneously. Peer-mediated instruction (PMI) is an intervention demonstrating effects for increasing both social and academic skills for students with autism (ASD).

This dissertation will expand the literature on the academic status and performances of students with autism through three studies. First, a comprehensive examination of the literature will evaluate quality, overall effects, moderators, and construct a distribution of effect sizes to use in benchmarking for future studies. Second, a single case experimental study will be designed to address these threats and fill missing pieces of the literature. Overall, these studies will add to the literature on the effects of peer-mediated academic instruction.

The first study will determine and report on the effect sizes of peer-mediated academic instruction (PMAI) to increase academic skills for students with ASD. ES are expected to demonstrate a moderate to strong effect when using PMAI to teach students with ASD. Effects will be described by study, participants, and conceptually derived

moderators of treatment. These results may validate if PMAI is effective when teaching academic skills to students with ASD.

In the second study, a multiple baseline experimental design will determine the effects of PMAI across three students in the academic content area of writing. Tutors (typically developing, same age, same grade peers) are provided training and visual prompting guides for working with tutee (students with autism). Anticipated results indicate peers can increase academic engagement during writing sessions with fidelity for students with autism. Social validity assessments will fill an existing gap in the literature and indicate the feasibility and acceptability of peer tutoring for teachers. Future directions and limitations are discussed.

DEDICATION

To my stinky head. I love you more than I can put into words. I hope through this experience and the times that we have shared while at “ATM” you too will follow your passion, never give up, and have confidence in yourself. Never lose sight of who you are.

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NOMENCLATURE

AB	Abstract
ASD	Autism Spectrum Disorder
BC-SMD	Between-Case Standard Mean Difference
CI	Confidence Interval
DE	Descriptors Exact
EBP	Evidence Based Practices
IEP	Individualized Education Program
IRD	Improvement Rate Difference
μ	Mean
NAP	Nonoverlap of All Pairs
PAND	Percentage of All Nonoverlapping Data
PMI	Peer-mediated instruction
PMAI	Peer-mediated academic instruction
PND	Percentage of Nonoverlapping Data
PRISMA	Preferred Reporting in Systematic Reviews and Meta-Analysis
SCED	Single-case experimental design
SD	Standard deviation
SU	Descriptors
τ	Tau
TI	Title
TPB	Theory of Planned Behavior
WWC	What Works Clearinghouse

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1. INTRODUCTION

1.1. Introduction

1.1.1. Autism Spectrum Disorder in the Schools

Diagnosis of individuals with autism spectrum disorder (ASD) is somewhere between 1 in 54 children (Maenner et al., 2020;), with approximately 3.5 million individuals diagnosed with ASD (Buescher, Ciday, Knapp, & Mandell, 2014) in the U.S., of those, 617,000 (National Center for Education Statistics, 2019) are currently school age (five to 21 years of age). Approximately, 62.5% of students with autism currently spend 80% of their time in the general education setting (NCES, 2019).

Students with ASD demonstrate deficits in social and communication skills (American Psychiatric Association, 2013), academic skills, and behavior regulation. These deficits lead to poor academic performance, social isolation, and poor behavior regulation; intensifying social isolation and academic underperformance, which can later impact an individual's quality of life (Chiang & Wineman, 2014; Kim & Bottema-Beutel, 2019). As individuals with ASD get older, if not treated or intervened, an individual's deficits may magnify (Franchini et al., 2018; Horner, Carr, Strain, Todd, & Reed, 2002), resulting in meager quality of life into adulthood (Franchini et al., 2018). Biggs and Carter (2016) examined the quality of life for transition age students with ASD, finding social-related interventions and inclusive practices are important for improving quality of life for individuals with ASD. Researchers suggested providing targeted interventions and supports to care for students with ASD to increase positive outcome in their adult life (Biggs & Carter, 2016; Franchini et al., 2018; Pfeiffer et al., 2017).

1.1.2. Interventions for Autism Spectrum Disorder

Past research has implemented various interventions to address the above described deficits. However, most research is focused on increasing social and communication skills for students with ASD (Keen, Webster, & Ridley, 2016; Odom, Collet-Klingsenberg, Rogers, & Hatton, 2010). In National Clearinghouse on Autism Evidence and Practice's (NCAEP) current review, of the 456 studies reviewed, 76% of the studies addressed social and communication skills, 35% studied behavior, and 13% focused on academic skills. Interventions for these skills ranged from antecedent interventions to visual supports, for students across all grades (see Table 1-1).

Social and communication skills are important for relationships, school success, employment opportunities, and overall improvement of quality of life in later years (Eigsti, de Marchena, Schuh, & Kelley, 2011; Hattier & Matson, 2012; Koegel, 2000), however, academic skills also help the student succeeded in the aforementioned (Fluery et al., 2014). Poor post-secondary outcomes including not attending college or the inability to maintain employment is the result of the inability to perform basic employment skills (Reisen, Schultz, Morgan, & Kupferman, 2014). Many of these tasks involve problem solving, following written directions, performing simple math tasks, or working with others (Agran, Hughes, Thoma, & Scott, 2016; Byren, Potts, & Carey 2007; Ju, Zhang, & Pacha, 2012).

1.1.3. Academic Achievement for Students with Autism

Success in social skills and behavioral outcomes for students with autism can be predicted and improved when there is a focus on a student's academic success (Coie & Krehbiel, 1984; Fluery et al., 2014; Kurth & Mastergeorge, 2010; Murphy, 2017; Zucchetti, Candela, Sacconi, & Rabaglietti, 2015). Moreover, students placed in the

general education settings perform better academically, socially, behaviorally, and when forming friendships (Kurth & Mastergeorge, 2010; Troyb et al., 2014; Zucchetti et al., 2015). Other studies show students' academic competence influences social competence from year to year (Welsh, Parke, Widaman, & O'Neil, 2001), and a focus on academic skills training shows greater benefits to academic and social outcomes when compared to social skills training alone (Coie & Krehbiel, 1984; Fluery et al., 2014). Additional benefits for academic skills training include reducing frustration associated with academic challenges, thus reducing negative behaviors that are often stigmatizing and socially isolating (Coie & Krehbiel, 1984; Scheef, Hollingshead, & Voss, 2019; Welsh et al., 2001). These studies suggest teaching academics produces needed gains in academic and social needs. With a need to increase academic skills as well as mitigate social and communication deficits for students with ASD, an intervention is needed that will address all areas, as well as be socially valid, easy to implement, and cost efficient (Hoff & Robinson, 2002).

1.2. Peer Mediated Instruction

Peer mediated instruction (PMI) is a widely used practice that has been around for decades (Higgins et al., 2014; Maccini & Gagnon, 2006; Zeneli & Tymms, 2015). Throughout ones' school career individuals receive or provide help to others when learning, studying, or completing assignments. Peers are a readily available resource in schools and utilizing them to teach their peers is beneficial for both individuals involved (McCurdy & Cole, 2014). As defined by Wong et al., (2015) a peer mediator is an individual who works with another person to teach them a skill. Studies in peer mediation range from straightforward treatments (Carter, Cushing, Clark, & Kennedy, 2005; Kamps,

Locke, Delquadri, & Hall, 1989) to more manualized treatments (Delquadri, Greenwood, Whorton, Carta, & Hall, 1986; Fuchs, Fuchs, Mathes, & Simmons, 1997).

1.2.1. Efficacy of PMI

Peer mediated instruction is not only beneficial to the tutor, PMI can be beneficial to all including the teacher. Additionally, PMI demonstrates benefits beyond academics (Carter & Kennedy, 2006; Coie & Krehbiel, 1984; Franca, Kerr, Reitz, & Lambert, 1990; Kalfus, 1984; McMaster, Fuchs, & Fuchs, 2006; Schaefer, Canella-Malone, & Brock, 2018; Scheef et al., 2019; Scruggs, Mastropieri, & Richter,1985; Walker & Crogan, 1998). Implementing PMI in a classroom can increase exposure to academic tasks, increase a teacher's time for individualized instruction, and decrease disruptive behavior (Bowman-Perrott, Burke, Zhang, & Zaini et al., 2014; Kaya, Blake, & Chan, 2015). Peer mediated instruction also incorporates other instructional strategies such as opportunities to respond, active engagement, error correction, prompting, feedback, and reinforcement (Alresheed, 2013). Students learn study skills, how to analyze their work, resolve problems with their peers, ask questions, and encourages independence (Falchifov, 2001; Gaustad, 1993). Additionally, peers may be able to understand their peer's nonverbal behavior when struggling better than their teachers (Gaustad, 1993).

1.2.1.1. Teachers

Teachers can have students work on different levels of curriculum or different lessons based on students' needs (Fuchs, Fuchs, & Burish, 2000). Tutoring allows more time to focus on academic problem for specific students while other students are working together (Dineen, Clark, & Risley, 1997).

1.2.1.2. Tutors

Benefits of PMI extend beyond the tutee. When working with tutees, tutors' participation and homework increases as well as an increase or maintenance of academic engagement (Boudouris, 2005; Carter et al., 2005; Cushing & Kennedy, 1997; Franca et al., 1983; Shalev, 2014). Additionally, students who are at risk for school failure demonstrate academic gains when acting as tutors (Kennedy, 2002). Tutors benefit due to increased exposure to materials as well as facilitating retention because students understanding must improve to make tutoring successful (Carter & Kennedy, 2006; Gaustad, 1993). When participating in a peer tutoring program, tutors increased accuracy of math problem completion (Franca et al., 1990), and spelling accuracy (Dineen et al., 1977). While implementing classwide peer tutoring, tutors increased their academic engagement as well as their gain scores when completing academic tasks (Mortweet et al., 1999). Benefits of peer tutoring extend beyond academic gains, peers learn acceptance of their peer with disabilities (Harper & Maheady, 2007) and their self-esteem increases while teaching their peers (Gaustad, 1993).

1.2.1.3. PMI Across Populations

Academically, peer mediated instruction has been studies across different populations including typically developing peers (Medcalf, Glynn, & Moore, 2004), students with emotional behavioral disorders (Kaya et al., 2015; Sutherland & Snyder, 2007), students with intellectual disabilities (Carter et al., 2005; Schaefer et al., 2018), and even cross-age peer mentoring (Davenport, Arnold, & Lassmann, 2004; Gaustad, 1993; Kamps, Dugan, Potucek, & Collins, 1999; Robinson, Schofield, & Steers-Wentzell, 2005). It has also been studies across the major subjects including reading (Davenport et al., 2004;

Kamps, Barbetta, Leonard, & Delquadri, 1994; Regelski, 2016; Topping & Bryce, 2004), writing (Bedrosian, Lasker, Speidel, & Politsch, 2003; Medcalf et al., 2004), math (Fuchs, Fuchs, & Karns, 2001; Kunsch, Jitendra, & Sood, 2007; Robinson et al., 2005), science (Carter et al., 2005; Schaefer et al., 2018), and history (Dugan et al., 1995; Marshak; Mastropieri, & Scruggs, 2011; Mastropieri, Scruggs, Spencer, & Fontana, 2003). A few peer tutoring interventions and protocols (Delquadri et al., 1986; Fuchs et al., 1997) have been endorsed as an evidence-based practices through different agencies including the Institute for Education Sciences through the What Works Clearinghouse (WWC). Across skill set and populations, the effects of peer tutoring have demonstrated positive results.

However, information is lacking about the effects of peer tutoring of academic skills for students with ASD (Bowman-Perrott et al., 2013). Literature within the autism population, predominately explores the use of peer mediated strategies to increase social and communication skills (Banda, Hart, & Liu-Gitz, 2010; Bene, Banda, & Brown, 2014; Gunning, Breathnach, Halloway, McTiernan, & Malone, 2019; Hott, Alresheed, & Henry, 2014; Kamps, Mason, & Heitzman-Powell, 2017; Martinez, Waters, Conroy, & Reichow, 2019; Rodriguez-Medina, Martin-Anton, Carbonero, & Ovejero, 2016; Zhang & Wheeler, 2011).

1.2.2. Theory Behind PMI

Theories supporting why an individual engages in specific behaviors, help inform research, add to the literature, and help explain or justify outcomes of research (American Educational Research Association, 2006). Peer-mediated instruction can be supported by multiple theories including social cognitive theory, sociocultural theory, and the theory of

planned behavior (Bandura, 1982, Kodish, Kulinna, Martin, Pangrazi, & Darst, 2006; Vygotsky, 1978).

Peer supports within a student's learning environment can determine the level of participation for students with disabilities (Obrusnikova & Miccinello, 2012). Social cognitive theory supports PMI by supporting reciprocal social interactions through various behaviors, environments, and individuals, creating a sense of belonging (Bandura, 1982). Through PMI, students gain confidence in their abilities thus increasing their self-efficacy (Bandura, 2002). An increased self-efficacy results in individuals who are more willing to try new or harder tasks (Hidi & Boscolo, 2006). Through this theory PMI can increase self-efficacy for academic skills increasing the likelihood students are willing to engage in tasks that may seem more difficult (MacArthur & Graham, 2016; Pajare & Valiante, 2006).

Socio-cultural theory suggests learners partake in an active role in their education (Vygotsky, 1978). Socio-cultural theory stresses the importance of the social environment to support active learning (Schunk, 2012). PMI is supported through this theory because students are more active in the learning process. By working with together with peers, students learn strategies that will support their learning (Schunk, 2012). PMI promotes learning through social interaction and creating meaningful learning opportunities that are more likely to aid in skill acquisition (Schunk, 2012).

The theory of planned behavior (TPB) helps determine why an individual engages in a specific behavior (Ajzen, 1991). Understanding TPB helps us create plans that will support an individual when trying to increase the likelihood of them engaging in a desired behavior (Hodge & Elliot, 2013; Kodish et al., 2006). PMI can be supported by TPB

because PMI can reduce the stress of engaging in academic activities by providing more support through peers who may understand the student better (Gaustad, 1993). The use of multiple strategies within PMI encompasses the TPB's idea of understanding and providing support to increases the probability an individual will engage in the targeted behavior (Alresheed, 2013, Ajzen, 1991).

Peer-mediated instruction has long been studied; however, the subject has been understudied for students with autism and academic skills. The purpose of this dissertation is to identify the effects of peer-mediated academic instruction within the autism population by conducting a meta-analysis (Study 1) and to conduct a single case experimental study addressing the gaps identified within the meta-analysis (Study 2). The following questions will be addressed in these studies:

Study 1:

1. What is the overall magnitude of effect of PMAI for students with autism?
    a. Are there differential effects of PMAI for studies meeting quality standards or meeting quality standards with reservations compared to studies not meeting quality standards?
2. What is the magnitude of effect of PMAI on academic engagement, academic skill acquisition, reading comprehension, and author groups?
    a. Are effects of PMAI for academic engagement, academic skill acquisition, reading comprehension, and author groups influenced by studies not meeting quality standards compared to studies meeting them or meeting them with reservations.

3. How does the parametric effect sizes compare between single case and group design standard mean difference measures?
4. Is publication bias present, and what are the effects of PMAI when accounting for publication bias?

Study 2:

1. Is there a functional relation between peer-mediated academic instruction and academic engagement of writing assignments?
2. Can peer-mediated academic instruction increase number of words or sentences written related to an increase in academic engagement?
3. Can peers teach individuals with autism with fidelity?
4. How do educators view the feasibility and acceptability of peer-mediated academic instruction?

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Table 1-1 Interventions Across Skills

	Academic	Behavior	Communication	Social
NCAEP	19	21	26	25
Odom et al., 2010	10	15	20	13
Age				
0-5	14	14	21	20
6-14	14	20	26	25
15-22	4	12	8	9

2. PEER-MEDIATED ACADEMIC INSTRUCTION: A META-ANALYSIS

2.1. Introduction

2.1.1. Current Academic Performance

Autism spectrum disorder (ASD) is often associated with social and communication deficits. As a result, many educational programs emphasize increasing social and communication skills while academic skills are less emphasized (Keen, Webster, & Ridley, 2016; Wei, Christiano, Yu, Wagner, & Spiker, 2015; Wong et al., 2013; 2015). Even though, more than half of the students with ASD spend 40% or more of their time in general education, students with ASD still exhibit deficits in core academic skills (National Center for Education Statistics, 2019; Snyder, de Brey, & Dillow, 2016; Wei et al., 2015). Poor outcomes academically can affect one's quality of life after high school, including maintaining a job or engaging in postsecondary education; a requirement for obtaining more than 42% of jobs (Carnevale, Jayasundera, & Hanson, 2012; Carnevale, Smith, & Strohl, 2013; Newman et al., 2011).

2.1.2. Academic Achievement and Inclusive Settings

Learning challenges such as executive functioning and social and communication difficulties can result in exclusion, challenging behaviors, and stereotypy reducing the amount of time exposed to academic learning opportunities (Fleury et al., 2014; Paynter et al., 2016; Roberts & Webster, 2020; Watkins, Ledbetter-Cho, O'Reilly, Barnard-Brak, & Garcia-Grau, 2019). Additionally, support in the classroom may be affected by the teachers' training related to modifying tasks, accommodating learning difference, managing challenging behavior, and supporting relationships among students (Lindsay, Proulx, Thomson, & Scott, 2013).

Students with ASD demonstrate varied abilities in academic achievement, excelling in one subject and struggling in another; associated with the heterogeneity within this population (Chen et al., 2019; Griswold, Barnhill, Myles, Hagiwara, & Simpson, 2002; Kurth & Mastergeorge, 2010; Nation, Clarke, Wright, & Williams, 2006; Paynter et al., 2016; Regelski, 2016). Although faced with many challenges, some studies show students with ASD perform better academically in inclusive settings compared with other settings (Kurth & Mastergeorge, 2010; Troyb et al., 2014). Academic skills training can help reduce frustration related to academic challenges, resulting in the reduction of negative behaviors that can be stigmatizing and socially isolating (Coie & Krehbiel, 1984; Welsh, Parke, Widaman, & O'Neil, 2001). These studies suggest emphasizing academic instruction produces gains in both academic and social skill deficits. In fact, some studies show students' academic capacity effects their social ability (Welsh et al., 2001), and prioritizing academic skills training is more beneficial for academic and social outcomes compared to only providing social skills training (Coie & Krehbiel, 1984).

2.1.3. Research in Peer-Mediated Instruction

Fluery et al. (2014) and Krebs, McDaniel, and Neeley (2010) found students can be taught by their peers; improving social and academic outcomes concurrently. Defined by Wong and colleagues (2013), peer-mediated instruction is the use of peers who interact or help an individual learn a new skill in the natural environment. Peer-mediated instruction includes manualized treatments such as ClassWide Peer Tutoring and Peer Assisted Learning Strategies (Delquadri, Greenwood, Whorton, Carta, & Hall, 1986; Fuchs, Fuchs, Mathes, & Simmons, 1997), to more straightforward treatments such as peer supports and peer tutoring (Carter, Cushing, Clark, & Kennedy, 2005; Kamps, Locke, Delquadri, &

Hall, 1989). Within the ASD literature, peer-mediated instruction is most often used to improve social and communication skills with effects well documented (Watkins et al., 2019; Zhang & Wheeler, 2011).

Tutors are beneficial because they can decrease the averseness related to classwork while providing reinforcement through socialization; resulting in an increase in social and academic skills (Coie & Krehbiel, 1984). Successful implementation and positive effects related to peer-mediated instruction to increase social and communication skills for students with ASD, could prove as a beneficial strategy to increase academic achievement while concurrently improving social and communication skills; a main concern when educating students with ASD. Benefits of peer-mediated instruction are not one sided, peers gain by being exposed to learning materials more and learn acceptance and how to interact with their peers with ASD (Harper & Maheady, 2007). Peers are often able to understand their peer with ASD's nonverbal behavior, sooner than their teachers, they can serve as cues increasing generalization, and are a readily available resource (Gaustad, 1993; Hoff & Robinson, 2002; McCurdy & Cole, 2014).

2.1.4. Research in Peer-Mediated Academic Instruction

Peer-mediated academic instruction is well studied demonstrating strong effects for the learner and their peer, however, is understudied for students with ASD (Bene, Banda, & Brown, 2014; Bowman-Perrott et al., 2013; Cohen, Kulik, & Kulik, 1982;v Fitz-Gibbon, 1988; Hartely, 1977; Hott, Alresheed, & Henry, 2014). Limited studies for peer-mediated academic interventions and understanding of academic achievement for students with ASD are concerning and stress the need to address the research gap (Bene et al., 2014; Keen et al., 2016). A few meta-analysis and literature reviews included the use of peer-

mediated instruction to increase academic skills (Bene et al., 2014; Hott, Alresheed, & Henry, 2014; Wong et al., 2013; 2015). However, their definition of peer-mediated instruction was loosely defined (Bene et al., 2014) or include only a couple of studies related to academic skills (Hott et al., 2014; Wong et al., 2013; 2015). Both meta-analyses conducted moderator analysis analyzing the dependent variable, age, or setting. However, the dependent variables were categorized as academic, behavioral, or social, not reflective of the different types of skills taught within each category. Additionally, none of the studies included gray literature which could result in publication bias (Bene et al., 2014) and neither meta-analysis examined the quality of the literature, which can influence results (Cook et al., 2015).

2.1.5. Quality Standards

A review of the literature between 1990- 2011 identifies peer-mediated instruction as meeting What Works Clearinghouse (WWC) standards, however, just two studies involved academic dependent variables (Wong et al., 2013). Addressing limitations, Haas and colleagues (in revision) conducted an initial quality review of peer-mediated academic instruction (PMAI) including gray literature between 1960 and 2020. This review identified 17 studies (three group, and 14 single case). All studies demonstrated positive outcomes and a quality indicator analysis identified all group design studies meeting WWC standards and nine single case studies meeting WWC standards with reservations. These studies authored by eight research teams representing five geographic regions (Haas, Vannest, Thompson, Fuller, & Wattanawongwan, in revision) indicate PMAI could be considered an evidence-based practice (EBP) according to WWC standards. Identification of the quality of literature, inclusion of gray literature, and increasing the amount of studies

targeting academic skills, supports the need to quantifying the results related to PMAI. Additionally, with more studies, a moderator analysis can be performed to better understand for whom and under what circumstances PMAI is most beneficial.

2.1.6. Meta-Analysis

Students in special education tend to be a heterogeneous population of students with varying needs and abilities, because of this, it is difficult to execute group studies; making single-case experimental designs (SCED) a viable option for carrying out studies and making inferences, particularly with lower incidence disabilities (Alqraini, 2017; Odom et al., 2005; Tincani & Travers, 2018; Wendt & Miller, 2012). SCED are beneficial when identifying if an intervention works with a specific individual in order to determine whether to carry out the intervention with more students; whereas group designs look at the group of participants and effects among individuals with specific characteristics are not closely examined (Baer, Wolf, & Risley, 1968; Kazdin, 2011; Skinner, 1953). SCED can also enhance the knowledge of program effectiveness not seen in group designs, by allowing these variations to be explored and better understood (Pillemer & Light, 1980).

Meta-analyses are a statistical synthesis of quantitative data utilizing data extracted from a systematic review of original research to objectively identify the effectiveness of a specific topic (Beretvas & Chung, 2008; Borenstein, Hedges, Higgins, & Rothstien, 2011). Determining the effect size of an intervention provides confidence in the usefulness of the intervention (Carver, 1978; Rosnow & Rosenthal, 1989). Unlike the typical dichotomous rating seen in visual analysis (effect or no effect; relation or no relation), effect sizes provide a quantitative index of change to base treatment decisions on (Brossart, Parker, Olson, & Mahdevan, 2006). Additionally, effect sizes are not affected by the sample size,

and allows researchers to compare effect sizes across studies allowing more inferences to be made about the effectiveness of an intervention (Brossart, et al., 2006). Effect sizes are objective, can be verified, and replicated among naïve reviewers compared to visual analysis which is subject to the viewer's biases (Kavale, 1984). More recently, parametric single case effects sizes have been created to be comparable to group statistics such as Hedge's *g* and Cohen's *d* (Hedges, Pustejovsky, & Shadish, 2012; Hedges, Puestjovsky, & Shadish, 2013; Shadish, Hedges, Pustejovsky, 2014; Valentine, Tanner-Smith, Pustejovsky, & Lau, 2016).

2.1.6.1. Nonparametric Statistics

Nonparametric statistics are commonly used for single case research because single case designs violate assumptions of independence (Parker & Vannest, 2012). Dependent data can result in Type I and II errors as well as erroneous standard errors (Brossart, Parker, Olson, & Mahadevan, 2006). Nonparametric tests are distribution free, do not adhere to assumptions about a specific population, and can be used with smaller data sets (Grünke, Boon, & Burke, 2015). Limitations of nonparametric analysis include less statistical power, inferences are not easy to interpret, and does not perform well when analyzing skewed data (Rana, Singhal, & Dua, 2016). There are several non-parametric statistics that are commonly used when conducting a meta-analysis using SCEDs.

2.1.6.1.1. Tau-U

Tau-U combines Kendall's Tau and Mann-Whitney U, in order to analyze nonoverlapping data while controlling for trend (Parker, Vannest, & Davis, 2011; Parker et al., 2011b). Unlike the Improvement Rate Difference (IRD) and Nonoverlap of All Pairs (NAP), Tau-U can control for positive baseline trend, has strong statistical power,

generating more conservative results, and addresses known limitations of non-parametric statistics (Maggin, Cook, & Cook, 2019; Manolov, Losada, Chacon-Moscoco, & Sanduvete-Chaves, 2016; Parker et al., 2011b). Additionally, Tau-U can be used with smaller data sets (Vannest & Ninci, 2015), is distribution free which can account for the variability in data often seen in single case research and is not affected by ceiling effects (Parker et al., 2011b). Although Tau-U is popular due to strengths it is not without limitations. One limitation is that when baseline is corrected, the effects can be magnified and are not limited by their parameters, increasing Type-1 error. Tau-U can also be influenced by intervention phase length, with the data points likely resulting in a higher effect (Tarlow, 2017).

2.1.6.2. Parametric Statistics

Parametric effect size calculations are tests that make assumptions about a population based on a given distribution. Parametric tests rely on data that are independent and are measured using interval or ratio scales. However, parametric analyses are not useful for data sets with outliers or for small, ordinal, or nominal data sets. Yet, parametric analysis demonstrates strong statistical power and can produce meaningful inferences from results (van Dijk & Gage, 2019; Rana et al., 2016).

2.1.6.2.1. Between-Case Standard Mean Difference

Between Case Standard Mean Difference (BC-SMD) was introduced as an effect size estimate that could be used in conjunction with group design estimates such as Cohen's *d* or Hedges' *g* (Valentine et al, 2016). However, BC-SMD can only be computed for multiple-baseline and reversal designs and for data sets with three legs or demonstrations of effects. Using BC-SMD, allows researchers to compare both single case

and group studies when completing a meta-analysis, improving the power of the results found. BC-SMD is beneficial because of its power analyses with known sampling properties and unlike other parametric statistics, is can control for autocorrelation and trend (Hedges et al., 2012; Valentine et al., 2016).

2.1.6.2.2. Cohen's d

Cohen's *d* is a group statistic that estimates the standard mean difference of a sample. Use of this statistic allows for comparison of treatments that may not utilize the same type of measurement. Cohen's *d* is calculated by using the means and standard deviation of the treatment and control's posttest scores. Effect size calculations for Cohen's *d* can be biased if the sample size is small (i.e. smaller than 30; Cohen, 1988; Goulet-Pelletier & Cousineau, 2018).

2.1.7. Publication Bias

Publication bias is a threat to the validity of results due to a favoritism for journals to publish studies with positive results (Cook & Therrien, 2017; Gage, Cook, & Reichow, 2017; Rothstein, Sutton, & Borenstein, 2005; Thornton & Lee, 2000). Publication of only positive results can lead to an inflation of the effectiveness of in intervention. Special education research is less likely to include gray literature or analyze the possibility of publication bias (Gage et al., 2017). Publication bias can be mitigated by including gray literature such as dissertations, conference proceedings and desk-drawer publications. There are several statistical methods that can be used to assess publication bias. These methods are used to determine an estimated effect of all research conducted (Thornton & Lee, 2000).

2.1.8. Purpose

Understanding the effects of identified quality studies allow researchers and educators to select practices that are known to work for a specific population (Beretvas & Chung, 2008). The purpose of this study was to conduct an effect size analysis to establish the effects of PMI for academic skills with students with ASD. I will also conduct a moderator analysis to establish an effect size for each. Implications about the effect size results based on quality will be discussed in further detail.

1. What is the overall magnitude of effect of PMAI for students with autism?
    a. Are there differential effects of PMAI for studies meeting quality standards or meeting quality standards with reservations compared to studies not meeting quality standards?
2. What is the magnitude of effect of PMAI on academic engagement, academic skill acquisition, reading comprehension, and author groups?
    a. Are effects of PMAI for academic engagement, academic skill acquisition, reading comprehension, and author groups influenced by studies not meeting quality standards compared to studies meeting them or meeting them with reservations.
3. How does the parametric effect sizes compare between single case and group design standard mean difference measures?
4. Is publication bias present, and what are the effects of PMAI when accounting for publication bias?

2.2. Method

A comprehensive review of the literature related to PMAI included a systematic literature review, variable coding, a screening for quality threshold, data extraction, an examination of data extracted and effect size calculation for each study. Following this I implemented a meta-analytic approach to examining moderators, related to variables coded, and overall effects of this body of literature. The systematic search follows Preferred Reporting in Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009). This study adheres to guidelines and recommendations for engaging in high-quality comprehensive meta-analysis, which will be further described in each of the following sections as outlined by the PRISMA checklist (Moher et al., 2009).

2.2.1. Information Sources

Beginning with a database search using the following databases: *ERIC, PsycINFO, Academic Search Ultimate,* and *OpenDissertations,* key words were identified and a final search on January 7, 2020 was completed encompassing the full date range. Prior to the final search, I contacted two of the study authors who appeared in multiple studies to obtain additional unpublished studies.

2.2.2. Search

Using the databases, limits were set for English language journals only. A professional reference librarian conducted the search to reflect standards and ensure independence. Gray literature (dissertations/ theses, reports, conference papers, and books) were included.

Using the thesaurus in ERIC and PsycINFO®, I identified keys words to be included in the search. Utilizing the thesaurus in ERIC and PsycINFO®, terms associated with ASD such as: Asperger Syndrome and Pervasive Developmental Disorders were included. Additionally, the thesaurus identified terms associated with peer tutoring, instructional strategies, and outcomes, and academic subjects.

Additionally, key words in prior meta-analyses (Bene et al., 2014; Hott et al., 2014) that we had not previously identified were included. The identified databases were searched with 108 terms related to four categories: *autism* (3 terms), *academic subject* (73 terms), *peer tutoring* (20 terms), and *outcomes* (12 terms). To identify all possible articles, key terms were placed in the search field using the following drop-down selections: descriptors [exact] (DE), descriptors (SU), abstract (AB), and title (TI). Boolean strings included in the searches encompassed following: *autism* AND *academic subject* AND, *outcomes, OR autism* AND *academic subject* AND, *peer tutoring*. The comprehensive list of keywords will be provided in Table A-1 . This search procedure is a more comprehensive search methodology compared to prior studies. After identifying key terms and using the four databases, 7,640 articles were identified through the database search.

2.2.2.1. Eligibility Criteria

For the purpose of this meta-analysis, the author used the following definition for peer mediators: individuals who work with another person to teach them a skill (Wong et al., 2015). Studies included met the following criteria: (a) participants were school aged (k-12th grade), (b) participants were diagnosed with ASD, (c) interventionists identified as typically developing same age or grade peers, (d) experimental single case and group design methodology as opposed to narrative or non-experimental, (e) operationally defined

academic behavior as a dependent variable, and (f) studies were not written in English. If studies included participants who did not fit inclusion criteria (i.e., peers were different age or grade, one peer did not fall into the age range), those participants were excluded and participants who fit the inclusion criteria were included.

Studies were excluded for the following: (a) none of the participants in the study were not school aged (i.e., students were younger than five and older than 21, and were preschool or post-secondary students), (b) none of the participants in the study were diagnosed with ASD, (c) interventionist were not same age or grade typically developing peers, (d) studies identified as qualitative, reviews, or practitioner papers (e) behaviors not operationally defined or internalized behaviors such as reflection, thinking or cognitive tasks, behaviors not operationally defined or solely measuring social goals, and (f) studies in languages other than English, were also thrown out. Publication status of articles included peer-reviewed and gray literature including dissertations and desk-draw publications.

2.2.2.2. Title and Abstract Review

To complete the title abstract review, the 7,640 articles were exported and placed into Rayyan, a systematic review application that automates title abstract reviews and allows for interrater agreement (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016). During the exportation process, EBSCOhost did not export duplicate identified in its program. Once in Rayyan, 6,027 articles remained, of the remaining articles and an additional 228 articles were identified as duplicated. After screening those articles, 130 articles were true duplicates and deleted resulting in 5,897 articles for initial title abstract search. Using the inclusion criteria title abstracts were reviewed to determine if they met

criteria. If it was unclear whether the article fit criteria they were included for the full-text review. Title abstract review resulted in the exclusion of 5,877 and the inclusion of 20 articles that moved to the full-text review.

2.2.2.3. Forward and Ancestral Search

Forward and ancestral searching consisted of using the 20 articles to be included in the full-text review as well as contacting authors who appeared in multiple studies for any desk-drawer publications. Ancestral search consisted of reviewing the references within each article for possible titles meeting the criteria, through this two additional articles were identified. Forward search consisted of placing articles into Google Scholar and selecting cited by. This method did not produce any additional articles. Lastly, two authors were contacted and asked if they possessed any desk-drawer publications. This resulted in the identification of a one additional article. In total 23 articles were included for full-text review

2.2.2.4. Full-text Review

PDFs of the 23 articles included for full-text review were downloaded and added to Google drive to be screened using the same inclusion criteria. Of those articles, nine were excluded, two because no experimental design was present, three because the article did not have data that could be extracted, and four were excluded because the peer tutors were not the same ages as their peers with autism. Exclusion of the nine articles left 14 articles for analysis (see Figure 2-1).

After completing all the search procedures, studies included in prior meta-analysis, but not included or found through the search procedures described were reviewed (Bene et al., 2014; Hott et al., 2014). Studies were excluded for the following reasons: Peers served

as models (Egel, Richman, & Kogel,1981), the use of peers were unclear (Whalon & Hanline, 2008), students with autism served as the peer tutor (Kamps, Dugan, & Potucek, 1999), and communication skills served as the dependent variable (Chung et al., 2007; Hunt, Staub, Alwell, & Goetz, 1994; Krebs, McDaniel, & Neeley 2010; Petursdottir, McComas, McMaster, & Horner, 2007).

2.2.3. Data Collection

After screening articles for eligibility, studies were then coded for variables determined a priori and quality of study design, and data were extracted for all the studies. Data points from the single case study graphs were extracted and mean scores and standard deviations were extracted for the included group studies.

2.2.3.1. Variable Coding

Using a coding sheet created in Microsoft Excel, studies were coded for multiple variables to allow for identification of potential moderators; see Table A- for definitions used. The following data was collected for each study: (a) participant characteristics, including age, grade, sex, race, IQ, and functioning level (for peers with ASD) if data were not available, it was coded as NA; (b) setting (i.e., general education, special education, pull out program, etc.) (c) research design (i.e., multiple baseline, reversal, alternating treatment, randomized control trial, etc..); (d) independent variable (i.e., how was peer-mediated instruction was defined); (e) dependent variable (i.e., what skill set was being measured such academic engagement or academic skill acquisition such as reading comprehension, test scores, academic tasks such as money identification, etc.); and (f) academic subject targeted (i.e, reading, math, science, etc.) . Participant characteristics were coded for the students with autism as well as the typically developing peer.

2.2.3.2. Quality Standards Coding

Studies were evaluated using either the WWC standards for group or single case designs (Kratochwill et al., 2010; WWC, 2017). For group design studies, articles were evaluated on: (1) group assignment, (2) attrition, (3a) outcome measures, (3b) reliability, (3c) alignment, (3d) measurement, (4a) presence of confounding variables in a single study unit, (4b) presence of confounding variables in the group characteristics, (4c) presence of confounding variables in the independent variable, and (4d) presence of confounding variables related to timing of measures; see Table A-3for operational definitions. Single case studies were evaluated on the following: (a) independent variable manipulation, (2a) interobserver agreement data collection, (2b) interobserver agreement data collection for 20% of the data for each phase, (2c) average of interobserver agreement was at least 80%, (3) if there was an attempt to demonstrate effects, and (4) number of data points collected per phase; see Table A-4 for operational definitions. After reviewing the standards for each article, studies where scored as having met, meeting with reservations, or not meeting quality indicators, based on WWC criteria (Kratochwill et al., 2010; WWC, 2017). For the purpose of this meta-analysis, studies meeting and meeting standards with reservations were considered to be "quality studies."

2.2.3.3. Data Extraction

Original analysis sought to identify multiple moderators that may influence the effects of PMAI, however, characteristics such as setting were too homogeneous and age were too heterogeneous to allow for a moderator analysis (Lipsey & Wilson, 2001). Moderators included for analysis were academic engagement, academic skill acquisition, reading comprehension, and author group. Included single-case studies had raw data

extracted using the website https://apps.automeris.io/wpd/. This website allowed for data extraction of the standard celeration charts seen in Regelski (2016). For data to be extracted, a jpeg was created for each graph. If the graph utilized a multiple baseline design a jpeg was created for each leg. The jpeg was uploaded to the website where x-y axes were aligned based on number provided in the graphs. Data were then extracted by selecting each data point in order as close to the middle of the point as possible. Data points could be adjusted using the arrow keys as necessary to increase accuracy. Raw data were then exported as a .csv file then combined into an Excel sheet organizing studies by the author, year, participant, and academic skill. A-B phase contrasts consisted of baseline and intervention data fitting inclusion criteria (i.e. social data was not extracted).

2.2.4. Inter-rater Agreement

The first author and a graduate student individually reviewed 20% of the identified titles and abstracts (n =1,211) using the inclusion and exclusion criteria and 100% of studies during full text. Training for title and abstract review consisted of reviewing the inclusion/exclusion criteria, then reviewing two articles, one meeting criteria and one not. Agreement was 100% for the two articles including reason for exclusion. The graduate student was then asked to conduct a title abstract review for their portion of articles, because the same reviewer conducted the full text review only definitions were reviewed prior to the review. Training with a different graduate student for variable coding and quality indicators included reviewing definitions for each item, illustrations, and non-examples; because reliability and comprehension of definitions in the training session met 100% mastery, no additional training was required. Reliability was calculated as

agreements divided by agreements plus disagreements. If disagreements occurred, the article was reviewed together to reach a consensus.

Inter-rater agreement was 99% for studies coded for title and abstract review. All of the studies included for full-text review were coded for reliability using the same inclusion and exclusion criteria. Inter-rater agreement was 85% for studies coded for full text. Reliability for variable coding was 96% based on 71% of the articles. Scores ranged for each variable, with : (a) participant characteristics scores were 88 and 82% for participants with ASD and their peers respectively (b) setting (100%), (c) research design (100%), (d) independent variable (100%), (e) dependent variable (100%), and (f) academic subject (100%). Reliability for quality indicators was 83% based on coding 71% of the articles, scores ranged from 0-100%. Low scores for attrition (0%) and reliability of outcome measures (50%) were a result of only two studies being coded for group designs. Average reliability reported and number of data within the graph was 89% while the remaining single case quality standards received a score of 100%.

Inter-rater reliability was coded for data extraction using WebPlotDigitizer 4.1 (https://apps.automeris.io/wpd/). The same graduate student helped with data extraction. Since the graduate student was familiar with the program, training did not occur. For agreements during data extraction, if data points differed by less than or equal to 1% difference they were considered an agreement, this is due to the sensitivity when extracting data using the data extraction website (Boyle, Samaha, Rodewald, & Hoffmann, 2013; Drevon, Fursa, & Malcom, 2017; Rakap, Rakap, Evran, & Cig, 2016). Inter-rater reliability for data extraction is 83% and was assessed for 80% of the studies.

2.2.5. Effect Size Calculations

Data were analyzed using a number of statistical platforms. Tau-U was calculated using the Tau-U calculator (Vannest, Parker, Gonen, & Adiguzel, 2016). Between-case standard mean difference (BC-SMD) was calculated using the online BC-SMD calculator (Pustejovsky, 2016). R studio was used to calculate the other nonparametric single case effect sizes, Cohen's *d* for the group design studies, and a random effects model for the meta-analysis.

2.2.5.1. Tau-U

Using Tau-U, an omnibus effect was calculated for all the studies, individual studies, and the following moderators: academic engagement, academic skill acquisition, reading comprehension, and author groups. Using the Tau-U calculator (Vannest, et al., 2016), A-B phases were contrasted with and without a corrected baseline to find the effect size of each participant, then combined for study level effects. The Tau-U calculator was used because it provided standard deviations and confidence intervals.

Tau- U is calculated by comparing phase A and B data pairs and calculating the percentage of improvement. Calculating the percentage of improvement is completed by comparing phase A and B data points and determining if the data point is improved from baseline. Improvement is determined by the hypothesized direction of behavior change (e.g., if the intervention is to decrease the behavior, if phase B data points are lower than phase A, than improvement is made). Ties are considered half a point of non-improvement. Effect size is then calculated as improved data points minus non-improved data points plus ties divided by the total number of comparisons. For the purpose of this study, Tau-U scores were interpreted as follows: (1) Tau-U scores ranging from 0 to 0.20 demonstrate a

small effect; (2) Tau-U scores ranging from 0.20 to 0.60 demonstrate a moderate effect; (3) Tau-U scores ranging from 0.60 to 0.80 demonstrate a large effect, and (4) Tau-U scores raining from 0.80 and above indicate a very large change (Parker et al., 2011). However, these ranges are arbitrarily set, and effects should be viewed with caution.

2.2.5.2. Between-Case and Within-Case Standard Mean Difference

Between case standard mean difference (BC-SMD) creates an effect size by calculating the mean shift between baseline and intervention (Hedges et al., 2012). A .csv file was created for each study individually with columns labeled as case, representing the study and participant, phase, A indicated baseline and B indicated intervention, session, session number (e.g., 1,2,3…27), and outcome, where data extracted was placed. Studies measuring multiple outcomes would have a separate .csv file for each outcome (Kamps, Locke, Delquadri, & Hall, 1989; Regelski, 2016). Using the BC-SMD calculator each study was uploaded separately, and variables were checked to match each column, as well as indicating the type of design for each study. Under the model tab, the restricted maximum likelihood estimation method was chosen and the include random effect level box was selected in the treatment phase in addition to the other boxes pre-selected. The estimation method and random effect in the treatment phase were both selected to account for variability within the studies. Under the effect size tab produced the BC-SMD which was then downloaded and combined into the designated .csv file that would later be used for the meta-analysis calculation. Interpretation of each effect size can be seen in Table 2-1.

2.2.5.3. Cohen's *d*

Cohen's was calculated for the two group studies by taking the difference between the means and dividing them by the pooled standard deviation. Although Cohen's *d* can be biased, the sample sizes for both studies were large enough to reduce the likelihood for bias. Using the metafor package in R studio, Cohen's *d* was calculated for the two group studies. The effect size and standard error where then combined with the BC-SMD effect sizes for the single case studies for comparison purposes only. For both BC-SMD and Cohen's *d* scores less than 0.20 indicate a small effect, scores between 0.20- 0.50 indicate a medium effect, 0.50-0.80 demonstrate a large effect and scores above 0.80 indicate a very large effect (Cohen, 1988).

2.2.6. Meta-Analysis of Effect Sizes

After independent effect sizes were calculated using the various methods, the effect size and confidence intervals calculated using Cohen's *d* for the group studies and BC-SMD for the single case studies were combined to create a forest plot to compare the two effects because the single-case metric used is comparable to group design metrics although results for single case studies may be inflated (Ennis & Losinski, 2019; Shadish et al., 2014). A meta-analysis of effect sizes was run using the online Tau-U calculator. The online calculator can be used to combine individual effects into an omnibus effect for moderators and study effects.

2.2.6.1. Test of Homogeneity

A test of homogeneity also referred to as the *Q*-statistic, tests the null hypothesis that the effect sizes are representative of a population of effect sizes. Rejecting the null indicates the effect size does not reflect the population mean and study characteristics (i.e.,

moderators) may influence the effects (Lipsey & Wilson, 2001). In a test of homogeneity, I^2 represents the amount of variability that is not explained through sampling error, and τ^2 describes variation of the true effects (Pigott, 2012). A random-effects model assumes that studies are a sample from a population and the results from the sample should generalize to the population (Pigott, 2012).

2.2.6.2. Moderator Analysis

Studies were coded for multiple moderators, such as age, grade, gender, ethnicity, intervention, and behavior measured. However, with limited number of studies many moderators could not be analyzed either due to too much homogeneity or heterogeneity. A moderator analysis was conducted by using the effect sizes for each study. Using the Tau-U calculator, effect sizes at the participant level were combined for specific moderators (i.e., academic engagement, academic skill acquisition, reading comprehension, quality standards, and author groups) to create an omnibus effect size. At the study level, a Kruskal-Wallis one-way analysis of variance was calculated in R studio for each nonparametric effect to assess the statistical significance of each moderator (Kruskal & Wallis, 1952). Since each moderator was dichotomous, no further moderator analysis evaluation was needed.

2.2.7. Publication Bias

A test for publication bias was conducted in R studio after the effect size calculation for PMAI. Trim-and-fill, Egger's regression of the intercepts test, and Rosenthal's fail-safe *N* were used to assess publication bias (Egger, Davey Smith, Schneider, & Minder, 1997; Duval & Tweedie, 2000, Rosenthal, 1979). The trim-and-fill method uses the funnel plot analysis to add studies within the funnel plot until symmetry is

achieved and calculating a new effect size accounting for the added studies. Egger's regression anticipates the effect size assuming all studies are available. If the intercept is zero, this indicates no publication bias, however if the intercept is above zero publication bias is present.

2.3. Results

Overall, 12 single case studies that included 30 students with 4,279 A-B pairs and 37 AB phase contrasts and two group studies comparing 42 (Marshak et al., 2011) and 99 students (Carter et al., 2016) were analyzed. Nine (75%) single case studies met WWC quality indicators with reservations. Both group studies fully met WWC standards. The dependent variables and moderators for the studies fell into three categories: academic engagement, academic skill acquisition, and reading comprehension; moderators also included two author groups (see Table 2-2). Study dates ranged from 1989- 2018 with age and grade ranging from 8 to 19 years old and third to twelfth grade. An overall effect size of single case studies included in the meta-analysis demonstrates a Tau-U effect of 0.54 with a 90% CI [0.46, 0.61] and a BC-SMD effect of 0.57, 95%CI [0.30, 0.84] demonstrating moderate effects across both measures (Cohen, 1988; Sullivan & Feinn, 2012; Parker et al., 2011b).

2.3.1. Effects of Peer-Mediated Academic Instruction

The overall Tau-U effect size for PMAI on all academic behavior using was 0.54 with a 90% CI [0.46, 0.61] and a BC-SMD effect of 0.57, 95%CI [0.30, 0.84] indicating moderate effects (Cohen, 1988; Parker et al., 2011b). Studies meeting quality indicator standards produced a Tau-U and BC-SMD effect of 0.56, 90% CI [0.47, 0.64] and 0.58, 95% CI [0.27, 0.90] respectively indicating medium effects. On the other hand, studies not

meeting quality indicators produced a Tau-U and BC-SMD effect of 0.44, 90% CI [0.25, 0.64] and 0.51, 95% CI [-0.17, 1.21] indicating a slightly smaller yet moderate effect (see Figure 2-2 and Table 2-3).

A random-effects model using the BC-SMD suggests no statistical significance, $Q(8) = 9.22$, $p = .32$, $\tau^2 = 0.03$, and $I^2 = 15.06\%$. This suggests that students are representative of the population. Additionally, a test of heterogeneity for study quality suggests no statistical significance a $Q(7) = 9.15$, $p = .24$, $\tau^2 = 0.05$, and $I^2 = 24.19\%$. Both of these results indicate moderate variation with low heterogeneity.

2.3.1.1. Effect size for Moderator Variables

Effect size based on skills taught (see Figure 2-3), indicate academic engagement (Carter, Cushing, Clark, & Kennedy, 2005; Cater et al., 2016; 2017; Huber, 2016; Huber, Carter, Lopano, & Stankiewicz, 2018; Schaefer, Cannella-Malone, & Brock 2018), demonstrated a Tau-U score of 0.33, 90% CI [0.02, 0.47] and a BC-SMD score of 0.31 95% CI [-0.29, 0.92] indicating a medium effect. Academic engagement is slightly higher for studies meeting quality indicators (Carter et al., 2005; 2016; 2017; Huber et al., 2018; Schaefer et al., 2018) with a Tau-U score of 0.34 90% CI [0.17,0.50] and a BC-SMD score of 0.36, 95% CI [-0.69, 1.41], demonstrating a medium effect. Compared to those who did not, Huber (2016), demonstrated a Tau-U score of 0.33, 90% CI [0.10, 0.56] and a BC-SMD score of 0.26, 95% CI [-1.20, 1.71], indicating a moderate effect. A test of heterogeneity for quality of academic engagement studies produced a $Q(7) = 27.34$ with a p-value of 0.0003 and an $I^2 = 73.32\%$ with a $\tau^2 = 0.44$ indicate statistical significance with high variation and heterogeneity suggesting quality studies differ from studies that are not of quality.

Overall academic scores (Dugan et al., 1995; Kamps et al., 1989; Kamps, Barbetta, Leonard, & Delquadri, 1994; Kamps, Leonard, Potucek, & Garrison-Harrell, 1995; Koh, 2013; Marshak et al., 2011; Regelski, 2016; Reutebuch, Zein, Kim, Weinberg, & Vaughn, 2015) demonstrates a Tau-U score of 0.63, 90% CI [0.54, 0.73] and a BC-SMD score of 0.32, 95% CI [-0.10, 0.72] signifying large and medium effects respectively. Academic scores is similar for studies meeting quality indicators (Kamps et al., 1989; 1994; 1995; Marshak et al., 2011; Regelski, 2016; Reutebuch et al., 2015) with a Tau-U score of 0.63, 90% CI [0.53, 0.72] and a BC-SMD of 0.55, 95% CI [0.08, 1.03] representing large and medium effect size respectively. Whereas studies not meeting quality indicators (Dugan et al., 1995; Kamps et al., 1995; Koh, 2013) demonstrate large and very large effect sizes respectively with a higher Tau-U score of 0.73, 90% CI [0.36, 1.00] and a BC-SMD score of 1.03, 95% CI [-0.32, 2.37]. The results indicate that PMAI has a large and medium effect on increasing academic scores (see Figure 2-4 and Table 2-4). A test of heterogeneity for quality of academic scores studies produced a Q (7) = 8.41 with a p-value of 0.30 and an I^2= 12.04% with a τ^2= 0.02 suggesting no statistical significance and indicating low variation and heterogeneity.

Reading comprehension demonstrated a large effect of 0.75, 90% CI [0.63, 0.88] and 0.74, 95% CI [-0.03, 1.52] for Tau-U and BC-SMD respectively for all studies (Kamps et al., 1989; 1994; Koh, 2013; Regelski, 2016; Reutebuch et al., 2015). Studies meeting quality (Kamps et al., 1989; 1994; Regelski, 2016. Reutebuch et al., 2015) indicated a large and very large effect of 0.75, 90% CI [0.62, 0.87] and 1.06, 95% CI [0.52, 1.61] for Tau-U and BC-SMD respectively. However, the one study not meeting quality indicators (Koh, 2013) demonstrated a large effect of 0.94 90% CI [0.24, 1.00] for Tau-U. BC-SMD

could not be calculated for this study because there were not enough participants (see Figure 2-5 and Table 2-4). Additionally, a test of heterogeneity for quality of reading comprehension studies could not be calculated using the BC-SMD effects.

From all the studies, two author groups were prevalent (see Figure 2-6 and Table 2-4).

The first author group consisted of six studies (Carter et al., 2005; 2016; Huber, 2016; Huber et al., 2018; Schaefer et al., 2018) resulting in an effect size of 0.33, 90% CI[0.20, 0.47] and 0.31 with a 95% CI of [-0.29, 0.92] indicating a medium effect for Tau-U and BC-SMD respectively. Studies meeting quality (Carter et al., 2005; 2016; Huber et al., 2018; Schaefer et al., 2018) demonstrated a Tau-U effect of 0.34, 90% CI [0.17, 0.50] and a BC-SMD effect of 0.36, 95%CI [-0.69, 1.41], indicating medium effects. Studies not meeting quality standards demonstrated a medium effect of 0.33, 90% CI [0.10, 0.56] and 0.26, 95% CI [-1.2, 1.71] for Tau-U and BC-SMD respectively.

The second author group consisted of four studies (Dugan et al., 1995; Kamps et al., 1989; 1994; 1995) resulting in an effect of 0.87, 90% CI [0.74, 0.99] and 0.76 with a 95% CI [0.14. 1.38] suggesting a very large and large effect size for Tau-U and BC-SMD. Studies meeting quality (Kamps et al., 1989; 1994) demonstrated a Tau-U effect of 0.89, 90% CI [0.75, 1.00] and a BC-SMD effect of 0.69, 95%CI [-0.04, 1.42], indicating very large and large effects. Studies not meeting quality standards demonstrated a medium and very large effects of 0.65, 90% CI [0.22, 1.00] and 1.03, 95% CI [-0.34, 2.34] for Tau-U and BC-SMD respectively. A test of heterogeneity for author groups produced a Q (7) = 27.34 and 17.61 with p-values of 0.0003, and 0.014 with an I^2= 75.32% and 60.65 with a τ^2= 0.44 and 0.22 for author groups Carter and Kamps respectively. These results suggest

statistical significance among author group and quality with high variation and moderate to low heterogeneity.

A Kruskal-Wallis analysis was computed for the nonparametric effect size calculations to determine if a difference among moderators existed (Kruskal & Wallis, 1952). For all effect size calculations except IRD, the moderator of author produced statistically significant results indicating author groups are not similar. When running a moderated analysis using Tau-U effects, statistically significant results were found between the moderators of academic engagement and academic scores indicating the moderators are different.

2.3.2. Parametric Effects for Group and Single Case

When comparing BC-SMD effects to Cohen's *d*, BC-SMD effects align with Cohen's *d* (see Figure 2-7). Running a random effects model produces a Q (10) = 14.57 with a p-value of 0.15, an I^2 of 33.26% and a τ^2 of 0.24 and an effect of 0.62, 95% CI [0.36, 0.87]. This indicated results demonstrate a large effect with homogeneity and moderate variance.

Running test for publication bias results in three studies missing from the left side (see Figure 2-8) with an effect of 0.44, 95% CI [0.15, 0.73]. The test for heterogeneity produced a Q (13) = 29.18 with a p-value of 0.006, an I^2 of 57.67% and a τ^2 of 0.41 rejecting the null suggesting results are heterogeneous. Egger's regression test resulted in no statistically significant evidence for publication bias [z= 0.88, p-value= 0.38] indicating no publication bias.

2.3.3. Publication Bias

Running publication bias analyses help identify what effects an intervention may produce if all studies, even those with non-statistically significant results, were included in the meta-analysis. Although gray literature and desk drawer publications were sought out in this meta-analysis to reduce the likelihood of publication bias, I ran a funnel plot, trim-and-fill, and Egger's regression analysis for each effect size measure that produced an effect size and standard error to identify any publication bias. Inspection of the funnel plot indicates the data points are not symmetrical with a few of the points falling outside of the plot indicating some publication bias. Running Egger's regression test resulted in non-statistically significant evidence for publication bias [z= 21.11, p=0.27] using Tau-U effects. The trim-and-fill analysis to identify unbiased effects resulted in a Q(df=17) = 3,985.18 with a p-value <0.001 for Tau-U (see Figure 2-9). These statistically significant results demonstrate more heterogeneous effect sizes. The trim-and-fill model indicated two studies were missing on the left side for Tau-U producing a medium effects for Tau-U of 0.57 with a 95% CI [0.39, 0.76].

Using the parametric analysis BC-SMD, the trim and fill model indicated two studies were missing from the left side producing a Q (10) = 15.57 with a p-value of 0.11 indicating no statistical significance with an I^2 of 36.43% and a τ^2 of 0.09. These suggest homogeneous results with moderate variance. Egger's regression test resulted in no statistically significant evidence for publication bias [z= 0.90, p-value= 0.37] indicating no publication bias.

2.4. Discussion

Results suggest similar conclusions regarding the benefit from PMAI. An overall effect size for academic behaviors suggests moderate Tau-U and large BC-SMD effects for PMAI. Additionally, studies meeting quality resulted in slightly higher effect compared to those not meeting. When evaluating moderators, studies focusing on academic skills and reading comprehension demonstrate large Tau-U effects and moderate BC-SMD effect whereas studies focusing on academic engagement moderate effects. Similar to the overall effect, quality studies demonstrated slightly high effect sizes than studies not meeting quality standards, with the exception of reading comprehension, however, this could be the result of limited number of studies (n=1) and participants (n=1) used for the analysis examining studies not meeting quality. A test of moderators indicated that results were not influenced by moderators other than author groups. Variation in the results could be reflective of behaviors measured, that is percentage of engagement (Carter) compared to gain in academic scores (Kamps). These results suggest that PMAI may be more effective when teaching academic skills to students with ASD. It is important to note strength of effect was determined using an arbitrarily set standard (Cohen, 1988; Parker et al., 2011a; Vannest & Ninci, 2015), and the results should be interpreted with caution.

When examining results using parametric effect size calculations, overall results aligned with the non-parametric results of Tau-U. Although BC-SMD was created to have an effect size comparison comparable to Cohen's *d* or Hedges' *g*, results should be interpreted with caution. Although BC-SMD can correct for autocorrelation, the variances produced can result in large biases (Hedges et al., 2012). Additionally, four single case studies were excluded because they did not meet the minimum requirement of having three

cases (Shadish et al., 2014) limiting inferences that can be made. Evidence of publication bias indicates more research is needed or identified (i.e., desk drawer publications).

The current research results align with past studies that suggest heterogeneity of ASD may influence academic achievement (Chen et al., 2019; Griswold et al., 2002; Nation et al., 2006). To understand results specific to PMAI, future research should focus on creating benchmark effect sizes and using percentile ranking (Ganz et al., 2017).

Students with ASD typically have underlying behaviors that may interfere with learning such as communication difficulties, challenging behavior, or decrease cognitive functioning that are not targeted during intervention (Chen et al., 2019; Fleury et al., 2014; Griswold et al., 2002; Nation et al., 2006; Paynter et al., 2016; Roberts & Webster, 2020; Watkins et al., 2019). These diverse challenges may be reflected in the present meta-analysis in the heterogeneity. However, they were not coded because of the lack of data. Future research should identify and address if these or other variables may influence the outcome of results. For example, were prerequisite skills identified before intervention to ensure students would be capable of performing the task?

Peer-mediated interventions demonstrate positive effects for increasing social skills in children with ASD (Watkins et al., 2015; Zhang & Wheeler, 2011) as well as positive effects for increasing academic skills for students with different disabilities (Bowman-Perrott et al., 2013). Combining the results of this study provides a promising intervention that can be used to increase academic skills for children with ASD, a skill often understudied (Wei et al., 2015). Studies show an increase in social skills without additional training when using peer mediated instruction to change other behaviors (Fleury et al., 2014; Krebs et al., 2010).

Peers are useful for several reasons, first they can reduce stigma associated with a paraprofessional (Broer, Doyle, & Giangreco, 2005; Carter & Hughes, 2005; Copeland et al., 2004; Carter, Sisco, Melekoglu & Kurkowski, 2007). Peers are a value resource with students with disabilities because they are typically in the same settings and can act as a signal to remind students what is expected of them (McCurdy & Cole, 2014). Second peers can also help generalize skills in other settings they share with students with disabilities when they serve as a cue. Lastly, teachers' time is freed when peers are helping. This allows them to focus more on instruction or additional teaching support which proves to be time and cost efficient rather than focusing on challenging behavior (Hoff & Robinson, 2002).

Peer tutors and students with ASD benefit from this relationship. They become more confident, there are changes in their attitudes about school, and they form relationships with their peers (Asselin, & Vasa, 1981; Bedrosian et al., 2003; Carter et al., 2016; Franca, Kerr, Reitz, & Lambert, 1990; Scruggs, Mastropieri, Richter, 1985). Additionally, peer tutors acquire new skills by providing feedback and correction to tutees. Peers learn to work with and support their peers with disabilities (Asselin, & Vasa, 1981; Franca, 1984). Tutors deficient in skills benefit when teaching others (Franca et al., 1990; Scruggs et al., 1985) and those competent to teach the skills, build fluency and confidence (Asselin, & Vasa, 1981; Scruggs et al., 1985; Singh, 1982).

2.4.1. Implications for Practice

Given the results of these studies reviewed, students with autism may benefit academically when using peer-mediated instruction. PMAI frees up time for teachers to focus on instruction at an individual level. Peers can also be useful in keeping students on

task during independent work (Hoff & Robinson, 2002; McCurdy & Cole, 2014). PMAI is cost efficient and can be easy to implement after initial training, making the strategy socially valid for educators.

2.4.2. Implication for Research

Although the results of these studies are promising, there are a few implications for research that need to be addressed. First replication is needed to increase confidence in the results. Tt is also important to determine which strategy is the most effective because there is variation among the PMAI's procedure for implementation. More studies should focus on specific academic areas to better understand with whom and under what conditions PMAI is most beneficial. Studies should also focus on increasing academic skills and measuring social skills as a secondary effect outside of tutoring sessions. As noted above, effect sizes cannot distinguish between clinical and statistical significance. Therefore, future research should combine the use of visual and statistical analysis to determine what effect size range, using a percentile ranking, could determine clinical significance for PMAI (Ganz et al., 2017; Kromrey & Foster-Johnson, 1996).

2.5. References

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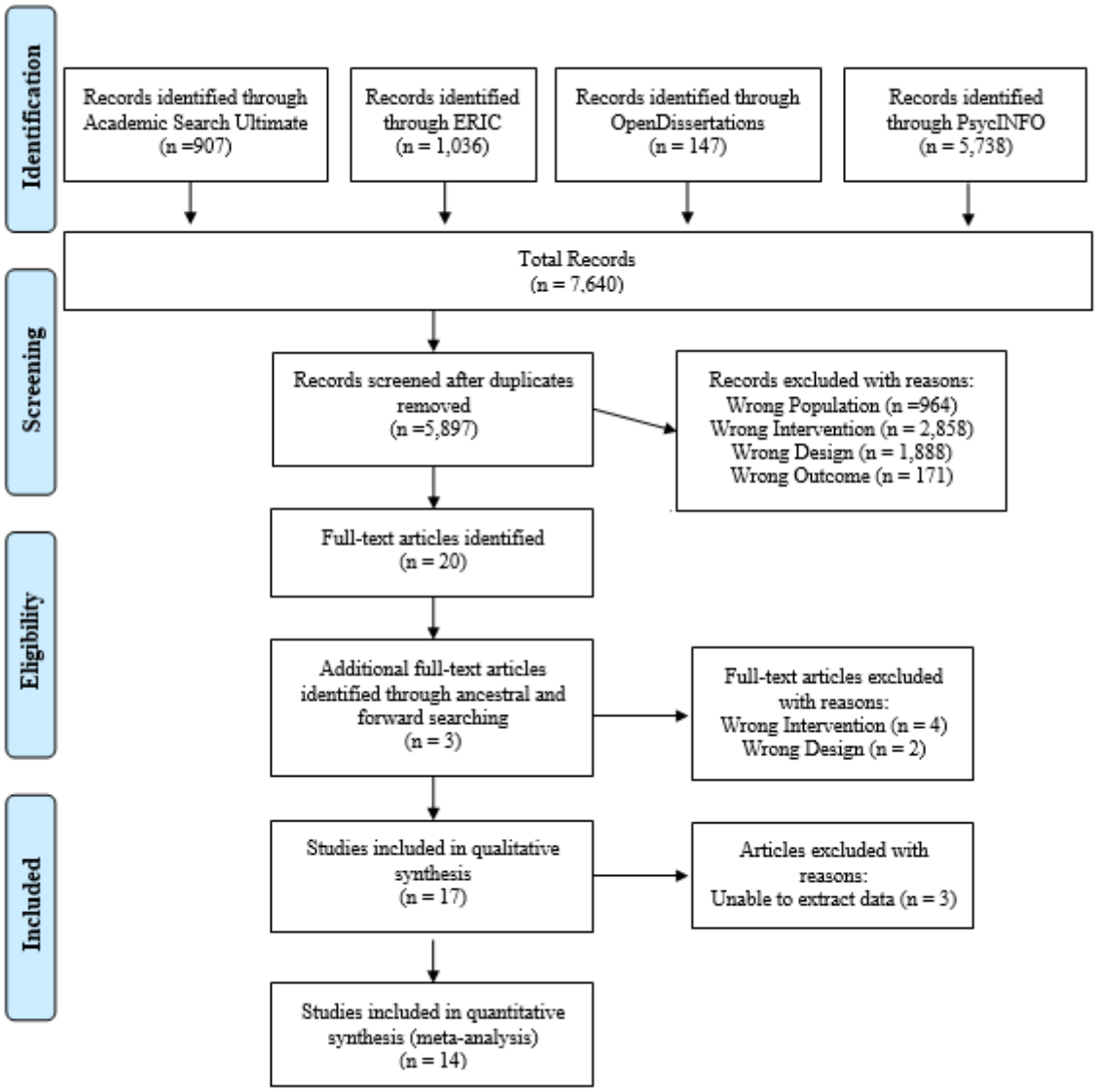

Figure 2-1 PRISMA Guideline for Inclusion

Reprinted From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

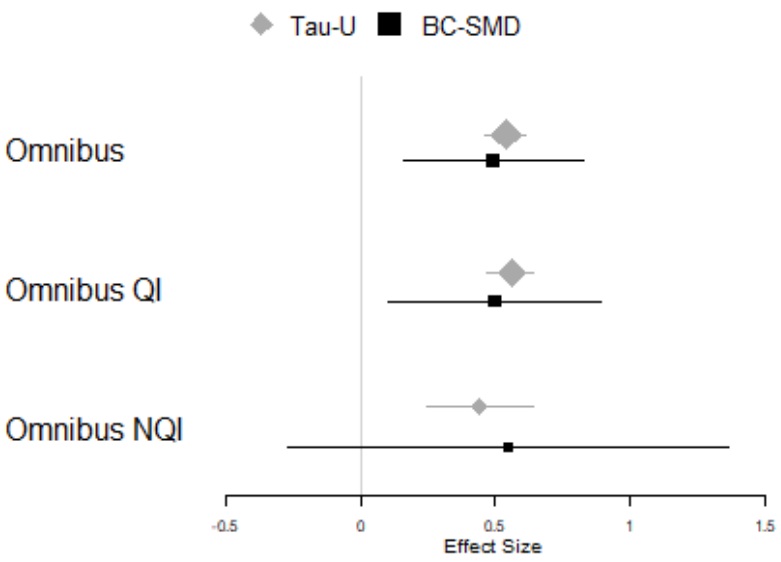

Figure 2-2 Omnibus Effect Size of PMAI

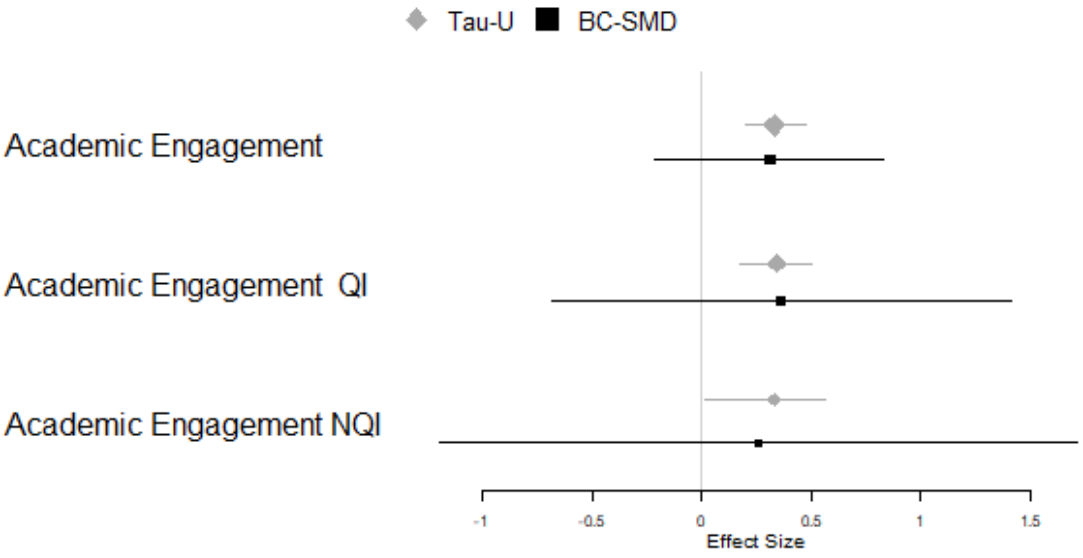

Figure 2-3 Quality as a Moderator for Academic Engagement

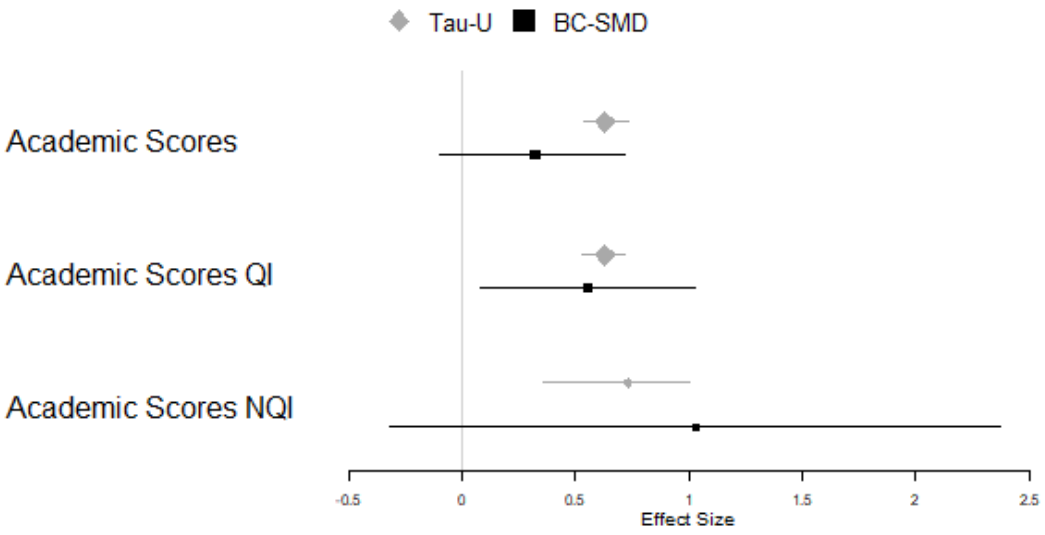

Figure 2-4 Quality as a Moderator for Academic Score

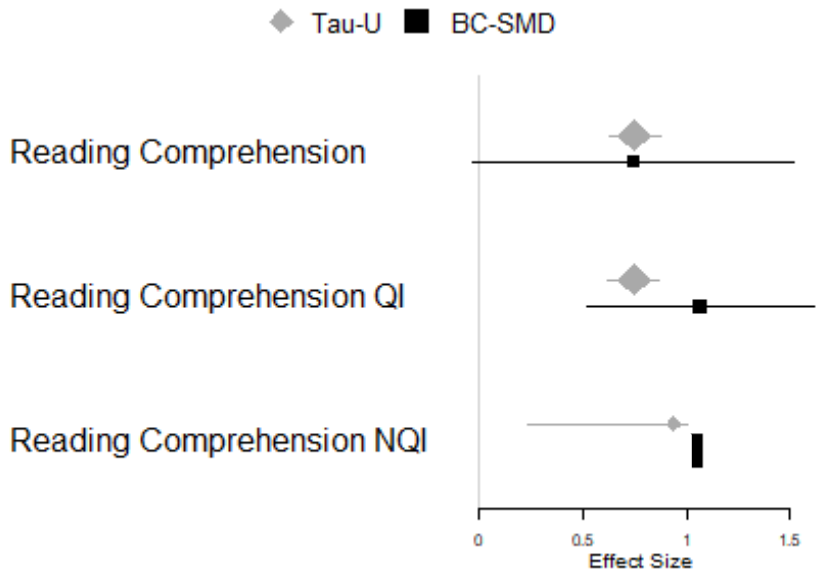

Figure 2-5 Quality as a Moderator for Reading Comprehension

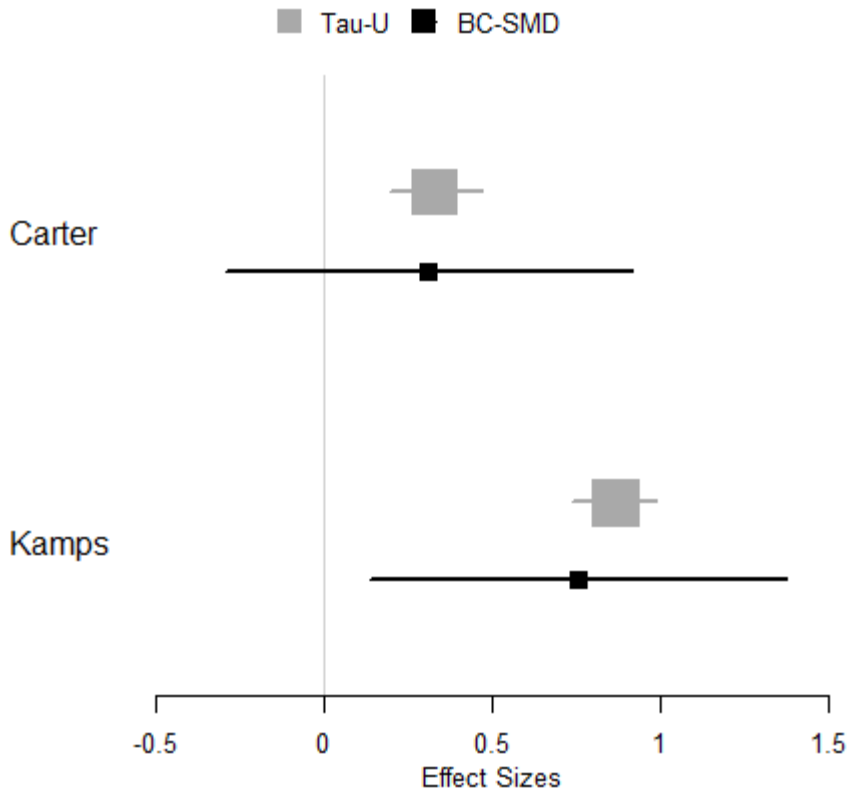

Figure 2-6 Effect Size of Author Group as Moderator

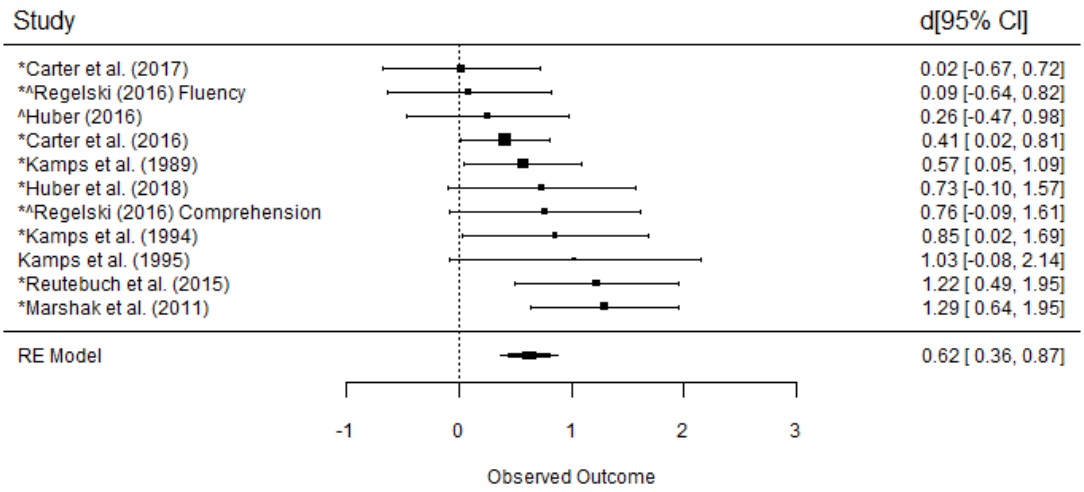

Figure 2-7 BC-SMD Forest Plot

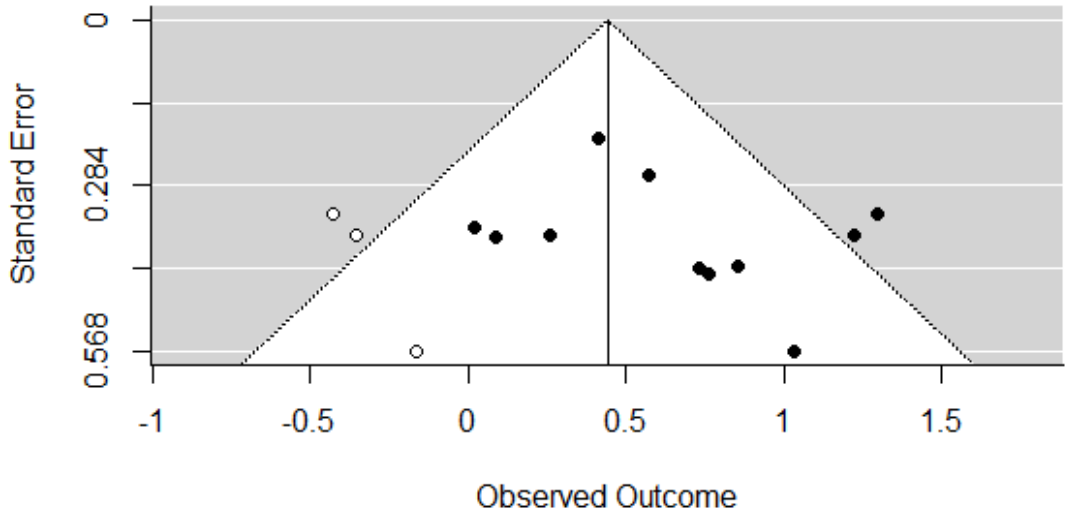

Figure 2-8 BC-SMD Trim-and-Fill Funnel Plot Analysis

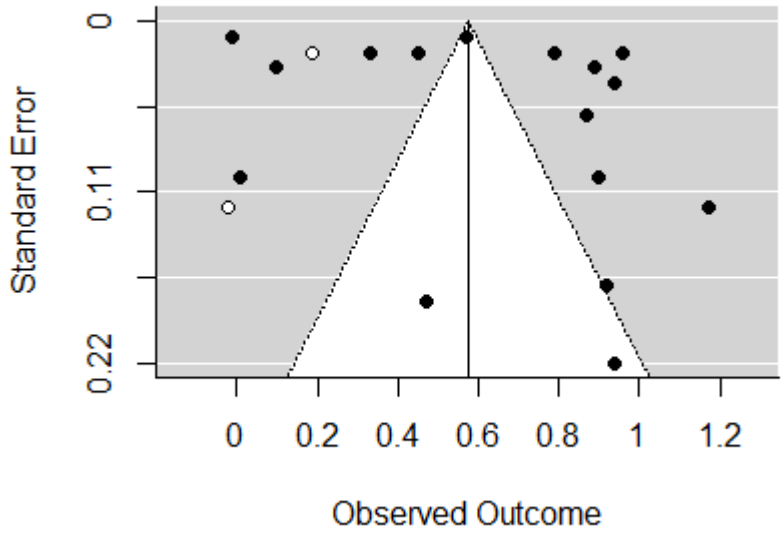

Figure 2-9 Tau-U Trim-and-Fill Funnel Plot Analysis

Table 2-1 Effect Size Benchmarks

Effect Size	No effect	Small	Medium	Large	Very Large
Tau-U		>0.20	0.20-0.60	0.60-0.80	<0.80
BC-SMD		>0.20	0.20-0.50	0.50-0.80	<0.80
Cohen's *d*		>0.20	0.20-0.50	0.50-0.80	<0.80

Table 2-2 Study Characteristics

	Quality Standards	Academic Engagement	Academic Scores	Reading Comprehension	Carter Author Group	Kamps Author Group
Carter et al. (2005)	X	X			X	
Carter et al. (2015)	X	X			X	
Carter (2017)	X	X			X	
Dugan et al. (1995)			X			X
Huber (2016)		X			X	
Huber et al. (2018)	X	X			X	
Kamps, et al. (1989)	X		X	X		X
Kamps et al. (1994)	X		X	X		X
Kamps et al. (1995a)			X			X
Kamps et al. (1995b)	X		X			X
Koh (2013)			X	X		
Marshak et al. (2011)	X		X			
Regelski (2016)	X		X			
Reutebuch et al. (2015)	X		X			
Schaefer (2018)	X	X			X	

Table 2-3 Effect Size per Studies

Study	TAU-U	CI_{90}	BC-SMD	CI_{95}
		UL, LL		UL, LL
*Carter et al. (2005)	0.01	-0.5, 0.52		
Carter et al. 2017	0.1	-0.2, 0.39	0.02	-0.65, 0.69
Dugan et al. (1995)	0.92	0.25, 1.00		
^Huber (2016)	0.33	0.1, 0.56	0.26	-0.18, 0.87
*Huber et al. (2018)	0.45	0.22, 0.69	0.73	-0.07, 1.58
Kamps et al. (1989)			0.57	0.17, 1.12
*Kamps et al. (1989) Language	0.96	0.71, 1.00		
*Kamps et al. (1989) Money	0.87	0.47, 1.00		
*Kamps et al. (1989) Reading	0.89	0.63, 1.00		
*Kamps et al. (1994)	0.79	0.55, 1.00	0.85	0.21, 1.72
Kamps et al. (1995)			1.03	0.13, 2.18
*Kamps et al. (1995a)	1.17	0.39, 1.00		
Kamps et al. (1995b)	0.94	0.24, 1.00		
^Koh (2013)	0.47	-0.09, 1.00		
*^Regelski (2016) Comprehension	0.57	0.37, 0.77	0.76	0.00, 1.63
*^Regelski (2016) Fluency	-0.01	-0.21, 0.20	0.09	-0.60, 0.79
*Reutebuch et al. (2015)	0.94	0.59, 1.00	1.22	0.53, 1.97
Schaefer et al. (2018)	0.9	0.38, 1.00		
Omnibus	0.54	0.46, 0.61	0.57	0.30, 0.84
Omnibus QI	0.56	0.47, 0.64	0.58	0.27, 0.90
Omnibus NQI	0.44	0.25, 0.64	0.51	-0.17, 1.20

Note. * indicates a dissertation, ^ indicates a study meeting quality standards, UL= upper limit, LL= lower limit

Table 2-4 Analysis of Quality as a Moderator

Moderator	TAU-U	CI_{90}	BC-SMD	CI_{95}
		UL, LL		UL, LL
Academic Engagement Omnibus	0.33	0.20, 0.47	0.31	-0.22, 0.83
Academic Engagement QI	0.34	0.17, 0.50	0.36	-0.69, 1.41
Academic Engagement NQI	0.33	0.01, 0.56	0.26	-1.20, 1.71
Academic Skill Acquisition Omnibus	0.63	0.54, 0.73	0.32	-0.10, 0.72
Academic Skill Acquisition QI	0.63	0.53, 0.72	0.55	0.08, 1.03
Academic Skill Acquisition NQI	0.73	0.36, 1.00	1.03	-0.32, 2.37
Reading Comprehension Omnibus	0.75	0.63, 0.88	0.74	-0.03, 1.52
Reading Comprehension QI	0.75	0.62, 0.87	1.06	0.52, 1.61
Reading Comprehension NQI	0.94	0.24, 1.00		
Carter	0.33	0.20, 0.47	0.31	-0.29, 0.92
Carter QI	0.34	0.17, 0.50	0.36	-0.69, 1.41
Carter NQI	0.33	0.10, 0.56	0.26	-1.2, 1.71
Kamps	0.87	0.74, 0.99	0.76	0.14, 1.38
Kamps QI	0.89	0.75, 1.00	0.69	-0.04, 1.42
Kamps NQI	0.65	0.22, 1.00	1.03	-0.34, 2.34

Note. QI= studies meeting quality standards, NQI= studies not meeting quality standards, UL= upper limit, LL= lower limit

3. USING PEER-MEDIATED ACADEMIC INSTRUCTION TO INCREASE WRITING SKILLS IN STUDENTS WITH AUTISM

3.1. Introduction

The majority of students with autism spectrum disorder (ASD) spend 40% or more of their time in general education (Snyder, de Brey, & Dillow, 2016; Zablotsky, Black, Maenner, Schieve, & Blumberg, 2015). Success in these settings requires effective and efficient intervention strategies, yet teachers face challenges in modifying tasks and instruction, accommodating differences, managing challenging behaviors, and supporting opportunities for students with ASD to interact and foster peer relationships (Lindsay, Proulx, Thomson, & Scott, 2013).

Academic achievement for students with ASD is often treated as secondary to communication and social skills (Petrina, Carter, & Stephenson, 2017) therefore research on academic achievement in the population is less prevalent than research in communication and social skills (Keen Webster, & Ridley, 2016; Wong et al., 2013; 2015). While students do face barriers to successful inclusion from anxiety, poor social skills, adaptability problems, and/or stereotypical behaviors (Carter et al., 2014; Lindsay et al., 2013), many students with ASD demonstrate deficits in core subject areas (Keen et al., 2016; Kurth & Mastergeorge, 2010; Wei, Christiano, Yu, Wagner, & Spiker, 2015). Differences in reading and math can be detected as early as preschool, and deficits in writing exacerbate these differences because students are unable to fully participate in the instructional practices (Mercer & Mercer, 2010; Miller et al., 2017; Pennington & Carpenter, 2019).

The task of writing encompasses motor planning, cognitive planning, and linguistic abilities, which students with autism can face challenges with one or more of these skill sets (Anzalone & Williamson, 2000; Dockrell, Ricketts, Charman, & Lindsay, 2014; Falk-Ross, Iverson, & Gilbert, 2004; Jansiewicz et al., 2006; Minshew, Goldstein, & Siegel, 1997; Myles et al., 2003). Writing is also a social skill requiring there to be an intended audience interested in the story being conveyed (Myles et al., 2003). Although writing is a major part of everyday education, very little research has been conducted examining writing intervention's effects on students with ASD's writing (Asaro-Saddler & Saddler, 2010; Pennington & Delano, 2012). Research available suggests that writing interventions can be used to increase targeted and non-targeted writing skills, however, replication is needed to establish evidence-based practices for specific interventions (Pennington & Delano, 2012). In one study, Medcalf, Glynn, and Moore (2004) implemented peer tutoring to increase writing development for students struggling in writing. Results indicated an increase in rate of writing and accuracy of mechanics.

Finding a way to foster peer relationships and address academic needs that is efficient and effective for teachers is needed. Peer-mediated instruction (PMI) is recognized as one of the most effective strategies available to educators (Higgins et al., 2014; Zeneli & Tymms, 2015). Peers teaching one another is both common and well respected in the research literature and practice (Asselin & Vasa, 1981; Delquadri, Greenwood, Whorton, Carta, & Hall, 1986; Scruggs, Mastropieri, & Richter, 1985).

Research conducted across grades and ages indicates PMI is robust. The evidence indicates PMI is effective in changing academic outcomes for individuals with disabilities in general, but lacking for students with autism (Bowman-Perrott et al., 2013; Lane, 2004;

Ryan, Reid, & Epstein, 2004; Vannest, Harrison, Temple-Harvey, Ramsey & Parker, 2011). PMI also demonstrates effects on non-academic social and communication skills for students with ASD (Bene, Banda, & Brown, 2014; Watkins, Ledbetter-Cho, O'Reilly, Barnard-Brak, & Garcia-Grau, 2015). Positive effects have been shown when using peer tutors for math and students with emotional and behavioral disorders (Hott, Evmenova, & Brigham, 2014; Schloss, Kobza, & Alper, 1997), reading, social skills, and students with autism (Kamps, Barbetta, Leonard, & Delquadri, 1994), and writing for students with autism and intellectual disabilities (Bedrosian, Lasker, Speidel, & Politsch, 2003; Campbell, Brady, Linehan, 1991). Additionally, Carter, Cushing, Clark, and Kennedy (2005) studied the effect on the number of peers used for peer tutoring. Authors found two peers showed a more significant increase in outcomes compared to one.

Benefits of PMI extend beyond academic and social skills. PMI may promote generalization; peers serve as a prompt across settings and may improve the larger school climate by reducing or eliminating the stigma associated with one-on-one support given to students with disabilities (Broer, Doyle, & Giangreco, 2005; Carter & Hughes, 2005; Copeland et al., 2004; Carter & Kennedy, 2006; Carter, Sisco, Melekoglu & Kurkowski, 2007). Tutees become more confident, attitudes about school change, and relationships with peers form (Asselin, & Vasa, 1981; Bedrosian et al., 2003; Carter et al., 2016; Franca, Kerr, Reitz, & Lambert, 1990; Scruggs et al., 1985). Teachers have a readily available resource in the instructional setting settings (McCurdy & Cole, 2014), leaving more time to focus on instruction instead of behavior and can provide additional teaching support making it cost and time efficient (Hoff & Robinson, 2002).

Peer tutors can also benefit from teaching others, acquiring new skills when providing feedback and correction to tutees and learning how to work with and advocate for individuals with disabilities (Asselin, & Vasa, 1981; Franca, 1984). Tutors who are deficient in skills benefit from teaching others (Franca et al., 1990; Scruggs et al., 1985) and those efficient in skills, build fluency and confidence (Asselin, & Vasa, 1981; Scruggs et al., 1985; Singh, 1982).

The purpose of this study was to conduct a systematic replication of the study by Medcalf and colleagues (2004). Systematic replication was selected because the tutees were students with autism and tutors were same age peers, additionally, the editing procedures were not implemented for this study (Ledford & Gast, 2018; Medcalf, Glynn, & Moore, 2004) This study sought to answer the following questions:

1. Is there a functional relation between peer-mediated academic instruction and academic engagement of writing assignments?
2. Can peer-mediated academic instruction increase number of words or sentences written related to an increase in academic engagement?
3. Can peers teach individuals with autism with fidelity?
4. How do educators view the feasibility and acceptability of peer-mediated academic instruction?

3.2. Method

The purpose of this study was to examine the effects of PMAI in writing for students with autism in a public school. Using a multiple baseline across participants, three individuals with ASD worked with peers to increase academic engagement during writing. Students were recorded and permanent product recording was used to measure academic

engagement, quantity and quality of writing during station work in their general education classroom.

3.2.1. Participants

In total, two teachers agreed to participate in the study, a general education student in the same class, was paired with one tutee, child with autism, for a total of three tutors and three tutees and eight participants overall. All participants including teachers were Hispanic and bilingual.

3.2.1.1. Inclusion-Exclusion Criteria and Screening

Teachers were included if a student with autism was included in their classroom. The special education teacher then introduced the researcher to the teacher and described the purpose of the study. Teachers who agreed took part in the study.

Dyads included in the study were students at the selected school. A checklist for each participant was reviewed with the teacher before to ensure students had the prerequisite skills to participate (see **Table B-1 Pre-screener for Tutor and Tutee**Table B-1**Error! Reference source not found.**). Inclusion criteria for the tutor included the student being in good academic standing in their current class and a willingness to work with individuals with disabilities. Tutor participants were excluded if they were absent frequently or if there was a schedule conflict that could not be resolved.

The tutees were students with a diagnosis of an autism spectrum disorder (ASD), had a deficit in an academic skill, and had the ability to communicate in some way with their peers; communication was not limited to verbal communication. Tutees were included if they were able to follow instructions by peers and work with their peers.

3.2.1.2. Ethics and Recruitment

IRB approval was obtained through a university. A school district was given the approved IRB, and an application for research through the school district was approved before beginning the study. Recruitment began by asking the principal of the school to identify teachers that taught students with autism and may be willing to participate in the study. If teachers agreed, they went through the consent process (described below). Students with autism (tutees) were then identified by the special education teacher as fitting the inclusion criteria to participate in the study. Parents who wished to have their students participate in the study went through the consent/ assent process described below. The tutors for the study were identified by a similar manner as the students with autism except the general education teachers reached out to the parents of the tutors. If both the parent(s) and the student were interested in participating consent and assent was obtained for the tutor.

3.2.1.3. Teacher

For this study a third and second grade teacher agreed to participate. Table 3-1 provides more information about the teachers. Teacher 1 and 2 taught third and second grade English Language Arts respectively. Teacher 1 had two of the three students with autism in her classroom. Both teachers indicated the best time to implement the peer tutoring procedure was during small group instruction.

3.2.1.4. Tutor

For this study, three tutors were selected by the teachers based on the inclusion criteria. Table 3-2 provides more information about the students. All three students sat near

the tutor, were in good standing academically, and often would help their peer throughout class.

3.2.1.5. Tutee

Tutees were identified by both the special and general education teacher as meeting the inclusion criteria. Tutees for this study were all identified as having deficits in writing. All students were able to demonstrate prerequisites skills needed to complete a writing task (i.e., all students were able to write independently). Table 3-3 provides more information about the students. Pseudonyms were used for all participants in the study.

Student 1, Miguel, and student 2, Ivan, were both third graders with ASD. Their teacher reported low performance in writing and engaging in avoidance behaviors during writing activities, however, these avoidance behaviors were not typically disruptive to the rest of the class or aggressive in nature. Both students were able to communicate to others verbally. Both Miguel and Ivan were identified as meeting eligibility criteria for autism by a school psychologist.

Student 3, Carlos was a second grader with ASD. His teacher reported that he does not like to be told what to do by his peers but believed that he would benefit from peer tutoring. The teacher indicated Carlos will participate in all activities, without behavioral issues and will complete assignment as imitation. Although he can communicate, he often uses unintelligible words. He too was identified as meeting eligibility criteria for autism by a school psychologist.

3.2.1.6. Interventionists' Trainer

The lead author, who was a fourth-year doctoral student studying special education, served as the trainer for the interventionists (i.e., tutors) to implement the PMAI procedure.

The interventionist had 10 years of experience working with children with autism and was certified as a Board Certified Behavior Analyst and licensed in her state.

3.2.2. Setting and Materials

The primary setting of the study was the general education class where writing was taught for all the students. Each classroom was similarly set up. Both classrooms were approximately 28 X 26 feet. Desks were clustered in five groups with a possibility of four to five students sitting within each cluster. In both classes, students would complete their writing assignment at their assigned desk. Tutors would sit in the desk next to or in front of the tutee.

Materials used includes worksheets/ homework provided by the teacher and a mini camera that can be clipped to an individual's shirt. Materials created by the teacher were used to ensure skills gained reflect what other students are learning, and a video recording device will be used to measure if students' fluency increases throughout the intervention as well as allow for inter-observer agreement. During the tutoring procedures, tutors were given a procedures visual and prompting procedure visual for if the tutee did not respond correctly, use of the visuals are described below in the procedures section and print out of the visuals can be seen in Additionally, tutors were given a what if visual (se) so tutors would know what to do if the tutee engaged in any challenging behavior, although this was never used.

3.2.3. Research Design

A multiple-baseline design across participants was chosen for this study to help control for the effects of maturation. This design was chosen to reduce the risk of carryover effects that may be seen with the use of a reversal design. This design was also used

because the target behaviors should not be reversed (Ledford & Gast, 2018). Each phase of the study included a minimum of five data points to better assess stability for trend and level. Intervention was introduced in the first tier when stability occurred, however, on the fifth day, the student engaged in high rates of behavior, therefore the researcher continued collecting baseline data for another day to control for regression to the mean. Introduction to the intervention occurred for the next two legs when an effect and stability was seen for at least three consecutive days (Ledford & Gast, 2018). For Carlos, intervention was introduced even though baseline data were high because the student was only available specific times and days, and the school was about to begin winter break.

3.2.4. Study Measures

The purpose of the study's primary purpose was to increase academic engagement during writing for three students with ASD. Additionally, the researcher measured secondary behaviors of rate of writing and mechanics of writing to identify if increasing engagement would increase word and sentence production as well as spelling and punctuation accuracy. For this study data was collected on the tutee's academic engagement, rate of words and sentences written per session, and accuracy of spelling and punctuation of the written assignment. Measures for the tutee included implementation accuracy of the PMAI procedure as well implementation accuracy of the prompting procedure (procedural integrity). Social validity was collected during, and after intervention for all participant.

3.2.4.1. Dependent Variables

All assignments used permanent products to score rate and accuracy of writing supplemented with videos to collect interval recording on academic engagement and implementation accuracy for the tutor.

3.2.4.1.1. Tutee Behavior

The purpose of this intervention was to increase academic engagement and writing behavior for three boys with autism. For purposes of interobserver agreement, contrived permanent product recording was used to measure academic engagement by video recording each session. To collect data on other writing behavior, permanent product recording in the form of a photograph was used for writing skills. Tutee behavior was collected on academic engagement during writing to determine if time on task increased. Academic engagement was scored using 30 second partial interval recording and scored as a percentage of number of intervals engaged/ total possible intervals during the session. Rate of word and sentences were collected by counting the number of each and dividing the time in minutes. Accuracy of punctuation and spelling was scored as either correct or incorrect. A percentage was calculated by dividing the number of correct items by the number of opportunities for each item (see Figure B-1).

3.2.4.1.1.1. Academic Engagement

Academic engagement was scored as occurring if the student was writing words with their pencil (not drawing), erasing, asking for help (for spelling or ideas), or discussing what they were writing about during any time during the interval. The interval was not scored if the student was talking about something off-topic, drawing, or not at their desk. Only observable behaviors were recorded.

3.2.4.1.1.2. Rate of Words and Sentences

Words per session were scored as number of words written by the individual, includes words student was told to write, in the session divided by the session duration. Similarly, sentences per session were recorded as number of sentences written divided by the session duration. A sentence was counted if there was a noun and verb and a separate thought. For example: “He lives in Texas He rode a tornado to California He thought he was a coyote” would be three separate sentences.

3.2.4.1.1.3. Accuracy of Punctuation and Spelling

Accuracy of punctuation was scored as the number of correct punctuations (include capitalization) divided by number of correct plus incorrect possible punctuation occurrences. Punctuations were counted as incorrect if the sentence was a question but did not end in a question mark, case of letters were incorrect (i.e. a word capitalized that should not be, or a letter within a word that is capitalized e.g. baLLooN). Punctuations including exclamation points were counted correctly because intent of the sentence could not be inferred unless explicitly stated in the sentence. Accuracy of spelling was scored as the number of correct words spelled divided by number of correct plus incorrect words written. If the word was written illegibly to determine spelling, it was counted as incorrect, incorrect case of the word or letters within the word were not counted as incorrect. Although these variables were not specifically targeted (i.e., tutors were not trained to correct spelling or punctuation) data were collected for these variables. However, because data indicated students’ accuracy was high (Miguel and Ivan) or the paraprofessional would provide the student with what to write (Carlos), these data will not be discussed in

the results section, but data will be provided in Table 3-4 and graphs and forest plots will be provided in Figure B-2, Figure B-3, Figure B-4, and Figure B-5.

3.2.4.2. Measurement Fidelity

Implementation fidelity, procedural fidelity, and treatment integrity were collected throughout the study for at least half of the sessions. Interobserver agreement was collected for at least 20% of the sessions in which fidelity or integrity had been collected. Behaviors were scored as occurring or not occurring.

3.2.4.2.1. Implementation Fidelity

Before intervention, each tutor was individually trained to implement the steps of the intervention. The researcher discussed with the tutor the purpose of the intervention and asked the tutors if they were interested in helping. If the tutor agreed and consent was obtained, the researcher went over the intervention step by step with the tutor. First, the research described to the tutor how to help the tutee with their writing (i.e. ask what they want to write about, expand, and praise). This also included what to do if the student was not responding. Then, the research discussed with the tutor what to do in case the tutee engaged in challenging behavior. Visuals for writing and challenging behavior accompanied each explanation, the researcher checked for understanding by asking questions such as “what is the first thing you need to do?,” or “what do you do if the tutee is not working?” If tutors answered incorrectly, the researcher would explain the procedures over again. In addition to explaining the procedure, the tutor and research (acting as the tutee) would roleplay different scenarios and the researcher would provide immediate feedback to the student. To control for threats to internal validity, tutors were trained on how to implement the procedure and did not begin the intervention until they

met 80% criteria. While the intervention was being implemented, the research collected data on procedural fidelity to ensure the intervention was being implemented as designed. If during the intervention procedural fidelity fell below 80%, tutors were retrained. Implementation fidelity was collected to determine how well the trainer adhered to the training procedures for the tutor (see Figure B-6).

3.2.4.2.2. Procedural Fidelity

Data was collected on the degree to which all procedures in the intervention were adhered to, including during baseline. A procedural fidelity form was used to score adherence to the training procedure throughout all the phases (see Figure B-7). Procedural fidelity was scored as occurring or not occurring and if prompted, what type of prompt was provided. For baseline, low scores are indicative of crucial intervention procedures not being implemented, reducing the threat of internal validity.

3.2.4.2.3. Treatement Integrity

Tutors were taught how to implement the steps in the PMAI procedure. Data was collected on the accuracy of the tutor's implementation of the procedure during intervention. The tutor observation form (see Figure B-8) was used to score treatment integrity. If prompts were provided to the tutor, the type of prompt was marked. Treatment integrity for each step was scored as occurring or not occurring.

3.2.4.3. Social Validity

Teachers completed a 5-point Likert- scale social validity survey with open-ended questions during, and after the intervention (Snodgrass, Chung, Meadan, & Halle, 2018). Data collected on the survey identified if the participants felt the intervention was socially important and the goals, procedures, and outcomes were acceptable and useful to the

participants and their stakeholders. Additionally, open-ended questions were provided so participants' could expand on their responses (Figure B-9).

3.2.4.4. Reliability

Reliability was assessed for at least 20% of the sessions across all the conditions (see Table 3-5). Data collection using the videos was subject to observer drift, therefore, reliability data was collected for at least 20% of the studies across each phase and participant. If agreement fell below 80% retraining of the second observer occurred. Retraining for two of the three tutors occurred one time each, reasons for low scores was typically due to the poor quality or angle of the video. Videos were selected using a random number generator. Reliability for the interval recording was scored using the interval-by-interval method; number of intervals agreed divided by number of intervals agreed plus disagreed (see Figure B-10).

3.2.5. Procedures

Each session lasted the duration of time the tutor and tutee were present at the writing station. Sessions lasted between three and 15 minutes three to four times a week for six weeks. Each session was completed during reading and writing stations for both classes while the teacher was engaged in small group instruction.

3.2.5.1. Baseline

Baseline was carried out as is apart from the researcher stating to the identified tutor to "help their friend with the writing," or "Remind your friend about what they should be doing." This was to collect data to on the effects of peers before implementing a structured intervention. Teachers would provide instruction on expectations for the assignments, or the assignment was posted on the smart board and the station's material

box and the students would work on classroom assignments independently. While students were working on their assignment, teachers were available to answer questions as they normally would during independent work. After each class, a picture of the writing sample was collected. The paraprofessional for students 1 and 2 would occasionally be present during baseline. If during baseline, while the researcher was recording, the paraprofessional began helping the tutee, the researcher would end the recording. However, for student 3 the paraprofessional was present during a majority of the baseline sessions. Data were collected as is.

3.2.5.2. Teacher Training

Although the teachers did not want to initially implement the PMAI alone, they did want to sit in on the tutor training to learn how to implement the procedure. Teachers were given an electronic copy of all the materials that could be adjusted in the future for the task they would implement PMAI.

3.2.5.3. Tutor Training

All students deemed as the tutor were trained individually before the tutee entered intervention. Each training session lasted between 15 and 20 minutes. Tutors were taught to ensure materials were present, provide instruction on the task, correct errors using least to most prompting, and provide reinforcement (see Figure 3-1). These procedures were taught using modeling, prompting, and roleplaying combined with feedback during the teaching process. After reviewing the material, comprehension checks were completed by asking questions such as “what do you do if__?”, and roleplaying the steps. Training lasted until tutors could implement the training procedure without missing steps. Variations of what could occur were also implemented to ensure tutors are confident in the steps to take.

For example, what steps should be taken if the tutee writes about the wrong topic without the help of the tutor, or what steps should be taken if error correction is not needed for a step. Researchers collected data on the fidelity of implementation using a task list that was provided to the tutor identifying steps to be taken. When the tutor began the intervention, the researcher provided visual or vocal prompts if a step was missed or an incorrect prompt was given during the sessions. Before the beginning of each session, the researcher would review the visuals and ask the tutors questions about the procedure.

3.2.5.4. Peer-Mediated Academic Instruction

During the intervention, the participants engaged in sessions similar to baseline. At the beginning of the activity, the researcher provided the tutor with the visuals and asked them if they would help their friend with writing.

During the tutoring sessions, students paired up and the following steps were implemented:

1. The tutor made sure all material needed were present.
2. Tutors told the tutees what they would be doing.
3. Tutors would ask tutees what they want to wrtie their story about.
4. If the tutee did not respond, the tutor provided choices.
5. If the tutee did not respond, the tutor told the tutee what to write.
6. If the tutee did not respond, the tutor wrote down the information.

a. These prompts followed the least to most prompting hierarchy until the tutee responded.

7. If the tutee responded correctly, the tutor reinforced the form of behavior specific social praise (Floress & Jenkins, 2015; Ennis, Royer, Lane, & Dunlap, 2018), using

phrases such or, “good job writing,” “you wrote a lot,” or “way to go writing your story.”

8. After the first response the tutor would attempt to have the tutee write more by asking questions intended to expand the story such as “What did you hear?”

Each session lasted between three and 15 minutes, time variation was a result of previous activities taking longer than anticipated or school wide activities occurred previously (school assemblies). Sessions were video recorded for data collection and pictures of written assignment was collected for analysis.

3.2.6. Analysis

Single case research is a type of methodology where data are collected repeatedly and effects of the independent variable on the dependent variable are determined through different methods (Kennedy, 2005). Recently design standards have been created to identify quality studies that add to the literature and provide confidence in reported results (Horner et al., 2005; WWC, 2017). Many of these standards describe the use of one or more method for analyzing single case research including visual, parametric, and nonparametric. However, debates still occur regarding which analysis is the best (Harrison, Thompson, & Vannest, 2009; Maggin, et al., 2014; Tincani & Travers, 2018). More recently, there has been a push to compare quantitative analysis to visual analysis to add strength to conclusions being made about the results of a study (Vannest, Peltier, & Haas, 2019). With this push, data for this study were analyzed through visual inspection by a person blind to the purpose of the study. Tau-U and between case standard mean difference (BC-SMD) was used to calculate the effect size.

3.2.6.1. Statistical Analysis

Quantitative effect size analyses were used to produce a magnitude of effect for PMAI on academic engagement during writing for three students with ASD. Analyses were selected that could control for trend, variability, and address autocorrelation because the data were single case (Hedges, Pustejovsky, & Shadish, 2013; Parker et al., 2011). Results of effect were compared in addition to being compared to visual analysis results. Nonparametric and parametric statistical analysis were conducted by importing the raw data into the Tau-U calculator available at singlecaseresearch.org and the BC-SMD online calculator.

Nonparametric Tau-U was chosen because it has shown to be effective for calculating nonoverlapping data. Unlike other nonparametric statistics, Tau-U is beneficial because it can control for baseline trend, has strong statistical power, and produces more conservative results compared to other statistical measures (Maggin, Cook, & Cook, 2019; Manolov, Losada, Chacon-Moscoco, & Sanduvete-Chaves, 2016; Parker et al., 2011). Tau-U is distribution free, which is beneficial for single-case data that contains a lot of variability. Additionally, Tau-U is not influenced by ceiling effects (Parker et al., 2011; Vannest & Ninici, 2015).

Parametric between case standard mean difference (BC-SMD) was also used to evaluate the effects of the intervention. This analysis was conducted because there is a push for the use of effect size measures that are comparable to group design effect size measures and to compare magnitude of effect with nonparametric statistics (Hedges et al., 2013). BC-SMD was created to approximate the sampling distribution related to Cohen's *d.* BC-SMD estimates the mean shift between baseline and intervention to produce an

effect that is comparable to group designs and accounts for variability, trend, and dependence in data produced during single case research (Hedges et al., 2013; Valentine, Tanner-Smith, Pustejovsky, & Lau, 2016). Statistical analysis was then compared to the visual analysis to identify if there was an agreement.

3.2.6.2. Visual Analysis

Visual analysis was conducted for trend, level, and variability for each phase. Visual analysis in baseline was used to determine stability and identify with whom intervention would begin. At the end of the study the researcher visually inspected each graph as well as showed the graphs to each teacher to receive input on whether they felt the intervention made a difference. Two raters considered experienced researchers were then asked to visually analyze the graphs without context using a scale of two or three and no visual aid to determine if the intervention effected the behavior (see Figure B-11). Variables were operationally defined to reduce bias from the raters past experiences and increase likelihood raters rated the graphs similarly (Ninci, Vannest, Wilson, & Zhang, 2015). Results of the masked visual analysis were compared in relation to the calculated effect sizes to support findings.

3.3. Results

This study implemented a multiple baseline design across participants to examine the effects of PMAI for academic engagement in writing for students with ASD. Students participated in the intervention three to four days a week with sessions lasting between three and 15 minutes. The researcher sought to answer whether PMAI could increase academic engagement, the rate of written words and sentences, and the accuracy of spelling and punctuation use for students with ASD. The researcher also sought to answer

if peers could be taught to implement an intervention with fidelity. Each question was answered using visual analysis as described by the what works clearinghouse (WWC, 2017) and statistical analysis using Tau-U (Parker et al., 2011) and BC-SMD (Hedges et a., 2013).

3.3.1. Effects of PMAI on Tutees' Writing

Overall, academic engagement demonstrated a Tau-U score of 0.60, CI 90% [0.33, 0.86] and a BC-SMD score of 1.12, 95% CI [0.54, 1.72], suggesting a large to very large effect. Rate of words per minute produced a Tau-U of 0.38, CI 90% [0.10, 0.65] and a BC-SMD score of 0.17, 95% CI [-0.36, 0.77] indicating a moderate and small effect respectively for increasing written word production. On the other hand, rate of sentences per minute showed a Tau-U of 0.16, CI 90% [-0.12, 0.43] and BC-SMD of 0.11, 95% CI [-0.41, 0.63] demonstrating small effects. Similarly, punctuation and spelling demonstrated Tau-U effects of 0.03, CI 90% [-0.27, 0.34] and -0.18, CI 90% [-0.48, 0.13] respectively and BC-SMD scores of -0.03, (% CI [-0.97, 0.90] and -0.17, 95% CI [-0.81, 0.45] respectively indicating a weak effect. These statistical results were confirmed with visual analysis suggesting PMAI only demonstrated a functional relation for academic engagement. This suggests PMAI can be effective for increasing engagement and rate or words while writing (see Figure 3-6 and Table 3-4).

3.3.1.1. Academic Engagement

3.3.1.1.1. Miguel

Visual inspection for Miguel's academic engagement (see Figure 3-3) indicates a contra therapeutic increasing trend in baseline followed by a therapeutic increasing trend in intervention. However, if the outlying data point in baseline were removed, trend would

change from increasing contra-therapeutic to decreasing therapeutic. This is supported with a low level and high variability (μ= 37.83, SD= 34. 37) baseline and an increase to a medium level with slightly less variability during intervention (μ= 56, SD= 22.34). Visual analysis is supported with a Tau-U score of 0.47, CI 90% [0.00, 0.94], indicating a moderate effect for Miguel's academic engagement (see Figure 3-7 and Table 3-4).

3.3.1.1.2. Ivan

Visual inspection for Ivan's academic engagement (Figure 3-3) indicates a therapeutic decreasing trend in baseline followed by a slight contra therapeutic decreasing trend in intervention. This is supported with a low level and high variability (μ= 32.30, SD= 20.83) in baseline and an increase to a medium level with less variability during intervention (μ= 69.36, SD= 14.24). Visual analysis is reinforced with a Tau-U score of 0.97, CI 90% [0.55, 1.00], indicating a very large effect for Ivan's academic engagement (see Figure 3-7 and Table 3-4).

3.3.1.1.3. Carlos

Visual inspection for Carlos's academic engagement (see Figure 3-3) indicates a contra therapeutic increasing trend in baseline followed by a steeper therapeutic increasing trend in intervention. This is supported with a medium level and high variability (μ= 40.23, SD= 27.04) in baseline and an increase in level with more variability during intervention (μ= 67.60, SD= 32.27), higher variability in intervention could be attributed to a substitute teacher present the first day intervention was introduced. Visual analysis is reinforced with a Tau-U score of 0.20, CI 90% [-0.31, 0.71], indicating a weak effect for Carlos' academic engagement (see Figure 3-7 and Table 3-4).

3.3.1.2. Rate of Words per Minute

3.3.1.2.1. Miguel

Visual inspection for Miguel's rate of words per minute (Figure 3-4) indicates a contra therapeutic increasing trend in baseline followed by a therapeutic increasing trend in intervention. Similar to academic engagement, if the outlying data point in baseline were removed, trend would change from increasing contra-therapeutic to decreasing therapeutic. Level from baseline (μ= 1.53) to intervention (μ= 1.51) slightly dropped, however variability decreased by more than half between baseline (SD= 1.92) and intervention (SD= 0.69). A Tau-U score of 0.30, CI 90% [-0.17, 0.77], suggests a weak effect for Miguel's rate of words per minute (Figure 3-8 and Table 3-4) confirmed through visual analysis.

3.3.1.2.2. Ivan

Visual inspection for Ivan's rate of words per minute indicates a therapeutic decreasing trend in baseline followed by a therapeutic increasing trend in intervention (see Figure 3-4). Level from baseline (μ= 1.27) to intervention (μ= 1.62) slightly improved, and variability decreased substantially between baseline (SD= 2.04) and intervention (SD= 0.54). A Tau-U score of 0.75, CI 90% [0.32, 1.00], suggests a large effect for Ivan's rate of words per minute (Figure 3-8 and Table 3-4) confirmed through visual analysis.

3.3.1.2.3. Carlos

Visual inspection for Carlos' rate of words per minute (Figure 3-4) indicates a contra therapeutic increasing trend in baseline followed by a steeper therapeutic increasing trend in intervention. Level from baseline (μ= 0.68) to intervention (μ= 0.53) slightly decreased, however, variability decreased between baseline (SD= 0.61) and intervention

(SD= 0.39). A Tau-U score of -0.18, CI 90% [-0.76, 0.39], suggests a weak effect for Carlos' rate of words per minute (Figure 3-8 and Table 3-4) confirmed through visual analysis. This could reflect the paraprofessional providing Carlos with what to write in baseline, whereas the tutor in intervention discussed with Carlos what he would like to write.

3.3.1.3. Rate of Sentences per Minute

3.3.1.3.1. Miguel

Visual inspection for Miguel's rate of sentences per minute (see Figure 3-5) is similar to rate of words per minute. Visual analysis is again supported with a low level and high variability (μ= 0.21, SD= 0.29) baseline and a marginally lower level with slightly less variability during intervention (μ= 0.19, SD= 0.17). A weak effect supporting visual analysis suggests a Tau-U score of 0.08, CI 90% [-0.39, 0.55], for rate of sentences per minute (see Figure 3-9 and Table 3-4).

3.3.1.3.2. Ivan

Visual analysis for rate of sentences per minute (see Figure 3-5) is similar to rate of words per minute. This is supported with a low level and high variability (μ= 0.11, SD= 0.22) baseline and a slightly higher level with less variability during intervention (μ= 0.16, SD= 0.12). A moderate effect supporting visual analysis indicates a Tau-U score of 0.38, CI 90% [-0.04, 0.81], for rate of sentences per minute (see Figure 3-9 and Table 3-4).

3.3.1.3.3. Carlos

Visual inspection for Carlos' rate of sentences per minute (see Figure 3-5) indicates a therapeutic decreasing trend in baseline followed by no trend in intervention. Level from baseline (μ= 0.04) to intervention (μ= 0.00) slightly decreased, however, variability

decreased between baseline (SD= 0.08) and intervention (SD= 0.00). A Tau-U score of --0.14, CI 90% [-0.71, 0.44], suggests a weak effect for rate of sentences per minute (see Figure 3-9 and Table 3-4) confirmed through visual analysis. Similar to words per minute results could be a reflection of Carlos being provided what to write in baseline.

3.3.1.4. Masked Visual Analysis

A masked visual analysis was performed by two experienced researchers in the field of special education. Researchers were asked questions about trend, level, variability, overlap, and whether or not they felt the intervention had an effect on the behavior. Blind to the intervention, the researchers were asked to rate the graphs independently for each student and for demonstration of effect (Figure B-11). The only information given to the reviewers was that behavior was targeted for an increase. Overall raters demonstrated a relatively high agreement of 74% for visual analysis (Ninci et al., 2015, Ottenbacher, 1993).

3.3.1.4.1. Academic Engagement

Raters disagreed (75%) on baseline and intervention trend and whether or not the trend was in a desirable direction. However, agreement was seen for variability and overlap (100%) for each student. Overall, for academic engagement both raters felt the intervention influenced the behavior (100%) and a functional relation could be established between intervention and behavior change (100%). The visual analysis demonstrates agreement between the researcher's visual inspection and Tau-U results suggesting a large effect for academic engagement.

3.3.1.4.2. Rate of Words and Sentences per Minute

Raters consistently agreed more across baseline and intervention trend (75%) while reviewing the graphs. Agreement about variability was slightly lower for rate of words and sentences (83%) but remained unchanged for overlap (100%). Overall, for rate of words per minute, raters were split on whether the intervention caused a behavior change (50%), however, they both agreed there was not a functional relation demonstrated for increasing the rate of words written per minute. This visual analysis indicates disagreement with the Tau-U results suggesting a moderate effect. For rate of sentences per minute raters agreed the intervention did not cause behavior change or demonstrate a functional relation. This visual analysis agrees with the Tau-U score of 0.02 indicating a weak effect.

3.3.2. Interobserver Agreement

Overall interobserver agreement was 89% for academic engagement with scores ranging from 67-100% (see Table 3-5). Agreement for Miguel resulted in a score of 85% (73- 93%) overall for 33% of the sessions and 88% (83-93%) for 50% of baseline sessions and 83% (77-92%) for 27% of intervention sessions. Agreement for Ivan resulted in a score of 85% (73- 100%) overall for 33% of the sessions and 81% (73-83%) for 40% of baseline sessions and 91% (79-100%) for 27% of intervention sessions. Agreement for Carlos resulted in a score of 96% (67- 100%) overall for 21% of the sessions and 95% (67-100%) for 21% of baseline sessions and 100% (100%) for 20% of intervention sessions. Low scores were typically reflective of poor video quality, or the inability to decipher what students were saying during the video.

3.3.3. Fidelity Measurement

Fidelity measurement was collected for at least 50% of all sessions across each phase where applicable (i.e., treatment integrity was only collected during intervention). Interobserver agreement was then collected on 20% of the sessions (see Table 3-6).

3.3.3.1. Implementation Fidelity

Implementation fidelity was collected during training of the tutors. During training, the researcher adhered to the training with 80% accuracy for all participants. The item most often missed during training was roleplaying. Overall IOA was 85% for 59% of the videos recorded. One parent of the tutor did not want their child recorded therefore IOA was not collected for implementation fidelity.

3.3.3.2. Procedural Fidelity

Overall procedural fidelity resulted in a score of 62%, however, this is reflective of low scores in baseline indicating the parts of the intervention were not being implemented during bassline sessions. During baseline, procedural fidelity ranged from 21-57% with an average of 36% fidelity. This indicates only 36% of the intervention occurred during baseline, scores indicate tutors getting material for the student and telling the student what the assignment was were implemented the most during baseline. During intervention procedural fidelity increased to 87% with scores ranging from 83-92% indicating 86% of the procedures were adhered to during intervention. Interobserver agreement was 82%, 86%, and 77% for overall, baseline, and intervention procedural fidelity. The low score for Carlos seen in intervention is a result of the paraeducator intervening while the tutor was implementing the intervention.

3.3.3.3. Treatment Integrity

Treatment integrity was collected for at least half of the sessions for each student across each phase. Integrity for tutors' implementation of the treatment during intervention was 87% with scores ranging from 83-92% indicating 86% of the procedures were adhered to during intervention. Interobserver agreement was 82%, 86%, and 77% for overall, baseline, and intervention procedural fidelity. Low scores were related to Carlos's paraprofessional intervening during the treatment phase. The most frequent item missed was tutors not providing praise or providing expanding questions to the student.

3.3.4. Social Validity

Multiple attempts were made to collect social validity, only one teacher filled out the social validity survey (see Table 3-7). Teacher 2 strongly agrees peer tutoring was effective for teaching writing to her student and that the intervention could be used to teach other skills or students. The teacher agreed she possessed the skills to create materials needed and the time requirements to teach and implement peer tutoring were reasonable. Although Teacher 1 did not fill out the survey, she did express that she noticed a difference in the quality of work both her students were turning in, she also was pleased to see how well the students with ASD responded to working with their peers.

3.4. Discussion

This intervention sought to identify if there was a functional relation in PMAI for academic engagement in writing. Visual and statistical analysis both agree a functional relation was seen when PMAI was implemented during writing stations for all three students with ASD. When evaluating whether a functional relation was produced for writing behavior (i.e., rate of words or sentences), statistical analysis indicated a small to

moderate effect whereas visual analysis indicated there was no functional relation. This could be related to the magnitude of change in behavior from baseline to intervention for all three participants, a limitation to visual analysis (Gage & Lewis, 2013; Parsonson & Baer, 2015).

However, these results should be interpreted with caution due to limitations within the study. The first limitation is the presence of the paraprofessional during most of Carlos' sessions throughout the study. Even though the researcher discussed the purpose of the study and asked the paraprofessional to not intervene for the duration of the session, the paraprofessional would still interact with the student. Although the paraprofessional was not always present during the entirety of session, this did influence engagement and writing behavior with the student. Another limitation was that the students were not always available during the entire station time. Students would either be pulled randomly for therapy sessions or arrive late to their class due to a therapy session running behind, this mostly affected Ivan and Carlos. This resulted in data collection being cut short for some of the videos, although the researcher would try to collect data with the student before they were supposed to leave for other therapies.

Many studies relating to peer-mediated instruction do not collect data for fidelity of implementation. This is problematic because researchers cannot be confident that results are reflective of the intervention being implemented as planned. Tutors for this study were able to implement the treatment as designed with 87% fidelity. However, one limitation is that sessions were implemented during writing stations when the teacher was engaging in small group teaching with other students. Tutors would often become distracted and needed redirection and prompting to continue helping their peer during writing. Future

research should evaluate effects of PMAI for the whole class during writing stations, this may reduce the disruptions caused by other students.

Altogether, both teachers felt the intervention was effective and useful for increasing engagement during writing stations for all three students. At the end of the intervention, one teacher asked for copies of the visuals so that she could continue the intervention when data collection was complete. She also asked the researcher to return to help teacher her how to implement the intervention herself.

3.4.1. Limitations and Future Research

Several limitations were discussed above. One was the therapy schedule of the students would interfere with duration of data collection. As a result, some data may not truly be reflective of the students' behavior because the student was not recorded the entire time. Another limitation included the presence of the paraprofessional for most of Carlos' sessions in baseline and intervention. A third limitation is that students who were not in small groups with the teacher or not the peer tutor was a variable that could not be controlled for. For example, during one tutoring session, a peer asked the tutor for help and they obliged. This reduced the time the peer was able to help the student during their writing station. Lastly, another limitation was that the teachers did not want to implement the intervention themselves. This is problematic because it reduces the likelihood the intervention will continue after the researcher leaves.

Future research should investigate utilizing the paraprofessionals to implement the PMAI procedure. Paraprofessionals are readily available and can implement the procedure with the tutors during the small group times the teacher cannot. Additionally, future research can examine the effects when controlling for peers who are participating in other

stations (i.e., have all students engage in PMAI during stations). More thorough research should be conducted on the degree of fidelity peers can implement PMAI. For this study data was collected on whether a procedure occurred, however, more detailed information can be gained by analyzing how much supervision or prompting a peer needed to implement the procedure with fidelity.

3.4.2. Implications for Practice

Peer-mediated academic instruction can be implemented easily after initial training and has many advantages making it a feasible intervention for educators. For one, students are a readily available resource, making it easy to procure support when needed. Additionally, peers sometimes understand each other quicker than their teachers, helping reduce frustrations (Gaustad, 1993). PMAI can increase exposure to instructional materials and increase individualized instruction provided by the teacher. Use of peer may also increase generalization of skills because they can serve as a cue to stay on task (Hoff & Robinson, 2002; McCurdy & Cole, 2014). PMAI also benefits both individuals involved including boosting their confidence in the skills learned or taught. Students can enhance their social and academic skills, and mold friendships (Asselin & Vasa, 1981; Bedrosian et al., 2003; Carter et al., 2016; Delquadri et al., 1986; Huber, 2016; Huber, Carter, Lopano, & Stankiewicz, 2018; Franca et al., 1990; Scruggs et al., 1985).

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Writing Help	
Materials 	
 **Ask**	
 **Expand**	
 **Choices**	
 **Praise**	

Figure 3-1 Tutoring Visual Support

What if peer is:		
Not working	**Remind peer by asking "what are you doing?"**	
Upset/ Mad/ Frustrated	**Ask peer if he needs a break (2 or 3 minutes)**	
Hit	**Stand up, walk to the teacher, do not say anything to peer**	

Figure 3-2 What if Visual Support

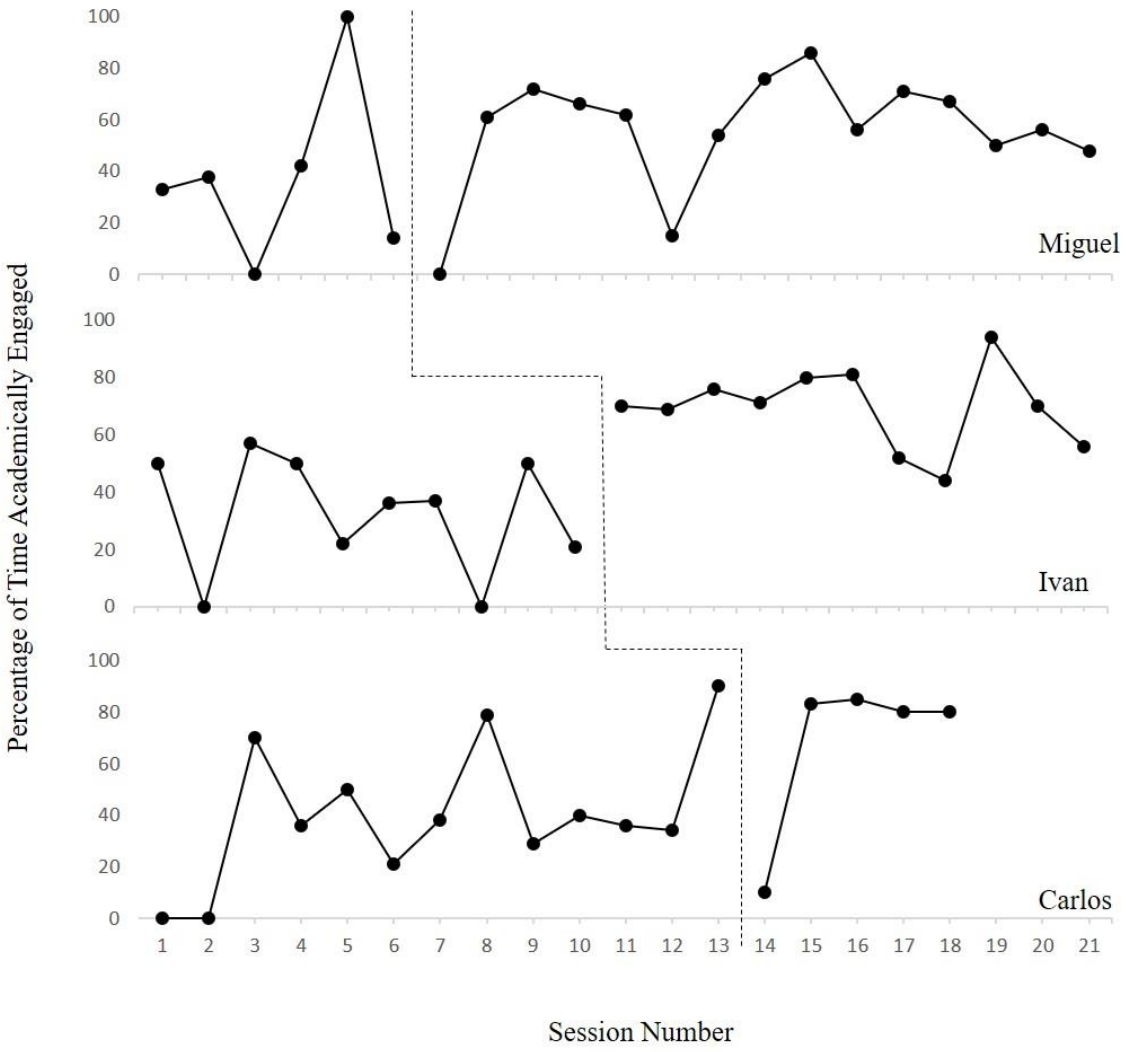

Figure 3-3 Percentage of Academic Engagement

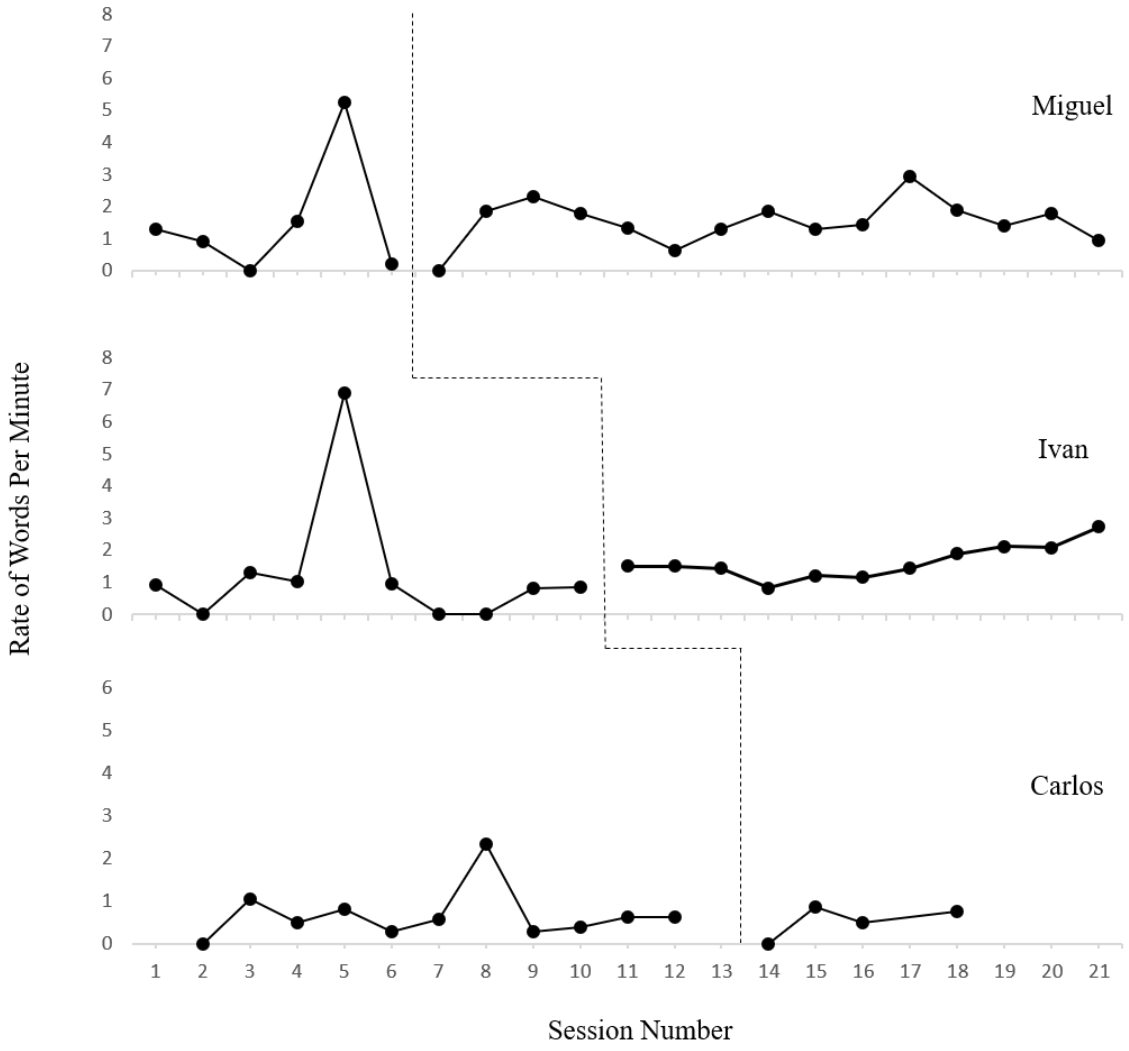

Figure 3-4 Rate of Words Written Per Minute

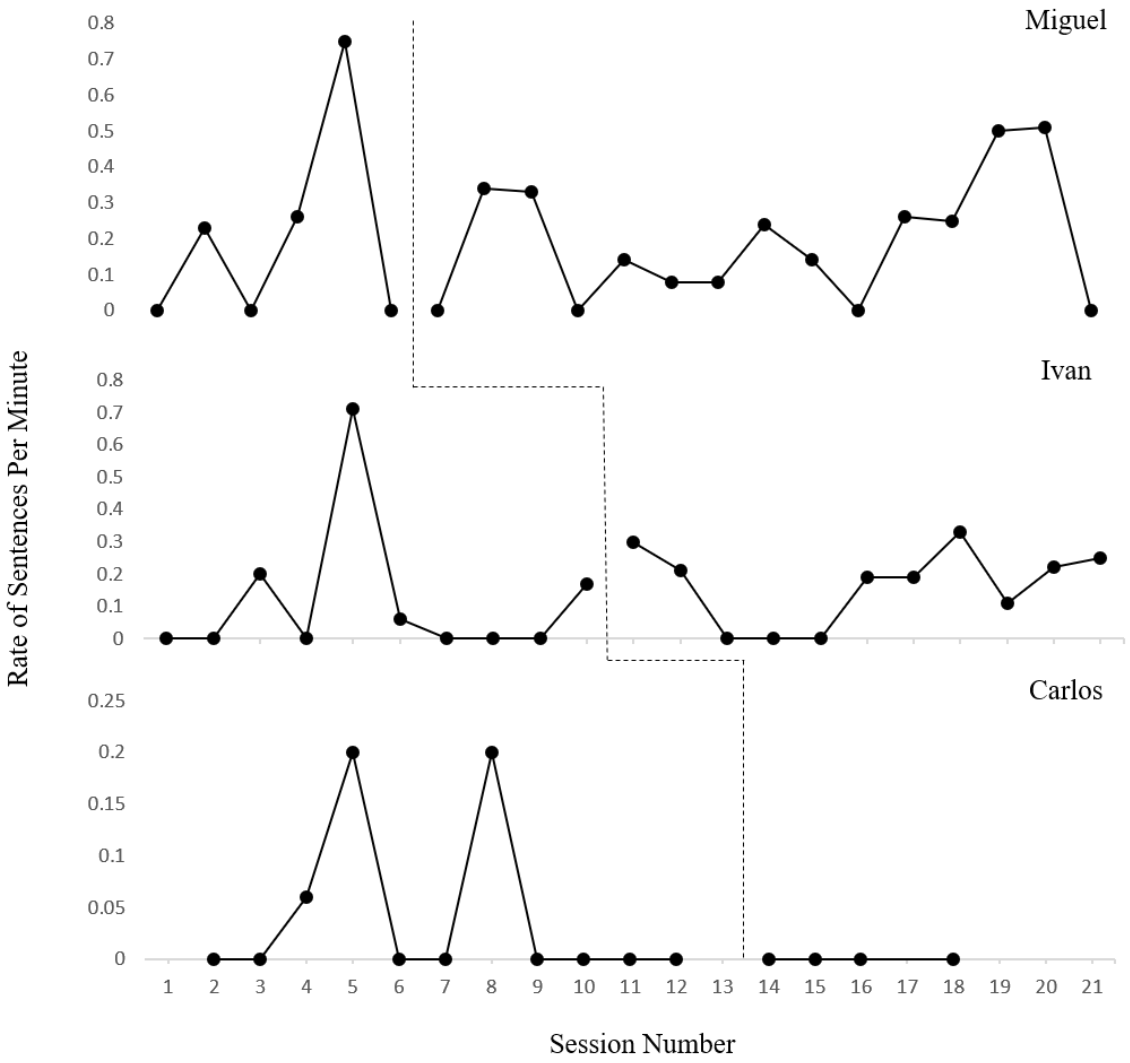

Figure 3-5 Rate of Sentences Written Per Minute

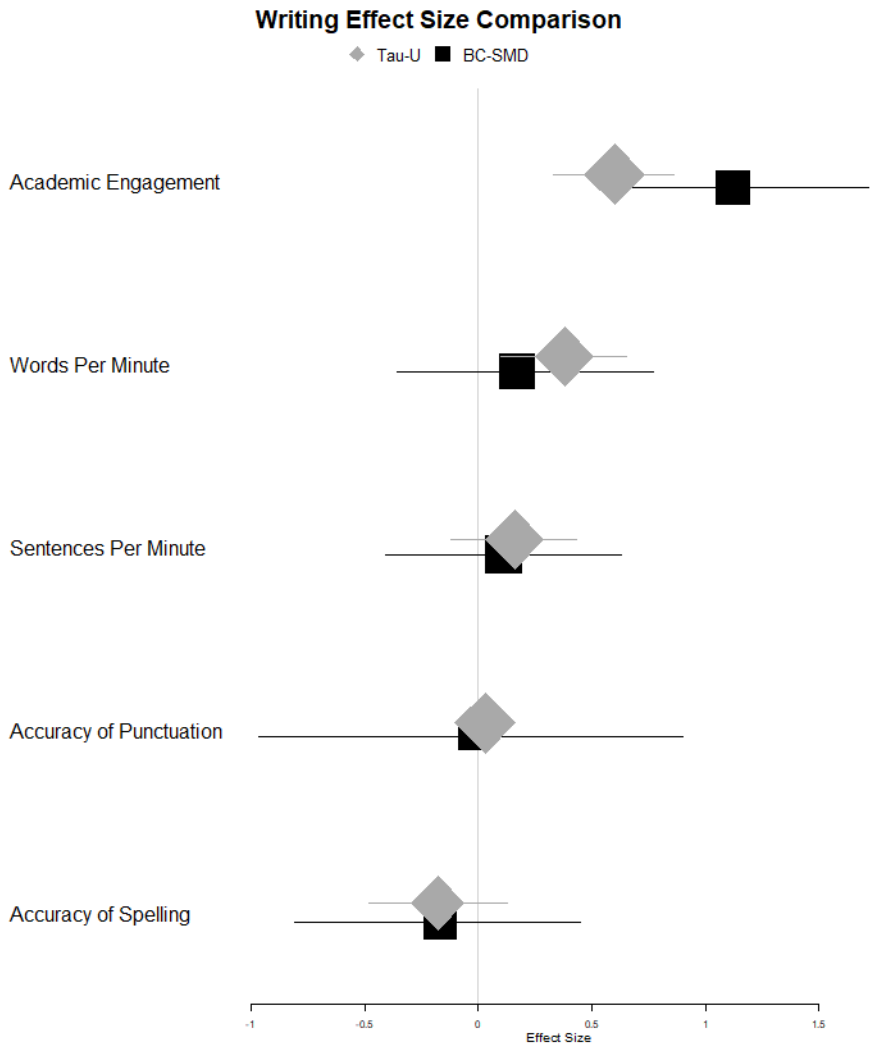

Figure 3-6 Effect Size Comparison Forest Plot

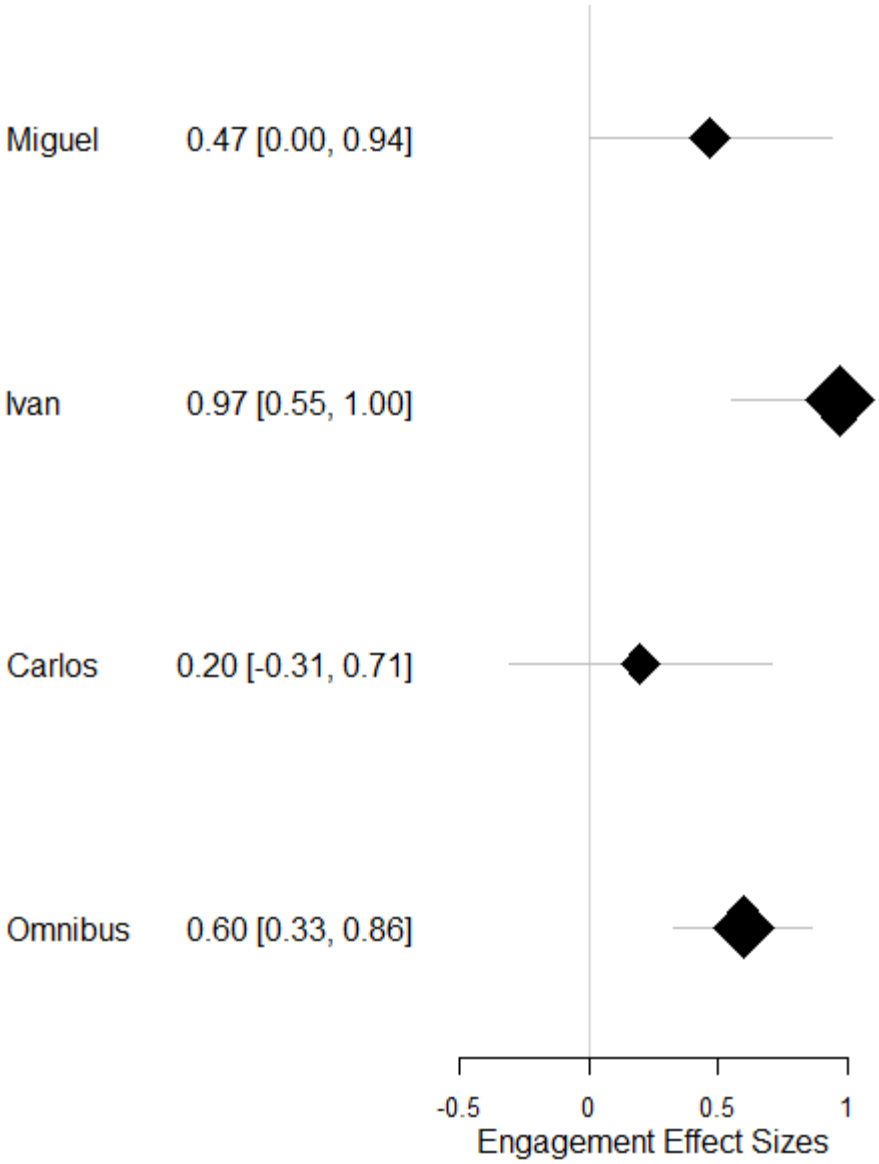

Figure 3-7 Academic Engagement Tau-U Forest Plot

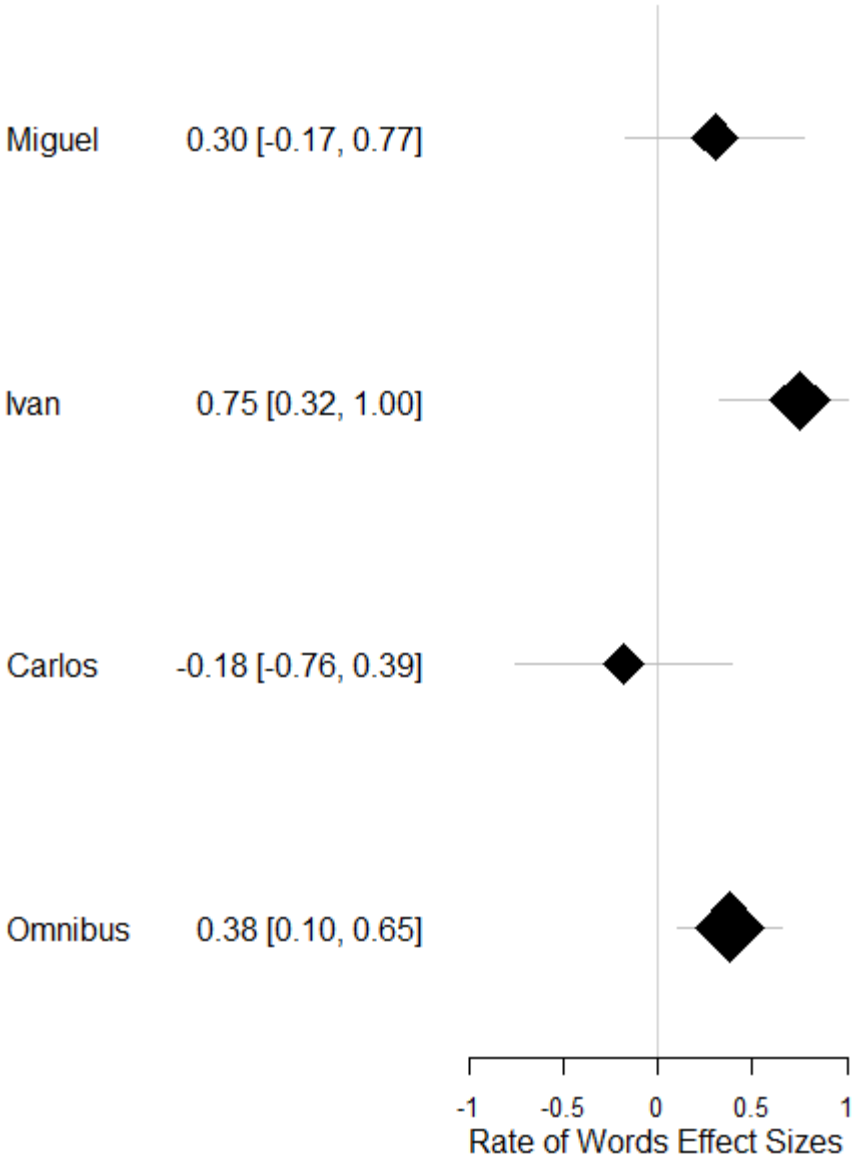

Figure 3-8 Rate of Words Written Tau-U Forest Plot

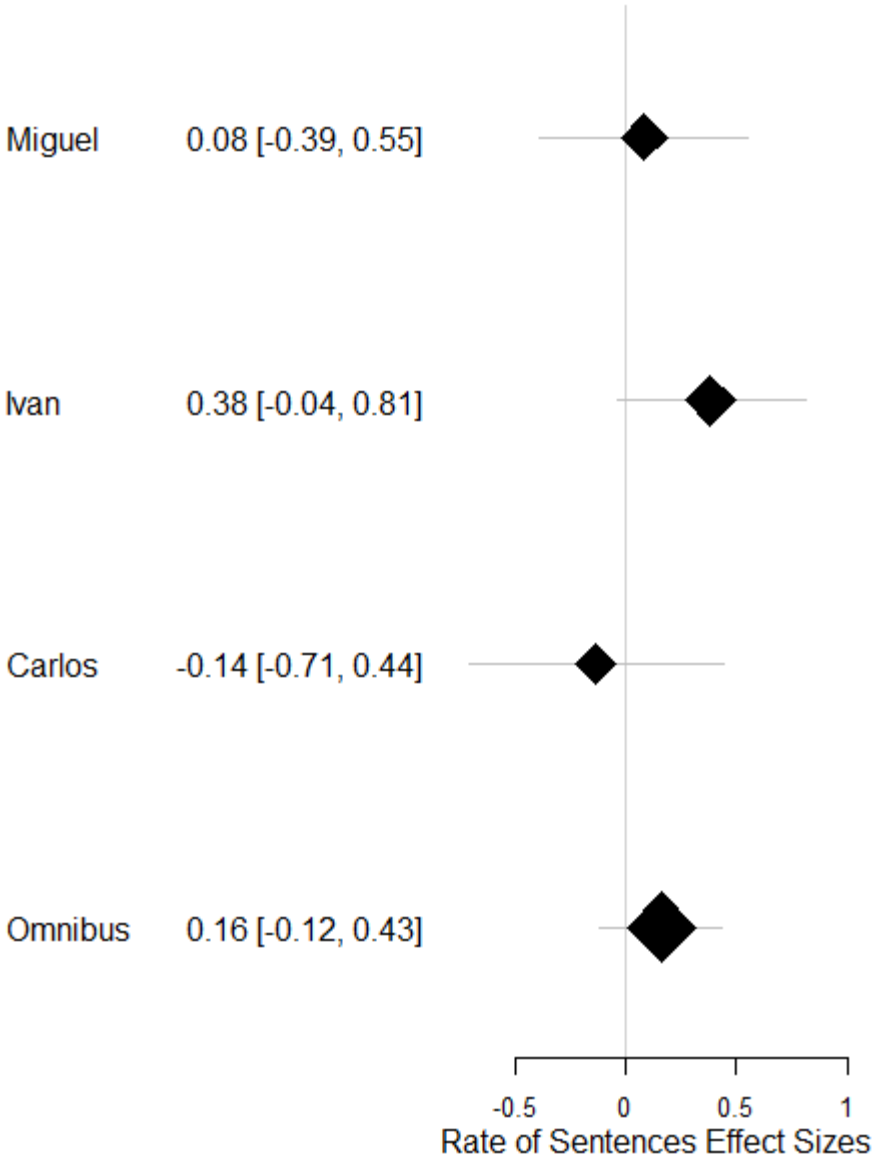

Figure 3-9 Rate of Sentences Tau-U Forest Plot

Table 3-1 Teacher Characteristics

	Gender	Age	Ethnicity	Education Level	Years Teaching
Teacher 1	Female	26	Hispanic	Bachelors	4
Teacher 2	Female	23	Hispanic	Bachelors	1

Table 3-2 Tutor Characteristics

	Gender	Age	Ethnicity	Grade
Katherine	Female	8	Hispanic	3rd
Maya	Female	8	Hispanic	3rd
Madeline	Female	7	Hispanic	2nd

Table 3-3 Tutee Characteristics

	Miguel	Ivan	Carlos
Gender	Male	Male	Male
Age	8	8	7
Ethnicity	Hispanic	Hispanic	Hispanic
Grade	3rd	3rd	2nd
Diagnosis	Autism, Speech and Language Impairment	Autism, Speech Impairment	Autism, Speech Impairment
Autism Assessments			
ASRS	**85**	56	**76**
BRIEF			**78**
ADOS-2	**12**		
GARS-3		**93**	**86**
SRS-2			**83**
Behavioral Assessments			
BASC-3	**X**	X	**X**
ABAS-3	90		**74**
Intellectual Assessment			
KABC-II	95		
Batería III (WJ-III; Written Subtest)	124		
WNV			102

Note. Bolded indicates significance or not average performance

Table 3-4 Data Analysis

Study	TAU-U	CI_{90}		p-value	BC-SMD	CI_{95}		Level	Trend	Variability	Overlap	Functional Relation
Engagement												
Miguel	0.47	-0.00	0.94	0.1021				U	U/Y	Y/N	Y	U
Ivan	0.97	0.55	1.00	0.0002				Y	U	Y	Y	U
Carlos	0.20	-0.31	0.71	0.5217				Y	U	Y/N	Y	Y
Omnibus	0.60	0.33	0.86	0.0003	1.12	0.54	1.72					Y
Words Per Minute												
Miguel	0.30	-0.17	0.77	0.2933				N	U	Y/N	Y	N
Ivan	0.75	0.32	1.00	0.0039				N	N	N	Y	U
Carlos	-0.18	-0.76	0.39	0.6015				N	N/U	N	Y	N
Omnibus	0.38	0.10	0.65	0.0249	0.17	-0.36	0.77					N
Sentences Per Minute												
Miguel	0.08	-0.39	0.55	0.7853				N	U/Y	U/Y	Y	N
Ivan	0.38	-0.04	0.81	0.1392				N	N/Y	N/U	Y	N
Carlos	-0.14	-0.71	0.44	0.6953				U	N	N	Y	N
Omnibus	0.16	-0.12	0.43	0.3512	0.11	-0.41	0.63					N
Punctuation Accuracy												
Miguel	-0.40	-0.91	0.11	0.1949								
Ivan	0.43	-0.04	0.90	0.1351								
Carlos	-0.05	-0.74	0.64	0.9093								
Omnibus	0.03	-0.27	-0.34	0.8899	-0.03	-0.97	0.90					
Spelling Accuracy												
Miguel	0.04	-0.47	0.55	0.8896								
Ivan	-0.55	-1.00	-0.07	0.0572								
Carlos	0.17	-0.48	0.82	0.6726								
Omnibus	-0.18	-0.48	0.13	0.3434	-0.17	-0.81	0.45					

Table 3-5 Interobserver Agreement for Academic Engagement

	Overall IOA	Baseline IOA	Intervention IOA
Miguel	85% (33%)	88% (50%)	83% (27%)
Ivan	85% (33%)	81% (40%)	91% (27%)
Carlos	96% (21%)	95% (21%)	100% (20%)
Overall	89% (29%)	88% (37%)	91% (25%)

Table 3-6 Fidelity Measures

	Overall	Miguel	Ivan	Carlos
Implementation Fidelity				
Fidelity	80% (83%)	80% (100%)	80% (50%)	80% (100%)
Interobserver Agreement	85% (59%)	90% (67%)	80% (50%)	n/a
Procedural Fidelity				
Overall	62% (59%)	75% (67%)	58% (52%)	52% (77%)
Interobserver Agreement	82% (33%)	85% (36%)	89% (27%)	72% (35%)
Baseline	36% (51%)	57% (50%)	31% (50%)	21% (53%)
Interobserver Agreement	86% (27%)	91% (33%)	90% (20%)	77% (29%)
Intervention	87% (69%)	92% (53%)	86% (54%)	83% (100%)
Interobserver Agreement	77% (37%)	78% (38%)	88% (33%)	66% (40%)
Treatment Integrity				
Intervention	87% (69%)	92% (53%)	86% (54%)	83% (100%)
Interobserver Agreement	77% (37%)	78% (38%)	88% (33%)	66% (40%)

Table 3-7 Social Validity

Questions	Teacher 1
Peer tutoring is an effective way to teach writing.	5
Writing is an important skill to learn.	5
I would recommend peer tutoring to other staff and teachers.	5
I believe peer tutoring could work for teaching other behaviors/ skills.	5
I would be willing to use this peer tutoring again.	5
Peer tutoring could be used with other students.	5
Peer tutoring is easy to implement.	4
Peer tutoring is cost effective.	5
Peer tutoring is effective.	5
I have the skills and materials necessary to create visuals for peer tutoring.	4
The time requirements to teach peer tutoring is reasonable.	4
The time requirements to implement peer tutoring is reasonable.	4

4. CONCLUSIONS

This dissertation sought to identify for whom and under what conditions peer-mediated academic instruction is beneficial for students with autism. A meta-analysis was conducted to evaluate the overall effect of PMAI and potential moderators influencing results. Additionally, multiple effect size calculations were evaluated to understand effect in relation to different measures and discuss results in relation to controversy of the use of one measure over another (Chen, Hyppa-Martin, Reichle, & Symons, 2017). The second study addressed gaps found in the literature by conducting a single case experimental design using PMAI in writing while collecting data on tutors' fidelity of implementation.

The meta-analysis sought to answer the following questions: (a) effect of PMAI including studies meeting quality and those that do not (b) comparison of magnitude of effect across different effect size measures (c) effects related to identified moderators including comparison of studies meeting and not meeting quality standards (d) comparisons of single case parametric effect size calculations to standard mean difference effect size calculations for group design, and (e) identification of publication bias. Results suggest PMAI has a moderate effect when targeting academic skills for autism with quality studies demonstrating a slightly higher effect than those not meeting quality. Comparison of effect size measures resulted in varied results for magnitude of effect, however IRD and PND effects produces the most variance among effect. Moderator analysis suggests that identified moderators other than author group did not influence outcomes, nor did the quality of moderators in relation to the studies. Parametric analyses aligned with nonparametric Tau-U indicating PMAI demonstrates a moderate effect for students with

autism. Lastly, publication bias analysis suggests a possibility for publication bias although the effects of PMAI would still be considered moderate.

The single case study implemented PMAI during writing stations for three students with autism to answer the following questions: (a) is there a functional relation between PMAI and academic engagement, (b) if academic engagement is increase will rate of word or sentences increase, (c) can peers implement PMAI with fidelity, and (d) how do teacher view the use of PMAI? Statistical and visual results indicate a functional relation between PMAI and increasing the rate of academic engagement, however, a functional relation was not established for increasing rate of words or sentences written. Results also demonstrate peers can implement PMAI with fidelity and teachers view PMAI as an intervention that can be useful for increasing students' engagement while completing assignments.

4.1. Implications for Practice

Results from the meta-analysis and single case study suggests that students with autism could benefit from peer-mediated academic instruction. PMAI is efficacious for multiple reasons. Utilizing peers is beneficial for all parties involved, including the teacher. PMAI solidifies knowledge by increasing exposure to educational materials, reduces frustrations often associated with academic work and influences social skills and friendships outside of the academic setting (Asselin & Vasa, 1981; Bedrosian, Lasker, Speidel, & Politsch, 2003; Carter et al., 2016; Delquadri, Greenwood, Whorton, Carta, & Hall, 1986; Franca, Kerr, Reitz, & Lambert 1990; Gaustad, 1993; Huber, 2016; Huber, Carter, Lopano, & Stankiewicz, 2018; Scruggs, Mastropieri, & Richter, 1985). Additionally, peers are more available than traditional supports (i.e., paraprofessional), which can lead to generalization since peers can provide reminders when students should

be engaging in an activity Lastly, the use of peer supports can increase a teacher's ability to provide individualized instruction to students who are struggling by reducing the amount of time that is spent during whole group instruction (Hoff & Robinson, 2002; McCurdy & Cole, 2014).

4.2. Limitations and Future Research

There are several limitations within this dissertation that should be addressed. First, although an attempt was made to identify all gray literature to reduce the risk of publication bias, there is still a potential that all studies were not identified. Another limitation for the meta-analysis is the strength of effects were identified using arbitrarily set standards. Future research should combine visual and statistical analysis to identify strengths of an effect using a percentile ranking specified for PMAI to determine clinical significance of results (Ganz et al., 2017; Kromrey & Foster-Johnson, 1996). More research is also needed to identify the strength of specific PMAI strategies and in what academic areas it is most beneficial.

Within the single case study limitations include the presence of the paraprofessional during the intervention. Future research could explore the use of the paraprofessional for monitoring the implementation of PMAI and providing support and redirection to students as needed. Another limitation included sessions being terminated early because students had to attend other therapies as prescribed in their IEP, this could have influenced the true value of the data collected. A third limitation was disruptions caused by other peers in the classroom. Students were participating in stations while the teachers engaged in small group activities. Other peers would ask the tutors questions or for help during intervention. Future research should control for this variable by

implementing PMAI with all the students or creating a procedure on how respond when another peer wants help or to ask a question. Another limitation was that although fidelity of implementation was collected to bridge a gap in the literature, data on procedures were collected as occurring or not occurring. Future research should evaluate the degree to which the procedures were implemented to better understand the level of supervision needed with implementing PMAI. Lastly, PMAI was implemented for writing, however, academic engagement was the primary dependent variable. Research suggests that increased engagement can result in increased academic achievement (Casuso-Holgado et al., 2013), however, future research should specifically target rate of word written to identify if PMAI is effective for writing.

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APPENDIX A

META-ANALYSIS KEY WORDS AND CODING INFORMATION

Table A-1 Comprehensive List of Key Words

	Key Words
Autism	Pervasive Developmental Disorders, Asperger Syndrome, Autism
Tutoring	Peer Relationship, Peer Groups, Peer Teaching, Peer Influence, Tutoring, Peer training, Peer modeling, Peer support, Peer mediated intervention, Peer to Peer, Training, Peer mentoring, Peer instruction, Peer tutor, Peer group tutoring, Peer facilitating, Peer education, Peer trainer, Peer interaction, Collaborative learning
Learning Outcomes	Learning Strategies, Reading Strategies, Outcomes of Education, Educational Benefits, Instructional Effectiveness, Outcomes of Treatment, Cooperative Learning, Academic Achievement, Educational Attainment, Student Promotion
Academic Area	Writing Composition, Basic Writing, Beginning Writing, Children's Writing, Content Area Writing, Creative Writing, Descriptive Writing, Expository Writing, Paragraph Composition, Social Studies, Language Arts, Handwriting, Listening, Reading, Spelling, Story Telling, English, Oral English, History, African American History, American Indian History, Asian History, Educational History, European History, Historiography, Latin American History, Medieval History, Middle Eastern History, Modern History, Oral History, Science History, Social History, United States History, World History, Sciences, Natural Sciences, Mathematics, Algebra, Arithmetic, Calculus, Geometry, Statistics, Trigonometry, Reading, Basal Reading, Beginning Reading, Content Area Reading, Corrective Reading, Critical Reading, Directed Reading Activity, Early Reading, Functional Reading, Independent Reading, Individualized Reading, Oral Reading, Reading Aloud to Others, Recreational Reading, Remedial Reading, Silent Reading, Speed Reading, Story Reading, Sustained Silent Reading, Reading Comprehension, Reading Instruction, Reading Improvement, Reading Skills, Reading Fluency, Reading Rate, Mathematics Skills, Writing Skills

Table A-2 Variable Coding Definitions

Variable	Definition
Participant Characteristics	
Sex	male or female, if not specified read narrative about participants to identity he/she
Age	age range or average age of participants
Grade	grade range of participants
Race	Caucasian, African American, Asian America, etc.
IQ	use IQ tests and norms to determine IQ level, i.e., below, average, above; for participants with ASD
Functioning Level	only record if specifically stated by the authors i.e., high functioning; for participants with ASD
Setting	
General Education	classroom includes students without disabilities; can include students with disabilities
Special Education	classroom includes only students with disabilities
Research Design	multiple baseline, multiple probe, reversal/ withdrawal, alternating treatment, etc.
Independent Variable	describe tutoring procedure, how were peers utilized, what was each other's role
Dependent Variable	percentage correct, rate of completion, etc.
Academic Subject Targeted	math, science, history, reading, etc.

Table A-3 WWC Group Design Standards Coding

Scoring Code	Definition for Scoring
Group assignment	
Meets	The study used a random or equivalently random assignment
Meets with Reservations	Baseline equivalence was established for studies not random of equivalently random
Does not Meet	Does not meet the above criteria
Attrition	
Meets	Attrition bias is calculated as < 0.05 standard deviations
Meets with Reservations	Attrition bias is not calculated as < 0.05 standard deviations but includes baseline equivalence
Does not Meet	Does not meet the above criteria
Outcome Measures	
Meets	Measures reported validity, can be interpreted, and measure what they were created to measure
Does not Meet	Does not meet the above criteria
Reliability	
Meets	Study reported if measures used meet minimum reliability
Does not Meet	Study did not report if measures used met minimum reliability
Alignment	
Meets	Outcome measures aligned with the intervention
Does not Meet	Outcome measures did not align with the intervention
Measurement	
Meets	Outcomes were measured the same way for both groups
Does not Meet	Outcomes were measured differently for both groups
Confounding Variables in a Single Study Unit	
Meets	Study did not contain single study unit
Does not Meet	At least one group contained a single study unit (i.e., two classrooms from different schools assigned to different conditions)
Confounding Variables in Group Characteristics	
Meets	Groups are similar
Does not Meet	Groups vary to the point outcomes may ne affected
Confounding Variables in the Independent Variable	
Meets	The independent variable was the only variable manipulated
Does not Meet	The independent variable was manipulated in conjunction with others
Confounding Variable Related to Timing	
Meets	Data were collected at the same time for both groups
Does not Meet	Data were not collected at the same time for both groups

Table A-4 WWC Single Case Design Standards Coding

Scoring Code	Definition for Scoring
Independent Variable Manipulation	
Meets	The independent variable was systematically manipulated
Does not Meet	The independent variable was not systematically manipulated
Interobserver Agreement	
Meets	Measurement of IOA was reported
Does not Meet	IOA measurement was not reported
Frequency of Interobserver Agreement	
Meets	IOA data were measured for 20% and reported for each condition
Meets with Reservations	IOA data were measured for 20% of the study
Does not Meet	IOA data were measured for less than 20% of the study
Interobserver Agreement Outcome	
Meets	IOA data scored 80% or above agreement across two raters
Does not Meet	IOA data scored less than 80% or agreement across two raters
Treatment Effects	
Meets	3 attempts were made to demonstrate effects
Does not Meet	Study did not include 3 attempts for demonstration of effects
Number of Data Points	
Meets	At least 5 data points per phase were present
Meets with Reservations	At least 3 data points per phase were present
Does not Meet	Less than 3 data points per phase were present

APPENDIX B

SINGLE CASE DATA COLLECTION SHEETS AND OUTCOMES

Tutee Observation Sheet

Participant ID:	Video Coded:	Date Watched:
Writing Prompt:	Condition:	Observer:

Academic Engagement: Score as occurring if the student is writing words with their pencil (not drawing), erasing, asking for help (for spelling or ideas) or discussing what they will be writing during any time during the interval.

Mark in the appropriate box if occurred using, an X, /, or ✔

0:00-0:30	0:30- 1:00	1:00-1:30	1:30- 2:00	2:00-2:30	2:30- 3:00	3:00-3:30	3:30- 4:00	4:00-4:30	4:30- 5:00
5:00-5:30	5:30- 6:00	6:00-6:30	6:30- 7:00	7:00-7:30	7:30- 8:00	8:00-8:30	8:30- 9:00	9:00-9:30	9:30-10:00
10:00-10:30	10:30-11:00	11:00-11:30	11:30-12:00	12:00-12:30	12:30-13:00	13:00-13:30	13:30-14:00	14:00-14:30	14:30-15:00

Writing Skills:

Words per session: Number of words written in the session divided by the session duration

Sentences per session: Number of sentences written divided by the session duration. Count as a sentence if there is a noun and verb. For example: "He lives in Texas He rode a tornado to California He thought he was a coyote" would be three separate sentences

Accuracy of punctuation: Number of incorrect punctuations (include capitalization) divided by number of possible punctuation occurrences. Count incorrect if the sentence is a ? and does not end in ?

Accuracy of spelling: Number of incorrect words spelled divided by number of words written.

Words per Minute:

Number of Words	Time	Rate

Sentences per Minute:

Number of Words	Time	Rate

Punctuation:

Number Incorrect	Number of Opportunities	% Correct

Spelling:

Number Incorrect	Number of Opportunities	% Correct

Figure B-1 Data Collection Form

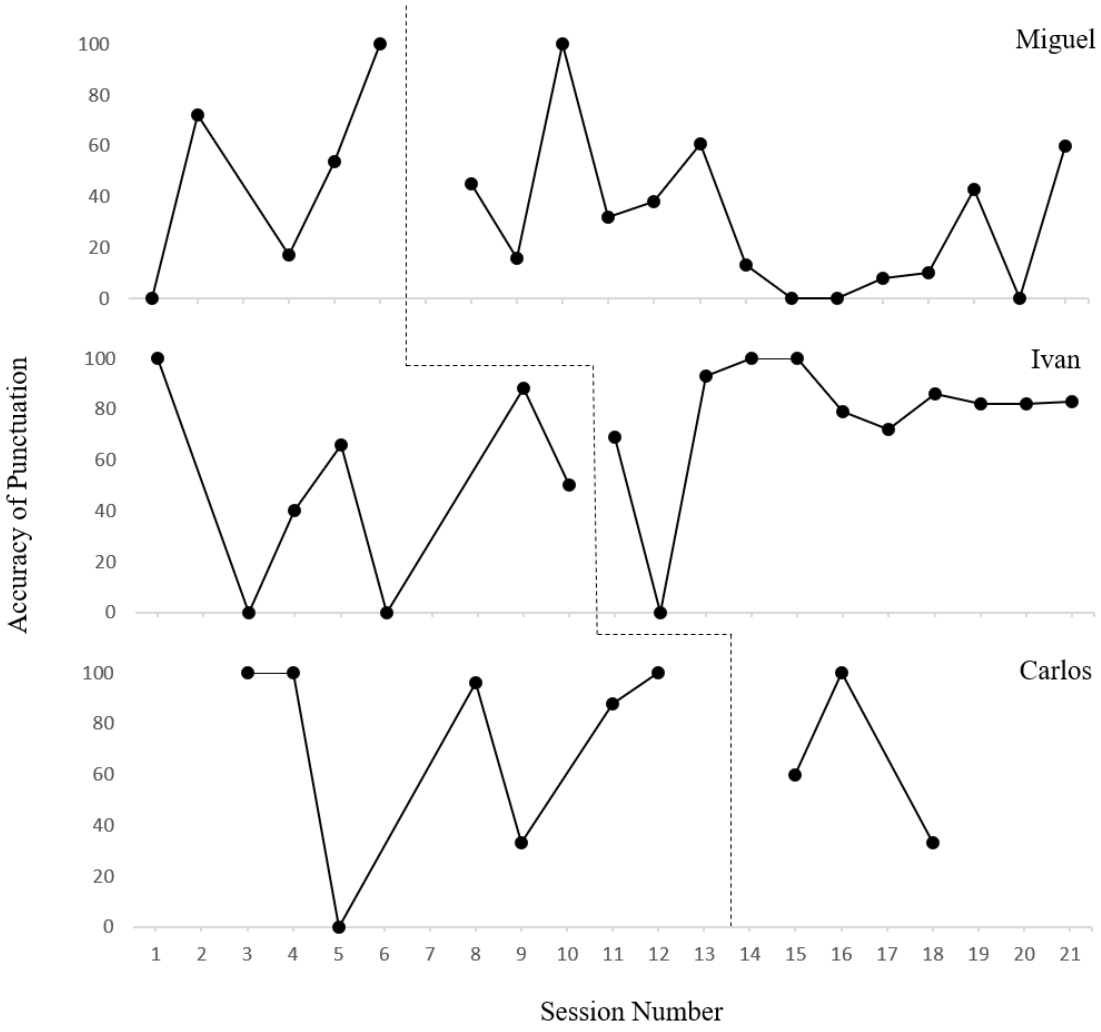


Figure B-2 Accuracy of Punctuation Graph

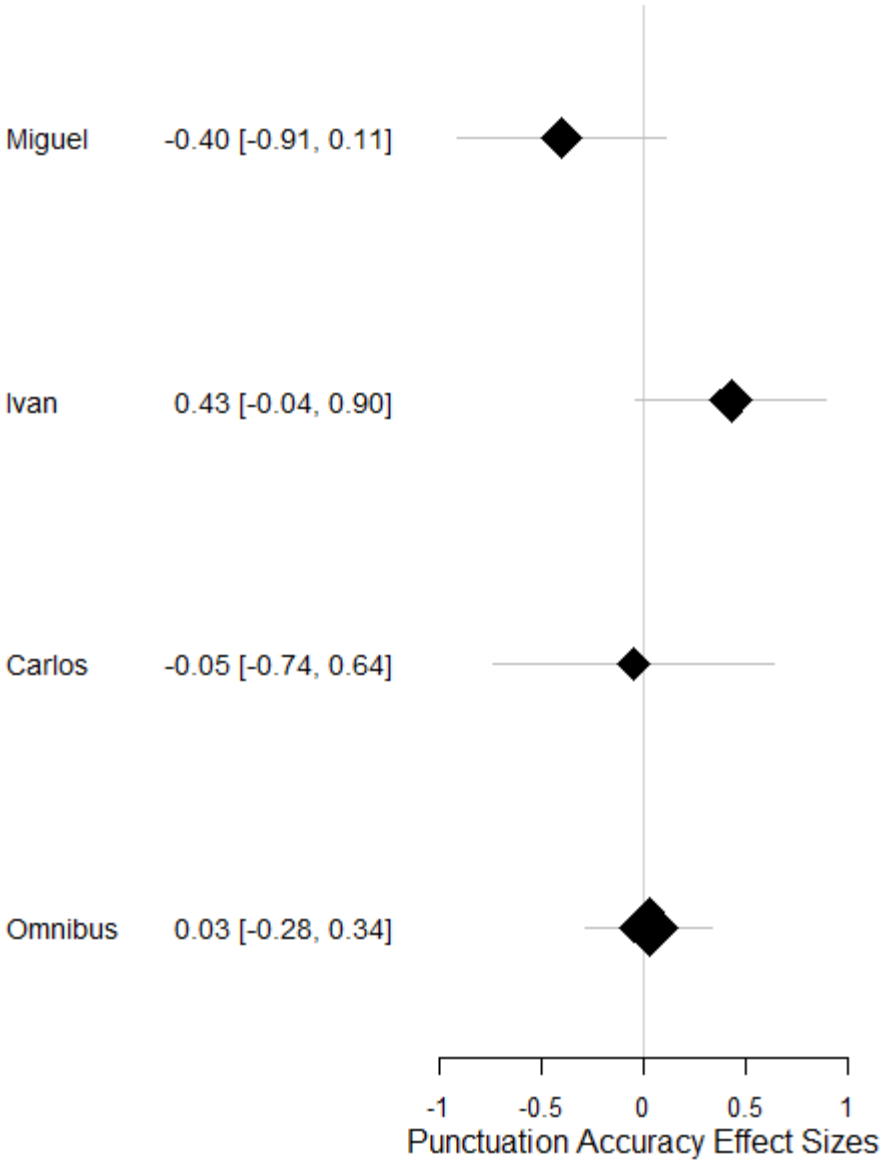


Figure B-3 Accuracy of Punctuation Forest Plot

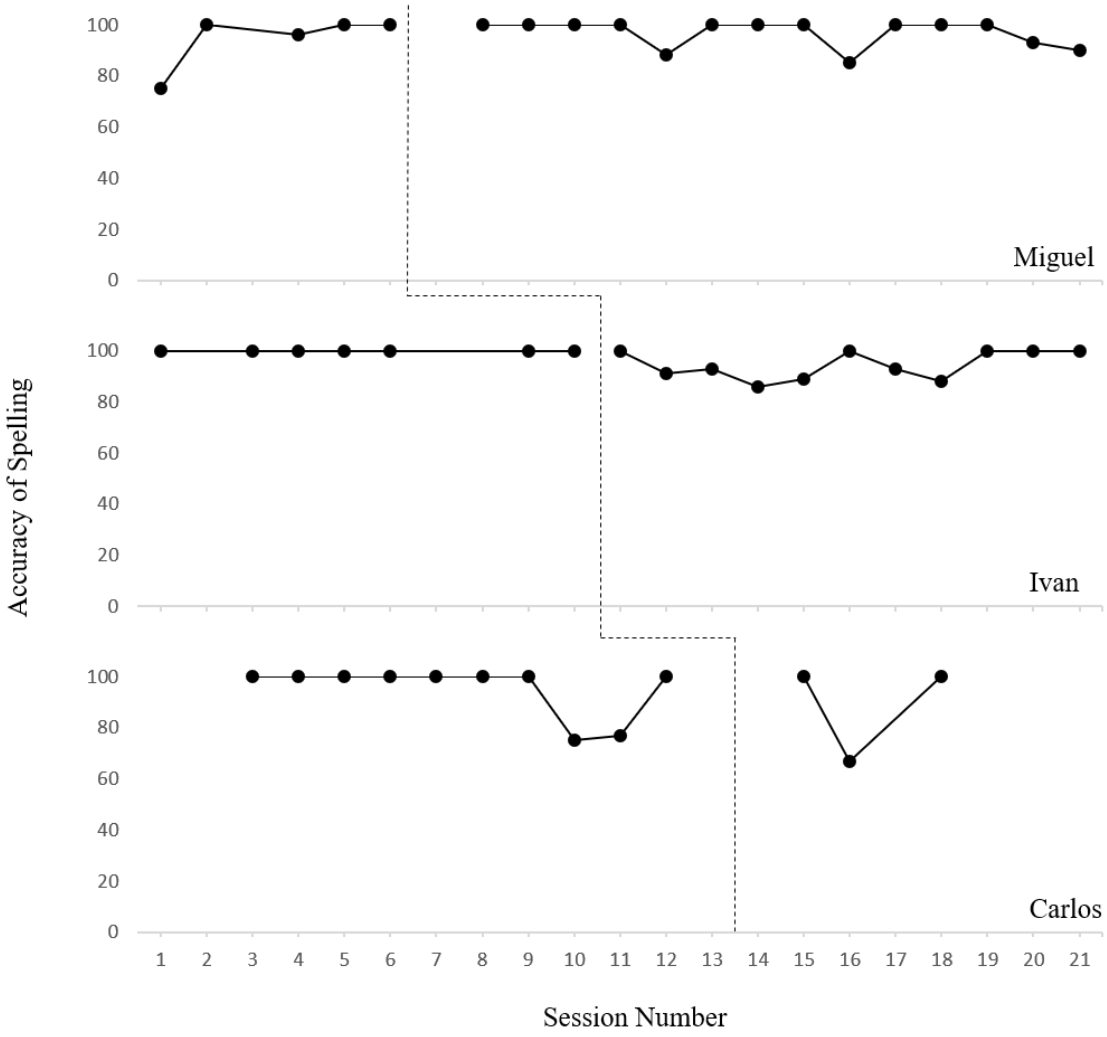


Figure B-4 Accuracy of Spelling Graph

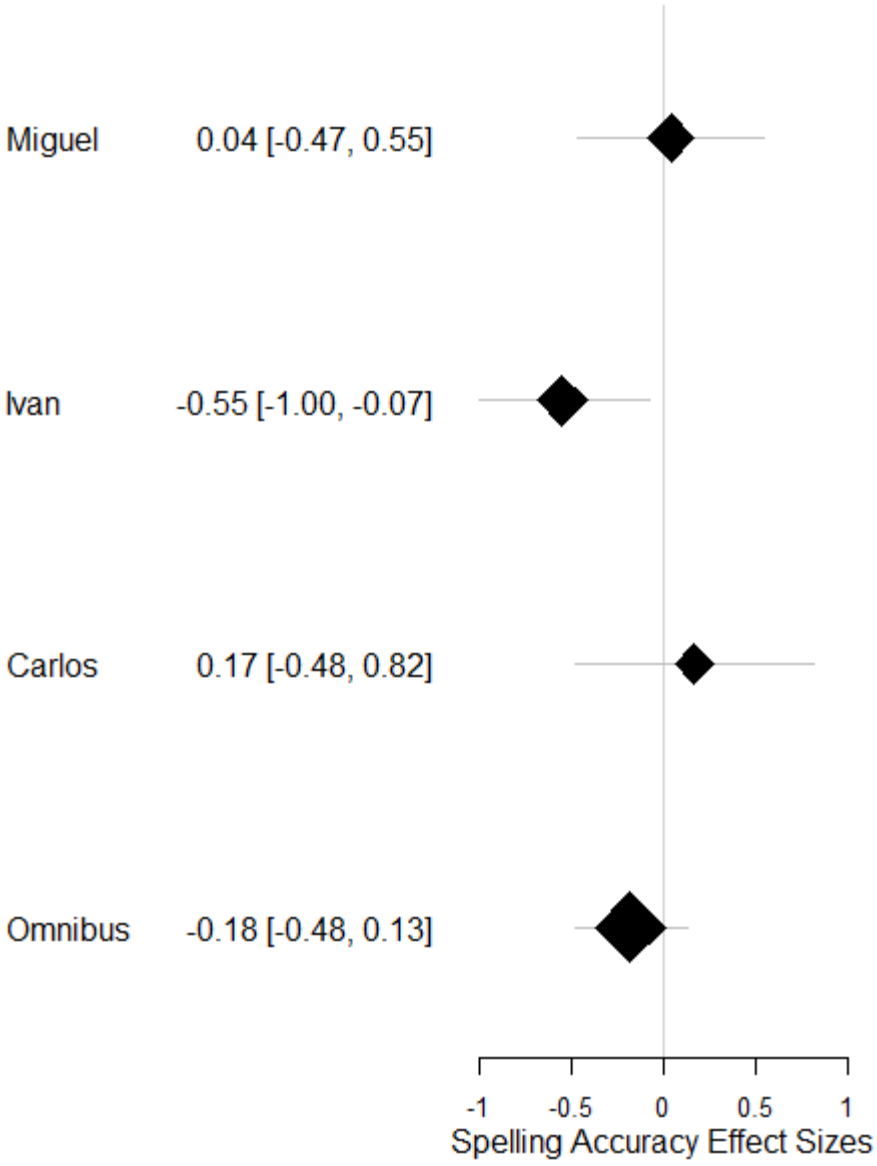
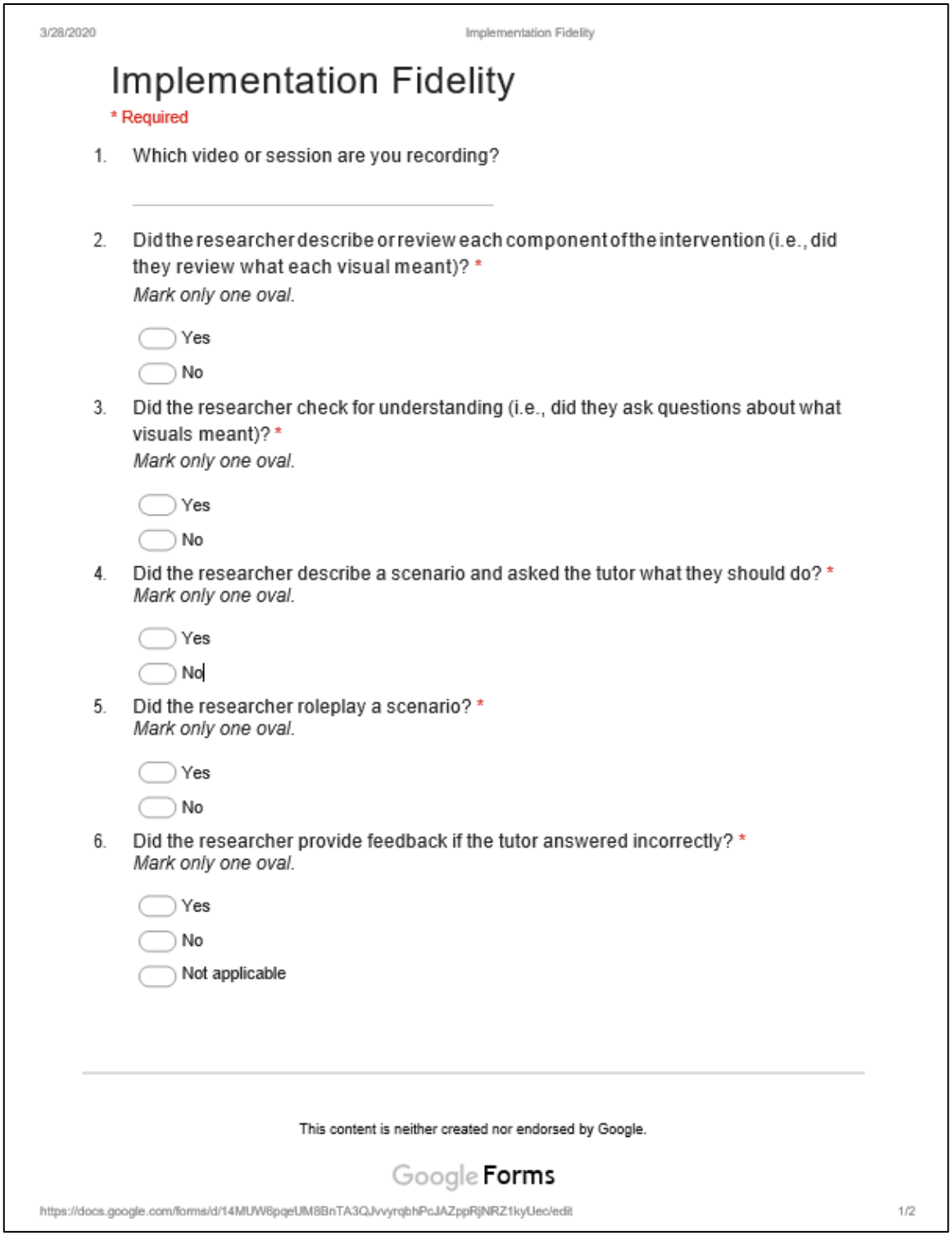


Figure B-5 Accuracy of Spelling Forest Plot



3/28/2020 Implementation Fidelity

Implementation Fidelity

* Required

1. Which video or session are you recording?

2. Did the researcher describe or review each component of the intervention (i.e., did they review what each visual meant)? *
Mark only one oval.
- Yes
- No

3. Did the researcher check for understanding (i.e., did they ask questions about what visuals meant)? *
Mark only one oval.
- Yes
- No

4. Did the researcher describe a scenario and asked the tutor what they should do? *
Mark only one oval.
- Yes
- No

5. Did the researcher roleplay a scenario? *
Mark only one oval.
- Yes
- No

6. Did the researcher provide feedback if the tutor answered incorrectly? *
Mark only one oval.
- Yes
- No
- Not applicable

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Google Forms

https://docs.google.com/forms/d/14MUW8pqeUM8BnTA3QJvvyrqbhPcJAZppRjNRZ1kyUec/edit 1/2

Figure B-6 Implementation Fidelity Questions

Procedural Fidelity

Use this form and the treatment integrity form for full procedural fidelity.

* Required

1. Which Student? *
   Mark only one oval.
   - ◯ CL
   - ◯ IR
   - ◯ MG
2. Session number *

   _____
3. Did the researcher ask the tutor to help the tutee or tell the tutee to work on the assignment? *
   Mark only one oval.
   - ◯ Yes
   - ◯ No
4. Was the student provided the writing assignment or told to work on the writing assignment? *
   Mark only one oval.
   - ◯ Yes
   - ◯ No
5. Did the tutor make sure all materials were present? *
   Check all that apply.
   - ☐ Independent
   - ☐ Prompted
   - ☐ Maybe/ Did not see (video started after)
   - ☐ No
6. Did the tutor tell/ ask the tutee what to write about? *
   Check all that apply.
   - ☐ Independent
   - ☐ Prompted
   - ☐ No
7. Did the tutor use and expanding question? *
   Check all that apply.
   - ☐ Independent
   - ☐ Prompted
   - ☐ No
   - ☐ Not Applicable

8. Did the tutor provide choices if the student did not respond? *
Check all that apply.
- [ ] Independent
- [ ] Prompted
- [ ] Not applicable
- [ ] No

9. Did the tutor tell the tutee what to write if they did not respond to the choices? *
Check all that apply.
- [ ] Independent
- [ ] Prompted
- [ ] Not Applicable
- [ ] No

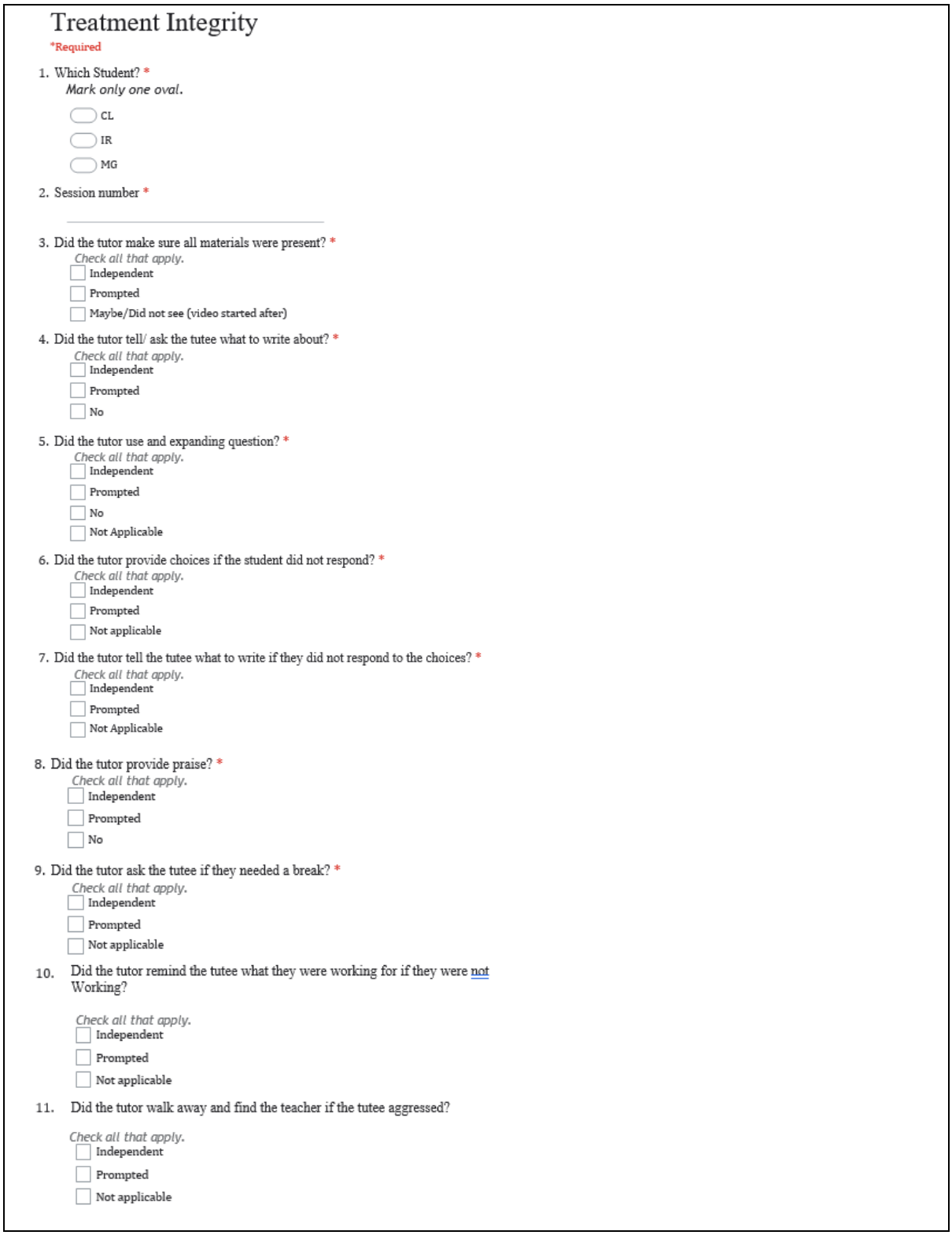
10. Did the tutor provide praise? *
Check all that apply.
- [ ] Independent
- [ ] Prompted
- [ ] No

11. Did the tutor ask the tutee if they needed a break? *
Check all that apply.
- [ ] Independent
- [ ] Prompted
- [ ] Not applicable

12. Did the tutor remind the tutee what they were working for if they were not working? *
Check all that apply.
- [ ] Independent
- [ ] Prompted
- [ ] Not applicable

13. Did the tutor walk away and find the teacher if the tutee aggressed? *
Check all that apply.
- [ ] Independent
- [ ] Prompted
- [ ] Not applicable

Figure B-7 Procedural Fidelity Questions

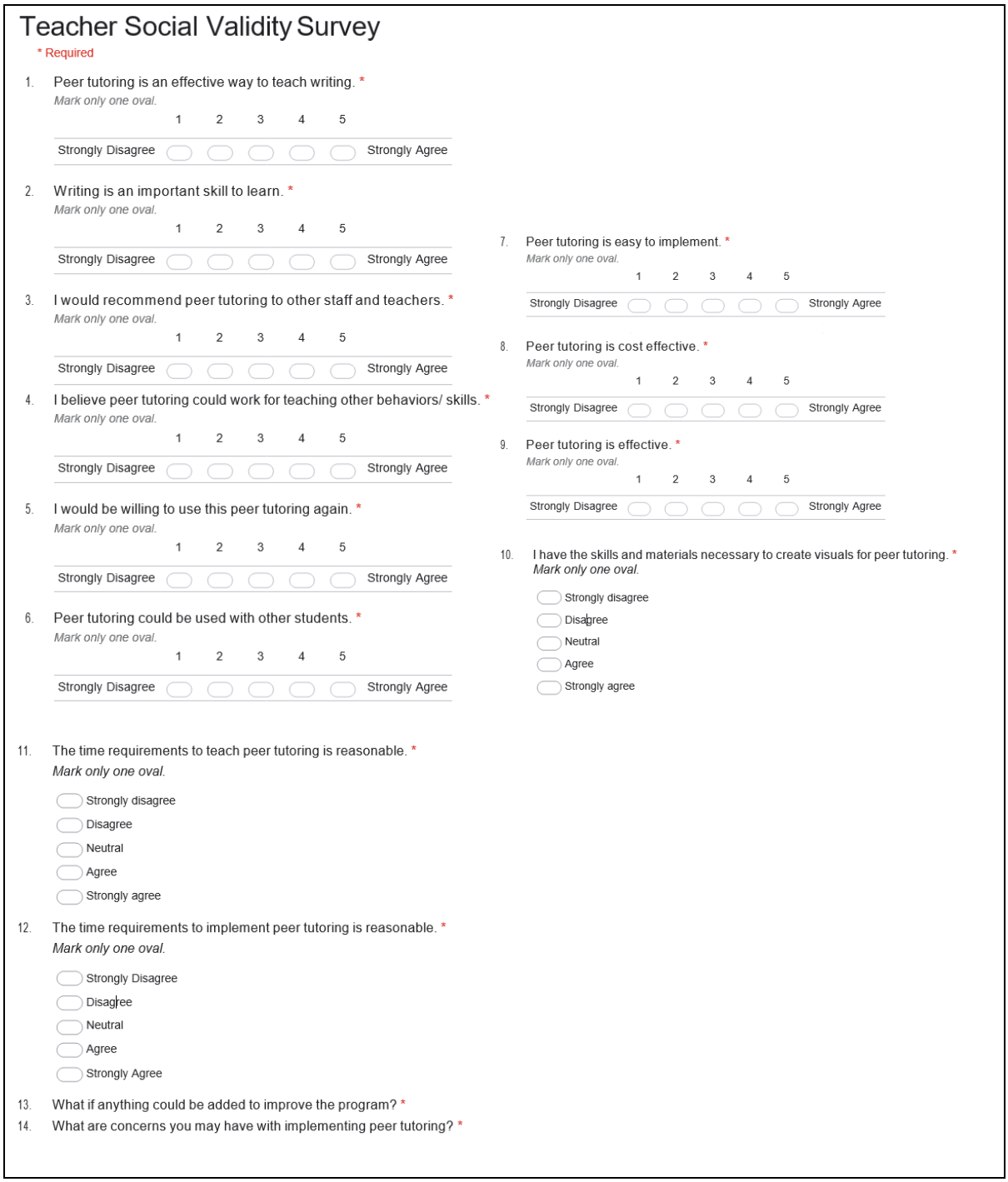


Treatment Integrity

*Required

1. Which Student? *
   Mark only one oval.
   - CL
   - IR
   - MG
2. Session number *
3. Did the tutor make sure all materials were present? *
   Check all that apply.
   - Independent
   - Prompted
   - Maybe/Did not see (video started after)
4. Did the tutor tell/ ask the tutee what to write about? *
   Check all that apply.
   - Independent
   - Prompted
   - No
5. Did the tutor use and expanding question? *
   Check all that apply.
   - Independent
   - Prompted
   - No
   - Not Applicable
6. Did the tutor provide choices if the student did not respond? *
   Check all that apply.
   - Independent
   - Prompted
   - Not applicable
7. Did the tutor tell the tutee what to write if they did not respond to the choices? *
   Check all that apply.
   - Independent
   - Prompted
   - Not Applicable
8. Did the tutor provide praise? *
   Check all that apply.
   - Independent
   - Prompted
   - No
9. Did the tutor ask the tutee if they needed a break? *
   Check all that apply.
   - Independent
   - Prompted
   - Not applicable
10. Did the tutor remind the tutee what they were working for if they were not Working?
    Check all that apply.
    - Independent
    - Prompted
    - Not applicable
11. Did the tutor walk away and find the teacher if the tutee aggressed?
    Check all that apply.
    - Independent
    - Prompted
    - Not applicable

Figure B-8 Treatment Integrity



Teacher Social Validity Survey

* Required

1. Peer tutoring is an effective way to teach writing. *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

2. Writing is an important skill to learn. *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

3. I would recommend peer tutoring to other staff and teachers. *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

4. I believe peer tutoring could work for teaching other behaviors/ skills. *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

5. I would be willing to use this peer tutoring again. *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

6. Peer tutoring could be used with other students. *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

7. Peer tutoring is easy to implement. *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

8. Peer tutoring is cost effective. *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

9. Peer tutoring is effective. *
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

10. I have the skills and materials necessary to create visuals for peer tutoring. *
Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

11. The time requirements to teach peer tutoring is reasonable. *
Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

12. The time requirements to implement peer tutoring is reasonable. *
Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

13. What if anything could be added to improve the program? *

14. What are concerns you may have with implementing peer tutoring? *

Figure B-9 Social Validity Questions

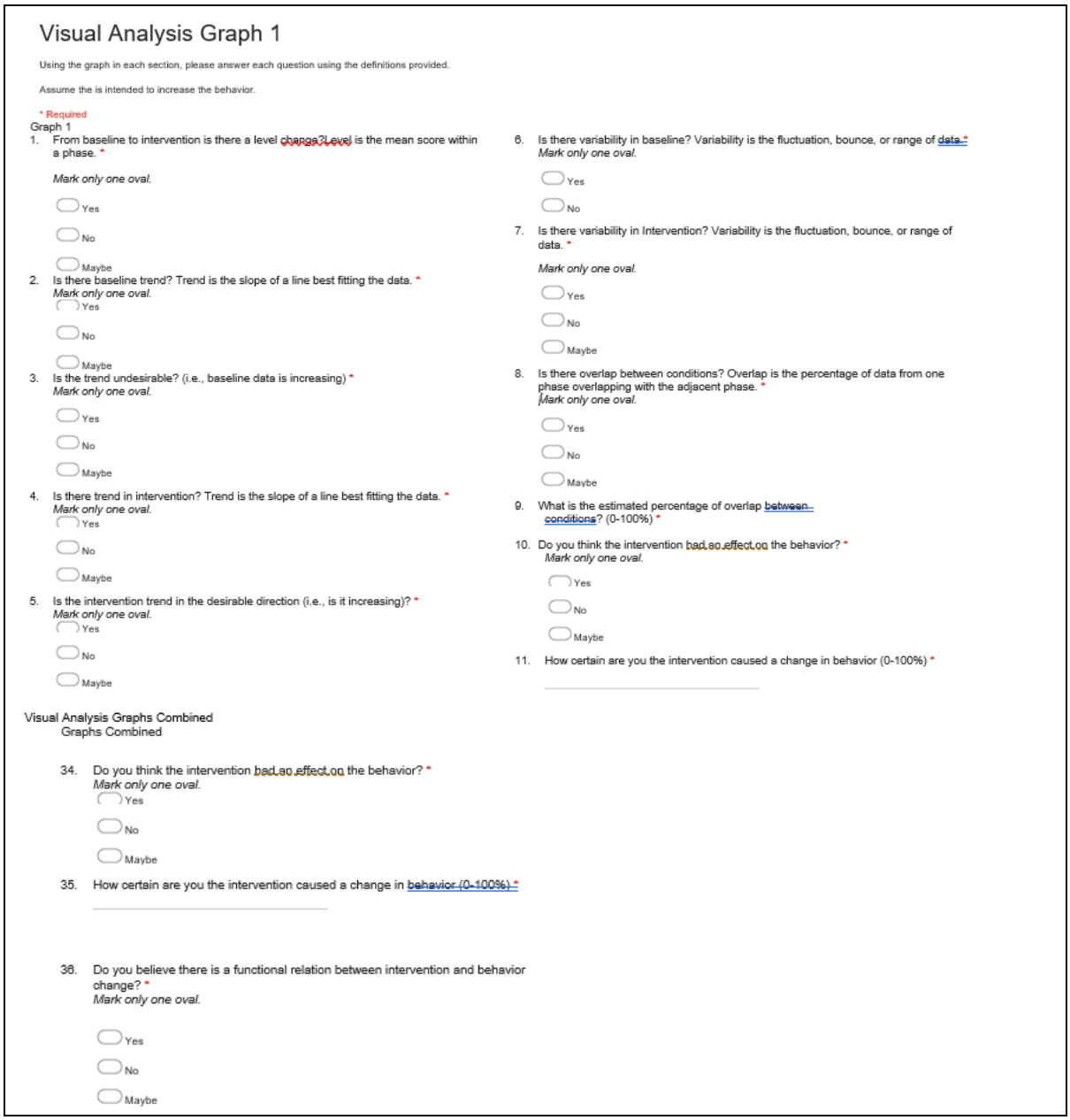
Tutee Observation Sheet

Participant ID:	Video Coded:	Date Watched:
Writing Prompt:	Condition:	Observer:

Academic Engagement: Score as occurring if the student is writing words with their pencil (not drawing), erasing, asking for help (for spelling or ideas), or discussing what they will be writing during any time during the interval.
Mark in the appropriate box if occurred using, an X, /, or ✔

0:00-0:30	0:30- 1:00	1:00-1:30	1:30- 2:00	2:00-2:30	2:30- 3:00	3:00-3:30	3:30- 4:00	4:00-4:30	4:30- 5:00
5:00-5:30	5:30- 6:00	6:00-6:30	6:30- 7:00	7:00-7:30	7:30- 8:00	8:00-8:30	8:30- 9:00	9:00-9:30	9:30- 10:00
10:00- 10:30	10:30- 11:00	11:00- 11:30	11:30- 12:00	12:00- 12:30	12:30- 13:00	13:00- 13:30	13:30- 14:00	14:00- 14:30	14:30- 15:00

Figure B-10 Interobserver Agreement Data Collection



Visual Analysis Graph 1

Using the graph in each section, please answer each question using the definitions provided.

Assume the is intended to increase the behavior.

* Required

Graph 1

1. From baseline to intervention is there a level change?Level is the mean score within a phase. *

   Mark only one oval.

   Yes
   No
   Maybe

2. Is there baseline trend? Trend is the slope of a line best fitting the data. *
   Mark only one oval.
   Yes
   No
   Maybe

3. Is the trend undesirable? (i.e., baseline data is increasing) *
   Mark only one oval.

   Yes
   No
   Maybe

4. Is there trend in intervention? Trend is the slope of a line best fitting the data. *
   Mark only one oval.
   Yes
   No
   Maybe

5. Is the intervention trend in the desirable direction (i.e., is it increasing)? *
   Mark only one oval.
   Yes
   No
   Maybe

6. Is there variability in baseline? Variability is the fluctuation, bounce, or range of data.*
   Mark only one oval.

   Yes
   No

7. Is there variability in Intervention? Variability is the fluctuation, bounce, or range of data. *

   Mark only one oval.

   Yes
   No
   Maybe

8. Is there overlap between conditions? Overlap is the percentage of data from one phase overlapping with the adjacent phase. *
   Mark only one oval.

   Yes
   No
   Maybe

9. What is the estimated percentage of overlap between conditions? (0-100%) *

10. Do you think the intervention had,ao effect,oo the behavior? *
    Mark only one oval.
    Yes
    No
    Maybe

11. How certain are you the intervention caused a change in behavior (0-100%) *

Visual Analysis Graphs Combined
Graphs Combined

34. Do you think the intervention had,ao effect,oo the behavior? *
    Mark only one oval.
    Yes
    No
    Maybe

35. How certain are you the intervention caused a change in behavior (0-100%) *

36. Do you believe there is a functional relation between intervention and behavior change? *
    Mark only one oval.

    Yes
    No
    Maybe

Figure B-11 Visual Analysis Questions

Table B-1 Pre-screener for Tutor and Tutee

Can Tutor Demonstrate	Yes	No
Reading materials to complete task		
The task		
Observing and recording if task is being performed correctly		
Providing instruction if task is performed incorrectly		
Providing prompts to tutee		
Providing feedback and reinforcement to		
Locating materials needed to perform task		
Following instruction from staff		
Does tutee:	**Yes**	**No**
Show interest in learning task		
Follow instructions from teachers		
Follows instruction from peers		
Have prerequisite skills to perform task		
Perform part of the task		