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Peer-Mediated Inference Making Intervention
for Students with Autism Spectrum Disorders

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Special Education

by

Hyo Jung Koh

2013
ABSTRACT OF THE DISSERTATION

Peer-mediated Inference Making Intervention for Students with Autism Spectrum Disorders

By

Hyo Jung Koh

Doctor of Philosophy in Special Education

University of California, Los Angeles

2013

Professor Connie Kasari, Chair

Promoting inference skills of students with poor comprehension has been suggested as an effective reading comprehension strategy (Cain & Oakhill; Cain et al., 2001; Oakhill & Yuill, 1986). Empirical studies show that students with autism spectrum disorders (ASD) have demonstrated relatively poor comprehension skills compared to their intellectual level and have shown deficits in inference making. However, teaching them how to make inferences appropriately in written text that may leads to better comprehension performance has not been fully investigated yet (Whalon & Hanline, 2008; Saldana & Frith, 2007). Under the framework of weak central coherence (Happe & Frith, 2006), this study developed peer-mediated inference making intervention: literal and goal inference making training through peer mediation. Peer-
mediation was implemented through interdependent group contingency and structured peer interactions.

Three elementary school students with ASD and six peers participated in the study. The students with ASD demonstrated a significant discrepancy between ability and reading comprehension. Each target student with ASD was placed in a small group, along with two peers: Three heterogeneous learning groups were composed. A multiple baseline design across participants was implemented (Kazdin, 2011) to assess the effects of peer-mediated inference making intervention on reading comprehension skills and behaviors of three target students with ASD. Participants’ Self-evaluation in Reading was examined to evaluate this study’s social validity. Three instructors held two, fifty- minute after-school tutoring sessions per week for 12 weeks.

After peer-mediated inference making interventions, students with ASD demonstrated score gains on their comprehension quizzes and collateral gains in contingent responses and verbal initiations. Peers at different levels of reading ability also showed gains in their scores. All participants reported promoted Self-evaluation in Reading. Findings from this study suggest that peer-mediated inference making intervention is useful comprehension strategies to promote both comprehension skills and appropriate behaviors of students with ASD. Peers’ positive outcomes and instructors’ high fidelity support this as a promising instructional approach in inclusive educational settings as well. Thus, this study contributes to the existing literature on effective educational strategies for students with ASD in inclusive educational settings.
The dissertation by Hyo Jung Koh is approved.

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Jennifer B. Symon
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University of California, Los Angeles

2013
DEDICATION PAGE

I dedicate this dissertation to my children, Michael, Brandon, and Bryan.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>ii</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>vi</td>
</tr>
<tr>
<td>List of Figures and Tables</td>
<td>viii</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>ix</td>
</tr>
<tr>
<td>Vita</td>
<td>x</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Literature review</td>
<td>2</td>
</tr>
<tr>
<td>Deficits in Reading Comprehension of Students with ASD</td>
<td>2</td>
</tr>
<tr>
<td>Reading Comprehension Strategies for Students with ASD</td>
<td>3</td>
</tr>
<tr>
<td>Inferencing Deficits in Students with ASD</td>
<td>4</td>
</tr>
<tr>
<td>Inference Making Training for Students with ASD</td>
<td>6</td>
</tr>
<tr>
<td>Theoretical Framework: Weak Central Coherence</td>
<td>10</td>
</tr>
<tr>
<td>Peer-mediated Inference Making Intervention for Students with ASD</td>
<td>11</td>
</tr>
<tr>
<td>Response to Intervention in Reading Instruction</td>
<td>13</td>
</tr>
<tr>
<td>Social Validity</td>
<td>14</td>
</tr>
<tr>
<td>Purpose of the Study</td>
<td>15</td>
</tr>
<tr>
<td>Method</td>
<td>16</td>
</tr>
<tr>
<td>Design</td>
<td>16</td>
</tr>
<tr>
<td>Participants</td>
<td>16</td>
</tr>
<tr>
<td>Instructors and Observers</td>
<td>20</td>
</tr>
<tr>
<td>Settings</td>
<td>21</td>
</tr>
<tr>
<td>Instructional Materials</td>
<td>21</td>
</tr>
<tr>
<td>Procedures</td>
<td>22</td>
</tr>
<tr>
<td>Dependent Measures</td>
<td>28</td>
</tr>
<tr>
<td>Reliability of the Dependent Measures</td>
<td>30</td>
</tr>
<tr>
<td>Treatment Fidelity</td>
<td>30</td>
</tr>
<tr>
<td>Results</td>
<td>31</td>
</tr>
<tr>
<td>Reading Comprehension Skills of Students with ASD</td>
<td>31</td>
</tr>
<tr>
<td>Reading Comprehension Skills of Peers</td>
<td>33</td>
</tr>
<tr>
<td>Inferential and Synthesizing Skills of Participants</td>
<td>34</td>
</tr>
<tr>
<td>Behaviors of Students with ASD</td>
<td>35</td>
</tr>
<tr>
<td>Self-evaluation in Reading</td>
<td>37</td>
</tr>
<tr>
<td>Discussion</td>
<td>37</td>
</tr>
<tr>
<td>Comprehension Skills of Students with ASD</td>
<td>38</td>
</tr>
<tr>
<td>Behavior Changes in Students with ASD</td>
<td>41</td>
</tr>
<tr>
<td>Social Validity: Self-Evaluation in Reading</td>
<td>43</td>
</tr>
<tr>
<td>Limitations</td>
<td>43</td>
</tr>
<tr>
<td>Future Directions</td>
<td>45</td>
</tr>
<tr>
<td>Conclusions</td>
<td>46</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES AND TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>49</td>
</tr>
<tr>
<td>Table 2</td>
<td>50</td>
</tr>
<tr>
<td>Table 3</td>
<td>51</td>
</tr>
<tr>
<td>Table 4</td>
<td>52</td>
</tr>
<tr>
<td>Table 5</td>
<td>53</td>
</tr>
<tr>
<td>Table 6</td>
<td>54</td>
</tr>
<tr>
<td>Table 7</td>
<td>55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>56</td>
</tr>
<tr>
<td>Figure 2</td>
<td>57</td>
</tr>
<tr>
<td>Figure 3</td>
<td>58</td>
</tr>
<tr>
<td>Figure 4</td>
<td>59</td>
</tr>
<tr>
<td>Figure 5</td>
<td>60</td>
</tr>
<tr>
<td>Figure 6</td>
<td>61</td>
</tr>
<tr>
<td>Figure 7</td>
<td>62</td>
</tr>
<tr>
<td>Figure 8</td>
<td>63</td>
</tr>
<tr>
<td>Figure 9</td>
<td>64</td>
</tr>
<tr>
<td>Figure 10</td>
<td>65</td>
</tr>
<tr>
<td>Figure 11</td>
<td>66</td>
</tr>
<tr>
<td>Figure 12</td>
<td>67</td>
</tr>
<tr>
<td>Figure 13</td>
<td>68</td>
</tr>
<tr>
<td>Figure 14</td>
<td>69</td>
</tr>
<tr>
<td>Figure 15</td>
<td>70</td>
</tr>
<tr>
<td>Figure 16</td>
<td>71</td>
</tr>
<tr>
<td>Figure 17</td>
<td>72</td>
</tr>
</tbody>
</table>
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Introduction

No Child Left Behind Act of 2001 (NCLB) and the Individuals with Disabilities Education Improvement Act of 2004 (IDEA) ensure that all students with disabilities are working toward the same state grade-level content and skills as their grade level peers (Cortiella, 2006). Accordingly, more students with Autism Spectrum Disorders (ASD) have been integrated in an inclusive educational setting to ensure their access to the general curriculum (White, Cahill, Klin, Koenig, & Volkmar, 2007). However, students with ASD can have great difficulties engaging with such environments, mainly triggered by their core symptoms of ASD, such as social and communication difficulties, and rigid and repetitive thinking and behaviors (American Psychiatric Association, 2000). In addition, their unusual academic profile that masks or is masked by discrepant general intellectual ability (Jones et al., 2009) appears to challenge educators in meeting needs of students with ASD as well as their peers. Responding to such emerging challenges in educating students with ASD in an inclusive educational setting, recent research has shown increased interest in strategies for achieving successful inclusion, focusing on academic and non-academic outcomes (Crosland & Dunlap, 2012; Ivannone, Dunlap, Huber, & Kincaid, 2003).

Students with ASD have been reported to demonstrate relatively poor reading comprehension performance compared to their intellectual ability (Jones et al., 2009; Mayes & Calhoun, 2008) and deficits in inference making (Minshew, Goldstein, Taylor, & Siegal, 1994; Norbury & Bishop, 2002). As a result, several studies on effective reading instructions for students with ASD have been conducted to improve their word or text comprehension skills (for reviews, see Chiang & Lin, 2007; Randi, Newman, & Grigorenko, 2010; Whalon, Ali Otaiba, & Delano, 2009). However, the majority of implemented strategies were rather instructional
approaches than specific comprehension strategies to scaffold the cognitive process involved in reading comprehension (Randi et al., 2010). Thus, at present, reflecting the unique academic attainment and cognitive style in ASD, effective reading comprehension strategies that can be implemented in more inclusive educational setting need to be explored.

Under the framework of weak central coherence (Happe & Frith, 2006), this study introduces peer-mediated inference making intervention that may improve reading comprehension skills of students with ASD by incorporating lexical inference and goal inference making in a cooperative learning group format. Students with ASD are expected to demonstrate collateral gains in social behaviors in terms of constructively interacting with their peers. Ultimately, this study had three research aims. The first aim is to examine the effect of peer-mediated inference making intervention on reading comprehension performance of students with ASD. A second aim is to examine collateral gains in quantity of appropriate behaviors of students with ASD through peer-mediated inference making intervention. The final aim is to evaluate whether peer-mediated inference making intervention is a socially validated intervention, by investigating participants’ self-evaluation in reading.

**Literature review**

**Deficits in Reading Comprehension of Students with ASD**

Students with ASD are reported to have good reading accuracy skills commensurate to their intellectual level as well as general language skills. There is also suggestion that basic word reading skills may exceed intellectual expectation in low functioning individuals with ASD (Mayes & Calhoun, 2003). However, such relatively good text-decoding skills of students with ASD contrast their limited skills in reading comprehension (Huemer & Mann, 2010; Minshew et al., 1994; Nation, Clarke, Wright, & Williams, 2006; Wahlberg & Magliano, 2004). Jones et al.
(2009) tested the IQ, literacy and mathematical abilities of a large group of adolescents with ASD. The most pervasive profile of academic attainment in ASD was discrepantly poor reading comprehension. Reading comprehension was distinct from other areas of attainment in being significantly lower than full scale IQ at the group mean level.

In Nation et al. (2006), the less-skilled comprehenders showed impairments in vocabulary and in oral language comprehension, relative to the skilled comprehenders, implying the association between language ability and reading comprehension. In addition, the more the reading comprehension skill fell below intellectual level, the greater the observed social and communication difficulties (Jones et al., 2009). Thus, reading comprehension difficulties may be associated with the core impairments in social and communication understanding that characterize children with ASD and, accordingly, efforts to improve their reading comprehension may be more effective when trying to remedy such core symptoms in ASD.

**Reading Comprehension Strategies for Students with ASD**

Reflecting NCLB and IDEA which mandate all children, including children with ASD, be taught to read in ways that are consistent with reading research, several reviews of the literature on reading intervention for students with ASD have been reported (Chiang & Lin, 2007; Randi et al., 2010; Whalon et al., 2009). They identified a consistent trend in reading intervention for students with ASD in the past decade. For instance, a majority of reading intervention studies for students with ASD targeted sight word comprehension or vocabulary comprehension, focusing on sight word comprehension skills, which examining the functional use of sight words (e.g., reading product warning labels, finding grocery items) or matching words to pictures (Eikeseth & Jahr, 2001, Mechling & Gast, 2003; Mechling, Gast, & Langone, 2002; Rehfeldt, Latimore, & Stromer, 2003). When the target students were high functioning
with average IQ, the reading comprehension strategies focused on procedure facilitation strategies such as anaphoric cuing (O’Connor & Klein, 2004) and reciprocal questioning (Whalon & Hanline, 2008).

Of the few reading intervention studies for students with ASD, the implemented strategies were rather instructional approaches than specific skills to scaffold the cognitive process involved in reading for meaning (Randi et al., 2010). For instance, peer-tutoring, cooperative learning (Kamps, Locke, Delquadri, & Hall, 1989; Kamps, Barbetta, Leonard, & Delquadri, 1994; Kamps, Leonard, Potucek, & Garrison-Harrel, 1995), or computer-based instruction (Williams, Wright, Callghan, & Coughlan, 2002) were shown effective instructional approaches for students with ASD. Responding to need for teaching reading comprehension strategies to students, the present study explores reading comprehension strategies tailored to the unique academic profile and cognitive style in students with ASD.

**Inferencing Deficits in Students with ASD**

It is well-established that poor comprehenders have poor inference ability as well. More specific, poor inference making ability appears to cause text comprehension difficulties (Cain & Oakhill, 1999; Cain, Oakhill, Barness, & Bryant, 2001). It is no surprise that students with ASD have difficulties in inference making considering that their poor reading comprehension profile. Inferencing is frequently commented on as an area of difficulty for people with autism, though there is limited number of studies in this area. For example, Minshew et al. (1994) compared the language performance of children with high functioning autism (HFA) with a control group of typical peers and found that autism group showed significant deficits in making inferences and processing of metaphoric expressions.
Norbury and Bishop (2002), on the purpose of differentiating children with pragmatic language impairment (PLI) from those with high-functioning autism (HFA), investigated the inferential processing abilities of children with PLI in relation to their age-matched peers, a group of children with more typical speech language impairment, and a small group of children with HFA. They were read five stories and asked six questions: two literal, two involving text-connecting inferences and two involving gap-filling inferences. They found that children whose performance was much worse with inferential than literal questions did not differ from others in their scores on standard language test, but they did have higher levels of autistic symptomatology than other children. In other words, those in the HFA group were more likely than either children with SLI or PLT to have inferencing deficits. These deficits were not attributable to general linguistic impairments. Instead, increasing presence of autistic behaviors characterized children with poor inferencing.

Happe (1994) and Jolliffe & Baron-Cohen (1999) investigated the abilities of individuals with HFA to comprehend stories that required them to infer a character’s mental state. In both studies, individuals with HFA were impaired in inferring a character’s mental state. However, the problem for individuals with HFA was not an inability to infer mental states, but rather a difficulty attributing a mental state that was appropriate to the story text. In other words, their limited inference making ability is due to their tendency to focus on details or individual words, making it difficult for them to understand text at the global level (Happe & Frith, 2006).

Inability to “see the big picture” of students with ASD has been demonstrated in other studies. Frith and Snowling used homographs (words with one spelling, two meanings and two pronunciations) to examine the use of preceding-sentence context to derive meaning and determine pronunciation (e.g., ‘In her eye, there was a big tear’; ‘In her dress there was a big
tack’). In their original studies and consequent studies on children with ASD, individuals with autism failed to use preceding-sentence context to determine the pronunciation of homographs (Frith & Snowling, 1983; Snowling & Frith, 1986; Happe, 1997). Thus, understanding difficulties in inference making of students with ASD from the perspective on cognitive style of autism is needed.

In summary, studies demonstrate that a strong relation between inference making ability and cognitive styles of students with ASD and provide a solid rationale for inference making training for students with ASD. Such finding aligns with the finding from Jones et al. (2009), in which the more the reading comprehension skill fell below intellectual level, the greater their observed social and communication difficulties (Norbury & Bishop, 2002). Thus, improving inference making of students with ASD may not only promote their reading comprehension performance but also ameliorate social communication difficulties as part of their specific characteristics.

Based on previous studies on reading comprehension and inference making of students with ASD, this study explores inference making training for students with ASD who have reading performance below their intellectual level, in order to improve their reading comprehension performance from the perspective on their unique cognitive style. The next section reviews specific inference training methods under the framework of weak central coherence.

**Inference Making Training for Students with ASD**

Inference is cognitive process connecting information from different sources (Loukusa & Moilanen, 2009). It is an especially important ability when deriving an implied meaning of an utterance, as shown by studies about text comprehension in children (Cain & Oakhill, 1999; Cain,
et al., 2001; Oakhill & Yuill, 1986). There are different stages of the inference making process where difficulties might arise. Incorrect premise recall is one type of information retrieval error, which occurs when an individual fails to retrieve the relevant premise from the text. Individuals may either forget the relevant premise or retrieve the incorrect premise from the story. Another type of information retrieval error is a failure to recall the correct item from the knowledge base. Integration failures occur when children fail to integrate the two relevant pieces of information when retrieved. Less skilled comprehenders’ inference failures could be attributed to a failure to recall the relevant premise from the text, relative to the skilled group’s errors. It is certainly not the case that less skilled comprehenders do not experience integration failures. Rather, the less skilled comprehenders’ difficulties arose at an earlier stage in the inference-making process: They often failed to recall the information that had to be integrated to generate the inference (Cain et al., 2001; Yuill & Oakhill, 1991). Thus, inference awareness’ training may be effective when sensitizing less skilled comprehenders to the types of inference they should make, as well as helping them in learning techniques for drawing these inferences (Yuill & Oakhill, 1988).

**Appropriate information retrieval training.** Yuill & Oakhill (1988) and McGee & Johnson (2003) used ‘lexical inference’ training for their inference training intervention. During this activity, the children were instructed how to look for clue words that would help them understand the text and what sorts of inference could be made from certain words. For example, ‘Sleepy Tom was late for school again’ was presented to children. Each child had to pick a word and to say what information it gave about the sentence. We know from ‘Tom’ that it is about a male person, and, combined with the word ‘school,’ that he is probably a pupil, since his first name is given, rather than a title such as ‘Mr. Smith.’ ‘Sleepy’ suggests that he overslept, perhaps because he stayed up late the previous night, and suggests why he was ‘late.’ ‘Again’
suggests that he has been late before, perhaps because he habitually stays up late. Children then applied these techniques to short, abstract stories.

Question-generation is another technique to promote inference making (McGee & Johnson, 2003; Yuill & Oakhill, 1988; Whalon & Hanline, 2008) by identifying the elements of the story (i.e., setting, characters, event, problem, and solution). Students were trained to generate questions such as “Where did Arthur have his pet business?” “Who is helping Arthur write his story?” “Why is Arthur not sleeping well?” or “What did Mr. Ratburn do to help Arthur solve his problem?” (Whalon & Hanline, 2008). Such lexical inference or question-generation techniques were demonstrated to be effective in helping students to retrieve the relevant textual premise to make appropriate inferences.

Another type of information retrieval error was failure to recall the correct item from the knowledge base, which means activating relevant knowledge. Happé (1994) and Jolliffe & Baron-Cohen (1999) demonstrated that individuals with autism might have difficulties accessing and using world knowledge to understand the text. On the Strange Stories battery, participants with autism were able to comprehend what they were reading in a literal sense. However, they were impaired in their ability to provide context-appropriate mental state explanations for the story character’s non-literal utterances, although they passed the 1st and 2nd order of Theory of Mind tasks. Instead of applying what social knowledge they may have in everyday life, participants with autism made idiosyncratic responses. For example, per the figure of the speech “a frog in your throat,” one subject said that the story character has swallowed a frog. Per the story about pretending a banana is a telephone, one subject explained that “some cordless telephones are made to look like fruit.” In Jolliffe & Baron-Cohen’s study, when participants
were asked to justify the character statements, readers with autism made their justifications based on the character statements rather than knowledge gained by reading the prior text.

In order to comprehend the character’s actions throughout a narrative, the readers should be able to infer the connections between goals of characters and other elements of a story. Such connection between character’s goals and elements of the story may help the readers to activate the appropriate knowledge. In order words, goal inference making may help the readers to glue events together to make a coherent story (Lynch & van den Broek, 2007).

The current study aims to develop inference making training for students with ASD who have difficulties in retrieving appropriate information from both the text and the knowledge base. Lexical inference and goal inference training related to the elements of the story (i.e., characters, setting, event, problem, and solution) are expected to help students with ASD to draw appropriate inferences.

**Integration training.** Wahlberg & Magliano (2004) assessed the extent to which high-functioning readers with ASD could use cues to relevant world knowledge to aid in their understanding of ambiguous text. Sixteen readers with ASD and matched normal readers were requested to recall stories after reading ambiguous texts. The experimental conditions were manipulated by the presence of an informative title and a primer text. The matched normal readers demonstrated that the provided cues (i.e., an informative title and a primer text) helped them recall more integrated clauses. Especially, readers without autism produced more integrated idea units when there was a primer present than when there was not, whereas readers with autism were not influenced by the presence of the primer. On the other hand, the presence of title did increase the likelihood that readers with autism would activate relevant background knowledge and incorporate into the memory representation for the ambiguous texts. These
results suggest that readers with autism were able to access and associate, at some general level, the relevant background knowledge with the ambiguous passages. This was also demonstrated in Saldana & Frith (2007) study.

Saldana & Frith (2007) used an indirect measure of the ability to make bridging inferences. Adolescents with ASD and the control adolescents matched based on word reading accuracy and vocabulary were asked to read short stories followed by a question. Correct answers were not the interests here but the time it took to read the questions. Reading times were shorter when the question was primed by an inference that could be driven from the story. Both groups showed similar reductions in reading times, indicating that they had made the appropriate inferences. Such results indicate that readers with ASD, just like controls, were activating appropriate world knowledge primed by implicit inferences while reading the vignettes. Thus, the comprehension problems in these readers cannot be attributed to an inability to make implicit inferences or to draw on relevant world knowledge.

These results suggest that inference making impairment found previously might not be due to poorer access to the knowledge base; instead, it might be due to poorer ability to integrate specific knowledge explicitly with the global text. Thus, inference training should focus on how to integrate the relevant information and enable students with ASD to understand the text at the global level and “see the big picture” (Happe & Frith, 2006).

**Theoretical Framework: Weak Central Coherence**

It is commonly believed that students with ASD have weak central coherence or a processing style that focuses on details or individual words, making it difficult for them to understand text at the global level. Happe and Frith (2006) rejected the view that weak central coherence reflects a deficit in central processing in those with ASD. Rather they explained it as
superiority in local processing and a processing bias or cognitive style (Randi et al., 2010). The inference making training in this study requires students to locate clue words related to the elements of a story (i.e., lexical inference) and character’s goals (i.e., goal inference), which utilize the strength of students with ASD in locally processing information. In order to help students with ASD integrate such clues related story elements and goals at the global level, the current study adopts peer-mediated intervention. Through peer-mediated inference making intervention, students are expected to work together to integrate their inferences to comprehend the text.

**Peer-mediated inference making intervention for Students with ASD**

Under the framework of weak central coherence (Happe & Frith, 2006), this study employs peer-mediated intervention in inference making training for students with ASD, in which students with ASD are expected to integrate drawn inferences into the big picture of the text through peer-assisted learning. Peer-assisted learning refers to learning environment in which small groups of students learn together to achieve a common goal (Johnson & Johnson, 1989). Especially, cooperative learning, as one type of peer-assisted learning, has been suggested for effective comprehension instruction for general population as well as students with autism (Chiang & Lin, 2007; Randi et al., 2010; Whalon et al., 2009), by motivating students to work together while providing them an opportunity to elaborate their understanding of the learning materials (Slavin, 1996). Research on cooperative learning of students with autism has reported to be effective on students’ academic and social outcomes when compared to teacher-directed instruction (Grey, Bruton, Honan, McGuinnes, & Daly, 2007; Kamps et al., 1989, 1994, 1995).

Research on cooperative learning found that an interdependent group contingency and structured peer interaction are strong moderators for positive student outcomes (Ginsburg-Block,
Rohrbeck, & Fantuzzo, 2006; Rohbreck, Ginsburg-Block, Fantuzzo, & Miller, 2003). In an interdependent group reward or interdependent group contingency, the entire group gains access to a reward dependent on the group’s performance while in an independent group reward or contingency, students earn reward based on their own behaviors meeting criteria (Skinner, Williams, & Neddenriep, 2004). Thorne and Kamps (2008) measured behaviors outcomes in a class-wide interdependent group contingency intervention. They implemented a class-wide interdependent group contingency intervention to decrease the frequency of inappropriate behaviors and, conversely, increase the academic engagement of twelve elementary students with problem-behaviors. Experimental control was demonstrated from most participants through a reversal and replication of the effect.

Evidence suggests that carefully structuring the interactions among students in cooperative groups can be also effective for positive student outcomes (Ginsburg-Block et al., 2006; Rohbreck et al., 2003; Slavin, 1995). In structured peer interactions, students are assigned to specific roles and work as team to accomplish a common goal (Fuchs, Fuchs, Kazdan, Kams, Calhoon, Hamlett, & Hewlett, 2000; Dugan et al., 1995; Xin, 1999). Verbal or visual scripts are often integrated to reinforce the peer interaction structure (Petursdottier, McComas, McMaster, & Horner, 2007; Whalon & Hanline, 2008), since such scripts have been shown effective in teaching a new skill to students with ASD (Sarokoff, Taylor, and Poulson, 2001).

Given this literature, an interdependent group reward and structured peer interactions are expected to promote students’ behaviors to work cooperatively while elaborating their understanding of the written text. However, use of both interdependent group contingency and structured peer interaction in peer-mediated instruction for students with ASD has been very limited to date despite the strong moderator effects on intervention outcomes. Thus, this study
employs an interdependent group reward and structured peer interaction as part of peer-mediated inference making intervention in order to reinforce constructive peer interactions.

**Response to Intervention in Reading Instruction**

This reading intervention utilizes peers to facilitate students with ASD to integrate drawn inferences into the context of the given story. Although this study particularly targets improving comprehension skills of students with ASD, learning benefits for peers cannot be ignored. Thus, Response to Intervention (RTI) approach in reading instruction is considered in designing peer-mediated inference making intervention: peers at risk and supplemental education.

Response to Intervention (RTI) is a method of academic intervention to provide early, systematic assistance to students are having difficulty learning. The purpose of RTI is both to provide early intervention for students who are at risk for school failure and to develop more valid procedure for identifying students with reading disabilities (Gersten & Dimino, 2006). With RTI, students are identified as learning disabilities (LD) when their response to educational intervention is dramatically inferior to that of peers. RTI’s approach to identify students with reading difficulties contrasts IQ-achievement discrepancy approach that which is the most widely used method of LD identification (Fuchs & Fuchs, 2006). In this study, target students with ASD will be those who already demonstrated a significant discrepancy between ability and achievement in reading. However, peers may or may not be identified as LD according to ability-achievement discrepancy method. Even peers who are not identified as LD based on ability-achievement discrepancy model may need more intensive reading comprehension intervention.

In the RTI process, service delivery is divided into three tiers of support, with the intensity of interventions increasing with each level. General education is considered the first tier and the students who are targeted for preventative intervention must first show evidence of
falling in that mainstream setting. Students who consistently do not perform within the expected level of performance through Tier 1 instructions are then provided with additional supplementary intervention at Tier 2. This targeted instruction may occur in the general education setting or outside in a smaller group setting with a specialized teacher. Tier 3 is for students who require more intense, explicit, and individualized instruction and have now shown sufficient response to Tier 1 and Tier 2 interventions. In some cases, Tier 3 is considered to be special education, with instruction being provided to individual students or small groups by special education teachers in place of general education instruction (Fuchs & Fuchs, 2006).

This peer-mediated inference making intervention will be provided to small group of students as supplementary educational opportunities outside of general education classroom. The intervention delivery method closely resembles Tier 2 instruction. If target students with ASD and peers with and without LD respond to peer-mediated inference making intervention, this instruction can be delivered at Tier 1 level, i.e., general education instruction. Namely, its proven efficacy at Tier 2 level may demonstrate its feasibility as instructional method in a more inclusive education setting. By employing RTI approach, this study will include peers, regardless of their LD identification, and be delivered as an after-school tutoring program, at least twice a week, for over 10-week period.

Social Validity

In addition to examining whether an intervention works in the field, determining how likely it is to be continued is crucial to assess its potential impact on student learning. An intervention’s sustainability depends not only on how effective it is for students but also on how well it fits into the classroom context and how it is perceived by those involved (Elliott & Von Brock Treuting, 1991). Thus, the social validity of interventions has become increasingly
important to researchers and practitioners alike. Social validity refers generally to consideration of social criteria for evaluating the focus of intervention, the procedures that are used, and the effects that these interventions have on performance. Subjective evaluation is one of the methods that is employed in single case research design. With the subjective evaluation method, the student’s performance is evaluated by persons who are likely to have contact in everyday life (i.e., teacher or parent) and the student him or herself (Kazdin, 2011).

The present study was implemented as a supplemental educational service in order to examine the effect of inference making training on reading comprehension skills or any collateral gains in students with ASD. Thus, participants’ reception of the intervention plays a crucial part in sustaining the intervention. It is likely that students’ perceptions of how worthwhile and enjoyable an intervention is might influence its implementation (Elliott & Von Brock Treuting, 1991). This study evaluates social validity in two ways. First, participants’ changes in Self-evaluation in Reading would reflect their positive perception on the intervention. Since reading achievement is positively correlated with self-concept in reading (see Marsh, Smith, & Banes, 1983 for review), participants’ positive changes in self-evaluation may contribute to their improved comprehension performance.

**Purpose of the Study**

The current study aims to examine the effects of peer-mediated inference training on reading comprehension skills of students with ASD and their collateral gains in behaviors. Participants’ self-evaluation in reading was examined to evaluate social validity.

**Research Aim 1**: To examine the effect of peer-mediated inference making intervention on reading comprehension skills of students with ASD
Hypothesis 1: Students with ASD will improve their reading comprehension skills after peer-mediated inference making intervention.

Research Aim 2: To examine the effect of peer-mediated inference making intervention on behavior changes in students with ASD

Hypothesis 2a: Students with ASD will increase the quantity of contingent responses and verbal initiations during peer-mediated inference making intervention.

Hypothesis 2b: Students with ASD will decrease the quantity of inappropriate behaviors during peer-mediated inference making intervention.

Research Aim 3: To evaluate social validity of peer-mediated inference making intervention

Hypothesis 3: Participants will demonstrate changes in self-evaluation in reading after peer-mediated inference making intervention.

Method

Design

A multiple-baseline design across participants was implemented to assess the effects of peer-mediated inference making intervention on both reading comprehension skills and behaviors of three target students with ASD. This research design provides a staggered duration of baseline phases that serves as control conditions for each of the participants (Kazdin, 2011). Participants’ Self-evaluation on Reading was examined to evaluate social validity of peer-mediated inference making intervention. Three instructors held two, 50-minute after-school tutoring sessions per week for 12 weeks. All the sessions were audio recorded for the fidelity check.

Participants
Three elementary students with ASD and six peers participated in the study. Under the permission from a local school district, emails recruiting instructors for the study were sent out to special education teachers. Two instructors at one elementary school showed an interest to participate in the study, and they started recruiting target students with ASD and peers at their school. Inclusion criteria for target students were as follows: First, students were diagnosed with ASD by a district evaluation team with expertise in ASD and exhibit characteristics of ASD according to the 4th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000). Second, they had to demonstrate an intellectual ability-achievement discrepancy, i.e., 14 points discrepancy between standard scores on the Wechsler Individual Achievement Test-Second Edition (WIAT-II; Wechsler, 2002) Reading and Wechsler Intelligente Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003) Full Scale IQ (FSIQ; Jones et al., 2009, Mayes & Calhoun, 2008). Last, students with ASD were integrated in general education setting during part of the school day. Among four students with ASD recruited by the instructors, three students were able to consent for study participation.

The researcher administered the WISC-IV and WIAT-II Reading Subtest to three target students with ASD; all target students with ASD demonstrated the discrepancy between intellectual ability and achievement in reading. Table 1 presents the results of the WISC-IV and WIAT-II along with other demographic information of the three target students with ASD.

**Student 1.** Emily, an African-American female, was a fourth grader who was fully mainstreamed in the general education class. Emily was referred by her resource teacher due to her limited comprehension skills. Her standard score on the WIAT-II Reading was 83 points (grade equivalent 2.5); 26 points lower than her WISC-IV Full Scale IQ (FSIQ) 109. In classroom, Emily struggled with 3rd grade-level reading materials and was often unable to
complete her assignments on time. Her classroom teacher and speech therapist reported that Emily was observed to be more passively responding to her peers when interacting with peers. She was often observed to be alone during recess and lunch. During reading instruction in a small group, Emily rather focused on her reading materials than interacting with her group members. Although she appeared to work on her assignments most of the time, she rarely completed her work on time. Emily frequently stayed after school to complete her classroom assignments. Lack of eye contacts with the classroom teacher, constructive peer interactions, and seeking for help were observed during classroom instruction.

**Student 2.** Aiden was a Hispanic fifth grader in the special education class for students with ASD. Aiden was planning to attend a fully inclusive middle school after summer. Aiden’s parents wanted him to get prepared for constructively interacting with his peers in a more inclusive setting. Aiden scored 41 on WIAT-II Reading, 26 points lower than his WISC FSIQ 66. He had strengths in Perceptual Reasoning and Processing Speed, which compensated his limited language skills. Aiden’s reading performances in the classroom were below the first grade. Aiden’s classroom teacher stated that although Aiden was able to read the first grade-level reading materials, he did not demonstrate an understanding of the story or words he read.

According to his speech therapist, Aiden required maximum-level of cueing and verbal models to use more than one-two word phrases when communicating wants and needs and sharing ideas. This limited his ability to fully get his messages across people. He also spoke in a remarkably low tone which made him difficult to be understood. In classroom, Aiden was a quiet and well-behaved student, who always followed the teacher’s directions. However, he was rather simply copying the board than producing his own work sample. When the teacher asked him questions regarding the given topic, Aiden’s responses were mainly nodding with a smile.
The teacher had to rephrase open-ended questions with close-ended ones to elicit “Yes” or “No” responses from Aiden. Aiden rarely interacted with his classmates during classroom instruction despite peer-interaction-promoted his seating arrangements.

**Student 3.** Jackson was an African-American fifth grader in the special education class for students with ASD. Aiden and Jackson were classmates. Jackson was one of top performing students in his special day class. His classroom teacher and parents wanted to challenge Jackson in the academic curricular since he was going to attend a middle school where academic tasks would be expected to be more demanding. Jackson’s standard score on WIAT-II Reading was 50 (grade equivalent 1.9), 36 points lower than his WISC-IV FSIQ 86. According to his classroom teacher’s report, Jackson was able to read simple stories at the second grade level and respond to the questions. His speech therapist stated that Jackson participated in activities and engaged in conversation when they were elicited. He exhibited difficulty identifying and producing appropriate responses during social situations. This impacted his ability to communicate functionally during class discussions, oral presentations and when asking and answering questions. Thus, he was recommended to interact with peers in structured learning environment where he could practice appropriate initiations and responses. In class, Jackson required consistent and frequent prompts to stay on the task. He often gazed in the space instead of engaging in the given activity. However, a verbal reminder was enough for Jackson to get back to his task. Jackson wrote extremely slowly, which appeared to hold his classroom performance back. He often couldn’t complete his assignments due to time constraint.

**Peers.** Six peers who participated in the study attended the same school with the target students with ASD and were recruited by the instructors. They were mainly referred by their classroom teacher or the resource teacher. The peers were fourth graders and recommended to
participate in the study by their classroom teachers, due to their limited comprehension performance in state tests. Reflecting RTI approach, they were considered to need a reading intervention at Tier 2 level. Among 10 students recruited by the instructors, 7 students were able to consent to participate in the study and one student could not meet on scheduled tutoring sessions. Six peers were administered WIAT-II by a researcher for grouping purpose, and their scores and other demographic information are presented in Table 2.

Peer 1 and Peer 2 demonstrated an average range of reading performance, whereas the other peers performed below average level. Peer 1 and Peer 2 were included in the study since peer-mediated inference training requires heterogeneous reading ability in each group. Peer 3 and Peer 6 were eligible for special education services as a student with a specific learning disability. Peer 3 had a pull-out resource program 180 minutes per week, and Peer 6 was placed in special day class for students with SLD for 64% of school hours.

**Instructors and Observers**

Two classroom teachers and one teacher assistant from the participants’ school provided the instruction to participants. The instructors had at least three years of classroom teaching experience for students with reading difficulties in special education. None of them was the participants’ classroom teacher during the period of the study. Instructors actively involved in the recruiting process for the participants and they carefully screened out students with aggressive behaviors. Before the study started, the researcher had met instructors as a group and individually for peer-mediated inference training. During the meetings prior to the study, major changes in supplemental instructional materials occurred as a result of agreement between the researcher and the instructors. In addition, the instructors strongly preferred a word-by-word scripted manual for every single session, which was accordingly developed by the researcher
before the tutoring session started. They also agreed their sessions would be audio recorded on
the purpose of qualitative data analysis and fidelity check.

Two graduate students with a special education major and one teacher assistant from the
school observed sessions in order to collect observational data. Prior to the study, they were
trained how to measure target behaviors through video clips recorded from a pilot study by the
researcher. Each observer was assigned to one target student with ASD and observed 15 minutes
for each session.

**Settings**

Two classrooms and one learning center at the participants’ school were used for the
study. Based on WIAT-II scores of the participants, one target student with ASD and two peers
each, three heterogeneous groups were formed. Bi-weekly after-school tutoring sessions were
held for 12 week-period. Each daily session lasted 50 minutes, including 10 minutes’
comprehension assessment. Each group was provided with a 5-minute interval timer; the
instructor and the students could monitor the group working-pace. One observer per each group
was present for 15 minutes in each session throughout the study. All the sessions were recorded
with a digital voice recorder for the instructor’s fidelity check.

**Instructional Materials**

**Reading materials.** In each probe, the students were provided with one narrative story.
The stories were adopted from publicly released state tests, and their reading levels were
determined through Flesch-Kincaid readability test using Microsoft Word 2000 program. In
order to maintain consistent reading level during the study, lengthy easy stories and short
difficult stories were evenly distributed. The average number of words was 486 and average
grade level of reading was at 3.4. Table 3 lists the number of words and readability level of the stories used in the study.

**Inference awareness worksheets.** In the intervention and maintenance probes, students were provided with an inference awareness worksheet, which was adopted from an inference making workbook (Spector, 2006). Students worked on making inferences from provided clues. Students inferred place, time, agent, feeling, and so on. Figure 1 shows one example of an inference awareness worksheet.

**Story map.** In the intervention and maintenance probes, the group was provided with a story map that could be posted on the wall. All the students also had their own copy (See Figure 2). The story map had five story elements such as setting, characters, events, problem, and solution. Additional components were added to the story map: “Want” component for each character and “Lesson” component for the whole story.

**Comprehension quizzes.** For each story, a comprehension quiz was handed out to each student. The comprehension quiz consisted of 10 open-ended questions that were modified from O’Connor & Klein’s (2004) study, permitting a total score of up to 21 points (See Figure 3 for quiz format). The sequence of questions included four “who, what, where, when” questions that required students to recall factual information explicitly stated in the passage (4 x 2 points), three “why or how” questions that required students to make inferences about information not explicitly stated in the passage (3 x 2 points), generating title for the story (2 points), identifying the main idea of the story (2 points) and free retelling (3 points).

**Procedures**

This study had three conditions, including the baseline, intervention, and maintenance conditions. Besides three conditions, students had mid-evaluation probes between the
intervention and maintenance conditions and post-evaluation probes after the maintenance condition.

**Baseline.** Once the target student with ASD and two peers were ready to start a session, the instructor passed out a story paper to each student, “This is the story we will read today. I will read the story aloud to help you understand the story. While I am reading the story, please pay attention to it.” The instructor read a story aloud while the students read it along. Then, the instructor passed out a comprehension quiz to each student and provided verbal directions:

“Now, you are going to answer the questions. Do not worry about spelling. If you are unsure of an answer for one question, just pass to the next one. Just try your best. If you have any questions, please ask me. You have 10 minutes to complete it.”

The instructor placed a timer where the students could see. Once the timer went off, the instructor collected the answered quizzes from the students. A single baseline probe lasted approximately 15-20 minutes. Since each tutoring session lasted 50 minutes long, two or three baseline probes were conducted depending on the group’s reading phase. The target students’ behaviors in each baseline probe were observed for 15 minutes. The baseline condition lasted until the target student’s scores on comprehension quizzes got stable and did not show any sign of visually remarkable increases. Length of baseline condition ranged from 3 to 5 probes staggered across three target students with ASD.

**Intervention: Peer-mediated inference making intervention.** Peer-mediated inference making intervention marked the intervention condition, which had three phases. Table 4 presents the procedures, the number of probes, instructor’s roles, student’s roles and comprehension story for each phase.
Phase I. The first two intervention probes were assigned to introducing the intervention procedure to students through a social story and group point system with the provided Group Point Chart (see Appendix). At the opening, the instructor informed the students that they would get a group point every five minutes when all of them stayed on task and worked together. The students were also informed that they would get a prize from the treasure box if they got 7 out of possible 10 points. Phase I consisted of six main activities: (a) inference awareness activity, (b) story map preview, (c) story pre-reading, (d) students’ story map activity, (e) comprehension quiz, and (f) retelling the story.

Inference awareness activity. This was a five-minute warming-up activity for students to get familiar with drawing inferences. The instructor passed out an inference awareness worksheet to students on which three sentences were written. Students were asked to examine each sentence for key words or phrases that would help them find major types of inferences such as location, time, agent, and so on. For example, the students were expected to infer the location from “Carly was talking loudly when she was asked to be quiet. Other people were reading and trying to concentrate” by identifying key words that gave them clues.

Story map preview. The instructor introduced the story elements such as setting, character, problem, events, and solution on the story map. This story map preview activity was extended from the previous inference awareness activity, by asking students to locate clue words that might indicate the story elements (i.e., lexical inference). In addition, the students were asked to find “What each character wanted” (i.e., goal inference) and “What lesson the character(s) or readers would learn from the story.” The instructor reminded the students of thinking all those story elements on the story map while reading the story.
**Story pre-reading.** This activity was the same as the baseline condition. After passing out the story paper to each student, the instructor read aloud the story and the students silently read along with her. The first social story, “Cooperative Learning Group” introduced students’ three assigned roles in peer-mediated inference making intervention, i.e., a facilitator, a writer, and a monitor, so students could become familiar with each role.

**Students’ story map activity.** After finishing the story, the instructor passed out the story map sheet to each student and posted an enlarged version on the wall. The instructor assigned a reading part to each student and started reading the story. After a student read the assigned part, the instructor asked the students if they located any clue words or phrases that might indicate the story elements. When the student’s response was correct, she said, “Good” and wrote it on the story map posted on the wall. If the student’s response was incorrect, she said, “We will see it” and wrote it with a question mark on the story map. If there were no responses from the students, the instructor waited for 5 seconds and repeated the question. After 5 seconds, still no responses from the students, the instructor provided an answer to the students while writing down it on the story map. The instructor repeated this process after each paragraph was read and completed the story map with the students. The order of the story elements completion was mostly setting, characters, what character(s) want, problems, events, solution, and lesson. Due to the time constraint, the first half of the story map was completed in the first intervention probe and the second part was completed in the second probe. The story map activity lasted approximately 15 minutes and the target student’s behaviors were observed during this activity.

**Comprehension quiz.** This was the same condition as the baseline probes. The instructor took off the story map from the wall and collected students’ story map worksheets. The students still had a story paper with them. The instructor passed out comprehension quiz paper to each
student and placed a timer where the students could see. The instructor provided verbal directions:

“Now, you are going to answer the questions. Do not worry about spelling. If you are unsure of an answer for one question, just pass to the next one. Just try your best. If you have any questions, please ask me. You have 10 minutes to complete it.”

Once the timer went off, the instructor collected the comprehension quizzes from the students.

*Retelling the story.* The instructor posted the story map on the wall again for visual aid and asked the students to retell the story together. If no one volunteered, the instructor picked one by one and made sure every single student in a group had a chance to retell the story in his or her own words.

During the session, the instructor marked on the group point chart every five minutes if the students stayed on the task and worked together. If they accumulated the points up to 7, they were able to get a prize from the treasure box.

*Phase II.* Phase II lasted for two probes in which the students started to take assigned roles such as a writer and a monitor. The instructor mainly modeled a facilitator’s role and guided the students to play two other roles. Phase I was for establishing the routine for story map activity, whereas Phase II focused on training the students to become familiar with three roles and consisted of six major activities: (a) inference awareness, (b) three roles review, (c) pre-reading, (d) story map activity, (e) comprehension quiz, and (f) retelling the story. Since the students became familiar with the story map activity, story map preview activity was replaced with three roles review activity in which the students reviewed the assigned responsibilities of a facilitator, a writer, and a monitor in *Cooperative Learning Group Role Chart* (See Appendix).
In the third intervention probe, “Writer’s Role,” the second social story, was comprehended and the instructor modeled the writer’s role.

The rest procedures were consistent with those in Phase I. In the fourth probe intervention, writer and monitor roles were assigned to the students and the instructor played the facilitator’s role. The instructor posted the *Cooperative Learning Group Roles Chart* on the wall and the student had the same copy with them. The instructor went over each role’s responsibilities on the chart with the students.

**Phase III.** Phase III consisted of five major activities: (a) inference awareness, (b) pre-reading, (c) story map activity, (d) comprehension quiz, and (e) retelling the story. All the students had an assigned role, i.e., facilitator, writer, and monitor and they started working on the story map with the instructor’s assistance. Phase III lasted until the students completed the story map activity at 100% accuracy with teacher’s prompts.

**Maintenance.** The maintenance condition consisted of four major activities: (a) inference awareness, (b) story map activity, (c) comprehension quiz, and (d) retelling the story. During the story map activity, the instructor’s role was decreased to the minimal level, by only providing prompts if necessary. It was the students who read the story and completed the story map. The group point system was continuously employed and the target student’s behaviors were observed during the story map activity.

**Evaluation probes.** Evaluation probes were employed to evaluate the extent to which inference making training was carried out to students’ performance in reading comprehension. All the participants had mid-evaluation probes after the intervention and post-evaluation probes after the maintenance condition. The procedure was consistent with the baseline condition. The
instructor passed out the story to the students and pre-read the story with the students. Then, the students independently took a comprehension quiz for the given 10 minutes.

**Dependent Measures**

Two major outcomes of the present study were reading comprehension skills and behaviors of the target students with ASD. As part of a social validity check, the participants’ self-evaluation in Reading and qualitative data were examined.

**Scores on comprehension quizzes of the participants.** Comprehension skills of the participants were measured by 10 open-ended comprehension questions in paper-and-pencil quizzes. The participants independently took a comprehension quiz for the given story in the baseline, intervention, maintenance, and generalization probes. Factual questions 6 points, inferential questions 8 points, and synthesizing questions 7 points, thus a total of 21 points were the possible scores on each quiz. Each participant’s scores were categorized into total scores, factual scores, inferential scores, and synthesizing scores, for further analysis. The scoring keys for a comprehension quiz are shown in Table 5. The researcher graded the participants’ quizzes and a graduate student checked the scores for 25% of the graded comprehension quizzes.

**Behaviors of the target students with ASD.** Behaviors of the target students with ASD were measured in order to determine whether they demonstrated collateral gains in behaviors through peer-mediated inference making intervention. Behavioral data were collected throughout the duration of the study for 15-minute reading activity. The measured behaviors included (a) contingent responses, (b) verbal initiations, and (c) inappropriate behaviors. The operational definitions for each behavior and measurements are described in Table 6.

**Contingent responses of the target students with ASD.** Contingent responses were operationally defined as a target student with ASD verbally and nonverbally responding to an
instructor’s utterance or a peer’s utterance within a 5-second interval. A frequency recording
system was used to record this variable during 15-minute reading activity for baseline,
intervention, and maintenance probes. The occurrences of the target students’ verbal and
nonverbal reactions to questions or prompts by the instructor or peers were counted. Since the
occurrences of responses were determined by the given opportunities, the total frequencies of the
opportunities provided by the instructor and peers were recorded as well.

*Verbal initiations of the target students with ASD.* Verbal initiations were operationally
defined as any functional verbalizations, including comments and requests, a target student with
ASD directed toward another person. Frequency data were collected on the occurrence of a
target students’ any verbal comments and requests to the instructor or peers on any given task.
Verbal initiations related to on-going reading activities were only counted.

*Inappropriate behaviors of the target students with ASD.* A target student’s 15-minute
reading activity was divided into 15 equal one-minute intervals and an observer recorded
whether an inappropriate behavior occurred at some point during each interval. Inappropriate
behaviors included aggression (i.e., hitting, pushing), out of seat/area, negative verbalizations to
peer (i.e., arguing, name calling, teasing), talking out, disruptive behavior (i.e. using materials
inappropriately, throwing objects), and off-task behaviors.

*Self-Evaluation in Reading.* Students’ self-evaluation in reading was asked as part of
subjective evaluation before and after the study. The questionnaire of students’ self-evaluation in
reading was adopted from *The Self-description Questionnaire* developed by Marsh and
colleagues (1983), whose coefficient alphas for the seven dimensions range from .80 to .92. As
seen in Figure 4, the students responded to each item either with “Like Me” or “Unlike Me” on
10 questions. When the student’s response on the item reflected positive self in reading, 1 point
was given and when reflecting negative self in reading, 0 point was given. Higher points reflected the student’s higher self-evaluation in reading.

**Reliability of the Dependent Measures**

Inter-rater reliability calculations were obtained for the dependent measures of contingency responses, verbal initiations, and inappropriate behaviors. Prior the study, three observers were trained on behavioral data collection through video clip observation by the researcher and they measured the target behaviors independently until their inter-rater reliability with the researcher were met at the range of 85-100%. Once the study started, one observer was assigned to each group and observed behaviors of a target student with ASD for 15 minutes in each probe. Inter-rater reliability with the researcher was computed for 27% of probes for Student 1, Emily, 26% for Student 2, Aiden, and 25% for Student 3, Jackson.

For quantity of contingent responses and quantity of verbal initiations made by the three target students with ASD, agreements were calculated with frequency ratio, in which the smaller total is divided by the larger total and then multiplied by 100 to form a percentage. The average reliability percentage for contingent responses across the three target students with ASD ranged between 64 and 82.4%. Reliability for verbal initiations ranged between 73 and 100% across the three students. For quantity of inappropriate behaviors, agreements were computed with point-by-point agreement ratio, in which both observers recorded the same instance in a given interval. That is, agreements of the observers were divided by the number of agreements and multiplied by 100 to form a percentage. The average reliability percentage for the three target students ranged between 75 and 88%. A summary of the percent agreements on the behavioral dependent measures are provided in Table 7.

**Treatment Fidelity**
Instructors’ adherence to the procedure of each session was evaluated for their treatment fidelity. Three instructors followed all the procedures written in the manual, according to audio files recorded in each session. Thirty percent of audio files in all the baseline, intervention, maintenance, and generalization probes were randomly selected for the fidelity check. All three instructors adhered to the procedure 100% of time.

Results

**Reading Comprehension Skills of Students with ASD**

Figure 5 depicts scores on comprehension quizzes in which three target students with ASD, Emily, Aiden, and Jackson, demonstrated their comprehension skills in the baseline, intervention, maintenance, and evaluation probes. The ordinates show the scores on comprehension quizzes in which the target students with ASD obtained and the abscissas show the consecutive probes. The results show that when the target students with autism were trained with peer-mediated inference making by an instructor and peers, they demonstrated increase on comprehension quizzes after the intervention.

**Baseline.** During the baseline condition, in which the participants were expected to comprehend a given passage independently and take a quizz, scores on comprehension quizzes remained at a low level for all three target students with ASD. For instance, Emily’s scores were below 10, out of possible 21 points, in all the baseline probes (range = 5-9, $M$=6 points) and both Aiden and Jackson showed flat low performance by scoring 0 points on the quizzes.

**Intervention.** During the intervention condition, each target student with ASD was grouped with two peers and peer-mediated inference making intervention was implemented under the instructor’s guidance. Student 1, Emily, started an intervention session as her scores during the baseline condition did not increase. Her scores increased to average 11.8 points
(range = 9-16) during the intervention condition. Student 2, Aiden, started his intervention right after Emily demonstrated scores increase on the comprehension quizz. Aiden’s scores immediately rose in the first intervention probe and consistently continued to increase after the third intervention probe (range = 0-6, \( M =1.9 \) points).

Once Aiden showed a positive change in his scores, the third target student with autism, Jackson, started his intervention session. Immediately after the start of intervention, Jackson exhibited scores increases on comprehension quizzes (range = 1-6, \( M=3.4 \) points).

**Mid-evaluation probes.** Once the target student with ASD demonstrated scores increases on comprehension quizzes consecutively more than three probes in the intervention condition and the participants were able to implement cooperative learning group activity at 100% accuracy with the instructor’s prompt, mid-evaluation probes were conducted. Student 1, Emily, was absent during the mid-evaluation probes, due to an arm injury. Next, Aiden’s scores in the mid-evaluation probes did not change from the baseline’s scores, by marking all 0 points. Student 3, Jackson’s scores increased in the mid-evaluation probes (\( M=2 \) points) from the baseline probes (\( M=0 \) points).

**Maintenance.** After the participants had mid-evaluation probes, the maintenance condition started in which the instructor minimized her prompts and the participants took charge of peer-mediated inference making intervention. Under a student facilitator’s active lead, the peer group completed each session. During the maintenance condition, scores on comprehension quizzes continuously increased for all the target students with ASD. Emily continued to demonstrate improved comprehension skills in the maintenance probes (range = 9-20, \( M= 14.4 \) points). Both Aiden and Jackson, exhibited higher scores, respectively \( M=3.4 \) points, \( M= 3.5 \) points, than the baseline and intervention conditions.
Post-evaluation probes. Post-evaluation probes were conducted after the maintenance condition and the procedure was same as the baseline and mid-evaluation conditions. All three target students with ASD demonstrated the effects of peer-mediated inference making intervention on reading comprehension skills, by increasing their scores. Although Emily did not have mid-evaluation probes, her scores in the post-evaluation probes demonstrated that her reading comprehension skills improved from the baseline condition, by jumping to average 16 points from average 6 points. Student 2, Aiden, who showed no change in the mid-evaluation probes, also demonstrated increased reading comprehension skills, by scoring average 2.5 points. Likewise, Student 3, Jackson, increased his scores to average 5 points from average 2 points.

Effect sizes. Percentage of non-overlapping data (PND) between the baseline and peer-mediated inference making intervention conditions were calculated to evaluate the intervention’s effect size on students’ scores. PND for Emily, Aiden, and Jackson was respectively, 84.6, 77.7, and 100, and average PND for all three students with ASD was 87.4. Since PND scores of 70 to 90 have been considered effective (Campbell, 2004), peer-mediated inference making intervention was effective to improve students’ scores.

Reading Comprehension Skills of the Peers

Six peers’ reading comprehension scores in the baseline, intervention, maintenance conditions, and both evaluation probes were also collected. All the peers demonstrated increased scores on reading comprehension quizzes in the intervention condition (See Figure 6). Peer 1, Peer 3, Peer 4, and Peer 6 increased their scores continuously in the maintenance condition, while Peer 2 and Peer 5 lowered their scores in the maintenance compared to those in the intervention condition. In the maintenance condition, two peers with a specific learning
disability, Peer 3 and Peer 6, doubled their baseline’s scores. Peer 3 increased her average scores from 8 to 15.8 points and Peer 6 increased his from 5 to 10 points.

The peers also demonstrated their improved reading comprehension skills by obtaining higher scores in both mid- and post-evaluation probes. Figure 7 shows increased scores in both evaluation probes by the peers. Peer 6 did not have post-evaluation probes after the maintenance condition due to his absence for a family matter.

**Inferential and Synthesizing Skills of Participants**

Comprehension quizzes (total 21 points) had three components such as factual (6 points), inferential (8 points), and synthesizing questions (7 points). All the participants’ scores were calculated for each component along with the total scores. Since Aiden and Jackson only scored on factual questions, their scores on inferential or synthesizing questions were not calculated. Thus, scores on inferential and synthesizing questions by Emily and peers were calculated to examine the effects of peer-mediated inference making intervention on the participants’ inferential and synthesizing skills.

Figure 8 shows average scores on inferential questions obtained by Emily and the peers in three conditions. Emily and five peers increased their scores on inferential questions throughout intervention and maintenance conditions. Only Peer 5 did not improve her scores on inferential questions, although her scores increased in both evaluation probes as seen in Figure 9, which depicts average scores on inferential questions in both evaluation probes by Emily and peers. Emily and all the peers increased their scores on inferential questions in the post-evaluation probes. Thus, peer-mediated inference training was effective in improving the participants’ inference making skills, as demonstrated in their scores.
Participants’ average scores on synthesizing questions (i.e., a main idea, a title, and a summary of a given passage) in the baseline, intervention, and maintenance conditions are graphed in Figure 10. Emily and all peers increased their scores on synthesizing questions in the intervention condition. Their scores in the generalization probes increased as well (see Figure 11). Thus, peer-mediated inference making intervention was effective to improve the participants’ synthesizing skills as well.

**Behaviors of Students with ASD**

**Verbal and nonverbal contingent responses of students with ASD.** The occurrences of the target students’ verbal and nonverbal reactions to questions or prompts by the instructor or peers were counted in the baseline, intervention, and maintenance conditions. In Figure 12, unfilled squares with dashed line show the frequency of opportunities given to the target students with autism by the instructor or peers. The frequency of the target student’s responses to the instructor was shown in unfilled circles with gray line. Filled triangles with black line depict the frequency of the target student’s contingent responses to peers.

All the target students with ASD demonstrated consistent behavior patterns throughout the study. In the intervention and the maintenance conditions, the students with ASD were provided with more opportunities to respond to the instructor or peers. Accordingly, their responses increased. As the maintenance condition started, the students with ASD responded to their peers more frequently than to the instructor. This demonstrates that more unprompted peer interactions than prompted ones occurred in the maintenance condition. Thus, the target students with ASD all demonstrated more responsive behaviors after the intervention started and their responses to peers noticeably increased in the maintenance condition.
Effect sizes on frequencies of contingent responses to peers during peer-mediated inference making intervention condition were calculated: PND for Emily, Aiden, and Jackson was respectively, 87.5, 58.4, and 81.3 and average PND for all three students was 75.7. Thus, peer-mediated inference making intervention can be considered as effective to promote students’ contingent responses to peers.

**Verbal initiations of students with ASD.** Figure 13 shows the occurrences of any verbal initiations by the students with ASD toward the instructor or peers on the given tasks. Verbal initiations related to on-going reading activities only were counted. Emily demonstrated more frequent verbal initiations in the intervention and maintenance than the baseline condition. Aiden’s verbal initiations were not consistently occurred in the intervention condition. However, his verbal initiations occurred more frequently in the maintenance than the baseline condition. Jackson demonstrated the similar behavior patterns as Aiden, by showing increased initiating behaviors in the maintenance than in the baseline condition.

Average frequency of verbal initiations by the students with ASD in the baseline, intervention, and maintenance conditions are shown in Figure 14. All students with ASD demonstrated increased verbal initiations in the intervention and maintenance conditions. Emily’s average frequency increased from 9 to 18.6, Aiden from 0.3 to 4.3, and Jackson from 0.4 to 3. PND for Emily, Aiden, and Jackson was respectively 100, 72.2, and 75, and average PND for all three students was 82.4. Thus, peer-mediated inference training was effective in promoting verbal initiations of the target students with autism.

**Inappropriate behaviors by students with ASD.** The frequency of inappropriate behaviors occurrences of the target students with autism are shown in Figure 15. The change pattern and trend of inappropriate behaviors over the baseline, intervention, and maintenance
conditions were not consistent across the three target students with autism. When calculating the averages, Aiden showed decreased frequency of inappropriate behaviors over the three conditions from 9.3 to 3.9 and finally to 2.5. Emily’s inappropriate behaviors did not change over the conditions, while Jackson’s inappropriate behaviors increased from 3.4 to 4.9, and finally to 5.3 in the maintenance condition. PND for Aiden only was calculated and it was 100. Thus, the effects of peer-mediated inference training on inappropriate behavior occurrences of the target students with autism were not empirically demonstrated.

**Self-Evaluation in Reading**

All the participants completed the Self-evaluation in Reading questionnaires before and after the study as part of social validity evaluation. Figure 16 depicts score changes in students with ASD and Figure 17 for the peers. The average scores of the students with ASD were 8 points in Pre and 9 points in Post evaluation. For peers, the average scores were 7.1 points in Pre and 8.9 points in Post evaluation. All the participants reported score increases in self-evaluation in reading after peer-mediated inference making intervention.

**Discussion**

This study developed a peer-mediated inference making intervention to help students with autism spectrum disorder (ASD) improve their reading comprehension skills, by incorporating information retrieval and integration training. This peer-mediated inference making intervention was evaluated in three domains. First, participant's scores on comprehension quizzes were examined in the baseline, intervention, and maintenance conditions to document a functional relationship between the training and score changes. Second, behaviors of students with ASD were measured in the baseline, intervention, and maintenance probes to explore any
collateral gains in their appropriate behaviors. Lastly, social validity of the study was evaluated by measuring the participants' Self-evaluation in Reading.

The results demonstrated the followings: 1) students with ASD and peers increased their total scores in comprehension quizzes, 2) a student with high functioning autism and peers increased their scores on inferential and synthesizing questions in comprehension quizzes, 3) students with ASD increased the quantity of contingent responses toward both the instructor and peers, 4) students with ASD increased the quantity of verbal initiations toward another person, 5) students with ASD did not decrease the occurrence of inappropriate behaviors, and 6) participants reported promoted Self-evaluation in Reading.

This discussion focused on the use of peer-mediated inference making intervention in teaching students with ASD to enhance their comprehension skills, on the collateral gains obtained in the quantity of contingent responses and verbal initiations, and possible mechanisms leading to such collateral gains. Additionally, contributions of the current study to the literature on peer-mediated reading instructions for students with ASD were discussed.

Comprehension Skills of Students with ASD

All three students with ASD empirically demonstrated the effects of peer-mediated inference making intervention on reading comprehension skills, by substantially increasing their scores on comprehension quizzes. Their scores continued to rise in the maintenance condition in which the instructor minimized their prompts and the students took over the session. Such consistent gains were kept in post-evaluation probes.

Such results in terms of overall scores on comprehension quizzes have several implications. First, despite the plethora of studies documenting improved reading comprehension performance of students with reading difficulties (See Browder, Wakeman, Spooner, Algrim-
exceptionally few have demonstrated improvement in reading comprehension of students with ASD (See Chiang & Lin, 2007; Judi et al., 2010; Whalon et al., 2009, for review). What is more, even fewer studies have shown gains in reading comprehension of students with moderate and low functioning ASD (Kamps et al., 1989, 1994). This study extends existing research by empirically documenting score gains in comprehension quizzes of students with ASD at different cognitive functioning levels after peer-mediated inference making intervention.

Second, all the peers also substantially increased their average scores on comprehension quizzes throughout the intervention and maintenance conditions and in post-evaluation probes. Although peers’ scores were not examined for the functional relationship with intervention, such gains cannot be ignored. Especially two peers, Peer 3 and Peer 6, who were served with special education services for a learning disability, literally doubled their scores during the study. Thus, peer-mediated inference making intervention may benefit not only students with ASD but also those with reading difficulties.

Literature on reading comprehension indicates that specific reading strategies to improve reading comprehension are in need for students with comprehension difficulties (Gajria et al., 2007; Gersten et al., 2001). Peer-mediated inference making intervention specifically taught the participants how to employ lexical inference and goal inference making and how to integrate such inferences into the whole text while working as a team. At the beginning, the story maps were often incomplete, leaving problem, solution, or lesson components unfilled. However, as the sessions went by, the participants were able to complete the story map within a given time frame, filling out all the components including the last one, lesson of the story.
Third, the data exemplified in Figures 11 and 12 are also consistent with findings in the literature documenting that inference making skills lead to comprehension skills (Cain & Oakhill, 1999; Cain et al., 2001). Emily and peers all demonstrated substantial score gains on the inferential and synthesizing questions. Especially Emily, Peer 3, and Peer 6, who were served with special education services showed remarkable improvement in answering both inferential and synthesizing questions. Such results confirmed the previous studies that enhanced inferencing skills lead to better comprehension performance (Lynch & van den Broek, 2007; McGee & Johnson, 2003; Whalon & Hanline, 2008; Yuill & Oakhill, 1988). Two other target students with ASD did not score on quizzes in the baseline condition: Their scores increases occurred on factual questions, such as where the story took place, what the characters did, or what happened to the characters. Thus, their scores on inferential and synthesizing questions could not be analyzed. Student 3, Jackson, showed improved inference making when retelling the story, although it was not reflected in his scores in comprehension quizzes. Jackson was able to infer what each character wanted and why a major problem occurred while retelling the story.

Such results imply the peer-mediated inference making intervention involves two different stages of inference making process. Students with poor comprehension show limited inference skills caused by either incorrect premise recall or integration failures or both (Cain et al., 2001; Yuill & Oakhill, 1991). Both Aiden and Jackson showed their learning benefits from the intervention, by improving their scores on factual questions. On the other hand, Emily and peers were already able to correctly answer most of factual questions. Their substantial score gains from inferential and synthesizing questions indicates that they may learn how to integrate their inferences in the given text. For Student 3, Jackson with moderate functioning autism, also
started showing his learning through activities although such changes were not reflected in the paper-and-pencil assessment yet.

The most prominent strength of peer-mediated inference making intervention may be its applicability to heterogeneous group of students with various levels of cognitive functioning and reading ability. Since this method facilitates different stages of inference making process, students were able to demonstrate positive outcomes in comprehension regardless of their cognitive or reading level.

Behavior Changes in Students with ASD

As illustrated in Figures 15-17, the data suggested that not only the students with ASD increased their scores on comprehension quizzes, they also exhibited collateral gains in their contingent responses and verbal initiations toward another person. That is, the current study specifically targeted improving comprehension skills. However, over the course of the intervention, not only was improved comprehension skills demonstrated but so was appropriate behaviors of students with ASD. This finding is perhaps the most important contribution of the current study to the existing literature. As previously discussed, collateral gains as a result of peer-mediated learning in social, self-concept, and behavior outcomes well documented in group design studies whose participants were mainly students without specified disabilities (Ginsburg-block et al., 2006).

Despite the plethora of studies documenting collateral gains in such areas, few studies to date have documented collateral gains in behaviors of students with ASD, through reading instruction intervention (Dugan et al., 1995; Kamp et al., 1994, 1995). Interdependent group contingency and structured peer interactions appeared to reinforce positive interactions between the target students with ASD and their peers. The target students with ASD were provided with
verbal scripts according to the given role (i.e., structured interactions), which helped them identify appropriate responses and initiations during reading activity. The interdependent group contingency also created positive atmosphere in which each group member was encouraged to get involved more actively. The evidence supported by this study not only provided support for utilizing comprehension strategies for students with ASD, it extends current knowledge about how to effectively intervene in peer interactions for this population.

Frequency of inappropriate behaviors of students with ASD did not show any change patterns or trend after peer-mediated inference making intervention was implemented. Student 2, Aiden showed overall consistent decreases in frequency of inappropriate behaviors. However, such decreasing trend was shown in the baseline condition as well. Thus, it is unclear to determine the functional relationship between peer-mediated inference making intervention and frequency of inappropriate behaviors for Aiden. When a target student was absent, an assigned observer to the group had a few chances to observe other peers. Compared to peers, the frequency of inappropriate behaviors by target students with ASD did not differ at a great level. Majority of inappropriate behaviors were off-task behaviors according to the observer’s notes, such as gazing in the space (for Jackson), self-stimulating behaviors (for Aiden), and talking with peers (for Emily). The instructors’ reminder for group reward easily redirected such inappropriate behaviors. Thus, inappropriate behaviors of the participants did not become issues during the study.

When decreasing an inappropriate behavior of students with ASD, teaching its alternative behavior with reinforcement after functional assessment is one of the most commonly used method (Alberto & Troutman, 2006). Once an alternative behavior is set up, concrete mediation such as self-monitoring or video-modeling is highly valuable methods when communicating
behavioral expectations to students with ASD (Coyle & Cole, 2004). Since this study did not specifically target the problem behavior for each student along with functional assessment nor did teach alternative behaviors to students with ASD, no remarkable results are no surprise.

Social Validity

This study evaluated social validity by examining participants’ self-evaluation in reading. Although Student 2, Aiden and three peers consistently reported high self-evaluation pre and post study, the fact that the rest of participants reported higher scores after the study itself indicates that peer-mediated inference making intervention was positively perceived by the participants. Participants’ positive experiences with peer-mediated inference making intervention were well reflected in the maintenance condition in which they were able to take over the session and complete all the given tasks. Peers, who more openly vocalized their opinions than the students with ASD, often commented to the instructor that they really enjoyed the session. Parents sometimes came early to pick up their child due to a family matter, which brought bitter some reactions from the participants. For students with ASD, Aiden’s and Jackson’s parents specifically expressed their satisfaction to the instructors and the researcher, every time they came to pick up their child. Student’s promoted self-evaluation in reading suggest that this study has a solid social validity.

Limitations

While this study is unique in its reading instructional strategies to enhancing comprehension skills as well as promoting appropriate behaviors in students with ASD, there were several limitations to this study. Although students with ASD recruited for this study were identified by their school district as having an autism spectrum disorder and referred to this study by school personnel, the researcher did not independently confirm children’s diagnoses of autism
using the gold standard Autism Diagnostic Observation Schedule (Lord, Risi, Lambrecht, Cook, Leventhal, DiLovore, et al., 2000) and the Autism Diagnostic Interview-Revised (Lord, Rutter, Le Couteur, 1994). Future studies should independently assess all students prior to enrollment to ensure experimental effects of peer-mediated inference making intervention in this population.

Having more participants would have helped with establishing the functional relation between the intervention and outcomes of students with ASD at different cognitive functioning and reading ability levels. Although all three students with ASD demonstrated score increases on comprehension quizzes, Student 1, Emily showed the most substantial changes. Thus, students with higher functioning autism might be more responsive to peer-mediated inference making intervention in terms of reading comprehension improvement. Having additional students with high functioning autism as participants would be more helpful in establishing effects of peer-mediated inference making intervention in this population.

This study employed scores on comprehension quizzes as only measurer for comprehension skills of the students. Despite positive outcomes for all participants, a traditional paper-and-pencil assessment did not seem sensitive to students’ gains in comprehension. For instance, Student 3, Jackson demonstrated his enhanced comprehension skills in interacting with the instructor or peers although his verbal performance was not reflected in his quiz scores. Thus, multiple measures for comprehension skills should be considered to sensitively reflect any gains in students’ performance.

Lack of peer comparison data was another limitation to this study. Target students with ASD did exhibit an increase in the quantity of contingent responses and verbal initiations they made toward another person after intervention. However, it is unsure if this increase was comparable to that of their peers. It should be helpful if future studies gathered normative data on
contingent responses, verbal initiations, and inappropriate behaviors and analyzed peers’ behaviors in detail.

This study employed mid- and post-evaluation probes after the intervention and maintenance conditions for measuring students’ growth in comprehension skills. However, generalizations over different formats of assessments or different settings were not tested. Generalization is an issue that continues to pose difficulties for professionals in the field (Hwang & Hughes, 2000), thus it would be important for future studies to measure generalization across assessments (i.e., multiple-choice test), or setting (i.e., in classroom during the school hours).

Future Directions

As noted throughout this discussion, the findings from this study reveal several areas that may be important to pursue in future research. First, given the literature on the importance of developing effective interventions that can be implemented in natural environment (Crosland & Dunlap, 2012), the current study could further be expanded by implementing peer-mediated inference making intervention in the participants’ classroom with their teacher and classmates. This may allow for students with ASD to have more chances to practice peer-mediated inference making over longer period of time.

Second, although the goal of this study was primarily to assess if students with ASD could improve their reading comprehension skills through peer-mediated inference making intervention, the comments of the instructors and observations of participants suggest several other measures that may be important to assess in the future research. Peers’ performances and behaviors should be measured same as students with ASD, since peer-mediated inference making intervention may benefit other peers as well. Such benefits for peers are critical to socially validate the current study and scale up the study to a larger sample.
Third, the reading materials in this study were grade-appropriate rather than individualized based on individual student’s reading level. Although all the target students with ASD demonstrated scores increases in the comprehension quizzes, the magnitude of score changes for two students with ASD, Aiden and Jackson, was not as large as Emily’s. Thus, a future study should consider using individualized reading materials, which may lead more significant outcomes of the intervention.

Last, peer-mediated inference making intervention is a combined intervention that delivers inference making training in peer-mediation. Thus, it is unclear which component of the intervention is the active ingredient for positive outcomes. In the future, comparison studies between peer-mediated inference making intervention and one-to-one inference making intervention or whole class inference making intervention are in need to identify the active ingredient.

Conclusions

Promoting inference skills of students with poor comprehension has been suggested as an effective reading comprehension strategies (Cain & Oakhill; Cain et al., 2001; Oakhill & Yuill, 1986). Empirical studies show that students with ASD demonstrate relatively poor comprehension skills compared to their intellectual level and deficits in inference making. However, to improve reading comprehension skills of students with ASD, teaching them how to make inferences appropriately in written text has not been fully investigated yet (Whalon & Hanline, 2008; Saldana & Frith, 2007). Under the framework of weak central coherence (Happe & Frith, 2006), this study developed inference making training utilizing peer-mediation method.

After peer-mediated inference making intervention, students with ASD demonstrated score gains on their comprehension quizzes and collateral gains in contingent responses and
verbal initiations during peer-mediated inference making intervention. In addition, peers at different levels of reading ability showed gains in their scores on comprehension quizzes. All participants reported promoted self-evaluation in reading.

Findings from this study suggest that peer-mediated inference making intervention is useful comprehension strategies to promote both comprehension skills and appropriate behaviors of students with ASD. Peers’ positive outcomes and instructors’ high fidelity and devotion support this as a promising instructional approach in inclusive educational settings as well. Thus, this study contributes to the existing literature on effective educational strategies for students with ASD in inclusive educational settings.
Table 1

*Testing Scores and Demographic Information of Three Target Students with ASD*

<table>
<thead>
<tr>
<th>Target Students with Autism</th>
<th>Emily</th>
<th>Aiden</th>
<th>Jackson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Female</td>
<td>Male</td>
<td>Male</td>
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<tr>
<td>Ethnicity</td>
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<td>African-American</td>
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<td>11</td>
<td>10</td>
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<tr>
<td>Grade</td>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>5&lt;sup&gt;th&lt;/sup&gt;</td>
<td>5&lt;sup&gt;th&lt;/sup&gt;</td>
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<tr>
<td>% of Time in an Inclusive setting</td>
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<td>36</td>
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<tr>
<td>WISC-IV Full Scale</td>
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<td>86</td>
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<tr>
<td>Verbal Comprehension</td>
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<tr>
<td>Perceptual Reasoning</td>
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<td>90</td>
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<tr>
<td>Processing Speed</td>
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<td>109</td>
<td>88</td>
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<tr>
<td>WIAT-II Reading Composite</td>
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<td>50</td>
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<tr>
<td>Word Reading</td>
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<td>41</td>
<td>45</td>
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<tr>
<td>Pseudoword Decoding</td>
<td>90</td>
<td>55</td>
<td>66</td>
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<tr>
<td>Reading Comprehension</td>
<td>89</td>
<td>56</td>
<td>61</td>
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Table 2

*WIAT-II Scores and Demographic Information of Peers*

<table>
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<th>Peers</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>IEP</th>
<th>Word Reading</th>
<th>Pseudoword Decoding</th>
<th>Reading Comprehension</th>
<th>Reading Composite</th>
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<tr>
<td>Peer 1</td>
<td>Female</td>
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<td>No</td>
<td>99</td>
<td>87</td>
<td>120</td>
<td>99</td>
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<td>Peer 2</td>
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<td>102</td>
<td>105</td>
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<td>97</td>
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<td>Peer 3</td>
<td>Female</td>
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<td>Yes</td>
<td>98</td>
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<td>85</td>
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<td>Peer 4</td>
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<td>No</td>
<td>80</td>
<td>80</td>
<td>95</td>
<td>82</td>
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<tr>
<td>Peer 5</td>
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<td>79</td>
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<td>75</td>
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<td>Peer 6</td>
<td>Male</td>
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<td>Yes</td>
<td>83</td>
<td>69</td>
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<td>82</td>
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Table 3

Number of Words and Readability Level of the Reading Materials

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<thead>
<tr>
<th>Probe</th>
<th>Title</th>
<th>Number of Words</th>
<th>Readability Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline 1</td>
<td>Slip, Slap, Slop</td>
<td>433</td>
<td>2.8</td>
</tr>
<tr>
<td>Baseline 2</td>
<td>How to Use Umbrella</td>
<td>316</td>
<td>3.6</td>
</tr>
<tr>
<td>Baseline 3</td>
<td>Be Thankful for What You Have</td>
<td>335</td>
<td>4.8</td>
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<tr>
<td>Baseline 4</td>
<td>An Elephant Never Forgets</td>
<td>395</td>
<td>4.0</td>
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<tr>
<td>Baseline 5</td>
<td>Lady Bird, Lady Bird, Fly Away from Home</td>
<td>427</td>
<td>2.4</td>
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<tr>
<td>Intervention 1</td>
<td>Cooperative Learning Group</td>
<td>731</td>
<td>4.1</td>
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<tr>
<td>Intervention 2</td>
<td>Cooperative Learning Group</td>
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<td>4.1</td>
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<td>Intervention 3</td>
<td>Writer’s Role</td>
<td>763</td>
<td>2.5</td>
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<tr>
<td>Intervention 4</td>
<td>Monkey Looks for Trouble</td>
<td>478</td>
<td>3.0</td>
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<tr>
<td>Intervention 5</td>
<td>Iris and Walter and the Field Trip</td>
<td>614</td>
<td>2.3</td>
</tr>
<tr>
<td>Intervention 6</td>
<td>Kara’s Good Work Pays Off</td>
<td>504</td>
<td>5.0</td>
</tr>
<tr>
<td>Intervention 7</td>
<td>The Cat, the Rooster, and the Mouse</td>
<td>264</td>
<td>4.1</td>
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<tr>
<td>Intervention 8</td>
<td>Trading Places</td>
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<td>2.5</td>
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<tr>
<td>Maintenance 1</td>
<td>Racing Team</td>
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<tr>
<td>Maintenance 2</td>
<td>Finding a Home</td>
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<tr>
<td>Maintenance 3</td>
<td>A New Chewing Gum</td>
<td>530</td>
<td>4.6</td>
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<td>Maintenance 4</td>
<td>A Dress for the Moon</td>
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<tr>
<td>Maintenance 5</td>
<td>That Will Teach You, Bear!</td>
<td>247</td>
<td>3.3</td>
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<tr>
<td>Maintenance 6</td>
<td>Callie’s Choice</td>
<td>492</td>
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<tr>
<td>Mid-evaluation 1</td>
<td>The Cat Who Caught His Own Tail</td>
<td>433</td>
<td>2.5</td>
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<td>Mid-evaluation 2</td>
<td>Slip, Slap, Slop</td>
<td>433</td>
<td>2.8</td>
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<td>Mid-evaluation 3</td>
<td>Spider and Turtle</td>
<td>367</td>
<td>3.5</td>
</tr>
<tr>
<td>Post-evaluation 1</td>
<td>The Crow and the Water Jug</td>
<td>388</td>
<td>2.2</td>
</tr>
<tr>
<td>Post-evaluation 2</td>
<td>Cracks in an Old Clay Pot</td>
<td>580</td>
<td>4.1</td>
</tr>
</tbody>
</table>

Note. Readability Level was determined through Flesch-Kincaid Readability Test.
<table>
<thead>
<tr>
<th>Phase</th>
<th>Probes 1 &amp; 2</th>
<th>Probes 3 &amp; 4</th>
<th>Probes 5-8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Probes</strong></td>
<td>• Inference awareness</td>
<td>• Inference awareness</td>
<td>• Inference awareness</td>
</tr>
<tr>
<td></td>
<td>• Story map preview</td>
<td>• Three roles preview</td>
<td>• Pre-reading</td>
</tr>
<tr>
<td></td>
<td>• Pre-reading</td>
<td>• Pre-reading</td>
<td>• Story map activity</td>
</tr>
<tr>
<td></td>
<td>• Story map activity</td>
<td>• Story map activity</td>
<td>• Comprehension quiz</td>
</tr>
<tr>
<td></td>
<td>• Comprehension quiz</td>
<td>• Comprehension quiz</td>
<td>• Retelling the story</td>
</tr>
<tr>
<td></td>
<td>• Retelling the story</td>
<td>• Retelling the story</td>
<td>• Retelling the story</td>
</tr>
<tr>
<td><strong>Procedures</strong></td>
<td>Modeling</td>
<td>Modeling and guiding</td>
<td>Prompting</td>
</tr>
<tr>
<td><strong>Instructor’s Role</strong></td>
<td>None</td>
<td>Writer and monitor</td>
<td>Facilitator, writer, and monitor</td>
</tr>
<tr>
<td><strong>Students’ Roles</strong></td>
<td>Social story 1</td>
<td>Social story 2</td>
<td>Grade level story</td>
</tr>
<tr>
<td><strong>Comprehension Story</strong></td>
<td>Social story 1</td>
<td>Social story 2</td>
<td>Grade level story</td>
</tr>
</tbody>
</table>

*Table 4
Three Phases in the Intervention Condition*
Table 5

*Comprehension Quiz and Its Scoring Keys*

<table>
<thead>
<tr>
<th>Number</th>
<th>Question and Scoring Rubric</th>
</tr>
</thead>
</table>
| 1-3    | Fact questions (“Who?, What?, When?, Where?” questions)  
Examples: “Where did this story happen?” “Who ran the race?”  
2= Complete answer  
1= Part of the answer  
0= Wrong answer or irrelevant detail |
| 4-7    | Inferential questions (“Why? How?” questions)  
Examples: “Why did coyote agree to make a bet with frog?” “How was frog able to win the race?”  
2= Complete answer  
1= Part of the answer  
0= Wrong answer or irrelevant detail |
| 8      | Title: “What is a good title for this story?”  
2= Title expresses the main idea  
1= Title expresses part of the main idea  
0= Wrong answer or no answer |
| 9      | Main idea: “What is the main idea that the author is trying to tell us in this story?”  
2= Stating the main idea  
1= Stating part of the main idea  
0= Wrong answer or no answer |
| 10     | Unguided retelling: “Can you tell me the story in your own words?”  
3= Main idea and unguided retelling of some of the main points.  
2= Main idea only, no elaboration  
1= Stating a main point, but not stating the main idea  
0= Wrong answer, no answer |

*Note.* Adopted from O’Connor & Klein (2004)
Table 6

**Dependent Measures**

<table>
<thead>
<tr>
<th>Dependent Measure</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingent responses</td>
<td><strong>To Instructor:</strong> A target student responds (verbally or nonverbally) to an instructor’s utterance within a 5-second interval</td>
<td>Acknowledging the peer, agreeing, answering a question, responding with a related comment, or clarifying the peer’s comment or question. This includes nonverbal behaviors, such as nodding, shaking the head, making facial expressions and so on.</td>
</tr>
<tr>
<td></td>
<td><strong>To Peers:</strong> A target student responds (verbally or nonverbally) to a peer’s utterance within a 5-second interval</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Related: Coded as “+” when the response is related to an instructor’s utterance or a peer’s utterance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unrelated: Coded as “-” when the response is not related to an instructor’s utterance or a peer’s utterance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No response: When a target student does not respond within a 5-second interval</td>
<td></td>
</tr>
<tr>
<td>Initiating comments</td>
<td>A target student makes a comment. The comment is not contingent on an instructor’s utterance or a peer’s utterance and not used to request information.</td>
<td>The comments may describe activity, compliment peer, reinforce peer, or express enjoyment.</td>
</tr>
<tr>
<td></td>
<td>Related: Coded as “+” when the comment is related to on-going topic or activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unrelated: Coded as “-” when the comment is unrelated to on-going topic or activity</td>
<td></td>
</tr>
<tr>
<td>Initiating requests</td>
<td>A target student request information, objects, or actions. Related: Coded as “+” when the comment is related to on-going topic or activity</td>
<td>This does not include requesting clarification of a peer’s prior utterance and is not contingent on peer’s utterance.</td>
</tr>
<tr>
<td></td>
<td>Unrelated: Coded as “-” when the comment is unrelated to on-going topic or activity</td>
<td></td>
</tr>
<tr>
<td>Inappropriate behaviors</td>
<td>A target student engages in the following behaviors for more than 5 seconds at a time to be recorded Including, aggression (i.e., hitting, pushing), out of seat/area, negative verbalizations to peer (i.e., arguing, name calling, teasing) or to the instructor, talking out, disruptive behavior (i.e. using materials inappropriately, throwing objects), and off-task behaviors.</td>
<td></td>
</tr>
</tbody>
</table>

*Note. Adopted from Delano & Snell (2006), Whalon & Hanline (2008)*
Table 7

*Reliability Ratings for All Dependent Variables for Each Target Student*

<table>
<thead>
<tr>
<th></th>
<th>Emily</th>
<th>Aiden</th>
<th>Jackson</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M Range</strong></td>
<td>M Range</td>
<td>M Range</td>
<td>M Range</td>
</tr>
<tr>
<td><strong>Quantity of Contingent Responses</strong></td>
<td>82.4 53.3-100</td>
<td>63.9 50-100</td>
<td>82.8 71.4-100</td>
</tr>
<tr>
<td><strong>Toward Instructor</strong></td>
<td>70.6 50-100</td>
<td>64.4 20-100</td>
<td>87.9 66.6-100</td>
</tr>
<tr>
<td><strong>Toward Peers</strong></td>
<td>68.3 40-100</td>
<td>96.2 84.6-100</td>
<td>86.7 55.5-100</td>
</tr>
<tr>
<td><strong>Quantity of Verbal Initiations</strong></td>
<td>81.0 68.4-95.2</td>
<td>100 100</td>
<td>73.2 50-100</td>
</tr>
<tr>
<td><strong>Inappropriate Behaviors</strong></td>
<td>88.3 73.3-100</td>
<td>75 66.6-93.3</td>
<td>80 66.6-86.7</td>
</tr>
</tbody>
</table>
Figure 1

An Example of an Inference Awareness Activity Worksheet

<table>
<thead>
<tr>
<th>Inference Awareness Activity: Location 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directions: For each item on this page, a location (place) is implied. Carefully examine each item for <strong>key words or phrases</strong> that will help you infer the location.</td>
</tr>
</tbody>
</table>

1. Carly was talking loudly when she was asked to be quiet. Other people were reading and trying to concentrate.
   a. Where was Carly?
   b. Which key words give you clues to Carly’s location?

2. The boys in front of Dillon kept jumping out of their seats to get popcorn, candy, and soft drinks. It was very annoying.
   a. Where was Dillon?
   b. Which key words give you clues to Dillon’s location?

3. Angel ordered a cheeseburger. He also ordered fries and a soft drink.
   a. Where was Angel?
   b. Which key words give you clues to Angele’s location?

*Note.* Adapted from “Between the Lines: Enhancing Inferencing Skill” (Spector, 2006).
Figure 2

A Story Map Template

Front Page

Back Page
**Comprehension Quiz Format**

<table>
<thead>
<tr>
<th>Question</th>
<th>Type</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Q1       | Setting| • Where did the story take place?  
|          |        | • When did the story take place?  
|          |        | • Where did the main character live?  
|          |        | • Where were the characters heading for?                                |
| Q2 & 3   | Characters| • How was the main character feeling?  
|          |        | • Describe the main character’s personality.  
|          |        | • What did the main character want?  
|          |        | • Why did the character do A?                                            |
| Q4 & 5   | Event  | • What happened to the main character?  
|          |        | • What did the characters do?                                            |
| Q6       | Problem| • What was the problem?  
|          |        | • Why did the problem happen?  
|          |        | • What did the characters do to solve the problem?                       |
| Q7       | Solution| • How was the problem solved?  
|          |        | • How did the characters solve the problem?                              |
| Q8       | Title  | • What would be a good title for this story?                             |
| Q9       | Main idea| • What is the main idea of this story?  
|          |        | • What lesson could be learned from this story?                          |
| Q10      | Retell | • Retell the story in your own words.                                   |

*Note.* Three factual questions (6 points), four inferential questions (8 points), three synthesizing questions (7 points): Possible total scores 21 points
**Figure 4**  

*Students’ Self-Evaluation in Reading*

---

**STUDENTS’ SELF-EVALUATION IN READING**

<table>
<thead>
<tr>
<th>Self-evaluation Items</th>
<th>Like Me</th>
<th>Unlike Me</th>
</tr>
</thead>
<tbody>
<tr>
<td>I get good marks in reading.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I like reading.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I look forward to reading.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am interested in reading.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am dumb in reading.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy doing work for reading.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work in reading is easy for me.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am good at reading.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I hate reading.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I learn things quickly in reading.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Adopted from Marsh, Smith, & Barnes (1983)*
Figure 5. Scores on Comprehension Quizzes by Target Students with Autism
Figure 6. Average Scores on Comprehension Quizzes by Peers in the Baseline, Intervention, and Maintenance Conditions

*Note.* Peer 2 & 3: Students with a specific learning disability (SLD)
Figure 7. Average Scores on Comprehension Quizzes by the Peers in the Mid- and Post-evaluation Probes

Note. Peer 2 & 3: SLD
Figure 8. Average Scores on Inferential Questions by Emily and Peers in the Baseline, Intervention, and Maintenance Conditions

Note. Peer 2 & 3: SLD
Figure 9. Average Scores on Inferential Questions in the Mid- and Post-evaluation Probes by Emily and Peers

Note. Peer 2 & 3: SLD
Figure 10. Average Scores on Synthesizing Questions by Emily and Peers in the Baseline, Intervention, and Maintenance Conditions

*Note.* Peer 2 & 3: SLD
Figure 11. Average Scores on Synthesizing Questions by Emily and Peers in the Mid-and Post-evaluation Probes

Note. Peer 2 & 3: SLD
Figure 12. Frequency of Contingent Responses by the Target Students with Autism in the Baseline, Intervention, and Maintenance Conditions
Figure 13. Frequency of Verbal Initiations by the Target Students with Autism in the Baseline, Intervention, and Maintenance Conditions
Figure 14. Average Frequency of Verbal Initiations by the Target Students with Autism
Figure 15. Frequency of Inappropriate Behaviors by Students with Autism
Figure 16. Scores on Self-Evaluation in Reading by the Target Students with Autism in Pre and Post Study
Figure 17. Scores on Self-Evaluation in Reading by Peers in Pre and Post Study

Note. Peer 3 & 4: SLD
Appendix A
Group Point Chart

Group Point Chart
- Two prizes for 10 points
- One prize for 7 points up

Facilitator: Make sure every voice is heard.
Writer: Make sure every voice is recorded.
Monitor: Make sure every step is completed.

<table>
<thead>
<tr>
<th>5&quot;</th>
<th>10&quot;</th>
<th>15&quot;</th>
<th>20&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25&quot;</td>
<td>30&quot;</td>
<td>35&quot;</td>
<td>40&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45&quot;</td>
<td>50&quot;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Kids in Charge!
Reading Club
Appendix B
Cooperative Learning Group Role Chart

**COOPERATIVE LEARNING GROUP ROLES**

**Facilitator** “Make sure every voice is heard.”
- Assign the reading part to the team.
- Ask the team to find story elements.

**Writer** “Make sure every voice is recorded.”
- Write the answers on the story map.

**Monitor** “Make sure every step is completed.”
- Pass out all the materials to the team
- Check if the team completes the story map.
- Collect the materials from the team.

<table>
<thead>
<tr>
<th>Facilitator</th>
<th>Writer</th>
<th>Monitor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before reading</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td>Who wants to read the paragraph?</td>
<td>Does everyone have a story paper and a story map? Does everyone have a pencil and an eraser?</td>
</tr>
<tr>
<td><strong>Story Map</strong></td>
<td>Who found clues for _________?</td>
<td>Where should I write your answer? Did I write your answer correctly? Can you help me spell the words?</td>
</tr>
<tr>
<td><strong>After reading</strong></td>
<td></td>
<td>Did everyone complete the story map? Did everyone turn in the story map?</td>
</tr>
</tbody>
</table>
REFERENCE


