Classroom teachers' implementation of the Social Stations intervention to improve the verbal initiations and responses of students with autism.

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Abstract

Students with autism often show challenges in social communication, particularly in initiating and responding behaviors. While the classroom offers a natural context for peer interactions, few interventions are designed specifically for classroom settings. This study investigated the effects of a classroom-teacher implemented social communication intervention, known as *Social Stations*, on the initiating and responding behaviors of students with autism. The study was set in an inclusive primary school, with the teacher embedding the intervention into the student's daily literacy lessons. All students with autism showed significant improvements in the targeted behaviors, with improvements maintained over time. This study suggests that social communication interventions can be implemented by teachers as part of a daily classroom program.

Keywords: Social communication; school; iPad; autism spectrum disorder; intervention

Difficulty with social communication is regarded as one of the most significant characteristics of students diagnosed with autism spectrum disorder (American Psychiatric Association, 2013). For students attending inclusive schools, social communication deficits can have a profound impact on their ability to participate in classroom learning activities and engage with peers (Sparapani et al. 2016). The behaviors of verbal initiating and responding are especially important to successful communication and positive interactions between students with autism and their typically developing peers (Bauminger-Zviely et al. 2014; Murdock et al. 2007). Verbal initiations have been described as a verbal attempt to gain the attention or a response from a peer (Whalon et al. 2015). For example, a student might say the name of a peer or make a comment about something they see. Verbal responses occur immediately following an initiation from a peer (Whalon et al. 2015), for example when the child says 'yes' in response to a question or adds an additional comment.

Although many students with autism initiate less frequently when compared to typically developing students (Bauminger et al. 2003), others may over-initiate without giving their conversational partner opportunities to respond (Adams et al. 2002; Eagle et al. 2010). Students with autism are also less likely than their peers to respond contingently to others (Nadig et al. 2010). In addition, the quality of communicative initiations and responses may be affected by a student's difficulty with remaining on-topic during conversations (Capps et al. 1998; Paul et al. 2009; Sng et al. 2017). As a result, students with autism may make irrelevant or idiosyncratic off-topic comments, which disrupt the flow of conversation (Losh & Capps, 2003).

Social communication interventions for school-age students with autism have been the topic of much research. Watkins et al. (2015) identified 24 evidence-based intervention strategies for this age group, which include behavioral approaches, visual approaches (visual supports and video modeling), social narratives, social skills training, and peer mediated

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interventions. Of particular interest to the current study is previous empirical support for peer-mediated interventions for teaching verbal initiating and responding behaviors. For example, Owen-DeSchryver et al. (2008) used peer training to increase the social initiations and social responses of three students with autism (ages 7 to 10 years) during free play sessions with peers. These initiations and responses were both verbal and non-verbal. In contrast, Koegel et al. (2012) used peer tutoring to increase the engagement and unprompted verbal initiations of three students (ages 9 – 12) with their peers during lunchtime clubs based on the student's interest. The authors measured initiations which were on topic or related to the club activity. Whether off-topic initiations changed following the intervention is unknown. While these studies took place on school grounds, they were set in empty rooms and occurred in activities specifically designed for the intervention rather than within the context of the typical class program. This seems a frequently occurring practice, as a recent systematic review (Sutton et al. 2018) found that school-based social communication interventions targeting initiating and responding behaviors of students with autism were most often implemented in isolated areas of the school such as resource rooms or empty classrooms. Moreover, these interventions were generally implemented by researchers rather than school personnel, despite a general consensus that interventions targeting social communication should occur in the student's natural context, should utilize naturally occurring activities and materials to improve generalization (Bellini et al. 2007; Cowan & Allen, 2007; Gresham et al. 2001; Hansen et al. 2017), and should be implemented by individuals, such as teachers, who are endemic to the school (Licciardello et al. 2008).

Embedding interventions into the academic curriculum has been recommended as a means of integrating social communication goals within the classroom context (Anderson, 2000; Fenty et al. 2008; Francis et al. 2013; Hart & Whalon, 2011; Schoenfeld et al. 2008) However, to date, only a few studies have integrated social communication interventions

within academic instruction. In one study, Cheung et al. (2020) examined the use of a prompt fading technique, which was embedded in a math lesson at a special school, on three students' verbal requests for quantities of items. The intervention was implemented by a teacher at the school although she was not the student's class teacher. The intervention was effective in increasing the student's requesting within the designated task. However, the authors did not report whether these behaviors generalized to different communication partners or other contexts. Other studies have incorporated teaching of verbal initiating and responding behaviors into class-based academic instruction such as social studies (Dugan et al. 1995) and reading lessons in inclusive school settings (Kamps et al. 1994; Miller et al. 2011). These interventions were implemented by researchers in the classroom who did not address how the intervention could be implemented or sustained without researcher support. Taken together, this indicates a clear need for classroom-based research on social communication interventions for students with autism that can be implemented by people who typically work in classroom settings.

Considering the importance of social communication for participation in the classroom and peer interaction, this study investigated the impact of a classroom-based intervention on verbal initiating and responding behaviors of elementary school students with autism during classroom-based peer interactions. We evaluated whether teachers could be primarily responsible for implementing a classroom-based social communication intervention, known as *Social Stations*, and whether this intervention could positively impact both the frequency and quality of verbal initiations and responses used by students with autism to communicate with peers. We also asked the participant teachers to complete a rating scale to evaluate their perspective on the social validity of the intervention. The purpose of this study was to evaluate the impact of the *Social Stations* intervention,

implemented by teachers in the context of the class program, by asking two specific questions:

1. Does the *Social Stations intervention* change the frequency of on-topic verbal initiations and responses used by students with autism when conversing with their peers?

2. Does the *Social Stations intervention* change the frequency of off-topic responses used by students with autism when conversing with their peers?

Method

Participants

Ethical clearance was obtained from [name withheld for anonymous review (2015/25)].

Teachers

A total of four classroom teachers from an inclusive elementary school in [withheld], enrolled in the study following an information session provided by the researcher. These teachers taught across three classrooms (grades 1, 3, and 4) as two teachers' job-shared a single teaching position in the grade 4 classroom. All teachers were female and had a minimum of five years' teaching experience.

Students with Autism

The teachers were asked to select students who met the following criteria: a) verified by the [withheld] Education Department as meeting the criteria for autism spectrum disorder b) full-time attendance in an inclusive classroom, c) communicating verbally (in line with the study's focus). Information packages were sent home to eligible students and parents who were asked for consent for their child to participate in the study. Participants included three

male and two female students with autism (ages 6 to 9 years) who were enrolled in grades 1 - 4.

To describe the students' pragmatic language performance in a natural social setting prior to the intervention, the students' classroom teacher completed *The Pragmatic Language Skills Inventory (PLSI)* (Gilliam & Miller, 2006). The *PLSI* is a norm-referenced assessment for students aged 5 to 12 years and is designed to assess a student's pragmatic language skills in the areas of (a) personal interaction, (b) social interaction, and (c) classroom interaction. This assessment was selected, because it includes specific items that assess a student's ability to verbally initiate and respond to peers, such as initiating conversations, taking turns in conversation, introducing a topic, and participating in verbal exchanges with peers.

The core language subtests of the *Clinical Evaluation of Language Fundamentals – Fourth Edition, Australian Standardised Edition* (CELF-4; Semel et al. 2006) were administered by the first researcher, a certified practising speech language pathologist, to describe the participants' structural language skills. Table 1 provides an overview of the students' characteristics and assessment results. While two of the five students obtained core language scores in the average range (standard score range: 85-115), all five students had scores below 85 on the PLSI indicating poor (Mean: 70-79) or very poor (Mean <70) pragmatic skills.

(Insert Table 1)

Classroom Peers

The enrolled teachers also selected classroom peers to participate in the intervention. Teachers selected peers using criteria suggested by Sperry et al. (2010). These criteria state that peer models should: (a) exhibit good social, language, and age-appropriate play skills; (b) be well-liked by peers; (c) have a positive social interaction history with the focal child; (d) be generally compliant with adult directives; (e) be willing to participate; and (f) attend

school on a regular basis (Sperry et al. 2010, p.257). Consent was sought from the parents of these students with a total of 23 peers selected across the three classrooms. Each participant was matched with at least four peers to support generalization of skills (Brown & Odom, 1994).

Research Design

Experimental Design

A single case, multiple baseline across participants design was used to evaluate the effectiveness of the *Social Stations* intervention This design is appropriate for early stage effectiveness studies, as it can be adapted to suit the needs of the individual participant and setting (Bulkeley et al. 2013) and allows for detailed evaluation of responders and non-responders (Horner et al. 2016). Typically, in a multiple baseline study, the baseline would be staggered across each participant. However, in the *Social Station*s study, five participants were enrolled across three different classrooms. As peers would receive training as part of the intervention, the start of the baseline was staggered across the three classrooms or teachers.

The *Social Station*s study included teacher and student training, a baseline phase, intervention phase A (including iPad app), intervention phase B (withdrawal of iPad app) and generalization and maintenance checks (see Appendix A). The classroom teacher was responsible for implementing the baseline, intervention, and maintenance phases which were scheduled when other students in the classroom were participating in regular classroom activities. The researcher implemented the generalization checks which were administered in a quiet area away from the classroom. The researcher, an experienced speech language pathologist, was responsible for providing teacher training, modelling the intervention during structured teaching lessons, and collecting and analyzing the data.

Measures

Audio recordings of participants' conversations during all phases were recorded on an iPad. Data were collected for the first 10 minutes of each recording to measure the frequency of each social communication behavior. During the intervention phase, data were collected for every second intervention session. As the generalization probes and maintenance checks only involved two sessions each, data were collected for each of these sessions. To analyze session data, the researcher recorded a tally for each initiation and response which was on- or off-topic. The total number of tallies for each behavior was then divided by 10 to calculate the frequency of each behavior per minute e.g., initiations on-topic/min.

In addition, probes of the social communication behaviors of typically developing peers were undertaken. The purpose of these probes was to confirm that the students with autism differed from their peers in their verbal initiations and responding behaviors before the commencement of the intervention. For each student with autism, the teacher randomly chose two enrolled peers to talk together in a peer-peer dyad. A single recording of two peers in each class was obtained and frequency scores tallied following the same procedure as outlined above.

Statistical analysis

Intervention effects (change in frequency and quality of initiating and responding behaviors between baseline and intervention phase for each student) were analyzed using visual analysis and Tau-U analysis, as recommended by Vannest and Ninci (2015). Tau-U scores of up to 0.2 are interpreted as a small effect size, 0.2 to 0.6 as a moderate effect size, scores of 0.6 to 0.8 as a large effect size, and scores > 0.8 as a very large effect size (Vannest & Ninci, 2015).

Social validity

The teacher's perception of social validity of the *Social Station*s intervention was assessed using the *Behavior Intervention Rating Scale (BIRS)* (Elliott & Treuting, 1991). This scale measures the degree of acceptance of an intervention or procedure in a school setting and has been used in previous research to assess interventions for students with autism in school settings (Gibson et al. 2010; Radley et al. 2014). The *BIRS* consists of 24 statements, with the teacher required to rate each statement on a six-point Likert-type rating ranging from 1 (strongly disagree) to 5 (agree). In the current study, the four teachers' scores for each question were totaled, and an average score calculated.

Procedural Fidelity

Procedural fidelity checklists were developed for the teachers for each phase of the intervention and these checklists were kept on the wall next to the *Social Station*. The researcher observed one session at baseline and intervention for each participant and marked each item on the checklist with a score of Yes (1) or No (0) before calculating the total percentage of procedural fidelity. If fidelity was less than 90%, the researcher met with the teacher and the procedures were reviewed in the *Social Stations* manual. The fidelity measurement was subsequently repeated at the following session. Fidelity of 90% or greater was considered acceptable.

Procedure

Baseline

During baseline, the teacher directed each student with autism and a peer to find a table anywhere in the classroom and instructed the students to talk together for 10 minutes about three books which had been pre-selected by the student and peer. These conversations were recorded on an iPad and were subsequently reviewed by the first researcher to measure how frequently the students verbally initiated and responded either on- or off-topic and to

observe baseline trend. The definitions of these behaviors were based on those used in

previous studies of social communication in school settings (Delano & Snell, 2006; Hanley-

Hochdorfer et al. 2010; Shabani et al. 2002; Whalon et al. 2015) and are described in Table 2.

Originally, the researcher intended to measure responses both on- and off-topic. However, at

baseline, only one participant, responded off-topic, but did so at a low frequency. All other

students either responded on-topic or not at all. Thus, data collection for responses off-topic

were discontinued. A stable baseline was obtained for each participant ranging from five to

nine baseline sessions.

(Insert Table 2)

Social Stations intervention

Social Stations is a manualized intervention (please contact the lead author to request

access to the manual), designed to be implemented by the classroom teacher during literacy

lessons. The *Social Station* consists of a table and two chairs located in a quiet area of the

classroom (see Figure 1). The materials utilized in the study are detailed in Appendix B. The

materials included the *Social Station*, books, video models, iPad and apps and a visual cue

card and movie cards. In the classroom the *Social Stations* incorporates a combination of

evidence-based elements including peer-mediated intervention, video modeling, visual

prompts, and technology-aided instruction (Hume et al. 2021). The *Social Station* provides

opportunities for students with autism and peers to engage in structured social

communication exchange about books. A student with autism and a peer sat at the *Social

Station* and engaged with a commercially available iPad app (*Puppet Pals*) (Polished Play

LLC, 2015). *Puppet Pals* is a gaming app that enables users to create an animation of a

puppet show with puppets moving around on a stage. Using the *Puppet Pals* iPad game,

students and peers were able to manipulate digital puppets, which are located on a stage, to

enact dialogue. Photos of books were uploaded to create the stage backdrop providing a further stimulus for conversation via the digital puppets.

(Insert Figure 1)

Teacher and Student Training

The four classroom teachers attended three teacher training sessions with the researcher occurring before baseline, intervention A and intervention B for a total of 120 minutes. All sessions occurred in the teacher's classroom before school or during breaks. The baseline training session outlined the baseline procedures and lasted 30 minutes. During the intervention training, teachers received direct instruction in the use of the intervention, engaged in role play, and were provided with feedback.

Teachers were then asked to explain *Social Stations* to the whole class and to demonstrate the *Puppet Pals* app using two video models, which were screened across two different days. Participating students and peers attended two structured teaching lessons (45 minutes) in which they familiarized themselves with the materials, practiced the intervention and received feedback from the researcher and classroom teacher. These lessons took place during regular class times when teacher aides or the head of special education was available to support non-participating students. The researcher attended the first lesson to model the steps in the intervention, to check for fidelity and provide feedback and support to the teacher.

Intervention A

The intervention was implemented for each participant during 30, 10-minute *Social Stations* sessions over a two-month period. In the first intervention phase (A), students utilized both the *Puppet Pals* app on the iPad and the visual prompt. In the second intervention phase (B), the iPad was withdrawn to determine if students would continue to utilise targeted social communication behaviors to engage with peers using only visual

prompts (see Appendix C). It was felt that this intervention phase would most closely resemble natural classroom activities, and that visual prompts could be displayed on an ongoing basis.

During the first intervention phase (A), each student with autism and a peer was directed by their teacher to select three books and move to the *Social Station*. The students set up the *Puppet Pals* app for the session, then talked to each other about the three books for a total of 10 minutes while moving their puppets on the screen. The puppets served as a temporal support to show students when it was their turn to initiate or respond. Conversations were recorded as students played with *Puppet Pals*. Each student with autism and peer participated in 20 sessions during intervention A.

Intervention B

The second phase of intervention (B) was conducted in the same fashion as the first phase, with the exception that the students did not use the puppets to act out their conversation, using only the visual cue card as a prompt. In this phase, the students and peers used three books as stimulus, changing them every three minutes. (See Appendix D). All five students with autism and their peers engaged in intervention B for 10 sessions over a five-week period.

Generalization Across Topic

Generalization checks were included to assess whether the effects of the intervention would generalize or transfer to a new topic once the intervention and cue card was withdrawn. During generalization, students and peers were taken to an empty area of the school and asked to talk together about movies using movie cards. Informal discussion with students in grades 1 to 4 led to a list of 12 movies which were represented by pictures on movie cards. Generalization checks were completed at 2 to 4 weeks post-intervention.

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Maintenance Checks

A check occurred at least two months post-intervention (range 8 to 12 weeks) to determine if students with autism had maintained their initiating and responding behaviors. These sessions replicated the baseline conditions with three books used as the topic of conversation. Consistent with baseline, students sat at any table in the classroom and discussed three books that had been selected by the students. The *Puppet Pals* app and cue card were not available in this phase. Students were asked to talk together for 10 minutes about the three books. The teacher gave no other instructions during the maintenance sessions. Each student completed two maintenance checks over a two-week period.

Results

Initiations On and Off-topic

As shown in Table 3 (and visually displayed in Figure 2), for four students (AK, CM, NB, TD) the intervention resulted in significant increases in initiations on-topic/min by the end of intervention B, with large to very large effect sizes. During intervention B, following the removal of the *Puppet Pals* app, these four students' frequency of initiations on-topic/min continued to increase. The fifth student, CR demonstrated a different pattern of initiations, exhibiting higher frequency of initiations on-topic at baseline (4.8 initiations/min) than his classroom peers (3.0 initiations/min). During intervention A, he demonstrated a rapid decrease in this behavior, which stabilized during intervention B. Although non-significant (p =.34), the intervention had a positive result for CR as it reduced his frequency of initiating, with a small to moderate effect size (0.29). All students maintained changes in frequency of on-topic initiations when talking about a new topic during generalization probes; the average frequency of initiating on-topic was stable for all five participants across the two maintenance probes (m- 2.7 – 2.9 initiations on-topic/min).

(Insert Table 3)

(Insert Figure 2)

In intervention A, all five students reduced their frequency of initiations off-topic/min (m < 0.3), which decreased further (m= 0.0) in intervention B (Figure 4). A slight increase was noted at maintenance checkpoints (m = 0.1 initiations off-topic/min). As mentioned previously, CR demonstrated a different pattern of behaviors at baseline. During intervention, his initiations off-topic decreased, with a moderate, but non-significant (p =.20), effect size (0.39). The remaining four students reduced their initiations off-topic significantly *(p <.001 – .012)* with large to very large effect sizes – (0.71 to 0.88).

(Insert Figure 3)

Responses on-topic

All five students demonstrated significant increases in their frequency of responses on-topic, with large to very large effect sizes (0.69 to 1.03). In intervention A, their frequency of responses on-topic/min increased from 1.2 to 2.3 responses/min. In intervention B, responses on-topic/min continued to increase to a mean of 3.1 across the five students (Figure 3). These responses stabilized during the generalization phase but decreased to 2.8 responses on-topic/min in the maintenance phase.

(Insert Figure 4)

Procedural Fidelity

Five fidelity checks were completed for each student with autism. A total of 23 of the 25 fidelity checks were rated as achieving 100% fidelity. TD's teacher was struggling to give students appropriate feedback during the pre-intervention structured teaching session. This resulted in a score of 75% fidelity. The researcher modelled giving feedback to the student and the fidelity checklist was repeated at a second structured session with 100% fidelity. Student NB appeared distracted during the iPad intervention session and was playing with the

characters in the iPad app. His teacher observed this and reminded him to stay on task. The fidelity checklist was then repeated at the following session and NB achieved 100% fidelity.

Reliability

To determine reliability of frequency data, two speech language pathology students listened to the recordings and independently rated at least 20% of sessions, selected at random, for each participant across the four intervention phases. A Krippendorff alpha coefficient was calculated to compare the agreement between the frequency calculations of the researcher and the two students (Krippendorff, 2013). Results revealed high levels of inter-observer agreement for all dependent variables: initiations on-topic (0.99), initiations off-topic (0.98) and responses on-topic (0.98).

Social Validity

Overall, the teachers indicated that *Social Stations* intervention was a socially valid intervention for teaching social communication behaviors, reflected in a mean score of 4.84 (range 4.75 - 5) on the *BIRS* across 24 questions. The only statement that received a rating of "slightly disagree" was "The intervention should produce enough improvement in the student's social communication skills so that these skills are no longer a problem in the classroom". The two teachers who rated this low both worked part time in the same classroom. The two participant students with autism in their classroom had several challenging behaviors but improved their social communication behaviors following the intervention. These students' challenging behaviors not targeted by the intervention may have accounted for these teachers' low rating on the *BIRS* for this statement.

Discussion

The current study is one of the first to investigate the effectiveness of a social communication intervention, implemented by teachers, as part of the literacy curriculum. The

purpose of this study was to investigate if the *Social Stations* intervention results in positive changes in the frequency and quality of verbal initiating and responding behaviors of school-age students with autism. Of the five students, four significantly increased their frequency of verbal initiations following the intervention, with large to very large effect sizes, while all five students increased the frequency of responses following interventions. In addition, all five students reduced their off-topic initiations significantly with a large to very large effect size and all changes were maintained two months later. Results from the social validity rating scales indicated that teachers felt the intervention was socially valid for teaching social communication to their students with autism. These findings suggest that classroom-based interventions can have a significant impact on the social communication behaviors of students with autism, particularly as they interact with peers in their class.

At baseline one student demonstrated on-topic initiations at a fairly high frequency and almost no off-topic responses were recorded for any student. These findings underscore the importance of measuring social communication behaviors before intervention. Interestingly, a review of the literature on social communication interventions (Sutton et al. 2018) found that most studies employed in schools provided only anecdotal descriptions of the social communication skills of the participant students with autism. Given the spectrum of abilities of students with autism, it is vital that the unique social communication profile demonstrated by individual students is determined prior to interpreting the results of an intervention.

The classroom is an underutilized setting for social communication interventions for students with autism (Sutton et al. 2018). The *Social Stations* intervention was developed to be implemented by the classroom teacher in the student's natural social setting (the classroom) during academic instruction (literacy lessons) and include materials that are naturally available in the classroom (iPad, books, and visual supports). The results from the

current study add to the emerging evidence for embedding social and communication goals into the academic program (Francis et al. 2013). The *Social Stations* intervention requires little additional effort on the part of the teacher and can be easily embedded into the typical school routine. The evidence from this study suggests that teachers can implement strategies that will improve social communication behaviors of students with autism in the classroom while pursuing curriculum objectives.

Implications for Practice

The findings from this study suggest that classroom teachers can successfully implement social communication interventions as part of their usual program. Moreover, the teachers reported that the intervention was socially valid, an important consideration for teachers and school leaders when choosing an intervention (Callahan et al. 2008). As this study was set in a real-world setting, fidelity of implementation was particularly important (Chang & Locke, 2016). This study has shown that teachers can autonomously implement a social communication intervention with fidelity.

Importantly, this study has shown that teachers can implement a social communication intervention with positive effects, with modest training and support from a speech language pathologist. The evidence from this study suggests that teachers and therapists can work together to adopt strategies that will improve social communication behaviors of students with autism in the classroom without distracting from curriculum objectives. Successful collaboration between teachers and therapists requires school administrators to provide the necessary time and resources. School leadership will also need to consider providing additional non-contact time for teachers to meet with therapists and for staff to receive training on social communication as well as strategies for embedding interventions into academics.

The results from this study highlight the effectiveness of the *Social Stations* intervention regardless of the students' language ability (as measured using a standardized language assessment). Furthermore, they emphasize the importance of measuring the frequency of verbal initiations and responses in students with autism prior to intervention. As shown in Table 1, three of the five students demonstrated a severe language disorder, which did not seem to be related to their frequency of verbal initiations. To illustrate, it was expected that the two students with average language abilities in this study, CR and CM, would be over-initiators as this has been previously suggested in the literature (Adams et al., 2002; Bauminger et al., 2003). However, while CR was an over-initiator, CM was not. The specific reason for this difference was not clear from the present study, but the findings clearly suggest speech pathologists need to go beyond standardized language testing and carefully appraise the frequency of verbal initiations and responses in all students with autism they assess in their schools.

Limitations and Future Research

Despite the positive findings in this study, there are several limitations that should be noted. *Social Stations* is a multi-component intervention that combines peer-mediated intervention and child-specific interventions (using technology, video modelling, and a cue card). Due to the complexity of the intervention, it is not known whether one component alone or all components in combination contributed to the results. Further research will be needed to unpack the 'active' ingredients of the intervention. One suggestion would be to utilize a comparative group design in which one group utilized the full *Social Stations* intervention with the video models, *Puppet Pals* program and visual prompts, while another group used only the video models and visual prompts.

The current study included only a small number of teachers and students. Although findings strongly support the effectiveness of the *Social Stations* intervention in increasing

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social communication behaviors, more research is needed to determine if this finding would translate to other students and generalize to other settings (e.g., playground or home). In addition, none of the examiners completing the assessments were blind to the purpose of the study or to the students' progress through the phases of the intervention. This could have introduced experimenter bias, which occurs when the outcomes of research could be unduly influenced by the expectations of the person evaluating the outcomes (Creswell, 2012).

Finally, maintenance results must be interpreted with caution, as maintenance probes were recorded in the classroom using books as the conversational topic. These contrived conversations may not represent the typical conversation of the students with autism away from a structured setting. Therefore, future research should investigate if intervention changes can generalize to other topics and in other settings such as the playground or during lunch time.

Conclusion

This study provides preliminary evidence for the effectiveness of the *Social Stations* intervention to improve the social communication behaviors of initiating and responding in primary school-aged students with autism, regardless of their language ability. Importantly, this study has shown that teachers can autonomously implement a social communication intervention in their classroom as part during an academic activity, with support from a speech language pathologist. The lessons learned from this study paint a positive picture for the future of teacher implemented social communication interventions within the regular classroom setting. Considering the value of social communication to the development of social interactions between peers, this research is an important first step towards embedding social communication interventions in the naturalistic classroom setting.

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    2373-1

Appendix A The phases of the *Social Stations* study

Phase	Description	Length of session (number)
Teacher training on the baseline phase.	Researcher provided training on giving instructions to students and recording the conversation using *Audio Memos* app.	30 mins (1 per classroom)
Baseline for students with autism	A student with autism and a peer chooses 3 books and are instructed to talk about these books together. Their conversations are recorded on the iPad.	10 mins (5 – 9 per student with autism)
Baseline for peers	Two enrolled peers choose 3 books and are instructed to talk about these books together. Their conversations are recorded on the iPad.	10 mins (1 per classroom)
Teacher training on intervention A	Researcher provided training on whole class instruction (videos and brief explanation) and intervention A.	60 mins (1 per classroom)
Whole class introduction	Teachers briefly explained that the *Social Stations* intervention and showed the two video models to the whole class.	10 mins (Each video viewed twice per classroom)

Structured teaching session	The teacher conducted structured teaching sessions at the *Social Station* for students with autism and peers. Sessions included modelling, practice, and feedback to the students. The researcher attended the first session.	45 mins (2 per classroom)
Teacher training on intervention S	Researcher provided training on intervention A.	30 mins (1 per classroom)
Intervention A (*Puppet Pals* and cue card)	The students with autism and their peers talk about three books while playing *Puppet Pals*. Teachers provide instruction on the social communication strategy. This strategy is provided on a cue card.	10 mins (30 per student with autism)
Teacher training	Researcher provided training on intervention B.	30 mins (per teacher)
Intervention B (cue card only)	A student with autism and a peer chooses 3 books and talks about these books at the *Social Station*. The teacher reminds the students of the communication strategy and the cue card is available.	10 mins (10 per student with autism)
Generalization checks	A student with autism and a peer talked together in an empty classroom/corridor about movies. Pictures of twelve children's movies were available to prompt discussion.	10 mins (2 per student with autism)

Maintenance checks	A student with autism and a peer chooses 3 books and are instructed to talk about these books together. Their conversations are recorded on the iPad.	10 mins (2 per student with autism)

Appendix B The materials included in the *Social Stations* intervention**.**

Materials	Description
Social Station	A table and two chairs positioned in a quiet area of the classroom.
Books	Books familiar to the students and available in the classroom.
iPad	The classroom iPad was used throughout the study.
Audio Memos app	A voice recording app.
Video models[2]	Video 1 provides instructions on the use of the *Puppet Pals* app.
	Video 2 provides instructions on the social communication strategy. This is to "Make comments to your friend about the book" and "Comment back to your friend about what they say".
	These video models are available on YouTube.
	https://www.youtube.com/watch?v=T8Le3BzwQSo
	https://www.youtube.com/watch?v=3cUI6j2hMPI&t=36s
Puppet Pals app	A gaming app that shows a virtual puppet theatre. Students choose puppets that they can move around on stage. Students record their voice on the app as they play the game.
Cue card	A laminated card with graphics and text. The cue card is a visual prompt to remind students of the social communication strategy.
Movie cards	Cards showing photos of twelve movies used for generalization probes.

Appendix C The steps in intervention A.

1. The student with autism and a peer chooses three books from the classroom then sit with the books at the *Social Station*.

2. The students put the books and the iPad between them.

3. The teacher places the cue card on the top of the iPad.

4. The teacher instructs the students to "Make comments to your friend about the book" and "Comment back to your friend about what they say".

5. The students open the *Puppet Pals* app.

6. Each student selects a *Puppet Pals* puppet for the session.

7. The background picture in the *Puppet Pals* app can be changed by pulling down on the gold tassels. Students take a photo of each of the three books and select these photos as the background for their recording.

8. Students press the start button and begin having a conversation about the book using the *Puppet Pals* app.

9. Each student takes turns to speak while moving their puppet on the screen.

10. At around the three-minute mark, the students pull down the gold tassel at the top of the screen and another book cover appears. Students would continue talking about the second book.

11. At around the six-minute mark, the students would pull the gold tassel down again and talk about the third book.

12. When the 10-minute recording is completed, the students saved their names and the date of their recording onto the *Puppet Pals* app.

Appendix D The steps in intervention B.

1. The student with autism and a peer chose three books from the classroom then sit with the books at the *Social Station*.

2. The students put the books between them.

3. The teacher places the cue card on the table.

4. The teacher instructs the students to "Make comments to your friend about the book" and "Comment back to your friend about what they say".

5. The teacher begins the recording of the student's conversation on the *Audio Memos* app on the iPad.

6. When the 10-minute recording is completed, the students saved their names and the date of their recording onto the *Audio Memos* app.

Figure Caption Sheet

Figure 1. The positioning of materials at the *Social Station* during intervention A

Figure 2. Initiations on-topic per minute across phases for all students with autism

Figure 3. Initiations off-topic per minute across phases for all students with autism

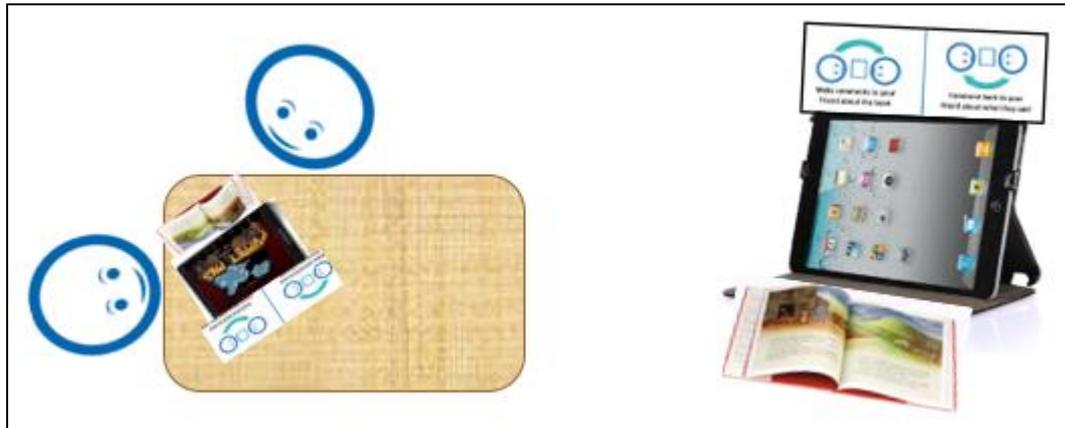*Figure 4.* Responses on-topic per minute across phases for all students with autism

Figure 1 The positioning of materials at the *Social Station* during intervention A
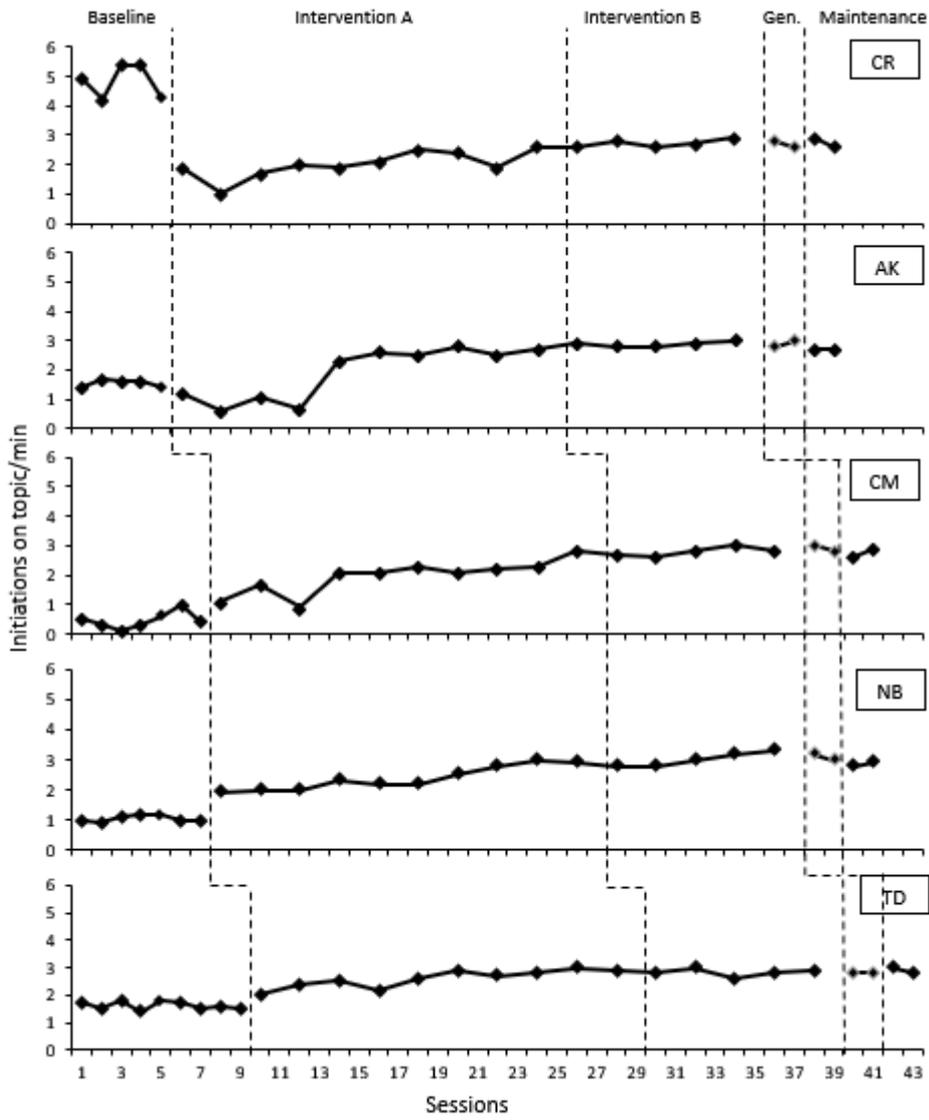
Figure 2 Initiations on-topic per minute across phases for students with autism
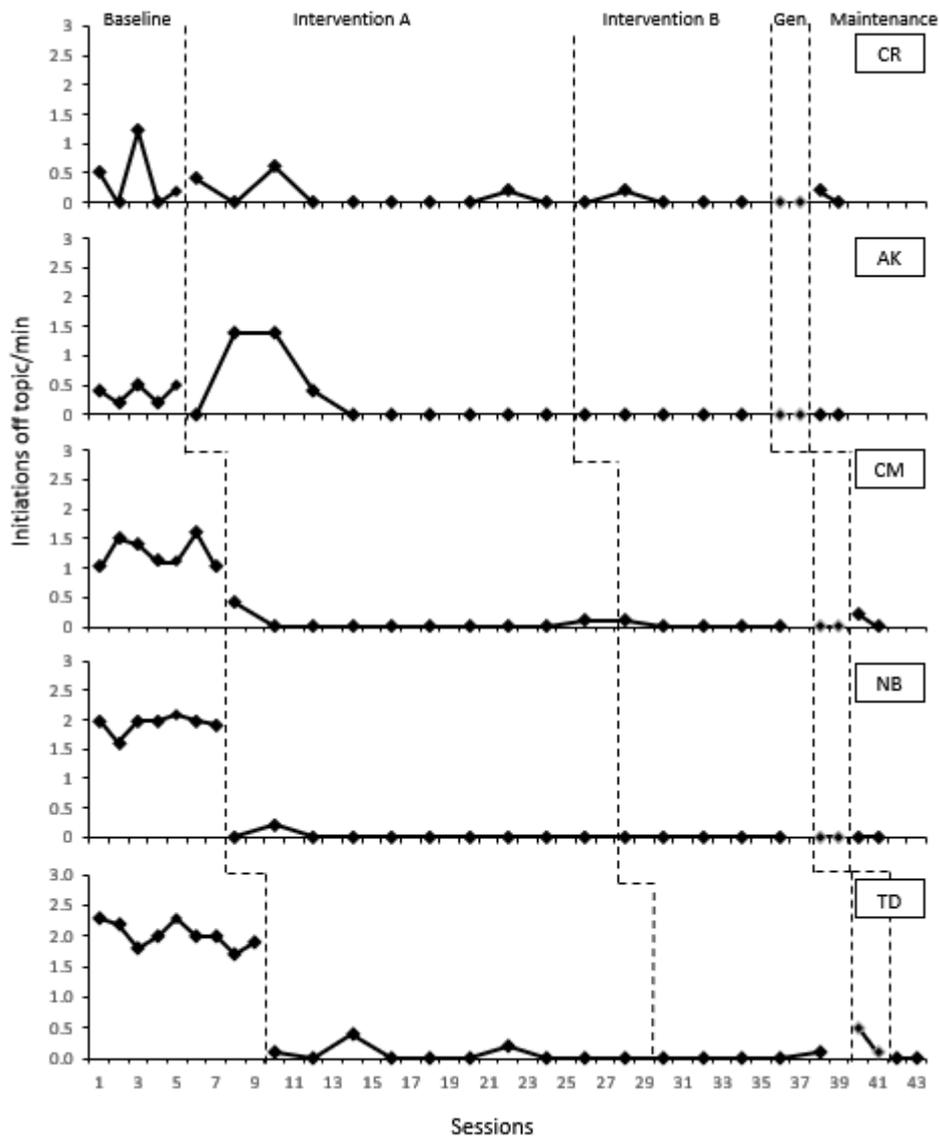
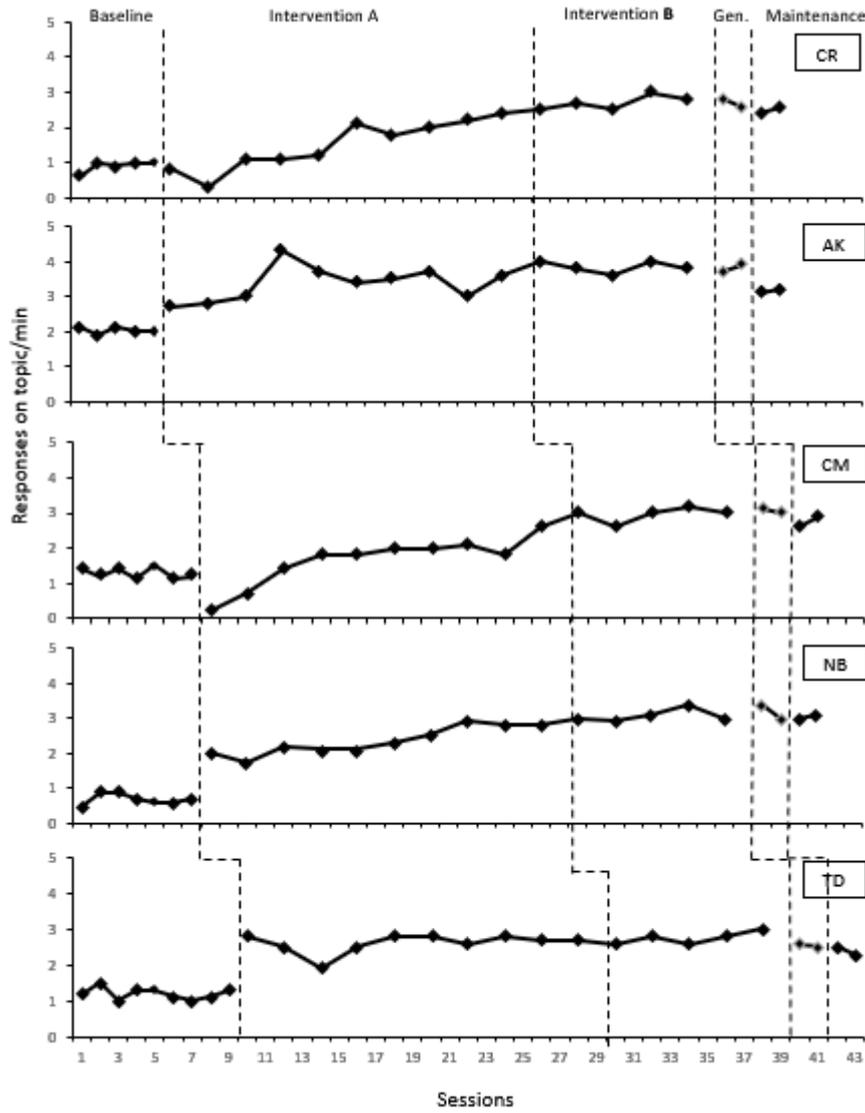**Figure 3** Initiations off topic per minute across phases for all students with autism

Figure 4 Responses on-topic per minute across phases for all students with autism

Table 1. Participant characteristics and assessment results

Student	Gender	Age	Grade	CELF Core language score (interpretation)	PLSI Pragmatic language index (descriptive rating)
CM	Male	6	1	102 (average)	74 (poor)
NB	Male	6	1	44 (severe disorder)	71 (very poor)
TD	Female	9	3	48 (severe disorder)	76 (poor)
AK	Female	9	4	55 (severe disorder)	62 (very poor)
CR	Male	9	4	98 (average)	78 (poor)

Note. CELF: Clinical Evaluations of Language Fundamentals, 4th Edition (Semel et al. 2006), standard scores; PLSI: Pragmatic Language Skills Inventory (Gilliam & Miller, 2006), standard scores.

Table 2. The social communication behaviors measured in the study

Social communication behavior	Definition
Verbal initiations on-topic	An independent verbal communication directed to a peer that discussed the current topic. These initiations did not include (a) imitation of peers, (b) a contingent response to a peer's utterance, or (c) an answer to a question. An initiation could comprise of one or more utterances.
Verbal initiations off-topic	An independent verbal communication directed to a peer that did not discuss the current topic. These initiations did not include (a) imitation of peers, (b) a contingent response to a peer's utterance, or (c) an answer to a question. An initiation could comprise of one or more utterances.
Verbal responses on-topic	A verbal communication to a peer that was contingent on the peer's previous utterance and is on the current topic. A response could comprise of one or more utterances.
Verbal responses off-topic	A verbal communication to a peer that is related to the peer's previous utterance but does not discuss the current topic. A response could comprise of one or more utterances.

Table 3. Evaluation of change in communication behaviors from baseline to intervention

Participant behaviors	Baseline average	Peers baseline average	Change following intervention A and B		
			p value	Change	Tau-U
Initiations					
CR	4.8	3.0	.34	Decrease	0.29
AK	1.5	4.1	.026*	Increase	0.68
CM	0.5	3.5	< .001*	Increase	1.00
NB	1.1	3.2	< .001*	Increase	1.02
TD	1.6	4.0	.001*	Increase	1.00
Mean (SD)	1.9 (1.7)	3.5 (0.5)			
Initiations off-topic					
CR	0.4	0.1	.20	Decrease	-0.39
AK	0.4	0.0	.012*	Decrease	-0.71
CM	1.2	0.0	< .001*	Decrease	-1.00
NB	1.9	0.0	< .001*	Decrease	-1.01
TD	2.0	0.0	.004*	Decrease	0.88
Mean (SD)	1.2 (0.8)	0.0 (0.0)			
Responses on-topic					
CR	0.8	4.6	.01*	Increase	0.78
AK	2.0	4.7	< .001*	Increase	1.03
CM	1.3	4.6	.01*	Increase	0.69
NB	0.7	4.6	< .001*	Increase	1.02
TD	1.2	5.0	< .001*	Increase	1.00
Mean (SD)	1.2 (0.5)	4.7 (0.2)			

*Note: *significant treatment effect*