The Use of a Robot to Teach Social Skills to Children with Characteristics of Autism Spectrum Disorder in a School Setting

By

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Dedication

To my parents, thank you for all the guidance and endless support that you both have given me and for encouraging me to strive and achieve my goals. Thank you for supporting me in the decisions that I have made towards my future.

To my brother, thank you for your endless support and for believing in me.

To my dog Max, thank you for giving me endless cuddles and for staying beside me over the past 4 years.

To my grandparents, thank you for all your support, for encouraging me to do the best I can, and for pushing me to succeed.

To my boyfriend Matthew, thank you for all your support over the last 4 years. It has been greatly appreciated.

“An investment in knowledge always pays the best interest.”

- Benjamin Franklin
Abstract

The use of social robots to teach social skills to those who have or display symptoms of autism spectrum disorder is being evaluated and compared to a human teaching those same skills. This study sought to investigate how social skills can be effectively taught with two individuals and how the use of technology in the form of a robot can be used to deliver lessons on social skills when compared to a human delivering the same lessons. Two participants were given the opportunity to learn two social skills: greetings and leave-taking. The first participant was taught greetings by the robot (Milo) and the second participant was taught leave-taking by the human. The conditions were then switched such that the human taught participant one leave-taking and Milo taught participant two greetings. The sessions took place twice a week at an elementary school from 20 to 45 minutes each. It was hypothesized that the participants would have an increase in correct responses when asked questions regarding greetings and leave-taking skills in the robot condition compared to the human condition. This was measured by averaging the percentage of correct responses of the participants under both conditions and comparing results by the mean, median, and standard deviation. Overall, the hypothesis was supported. The participant showed an increase in correct responses in the robot condition compared to the human condition. The results of this study suggested that the use of robots to teach social skills is slightly more beneficial to those with or who display characteristics of ASD compared to a human teaching the same skills. However, limitations such as participant attendance and inconsistence between both conditions occurred in the study. Therefore, more research is needed in this area as the results were not statistically significant. Further studies should examine using larger sample sizes so that the results can be generalized to a larger number of participants and to ensure that the skills being taught can be generalized to the classroom and to social situations.
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The Use of a Robot to Teach Social Skills to Children with Characteristics of Autism Spectrum Disorder in a School Setting

Chapter I: Introduction

Background Information

Autism spectrum disorder (ASD) is currently the second most common developmental disability in the United States (Phillips, Minjarez, Mercier, Feinstein, & Hardan, 2011). This disorder causes deficits in communication, social interactions, and causes the individual to engage in repetitive behaviours (Phillips et al., 2011). Autism is becoming more common as the number of diagnoses increase each year (Phillips et al., 2011). With this disorder increasing immensely and with more research needing to be conducted on this disorder, it is leaving families who have recently received a diagnosis with little direction as to where to go after receiving the diagnosis (Phillips et al., 2011). Having a child with autism can make it difficult for families to make decisions as to what programs, medications, and therapies they should send their loved one to in order to address the deficits associated with this disorder. Since social interactions is an area that is impacted by this disorder, most individuals throughout their school years have trouble socializing and communicating with peers and teachers (Phillips et al., 2011). Social skills deficits often result in decreased academic performance, presents as a barrier to learning, results in making it difficult for the individual to establish and maintain friends, and more (Phillips et al., 2011). Previous programs and technologies have been implemented with individuals with ASD to try to see what best works to address these deficits (Phillips et al., 2011).

Various technologies have been studied to see whether children with ASD benefit from using them for learning social skills, daily living skills, and much more. A newer technology that is still being investigated is the use of robots to aid with social skills for individuals who have ASD. Research has shown that those who have ASD seem to connect better with the robot and show more interest in robots compared to humans (Begum, Serna, & Yanco, 2016). There are different types of robots that have been studied with individuals with ASD and most of the studies have shown an increase in social skills when taught by a robot over a human (Begum et al., 2016). Children who have a diagnosis of ASD seem to show behaviours towards robots that typically developing children show towards human interactions (Pennisi et al., 2016). When children who have ASD engage with robots, a reduction in less desirable behaviours and an increase in socially acceptable behaviours occurs (Pennisi et al., 2016). Using robots as a means of communicating with those who have ASD, aids with building connections and understanding those individuals better (Pennisi et al., 2016).

As stated above, social skills are a key area that is affected by ASD (Phillips et al., 2011). Therefore, having a way to teach children social skills effectively is important. Robots that teach social skills have been the new focus for this population as more and more studies involving ASD and social skills have increased (Diehl et al., 2012). Robots can teach social skills to children, have them practice those skills with the robot, and then prompt them to generalize those skills to others. These robots can also focus on areas where the child might need to specifically work on, such as greetings, leave-taking skills, etc., whereas teachers who teach social skills in the classroom environment might have a set curriculum that might not be individualized (Diehl et al., 2012). Diehl et al. (2012) examined past studies involving the use of social robots with children who have ASD and found that most of the studies conducted concluded that children benefited from being taught social skills from a robot compared to a human.
Rationale

Despite the positive correlations associated with robots teaching social skills to children who display characteristics of ASD, there is little research regarding this topic. Research is lacking in the areas of technology, such as comparing the use of robots to teach social skills and a human teaching social skills, as well as there is a lack of the generalization, and maintenance procedures in the research as well as sample sizes. The purpose of this research study is to see whether social skills can be taught more effectively through the use of a robot when compared to a human to children who display characteristics of ASD and whether those skills can be generalized and maintained effectively. In a review of the literature, Sartorato, Przybylowski, and Sarko (2017) mentioned that social robots may be beneficial as they provide a simplified version of human interactions. Therefore, it is hypothesized that there will be an increase in social skills taught by the robot versus the human as well as an increase in those skills being generalized and maintained to different settings and to different people.

Thesis Overview

This study consists of an introduction, literature review, methods, results, and discussion and conclusion section. More specifically, the literature review summarizes past and current research regarding the topic and is used to identify gaps in previous research studies. The methods section provides information regarding participants, research design, setting, apparatus, measures, and procedures. The fourth chapter, which is the results section will state the intervention results of the research study. Finally, the last chapter, the discussion and conclusion will touch on limitations, findings, areas for further research, and contributions to the field. Throughout these chapters, the thesis will provide information on the use of a robot versus a human to teach social skills to two individuals who display characteristics of ASD.

Chapter II: Literature Review

There have been some studies conducted on the use of technology to teach social skills to those with ASD. The focus of the study conducted by Yun, Choi, Park, Bong, and Yoo (2017) was to examine the effectiveness of a robot designed intervention for children with autism to teach social skills, specifically eye contact and facial emotion recognition. For the study, Yun et al. (2017) recruited children with autism and assigned them to one of two groups: a treatment group or a control group. The participants in the treatment group received social skills training from the robot and the control group received their training from a teacher (Yun et al., 2017). Both groups were taught the social skills modules in the exact same way by starting with the training element query module and ending with the follow-up action module. Both groups received the modules in the same sequence and with the same script. Results revealed there were similar positive outcomes on the acquisition of social skills when having a robot or a human teach these skills. After the intervention was put in place, the results (p> 0.05) demonstrated that there were similarities between the group receiving instruction from the robot and the teacher (Yun et al., 2017). Yun et al. (2017) concluded that robots might be useful when it comes to teaching social skills to individuals who have autism spectrum disorder because the results did show a slight increase in the use of social skills when children were given the chance to use those skills with a robot compared to other conditions in the study, such as using the skills with a
human. Even though the results were similar, the participants showed a slight preference towards the use of robots. This study has provided results that show that robots could potentially be useful; however, more research is needed to make stronger conclusions.

A literature review conducted by Sartorato, Przybylowski, and Sarko (2017) examined the effects of robots being used to teach social skills to children with ASD. Sartorato et al. (2017) mentioned that the use of robots to teach social skills is increasing. However, the research behind robots teaching social skills is limited and therefore, the benefits are unknown (Sartorato et al., 2017). In this review of the literature, Sartorato et al. (2017) stated that social robot interactions may provide benefits because the experience is a simplified version of human social interactions. Sartorato et al. (2017) concluded that children with ASD tend to be more interested in technology and children often interact with robots as their peers more so than real people; although, there is still more research needed regarding children with autism and robots teaching them social skills (Sartorato et al., 2017).

Similarly, Kim et al. (2013) examined social behaviours of children with ASD during three different interactions: between a human, a computer game, or a robot and the participants were taught social skills under these conditions. The condition with a human was when the human was teaching social interactions to the participants (Kim et al., 2013). The computer game and robot conditions taught the same social skills as the human conditions except these were taught using a computer and a robot (Kim et al., 2013). The results were compared between the three conditions and the authors found that when the children were paired with a robot, their social interactions increased as there was more talking (M= 29.5) over the other two interactions (human (M= 25.5) and computer game (M= 20.5). Kim et al. (2013) stated that social skills training with the use of robots for children with ASD may be beneficial, but they too noted that more research is needed in this area.

Amran, Gunasekaran, and Mahmoud (2018) conducted a review of the literature on the efficiency of using robots to aid with teaching social skills to children who have a diagnosis of ASD. This review paper consisted of examining five studies that looked at the use of robots for children with ASD and comparing each of the studies results (Amran et al., 2018). The first study that Amran et al. (2018) reviewed was conducted by Wainer (as cited in Amran et al., 2018). The focus of Wainer’s (as cited in Amran et al., 2018) study was to see the difference with eye contact made with the robot versus a human for those with a diagnosis of ASD. Wainer (as cited in Amran et al., 2018) mentioned that both eye contact with the human and the robot counted as eye contact. Wainer (as cited in Amran et al., 2018) stated that the children with ASD made more eye contact with the robot (28.32%) versus a human (4.95%). The second study was conducted by Kim (as cited in Amran et al., 2018) and focused on interactions with robots for children who have ASD. Kim (as cited in Amran et al., 2018) found that the individuals who had ASD interacted more with the robot (45 utterances) compared with any other interaction provided (human, etc.). The third study was conducted by Dunst (as cited in Amran et al., 2018), which examined social skills using a robot. The results of Dunst’s (as cited in Amran et al., 2018) study showed that the robot had 13 (mean of scores), which was the highest mean score regarding practicing social skills with the robot. The fourth study examined imitation with a robot and found that 61% of the children who had a diagnosis of ASD imitated the robot (Anzalone, 2011; as cited in Amran et al., 2018). The fifth study also investigated imitations with a robot for children who have ASD and the authors noted that the children were able to imitate the robot’s movements easier than other methods. Overall, this review of previous studies showed that children with ASD benefited from using robots compared to other methods of
teaching a variety of skills (Amran et al., 2018). In contrast, Amran et al. (2018) to the above literature review concluded that more research is still needed in this area. A longitudinal study was conducted by Robins, Dautenhahn, Boekhorst, and Billard (2005) examining four children with ASD and their interactions with different humanoid robots versus humans. Robins et al. (2005) gathered all of the recordings of each child’s interactions with the robots and with other humans and completed a quantitative and qualitative analysis. Each child was given an opportunity to interact with two different robots during the study (Robins et al., 2005). Both robots had different appearances, which helped with the children being able to generalize social skills between robots (Robins et al., 2005). This is an important piece as generalization of social skills is the aim of most studies. The results of the qualitative data showed an increase in social interaction skills, such as imitation and turn-taking more so with the robot than with other humans; similarly, the quantitative data showed an increase in the duration of these social skills being used with the robot (Robins et al., 2005).

A study conducted by Huskens, Verschuur, Gillesen, Didden, and Barakova (2013) focused on the effectiveness of an applied behaviour analysis intervention in a day treatment program that occurred twice a week for six children with ASD, in which they were being taught by a robot and by a human. The participants had to meet the following criteria in order to be selected for this study: have a diagnosis of ASD, be between 8 to 14 years of age, have an IQ above 80, could not initiate questions, be able to participate for the entire study, and worked well with robots (Huskens et al., 2013). The teaching sessions took place within the day treatment facility or within the children’s school. The children were then split randomly between two experimental groups: the robot group or the human group and then they switched groups so that all six participants had a chance to receive an intervention from the robot and the human (Huskens et al., 2013). During the study, the participants focused on asking questions and this was done by the robot or human giving examples, opportunities, and prompting the participants to get them to initiate question asking (Huskens et al., 2013). Huskens et al. (2013) stated that the results for both the robot group (p < 0.02) and the human trainer group (p < 0.02) increased. Huskens et al. (2013) noted that all six participants showed an overall increase with initiating questions from both groups. Since there was not a clinically significant difference between groups more research is needed in this area (Huskens et al., 2013).

Pop et al. (2013) implemented a study with a primary focus on whether social behaviours of two children with a diagnosis of ASD increased more so with a robot present versus with a human present. The following inclusion criteria had to be met to be selected to participate in the study: a diagnosis of ASD, a score between 10 to 18 on a gesture subscale, a score across 30 on the childhood autism rating scale, and a mental age of more than two years old (Pop et al., 2013). Pop et al. (2013) used an ABAB experimental design and the study was conducted at the autism therapy center. Both participants had two interaction sessions with the robot and with the human (Pop et al., 2013). Pop et al. (2013) noted that the interaction with the robot for the imitation session was lower than with the human (p= 0.033 and p= 0.285). However, there was an increase with attention (12/16 robot vs. 5/16 human) and physical interaction (4/16 robot vs. 0/16 human) with the robot over the human (Pop et al., 2013). Pop et al. (2013) concluded that more research is needed in the area of robots, social skills, and ASD.

Furthermore, another study focused on children with ASD and their interactions with robots. The aim of this particular study was to compare whether children with ASD and typically developing children performed more imitation tasks with the humanoid robot or with the human examiner (Warren et al., 2015). Warren et al. (2015) recruited eight children who had a diagnosis
of ASD and eight typically developing children from existing university-based registries. Each child had two sessions with the robot and two sessions with the human examiner (Warren et al., 2015). The main focuses of the sessions were imitation skills and attention (Warren et al., 2015). Warren et al. (2015) stated that the results showed that the children with ASD spent more time paying attention to the robot (11%) than the human examiner during sessions. When it came to performing imitation skills, the children with ASD performed 38% more correct imitation skills with the robot than with the human examiner (Warren et al., 2015). The typically developing group of children showed no significant difference between the sessions with the human examiner and the robot (Warren et al., 2015). Warren et al. (2015) concluded that the robot had a greater effect on the children who had ASD for teaching them skills and for them being able to generalize the skills taught during the sessions.

A study conducted by Werry, Dautenhahn, Ogden, and Harwin (2001) looked at different technologies, such as robots to teach social skills to those with ASD. In this study, Werry et al. (2001) recruited two pairs of children who had a diagnosis of ASD. The children then engaged in using social interaction skills with the robot, humans, and other forms of technology, such as software on computers (Werry et al., 2001). It was found that the interaction skills of the children increased when used with technology, such as the robot and it was concluded that technology, such as robots are beneficial for teaching social skills to those who have ASD (Werry et al., 2001). It was noted that further research in this area is needed (Werry et al., 2001).

Albo-Canals et al. (2018) completed a study around the feasibility of using robots for emotional development and social skills for children with severe ASD. There were 12 participants in this study between the ages of four to seven and all of them had a diagnosis of ASD (Albo-Canals et al., 2018). Albo-Canals et al. (2018) introduced the robot to the participants and each participant was given four consecutive days to interact with the robot and these interactions were observed and video-taped. Two participants out of twelve were able to finish over six play sessions with the robot and further data was gathered on these two participants (Albo-Canals et al., 2018). Albo-Canals et al. (2018) concluded that there was an increase in the amount of interactions with adults after engaging with the robot and with robot. Similarly to the above studies, Albo-Canals et al. (2018) noted that although their results were positive further research is needed.

This was another study that looked at ASD and social robots. The purpose of this study was to compare three pairs of children (siblings, twins, and classmates) with ASD and their interactions with social robots (Taheri, Meghdari, Alemi, & Pourtemad, 2018). The children participated in a 12-session program with the robot, which focused on group games where the researchers observed the children in pairs and individually throughout these sessions (Taheri et al., 2018). The results showed an increase in social skills, a decrease in ASD symptoms, and progress with behavioural matters (Taheri et al., 2018). Taheri et al. (2018) also stated that verbal communication increased significantly (p < 0.05).

Pop et al. (2013a) conducted a study regarding whether social stories are more effective being presented by a robot or on a computer for 20 participants between the ages of seven to nine with ASD. Each participant was randomly placed in one of three groups: control group (n= 7), computer group (n= 6), and robot group (n= 7) (Pop et al., 2013a). The control group was given social stories by a human (Pop et al., 2013a). The computer group were given social stories on a computer (Pop et al., 2013a). The robot group was presented with social stories by the robot (Pop et al., 2013a). All three groups were presented with social stories under different conditions (with a human, computer, or robot) and all groups were given the opportunity to demonstrate their
social abilities after being presented with social stories under the different conditions (Pop et al., 2013a). Pop et al. (2013a) compared results from each group and concluded that the group that had access to the social stories via the robot had an increase in social skills.

Mengoni et al. (2017) conducted a study to see whether social robots had an impact on children with 40 children between the ages of five to ten with ASD and developing social skills. All participants had to meet the following criteria in order to be able to participate in the study: diagnosis of ASD, an IQ over 70, English comprehension, a guardian who could complete questionnaires, and not currently enrolled in another social communication intervention (Mengoni et al., 2017). The participants were randomly assigned to one of the following groups: the therapist and the robot or just the therapist (Mengoni et al., 2017). The sessions lasted for eight weeks and consisted of two sessions with familiarizing themselves with the robot and six treatment sessions (Mengoni et al., 2017). Mengoni et al. (2017) handed out questionnaires to be completed by the guardians of the participants. After the intervention was finished, the questionnaires were completed, and results showed that the participants who were in the robot group showed an increase in social skills (Mengoni et al., 2017).

Valadao et al. (2016) conducted a study regarding whether a robot will stimulate social skills with children ten children between the ages of 7 to 8 years old with half (50%) of them having a diagnosis of ASD. The participants without a diagnosis of ASD were the control group. Valadao et al. (2016) set up sessions for the children to engage with the robot and they assessed the following social skills during each session: eye gazing, touching the robot, and imitating. The results of the study showed an increase in social skills when the children with ASD engaged with the robot (Valadao et al., 2016). Eye gazing had a median of 2.73, imitation was 0.18, and touching the robot was 2.97 for the participants who had a diagnosis of ASD (Valadao et al., 2016). The results for the control group were: eye gazing was 2.59, imitation was 0.2, and touching the robot was 0.76 (Valadao et al., 2016). Overall, the results showed more of an increase with social skills in the group of children who had ASD compared to the control group (children without ASD) (Valadao et al., 2016). Valadao et al. (2016) concluded that their study showed that robots are helpful with aiding in teaching social skills to those who have ASD.

In summary, the research presented examined the use of robots teaching social skills to children with ASD or who display characteristics of ASD and it can be concluded that robots are effective in teaching social skills to this population. However, the studies mentioned how more research is needed on this topic to further support the benefits of using robots to teach social skills. Therefore, it is important to conduct further research in this area. The research above also stated that it is important for further research to use bigger sample sizes in order to generalize these findings to a bigger population. Although, single case design means that each participant would serve as their own baseline. Using single case design can aid with the improvement of validity. However, this depends on direct observations and tests the reliability of data collection procedures. The current study expanded research in this area of robots teaching children social skills and the effectiveness around this. The conditions in most studies above were similar to those in the current study in that this study will have two conditions: social skills being taught by a human and social skills being taught by a robot. That said, there are some things that were different in this study compared to the studies above. This study will be focused on two social skills: greetings and leave-taking. These two skills are important for effective communication.
among peers, adults, teachers, etc. Greetings and leave-taking skills are also used on a daily basis, which is why it is important for this population to be able to understand these skills and use them effectively. The purpose of the current study is to evaluate how social skills can be effectively taught with two individuals who display characteristics of ASD in particular, how the use of technology in the form of a robot can be used to deliver lessons on social skills when compared to a researcher delivering the same lessons.

Chapter III: Method

Participants

There were two participants in this research study. Both participants were elementary school-aged children and were male. One of the participants was in grade 1 and the other participant was in senior kindergarten at the same school.

Selection procedures. The participants were recruited by the applied behaviour analysis (ABA) Advisors at the local District School Board. The participants had to meet the following criteria in order to be a part of this study: they had to have a diagnosis of ASD or display characteristics of ASD (i.e. hand flapping, minimal eye contact, trouble with communication and social skills) and both participants had to have similar needs and similar developmental level. The participants were required to be able to use consistent means to request, demonstrate the ability to understand spoken language, monitor their caregiver’s actions, predict what might come next during interactions with others, make comments and respond to comments, answer questions, and have fine motor abilities.

Consent and assent procedures. The consent form (Appendix A) was designed by the researcher (St. Lawrence College student) and was approved by the researcher’s college supervisor and the Research Ethics Board at St. Lawrence College. Before the participants took part in the study, a consent form was sent home by ABA Advisors from the District School Board and was addressed to the parents or guardians of the participants. This consent form had to be signed by the parents or guardians and sent back to the school before students could participate in the study. The consent form includes the purpose of the research, the risks and benefits for participating in this research study, limitations, and the process for the intervention that was being investigated. The parents or guardians were given contact information for the college supervisor, placement supervisors, and the Research Ethics Board. If any questions or concerns arose before, during, or after the research study, parents or guardians were instructed to contact one of these individuals. The consent form also states that participation in the study is voluntary and any parent or guardian could withdraw their child from the study at any point and without any penalty. If the participants were showing signs of distress, the study will stop immediately and a debrief session would be put in place. The consent form mentions the use of the sessions being videotaped and outlines the risks and benefits associated with participating in the study.

Verbal assent procedures were put in place and assent was obtained from all participants involved in the study. More specifically, the assent form (Appendix B) was read to the participants and any questions or concerns were answered before the participants moved forward. Once any questions and concerns were addressed, then the participants were asked whether they would like to participate in the study. Both participants provided verbal assent and the date that this was provided was documented on the assent form and is being stored at St. Lawrence College.
Design
This research study used an A-B-C design replicated across two participants. During the intervention phases (B) and (C) the intervention procedures were implemented through teaching social skills by using a robot (B) and by using a human (C).

Independent variable. The independent variables being investigated were social skills instruction being delivered by a robot versus by a human.

Dependent variable. The dependent variable was the greetings and leave-taking responses (i.e. correct or incorrect response) given by the participant during instruction in both the robot and human condition. The correct responses for greetings and leave-taking are operationally defined in the paragraph below.

Greetings. A greetings is operationally defined as looking at the person greeting you, smiling at that person, and saying a greeting word, such as hi, hey, or hello.

Leave-taking. Leave-taking is operationally defined as looking at the person, smiling at that person, and saying a leave-taking word, such as bye, see you later, or goodbye.

Setting and Apparatus
The study took place in a space outside of the classroom, in an elementary school, two days per week for 45 minutes, and during class time. The materials that were required for this study included: data sheets, a motivator vibrating timer, recording materials (camera, tripod, and iPads), Milo (the robot), the script for the training modules, visual supports, token boards (Appendix C), tokens, reinforcers (i.e. smarties, m&ms, chips, skittles, iPad, and toys) and a copy of social narratives.

Measures
Milo collects accuracy data based on the student’s responses and from there, the data is then extracted and graphed as a line graph. Each module provides three opportunities where the participant will be asked three questions per module. The percentage of questions that the participant answered correctly is then calculated. In order to achieve each module, the accuracy had to be 100% over three times before moving to the next module. If the participant achieved 100% on the practice module then the lesson for that module did not need to be taught as the participant had already mastered the skill. Each module was recorded with an iPad and the number of sessions it took for the participants to receive 100% on the modules were collected to compare whether social skills taught by the researcher or with Milo the robot took less training sessions. The amount of time it takes to complete a module accurately was recorded and examined by the researcher. This aids with concluding results based on what type of technology was more effective for this population when teaching social skills, such as greetings and leave-taking. IOA (inter-observer agreement) was collected and compared to the data that Milo produced to ensure accuracy of the data. The IOA data was collected for 20% to 30% of the sessions and was collected by the ABA advisor. The ABA advisor watched the videos for one participant after the sessions to collect the data. For the other participant, the ABA advisor collected the data during the sessions. This data was later compared to the data collected by the researcher to see whether there were any discrepancies.

Procedures
The intervention consisted of the participants being taught social skills by the Robokind robot by the name of Milo, and by the researcher. Milo is programmed to deliver 13 social skills
training modules to children. Participants in this study were taught two of these training modules, greeting and leave-taking. Teaching sessions took place twice a week for 45 minutes. One participant was taught greetings by Milo and leave-taking by the researcher, and the other participant was taught greetings by the researcher and leave-taking by Milo. The participants had to achieve 100% over three times to continue on to the following module. Modules were delivered until mastery was reached, therefore the duration of the intervention depended on the rate of progress of each participant. Calm down modules consisted of six modules regarding various calm down strategies that can be used when one is feeling frustrated or angry. These modules focused on strategies, such as counting to 10, squeezing a ball, and taking a break. These modules provided the opportunity for participants to try all of the calm down skills and find which ones work best for them. This also provided an opportunity for participants to watch scenarios and label which calm down strategy was being used. Calm down modules were taught to the participants before the start of the social skills training. The calm down modules were used to teach the participants how to respond and interact with Milo prior to starting the intervention conditions. Participants also had to receive 100% over three sessions to continue on to the next calm down module.

Verbal reinforcement in the form of social praise was used throughout the intervention procedures to aid with the participants’ achievement of each module along with reinforcement of other desired behaviours, such as sitting and listening during the sessions, using a token economy. A token board was used with both participants allowing them to receive five tokens before accessing a preferred activity or edible, such as smarties, m&ms, chips, skittles, the iPad, or other preferred toys. The schedule of reinforcement used for both participants was a fixed interval (FI2) schedule. This means that both participants received tangible reinforcement in the form of a token every two minutes when the Motivator timer went off. If the participants were engaging in desirable behaviours, such as sitting on the chair, answering questions that Milo (the robot) or researcher asked them, or listening and looking at the robot or researcher, then they would receive a token. Tangible reinforcement was not provided for correct responding during the intervention conditions.

At the beginning of each session, the participant would go back and do the practice phase of the previous module taught to them until they reached 100% over three times. Each session started with practicing the required skill(s) for that specific module. If the participant received 100% during the practice phase of the module then they moved on to the next module. If the student did not receive 100% during the practice phase, then they moved onto the teaching phase for that module. The teaching phase taught the lesson and the skills required for that lesson. During this phase, the practice lessons were expanded on while providing information on greetings or leave-taking skills. The teaching phase provided opportunities for participants to expand their knowledge around the specific skill as well as practice the skills and label the skill by watching scenarios. After the teaching phase, the participants went back and completed the practice phase of that module again until they received 100%. This was the same for both the robot condition and the human condition.

During the lessons for the human condition, the script (Appendix D) was used for all modules. The script consisted of the exact wording that Milo (the robot) said during all of the lessons, so as to keep it consistent between both conditions. The lesson in the human condition would start off by going through the entire script word for word. During the parts where videos had to be shown, the video would be shown on the tablet. After most videos, questions would be asked. In this condition, visuals were used in order for the participant to choose an answer. If the
answer chosen was correct, then the researcher went back to reading the script and continuing with the lesson. If the participant chose the incorrect answer, the video was shown again, and the question was asked again. If the participant chose the incorrect answer three times, then the correct answer was provided along with an explanation of what was happening in the video and the lesson went on.

During the robot condition, everything was the same as the human condition except the visuals would appear on the tablet and the participants would identify the correct answer by selecting the correct visual on the tablet.

Chapter IV: Results

Intervention

Greetings with Human. As shown below in table 1, the participant’s average for correct responding during the greetings lessons was 48.88% overall. The average for correct responding for lesson 1 was 46.66%, the average for lesson 2 was 0.00%, and the average for lesson 3 was 100.00%. The participant had difficulty with the content during the greeting lessons and therefore often chose the incorrect answers during the modules (Appendix E). This led to an overall average of 51.12% for incorrect responding.

Table 1

Summary of Mean, Median, and Standard Deviation for the Participant’s Intervention Greeting Skills

<table>
<thead>
<tr>
<th></th>
<th>Lesson 1</th>
<th>Lesson 2</th>
<th>Lesson 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>46.66</td>
<td>0.00</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>1.0</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td>24.02</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Leave-taking with Milo (robot). As shown in table 2, the participant also had some difficulty with the leave-taking modules, which was under the robot condition. The results below show that the participant had a higher average of choosing the correct answers over the incorrect ones during this condition (Appendix F) compared to the human condition. The participant’s average for correct responding was 70.36% overall. The average of correct responding for lesson 1 was 27.77%, the average for lesson 2 was 83.33%, and the average for lesson 3 was 100.00%. The average of incorrect responding overall was 29.64%.
Table 2
Summary of Mean, Median, and Standard Deviation for the Participant’s Intervention Leave-taking Skills

<table>
<thead>
<tr>
<th></th>
<th>Lesson 1</th>
<th>Lesson 2</th>
<th>Lesson 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>27.77</td>
<td>83.33</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>0.00</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td>15.71</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*Figure 1. Average score under the human condition and robot condition during intervention.*
Visual Analysis

A visual analysis (Appendix G) was used to compare both conditions during the intervention phase. A trendline, PND line, and PEM line was put into the graph to compare results between both conditions. The graph showed that the participant was more successful with certain lessons over others in both conditions. The lessons that the participant was more successful with during the human condition were lessons one and three and lessons two and three during the robot condition. The graph also showed that the participant was more successful in the robot condition compared to the human condition as the mean for correct responses was 48.88% in the human condition and 70.36% in the robot condition meaning there was a 21.48% increase of correct responses under the robot condition. Overall, the graph showed that the average score for correct answers was higher during the robot condition compared to the human condition during the intervention.

Summary of Results

Overall, the results showed that the percentage of correct responses was 21.48% higher in the robot condition compared to the human condition. Both the human condition and robot condition showed that the participant was more successful with some lessons over others as discussed above. However, the data in both conditions is variable. This means that the data under both the human condition and the robot condition were not stable. Depending on the lesson and the condition, some of the correct responses were higher then others leaving the data unstable. Based on the results above, more research is needed in this area to further generalize results and see whether robots are an effective and efficient way to teach social skills to children who have ASD or display symptoms of ASD.

Chapter V: Discussion

This study examined the use of a social robot (Milo) versus a human to teach greeting and leave-taking skills to two children who displayed characteristics of autism spectrum disorder (ASD). The results showed that there was a 21.48% increase in correct responses in the robot condition compared to the human condition. These results supported the thesis hypothesis, which was that the correct responses would be higher in the robot condition over the human condition.

Context of the Current Literature

There was literature that examined the use of social robots versus humans to teach social skills to children who had a diagnosis of or displayed characteristics of ASD. The results of this research study are consistent with research findings by Kim et al. (2013), which found that the participants that were under the robot condition had an increase in social interactions compared to the human condition and the computer game condition. Kim et al. (2013) mentioned in the study that the results were not significant and therefore more research is needed in this area to conclude further findings. While the research findings by Robins, Dautenhahn, Boekhorst, and Billard (2005) found similar findings as their results showed an increase in social interaction skills under the robot condition compared to the human condition. Robins et al. (2005) research findings also found an increase in duration of social interaction skills from those participants who were under the robot condition. This means that the participants who were under the robot condition were able
to use the social interaction skills over a longer period of time compared to the human condition. This could also be viewed as the participants under the robot condition being able to generalize the skills learned. Thus, the results of this research study matched the results of the current literature, which concluded that there were similar findings with an increase in social skills in the robot condition compared to the human condition, but more research is needed in this area.

**Strengths and Limitations**

**Strengths.** There were some strengths in regards to this research study. The first strength was that this research study focused on social skills. Children with ASD often have difficulties with social interactions and often require explicit teaching to learn how to act in social situations. It was important that the focus of this study was to teach children who have or display characteristics of ASD social skills as it will be beneficial to them. Teaching social skills is a socially significant goal because it will benefit the students as they will be able to learn social skills, generalize the skills taught, and use them in social situations. This could also lead to a decrease in behavioural problems as the students will better be able to be successful in various social situations. The main focus of this research study was to determine how these social trainings should be delivered to this population, which was either by a human or a social robot (Milo). This was also beneficial to examine as finding out effective teaching methods to teach social skills to this population could aid with future success. The second strength was that all sessions were supervised by various experts in the field. This meant that professionals who work with children who have ASD were able to provide input, which could aid with future teaching methods for this population. The third strength was that this research study took place in a school setting. This was important as the participants were already familiar with the environment that they were in. The participants also spent five days a week in this environment, which consisted of various opportunities for social interactions to take place. Conducting this research study in an area that the participants spent most of their time allowed for promoting generalization as well. This also helped various education providers, such as teachers, educational assistants, early childhood educators, principals, and vice-principals to learn more information about the different teaching methods for the ASD population. This was also beneficial for the participants as in a school setting, they got the opportunity to learn and use other resources to aid with their success at school. The last strength of this research study was that inter-observer agreement data was collected throughout each session of the intervention, which aided with the reliability of the data that was provided.

**Limitations.** There were many limitations associated with this research study. The first limitation was participant attendance. In this study, there were two participants. One of the participants had poor attendance throughout the intervention of the research study and therefore not enough data was acquired from the participant resulting in not being able to use the data from this participant. The second limitation was time. Although there was at least two to three months dedicated to this research study, more time would have beneficial as more sessions could have been conducted and it would have allowed time for generalization within the classroom environment. The third limitation was the lack of prerequisite skills determined by the company of the social robot. Only a few prerequisite skills were mentioned in order to be able to use the social robot effectively. However, when the sessions with the robot continued, further prerequisite skills were recognized that were not noted earlier on. This led to some difficulties with teaching the sessions. The fourth limitation of this research study was not being able to keep both the human condition and the robot condition entirely the same. The same scripts that were used in both conditions of the research study had to be modified in order to aid with the participants
understanding of the content. Both participants had difficulty with some of the content in various lessons leading to more prompts and explanations being given as well as trying different exercises under both conditions. The fifth limitation was not being able to keep the schedule of reinforcement completely consistent. Some sessions had more content to cover then others, which led to reinforcement being given more often at times. During sessions when the participants were having difficulty with the material being covered, different exercises were done to aid with the participants understanding of the content and to make sure that the participant already had the required skills for the lesson. This led to more reinforcement being given in order to keep the participant engaged and to reinforce the participants for participating in the lessons. The sixth limitation is that this study measured the ability to answer questions related to social interactions, such as greeting and leave-taking skills. The study did not examine observations of the participants engaging in social interactions, which would have aided with overall generalization of the skills being taught to the participants in different settings. The last limitation was not being able to take generalization and maintenance data. Due to time restraints, generalization and maintenance data could not be collected. This makes it difficult to know whether the skills taught during the intervention phases were generalized and maintained to other people and environments. This also makes it difficult to see whether the participants retained any knowledge around greeting and leave-taking skills and whether they would still be able to use those skills successfully.

**Multilevel Challenges**

**Client level.** Participant attendance was a challenge associated at the client level during this research study. One participant had poor attendance throughout the intervention, which led to difficulties associated with gathering reliable and stable data for this participant, being able to teach all the content under both the human condition and robot condition, and with the participant not being able to fully benefit from the intervention. This also interfered with the participant being able to reach the mastery criterion of both conditions, which would have allowed for the participant to receive higher scores during the intervention and aided with further results to this research study.

**Program level.** A challenge that arose at the program level during this research study was that sessions took place twice a week, which put a demand on scheduling for the supervisor and the participants involved in the study. The supervisor had a full schedule, which allowed for limited time for make up sessions. Therefore, it was important for both participants in the study to show up to the scheduled sessions as re-scheduling sessions was not an option. This led to those who missed a session being behind in the content being delivered under both conditions and did not allow for any make up time. It was an option to have other supervisors assist if needed although other supervisors also had a heavy schedule and did not allow for much time.

**Organizational level.** The environment in which the sessions took place resulted in some challenges. Throughout the research study, there were limited spaces within the school environment that were available. Some spaces allowed for more distractions and led the participants to having difficulties with focusing on the social skills content. Some other environments had an open concept, which allowed for classes and other students to be a distraction at times and resulted in the space being noisy.

**Societal level.** A challenge that arose in the societal level was finding participants that fit the criteria for this research study. To be able to take part in this research study, certain social skills, such as greetings and leave-taking skills could not be acquired by the participants before the intervention. This allowed for limited selection of participants as most children already acquired the skills of saying hi and bye to others and responding to other’s greetings and leave-taking.
Contributions to the Behavioural Psychology Field
This research study was developed around ideas pertaining to the behavioural psychology field as principles of applied behavioural analysis (ABA) were at the forefront in planning how to answer this research question. These ABA principles included teaching a socially significant goal, the use of reinforcement, and using a single-subject design. This research study focused on teaching social skills to the ASD population. There have been various research studies in the field regarding methods for teaching social skills to children who have ASD. The results of this research study also pertained to the behavioural psychology field as the results showed a slight increase in correct responses when participants were under the robot condition compared to the human condition. This research study aids with the behavioural psychology field as it can help to find methods that work for individuals with ASD that will aid in the overall future success of this population. The use of reinforcement was also used in this research study, which is used to help with teaching new skills and increasing socially significant behaviours. The use of a single-subject design was used in this research study. In ABA, different research designs are often used, but mostly single-subject designs are used when using ABA. Overall, this study aids with the behavioural psychology field as it examined different ABA principles and aided with finding different teaching methods to teach social skills for those with ASD.

Recommendations for Future Research
The implementation of this research study brought about recommendations for future research in the area of ASD and how social skills are taught to this population. Although many research studies around this topic have been implemented, more research is needed in this area. Previous research studies around this topic have implemented a study only using a few participants, which makes it difficult to generalize the results of these studies to bigger populations. The results of previous research studies have also not found a significant difference between social skills taught by social robots compared to a human teaching social skills to this population. Future research needs to examine studies with bigger sample sizes, generalization, and more results with statistical significance between both conditions are needed in this area to further research.

Conclusion
This study aimed to provide conclusions around whether social skills are taught more effectively by a social robot versus a human to children who displayed symptoms of ASD. The results of the study showed a slight increase under the robot condition, but did not show a statistically significant difference between the robot condition and the human condition overall. Therefore, more research is needed in this area to generalize findings and to draw more conclusions in this area of research.
References


Appendix A
Consent Form

**Project Title:** The Use of a Robot to Teach Social Skills to Children with Autism Spectrum Disorder in a Classroom Environment

**Principal Investigator:** Ashley Kearney

**Name of Supervisors:** Laura Campbell, Meaghen Shaver

**Name of Institution:** St. Lawrence College

**Name of Institution/Agency:** Algonquin and Lakeshore Catholic District School Board (ALCDSB)

Dear **(Parent/Guardian),**

I am a student in the Honours Bachelor of Behavioural Psychology Degree program at St. Lawrence College. This program is over the course of 4 years, including 3 placement opportunities. I am currently on placement at the Algonquin and Lakeshore Catholic District School Board (ALCDSB). I am in my fourth year. As part of this placement, I am completing a research project (called an applied thesis). As part of my thesis, I will be conducting research on the effectiveness of using a robot to help children with Autism Spectrum Disorder learn social skills.

Your child has been selected by the Algonquin and Lakeshore Catholic District School Board (ALCDSB) as an ideal candidate that might benefit from participating in my research. Your child has been selected to be a potential participant in this research study for several reasons that make them an ideal candidate: they can have a diagnosis of ASD or display symptoms of ASD (ex. hand flapping, not saying hi or bye when appropriate, minimal eye contact, etc.) without having a diagnosis; they use consistent means to request; they demonstrate the ability to understand spoken language; they monitor their caregiver’s actions; they predict what might come next during interactions with others; they make comments and respond to comments; they answer questions; and they have fine motor abilities.

**Why is this research study being done?**

The purpose of my research study is to evaluate how social skills can be effectively taught, generalized, and maintained with children with autism spectrum disorder (ASD) or children who display symptoms of ASD. More specifically, I am interested in knowing how the use of technology, such as using a robot, can be used to deliver lessons on social skills, when compared to myself (the researcher) delivering the same lessons. The data for this research will be collected by using duration recording (timing how long it takes your child to finish a lesson). Frequency recording will also be used to record other behaviours, such as eye contact and smiling as the lessons go on (recording each time your child engages in one of these behaviours).

**How will this research involve my child?**

Your child will be asked to meet with me twice a week for 45 minutes for each session. Your child will work with the robot, Milo, and be taught basic social skills such as greetings and farewells. They will also work with me to learn other ways that they can greet people when they meet them. This research study will also require videos being taken of your child engaging in social skills training with the robot and with me.
**Inclusion Criteria**

For your child to be included in this research, there are certain expectations. Your child will be expected to: show up on the days that the social skills training sessions are assigned; listen to instructions; and participate in the sessions as much as they are possible. The study will be approximately 8 weeks long depending on how quickly your child goes through the material; however, each module contains four lessons and each lesson is approximately 45 minutes long. Sessions will take place twice a week.

**Are there any risks or benefits?**

Since this is a research study, there are always potential risks and benefits involved. Although risks associated with this study are considered minimal, your child might become frustrated or distressed during the learning sessions. It is hoped that your child will benefit from participating in this study, there is the risk that your child might not learn the social skills being taught or they may not enjoy the training sessions. If at any point during the study your child shows any signs of distress which includes abnormally high levels of challenging behaviour, the study will be stopped immediately and a debrief session will be put in place. Some potential benefits include your child learning new social skills. An indirect benefit is that through this research, I hope to demonstrate that the use of technology, such as a robot, can provide effective alternatives for children with ASD or children who display symptoms of ASD to help them learn social skills as well as being a useful tool in helping them maintain those skills once learned. I also hope that through dissemination of the results of my study in written articles and at conferences that my research will support further study in this area of research.

**How will my child’s privacy and confidentiality be protected?**

Throughout this research study and after, your child’s confidentiality and privacy will be protected to the best of my ability. According to the College of Psychologists of Ontario Standards of Professional Conduct, consent forms for children must be retained for 10 years beyond the child’s 18th birthday. Please note that consent forms will be retained by the Algonquin Lakeshore Catholic District School Board. The learning sessions with be videotaped. Videos will be taken with an IPad and shot from behind where your child is sitting, that way your child’s face will not be seen. These videos will be used for data collection purposes only in order to accurately compare the effectiveness of the social skills. Videos will be stored on a password protected IPad that will be stored in a locked file cabinet when not in use. The videos will be erased once the data has been recorded, which is no later than one week after the session has taken place. All other data collected on your child for this research will be kept in a locked filing cabinet at St. Lawrence College for up to 10 years after your child’s 18th birthday. After this, all data collected will be erased. During the study, all information will be kept in a password protected Word document on a password protected laptop to ensure that your child’s privacy and confidentiality are protected throughout the retention period of the data. To further ensure that your child’s privacy and confidentiality are protected, your child’s identity will be masked using a fake name on data collection sheets, in written reports, and in any presentations of research findings at conferences.
**Does your child have to take part?**
Your child’s participation in this study is voluntary. This means that you can withdraw your child from this research study at any time without reason and without any prejudice against you or your child at the school. I will also be seeking your child’s assent. This means that even if you give permission to have your child participate in my research study, if your child doesn’t want to participate in this study their choice not to participate will be respected. If you choose to withdraw your child from the study at any time during the study, please contact myself or one of my SLC faculty supervisors (contact information is below) or the school, Katie Phillips or Shauna Hoekstra by phone or e-mail by calling 613-354-6257 ext. 496 or sending an e-mail to philkath@alcdsb.on.ca or shoekstra@alcdsb.on.ca. Once your child is withdrawn from the study, they will no longer be required to participate in the social skills learning sessions that are part of this research.

**Contact for further information**
This research project has received ethical clearance from the St. Lawrence College Research Ethics Board (SLC-REB) [if applicable: and has been approved by the Algonquin Lakeshore Catholic District School Board]. The project was developed under the supervision of Laura Campbell and Meaghen Shaver, my thesis supervisors at St. Lawrence College. I appreciate your cooperation and if you have any additional questions, feel free to ask me, Ashley Kearney, or my college Supervisor, Laura Campbell, by phone or email by calling 613-544-5400 ext. 1544 or sending an e-mail to lacampbell@sl.on.ca. If you have concerns about the way this research is being conducted or about your rights as a participant you may contact the SLC-REB Chair at reb@sl.on.ca or you can call 613-544-5400 ext. 1621.

Sincerely,
Ashley Kearney, BP
Title of the study: The Use of a Robot to Teach Social Skills to Children with Autism Spectrum Disorder in a Classroom Setting
Principal Investigator: Ashley Kearney
Supervisors: Laura Campbell and Meaghen Shaver

I would like to tell you about a research study that I will be doing. A research study is done when someone wants to find out more about a certain topic or has a question about something. I would like to find out if my robot named Milo is useful at helping you learn social skills such as greeting others.

If you would like to help me by joining my research study, I will ask you to come meet with Milo and me twice a week for 45 minutes with each visit. Milo will teach you one of two different types of ways to respond to people such as ways to say hello and good-bye. I will also teach you some other ways that you can talk to people when you meet them.

I have told your mom and dad about my research study and that I would be asking you if you wanted to take part in my research study. They think it is okay and have agreed to letting you take part as long as you want to do so.

Your help with testing Milo’s teaching skills will be really useful and hopefully you will learn some things too. However, we might learn that Milo isn’t useful after all and that is okay as well. This is what you are helping me learn.

There is a chance that you may not enjoy your time with Milo and me, and that is okay! You don’t have to meet with Milo and me or do the learning sessions if you don’t want to. You can say “yes” now to meeting with Milo and me and you can change your mind later. If you ever want to stop what we are doing or stop meeting with me, all you have to do is let me know. No one will be mad with you.

Before you say yes or no to being in this study, we will answer any questions you have. If you join the study, you can ask questions at any time. Just tell me that you have a question and I am happy to answer it.

If after our meetings, you have any questions you can ask your parents to contact me, Ashley Kearney, or they can contact my supervisors, Laura Campbell, or Meaghen Shaver, at 613-544-5400 ext. 1544. In addition, you or your parents can contact the St. Lawrence College Research Ethics Board (SLC-REB) Chair if you don’t like the way you were treated during our meeting. For example, if you think that I haven’t answered your questions or that I haven’t listened to you and made you do things you didn’t want to do. You or your parents can contact the SLC-REB Chair at reb@sl.on.ca or call 613-544-5400 ext. 1621.

☐ Yes, I want to be in this research study.
☐ No, I don’t want to be in this research study.

<table>
<thead>
<tr>
<th>Child’s name (print)</th>
<th>Signature (if possible)</th>
<th>Date</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Person obtaining Assent</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
</table>
Appendix C
Milo (the robot)
Appendix D
Token Board

I am working for
Lesson 1: Introduction to Greetings

- We are going to learn about saying “hi” to friends today.
- This is called greeting.
- When we greet a friend, we look at our friend’s face, smile, and say “hi”.
- I can say “Hi” to other kids. I can say “hi” to grown ups.
- Let’s see some of my friends saying “hi” to each other.
- Look at the tablet. (Video Plays).
- Let’s watch another example. (Video plays).
- Let’s watch our last example. (Video plays).
- See how my friends looked at each other’s faces, smiled, and said “hi”.
- These were good greetings.
- Let’s watch more friends do it right.
- Look at the tablet (Video plays).
- My friend did not do a good job greeting. He did not do something.
- What does my friend need to do?
- Look at the tablet.
- (Visuals: look, smile, say “hi”)

<table>
<thead>
<tr>
<th>Correct Response</th>
<th>Incorrect Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>- You said look. You’re right.</td>
<td>- You said smile/Hi. Let’s watch the video again. Look at the tablet.</td>
</tr>
</tbody>
</table>

- Let’s watch my friend do it right.
- Watch my friends look at each other’s face, smile, and say “hi”
- Look at the tablet
- Video
- Let’s watch another friend and see if they give a good greeting.
- Look at the tablet.
- Video
- My friend did not do a good job greeting.
- My friend did not do something.
- What does my friend need to do?
- Look at the tablet.
- Visuals- smile, look, say hi, no response

<table>
<thead>
<tr>
<th>Correct Response</th>
<th>Incorrect Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>You said smile. You’re right.</td>
<td>You said look/ say hi. Let’s watch the video again. Look at the tablet.</td>
</tr>
</tbody>
</table>

- Let’s watch my friend do it right.
- Let’s watch my friend look at his teacher’s face, smile, and say hi.
- Look at the tablet.
- Video
• Let’s watch another friend and see if he does it right.
• Look at the tablet.
• Video
• My friend did not do a good job with the greeting.
• My friend did not do something.
• What does my friend need to do?
• Look at the tablet.
• Visual- look, smile, say “hi”

<table>
<thead>
<tr>
<th>Correct Response</th>
<th>Incorrect Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>You said look. You’re right.</td>
<td>You said smile/say hi. Let’s watch the video again. Look at the table.</td>
</tr>
</tbody>
</table>

• Let’s watch my friend do it right.
• Watch my friend look at his friend face, smile and say “hi”
• Look at the tablet.
• Video
• That was fun.
• Let’s play again sometime.
Lesson 2: Student Practices Greeting Milo

- You did a great job helping my friends greet each other.
- Now let’s practice.
- “Hi” (say)
- (Visuals- correct response, no response, eye contact + smile (no words), greeting + smile (no eye contact), greeting + eye contact (no smile)

<table>
<thead>
<tr>
<th>Correct Response</th>
<th>Incorrect Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thank you for greeting me.</td>
<td>You forgot to: <strong>Smile, say hi, or look at me.</strong></td>
</tr>
<tr>
<td></td>
<td>Let’s try that again. <strong>Hi (say)</strong></td>
</tr>
</tbody>
</table>

- That was fun.
- Let’s play again sometime.
Lesson 3: When to Greet- When We Have Been Away

- Hello.
- Last time you did a great job greeting me.
- Now let’s talk more about greeting.
- When we greet a friend we smile, look at the friend’s face, and say “hi”.
- Just like when you say “hi” to me.
- Let’s talk about when it is a good time to greet someone.
- We greet someone when we see him/her for the first time each day.
- We also greet when we see a friend, are away from them, and then see them again later.
- Let’s watch some friends.
- Look at the tablet. (Video plays).
- We also greet when we have been away from a friend and we see them again later.
- Look at the tablet. (Video plays).
- You do not greet again if you have not been away from the person even if you see them again.
- Look at the tablet. (Video plays).
- These friends should not say “hi” to each other.
- These friends have not been away from each other.
- Now, let’s watch some of my friends saying “hi”.
- Do my friends pick a good time to say “hi”?
- Look at the tablet. (Video plays).
- Did my friend choose a good time to say “hi”?
- Look at the tablet.
- (Visuals- yes, no)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Great job. (yes)</td>
<td>You said no. Let’s watch the video again. Did my friend choose a good time to say “hi”? Look at the tablet.</td>
</tr>
</tbody>
</table>

- My friend chose a good time to say “hi”. My friends were away from each other.
- That means they haven’t seen each other.
- Let’s try another.
- Look at the tablet. (Video plays).
- Did my friend’s chose a good time for a greeting?
- Look at the tablet.
- (Visuals- yes, no)

<table>
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</thead>
<tbody>
<tr>
<td>You’re right. (No)</td>
<td>You said yes. Let’s watch the video again. Did my friends choose a good time for a greeting? Look at the tablet.</td>
</tr>
</tbody>
</table>
• My friends did not choose a good time for a greeting.
• Let’s watch another. (Video plays).
• Did my friends pick a good time for a greeting?
• Look at the tablet.
• (Visuals-yes, no)

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<td>Great job. (Yes)</td>
<td>You said no. Let’s watch the video again. Did my friends pick a good time for a greeting? Look at the tablet.</td>
</tr>
</tbody>
</table>

• My friends were away from each other and did not see each other for a long time.
• That was fun.
• Let’s play again sometime.
Lesson 4: Different Greeting Words - hi, hey, hello

- Hello.
- We can greet by looking at someone’s face, smiling, and saying “hi”.
- Sometimes we can use different words to greet.
- Sometimes we can say “hey” or “hello”.
- These are different greeting words.
- We should look at someone’s face and smile when we use these different words to greet people.
- Let’s watch my friends use different words to greet people.
- Look at the tablet. (Video plays).
- Sometimes we greet to grown ups.
- When we greet to grown ups, we should use a formal greeting.
- Sometimes we say “hello” for a formal greet.
- Sometimes we say “hi” for a formal greet.
- We should smile and look at the grown ups face when we say “hi” or “hello”.
- It’s okay to say “hi” or “hello” when we do a formal greeting.
- Look at the tablet. (Video plays).
- Sometimes we greet another kid.
- When we greet other kids, we may use a casual greeting.
- I may say “hey” or “hi”.
- Sometimes we greet a grown up we know really well like our parents, babysitter, or therapist.
- When we know a grown up really well we can use a casual greeting.
- Sometimes it might be fun to use a casual greeting.
- Look at the tablet. (Video plays).
- We watched my friends use different greeting words like hi, hello, or hey
- We saw my friend use formal greeting like hi and hello with grown ups
- We saw my friend using casual greetings like hi or hello with grown ups they know well
- Sometimes my friends make mistakes.
- This is okay.
- Let’s help my friends make the right choice.
- Let’s watch.
- Look at the tablet. (Video plays).
- Did my friend choose the right greeting word?
- Look at the tablet.
- (Visuals)

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<tbody>
<tr>
<td>You’re right. You did a great job. (yes)</td>
<td>You said no. Let’s watch the video again. Did my friend choose the right greeting word?</td>
</tr>
</tbody>
</table>

- My friend used the formal greeting hello to greet his teacher who was a grown up.
• This was a great choice.
• Let’s watch another friend. Let’s try another.
• Look at the tablet. (Video plays).
• Did my friend choose the right greeting word?
• Look at the tablet.
• (Visuals)

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<tbody>
<tr>
<td>You’re right. My friend did not make a good choice. <strong>(No)</strong></td>
<td>You said <strong>yes</strong>. Let’s watch the video again. Did my friend choose the right greeting word?</td>
</tr>
</tbody>
</table>

• My friend was greeting his teacher who is a grown up.
• Let’s watch another friend.
• Look at the tablet. (Video plays).
• Let’s try another.
• Does my friend choose the right greeting word for this person?
• Look at the tablet.
• Video.
• Did my friend choose the right greeting word for this person?
• Look at the tablet.
• (Visual- **yes**, no)

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<tbody>
<tr>
<td>You said <strong>yes</strong>. You’re right.</td>
<td>You said <strong>no</strong>. Let’s watch the video again. Did my friend choose the right greeting word for this person?</td>
</tr>
</tbody>
</table>

• My friend used the casual greeting word “hey” to greet a friend on the playground that was a kid.
• Great job.
• Good choice.
• That was fun.
• Let’s play again sometime.
Lesson 5: When to Greet - Dos and Don’ts for Starting a Conversation

- Hello.
- You’re getting really good at greeting.
- You already know that we look at a friend’s face, smile, and say “hi”.
- You also know that you greet a friend when we have been away from each other.
- Sometimes it’s not a good time to greet a friend even if we’ve been away from a friend.
- They might be busy.
- Busy means they are doing something else.
- Maybe they are talking to another friend.
- Maybe they are talking to a teacher.
- Maybe they are working or reading.
- Maybe they are talking on the phone.
- Maybe they are on a time out or having quiet time.
- When we talk to someone who’s busy, this is called interrupting.
- People don’t like when we interrupt them.
- Sometimes friends are busy.
- We should wait until our friends aren’t busy to talk to them.
- When we wait, we can greet them later.
- We do not need to stand close to a friend to wait; we can go away from a friend and come back later.
- Look at the tablet. (Video plays).
- Let’s watch another example. (Video plays).
- Let’s watch our last example. (Video plays).
- These were all great times for my friends to do a greeting.
- They waited until their friend was not busy.
- They did not interrupt to say “hi”.
- We try to find a good time for a greeting.
- We try not to interrupt a friend when they are busy.
- We wait to greet a friend when they are not busy.
- Can you help my friends find a good time to do a greeting?
- Did my friend choose a good time to do a greeting?
- Look at the tablet.
- Visual-yes, no

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<tbody>
<tr>
<td>You’re right. My friend didn’t choose a good time to greet his friend. (No)</td>
<td>You said yes. Let’s watch the video again. Did my friend choose a good time to do a greeting?</td>
</tr>
</tbody>
</table>

- His friend was talking to another kid.
- His friend was busy.
- He interrupted his friend.
- People aren’t happy when we interrupt them.
- This was not a good time to talk to a friend.
• We try to not interrupt friends when they are busy.
• Look at the tablet.
• Video
• Let’s help more friends
• Does my friend choose a good time to greet the teacher?
• Look at the tablet
• Video
• Did my friend choose a good time to greet a teacher?
• Look at the tablet
• Visuals- yes, no

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<tr>
<td>You said no. You’re right.</td>
<td>You said yes. Let’s watch the video again. Did my friend choose a good time to greet a teacher?</td>
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</table>

• My friend did not choose a good time to greet the teacher.
• The teacher was talking to another student.
• The teacher was busy.
• The teacher was not happy when my friend interrupted her.
• This was not a good time to interrupt the teacher.
• My friend will talk to the teacher when she is not busy
• Let’s watch my friend do it right.
• Look at the tablet
• Video
• Let’s help more friend do it right.
• Does my friend choose a good time to greet their friend?
• Look at the tablet.
• Video
• Did my friend choose a good time to greet his friend?
• Look at the tablet.
• Visuals- yes, no

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<td>You said yes. You’re right.</td>
<td>You said no. Let’s watch the video again. Did my friend choose a good time to greet his friend?</td>
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• He chose a good time to greet his friend.
• His friend was not busy.
• His friend was not talking to anyone else.
• His friend stopped talking to the teacher.
• He chose a good time to greet his friend.
• This was fun.
• Let’s play again sometime.
Lesson 6: Question Greetings - What’s up, how’s it going, how are you

- Hello.
- Sometimes my friends use greetings that are questions.
- These are called question greetings.
- Sometimes my friend might say hi, how are you?
- Sometimes my friend might say what’s up?
- Sometimes my friend might say how’s it going?
- These are all question greetings.
- These are all common ways or routine phrases to answer question greetings.
- I can use different answers to question greetings.
- Sometimes people say hi, how are you?
- This can be a formal or casual greeting.
- When my friends say hi, how are you?
- Sometimes I might say fine, thanks.
- Sometimes I might say great, thanks.
- Sometimes I might say not bad, thanks.
- How are you?
- Sometimes my friend might not wait to hear my answer.
- This is okay.
- Question greetings do not always need an answer.
- Sometimes my friend might not answer when I use question greetings.
- This is okay too.
- Question greetings do not always need an answer.
- Look at the tablet. (Video plays)
- Let’s watch another friend.
- Look at the tablet. (Video plays)
- Let’s watch another friend.
- Look at the tablet.
- Video plays
- Another question greeting is what’s up?
- When my friend asks what’s up, he’s using a casual greeting.
- He is not asking what’s up above, what’s in the air, or on the ceiling.
- When my friend asks what’s up, I might say not much or what’s up with you?
- My friend might not wait for my answer.
- This is okay.
- My friend might not answer my question.
- This is okay too.
- Question greetings don’t always need an answer.
- Let’s watch some of my friends responding to the question greeting what’s up.
- Look at the tablet.
- Video
- Let’s watch some more friends.
• Look at the tablet.
• Video
• Let’s watch another friend.
• Look at the tablet
• Video
• Another question greeting is how’s it going?
• when my friend says how its going?
• My friend is asking a causal greeting.
• My friend isn’t asking how something moves.
• When my friend says how’s it going, I might say pretty good.
• I might say okay.
• My friend might not wait for an answer.
• This is okay.
• Let’s watch some of my friends responding and using the greeting.
• Look at the tablet.
• Video
• Let’s watch another friend.
• Look at the tablet.
• Video
• Let’s watch another friend.
• Look at the tablet.
• Video
• Sometimes my friends use question greetings.
• They might be causal greetings.
• The question greeting “hi, how are you” might be used as a causal greeting.
• Look at the tablet.
• Video
• Did my friends respond to the question greeting in the right way?
• Look at the tablet.
• Video
• Did my friend respond to the question greeting in the right way?
• Look at the tablet.
• Video

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<td>You said no. You’re right.</td>
<td>You said yes. Let’s watch the video again.</td>
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• My friend did not understand that his friend was using a question greeting.
• When my friend uses the question greeting he might say not much or nothing you?
• Let’s watch my friend respond in the right way.
• Look at the tablet.
• Video
• Does my friend respond to the question greeting in the right way?
• Look at the tablet.
• Video
• Did my friend respond to the question greeting in the right way?
• Look at the tablet.
• Visuals- yes, no

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• My friend did not understand that their friend was using a question greeting.
• When someone uses the question greeting how’s it going, my friend might say pretty good.
• Let’s watch my friend respond in the right way.
• Look at the tablet.
• Video
• Let’s watch another friend.
• Did my friend respond to the question greeting in the right way?
• Look at the tablet.
• Video
• Did my friend respond to the question greeting in the right way?
• Look at the tablet.
• Visuals- yes no

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<td>You said yes. You’re right.</td>
<td>You said no. Let’s watch the video again.</td>
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</table>

• My friend did a great job responding to his teacher’s question greeting.
• His teacher said hi how are you. He responded with fine thanks, how are you?
• This was a great choice.
• That was fun.
• Let’s play again sometime.
Lesson 1: Introduction to Leave-taking

- Hello.
- We have talked a lot about greetings.
- You just gave me a greeting to say “hello”.
- You looked at my face, smiled, and said a greeting word.
- Today, we are going to talk about what to do when you are leaving someone.
- This is called leave-taking.
- When we are leaving a friend, we look at the friend’s face, smile, and say “goodbye”.
- I can say “bye” to other kids.
- I can say “bye” to grown ups.
- Bye can be a formal or casual leave-taking word.
- Let’s see some of my friends saying “bye”.
- Look at the tablet. (Video plays)
- See how my friends looked at their friend’s face, smiled, and said “bye”.
- These were good to use when leaving someone.
- Let’s watch more friends to see if they can do it right.
- Do they look at each other’s face, do they smile, and say “bye”?
- Look at the tablet. (Video plays)
- My friend did not do something.
- She needs to try to look, smile, and say “bye”.
- What did my friend not do?
- Look at the tablet.
- (Visuals) Look, smile, bye

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<tr>
<td>You said <strong>look</strong>. You’re right.</td>
<td>You said <strong>smile or bye</strong>. Let’s watch the video again.</td>
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- My friend needs to look at her friend’s face.
- My friend looked away.
- Thanks for helping my friend with leave-taking.
- Let’s watch them do it right.
- (Video)
- Let’s watch another friend and see if they look, smile, and say “bye”.
- (Video)
- My friend did not do something.
- She needs to look at her friend, smile, and say “bye”.
- My friend did not do something.
- What does my friend need to do?
- (Visuals) **Smile**, look, bye

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<td>You said <strong>smile</strong>. You’re right.</td>
<td>You said <strong>look or bye</strong>. Let’s watch the video again.</td>
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</tbody>
</table>
• My friend needs to smile.
• Thanks for helping my friend with leave-taking.
• Let’s watch them do it right.
• (Video)
• Let’s watch another friend to see if they look, smile, and say “bye”.
• (Video)
• My friend did not do something.
• What does my friend need to do?
• Look at the tablet.
• (Visuals)- smile, bye, look

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<td>You said <strong>smile or bye</strong>. Let’s watch the video again.</td>
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• My friend needs to look at her teacher’s face. She looked away.
• Thanks for helping my friend with leave-taking.
• Let’s watch my friend do it right.
• Video
• Great try.
• Let’s play again sometime.
Lesson 2: When to use leave-taking skills

- Hello.
- You did a great job helping my friends with leave-taking.
- Now, let’s talk more about leave-taking.
- You look at the friend’s face, smile and say bye to them just like when you say bye to me.
- Now let’s talk about when we do this.
- We use leave-taking skills when we are leaving and will be away from each other.
- Let’s watch some friends.
- Look at the tablet.
- Video
- We use leave-taking when we leave for the day.
- We also use leave taking when we’re leaving someone for a while but will see them again later.
- Video
- We do not use leave taking when we are not leaving a friend even if we are finished talking to them.
- Video
- Now, let’s watch some of my friends using leave-taking skills.
- Do my friends choose a good time to say bye?
- Look at the tablet.
- Video
- Did my friends choose a good time for leave-taking?
- Visuals- yes, no

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<tr>
<td>You said yes. Great job.</td>
<td>You said no. Let’s watch the video again.</td>
</tr>
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</table>

- My friends chose a good time for leave-taking.
- The friends were leaving each other.
- That means the friends were not going to see each other for a long time.
- Let’s watch another friend.
- Do they look, smile, and say bye?
- Look at the tablet.
- Video
- Did my friends choose a good time for leave-taking?
- Visuals- yes, no

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<td>You said no. You’re right.</td>
<td>You said yes. Let’s watch the video again.</td>
</tr>
</tbody>
</table>

- My friends did not choose a good time for leave-taking.
- They said bye, but were not leaving each other.
- Let’s watch them do it right.
- Video
- Thanks for helping my friends with leave-taking.
Let’s watch more friends.
Do they look, smile, and say bye?
Look at the tablet.
Video
Did my friends choose a good time for leave-taking?
Visuals- yes, no

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<td>You said yes. Great job.</td>
<td>You said no. Let’s watch the video again.</td>
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My friends chose a good time for leave-taking.
They were leaving each other.
That was fun.
Let’s play again sometime.

**Lesson 3: Student Practices Initiating Leave-taking**
Hello.
You did a great job helping my friends with leave-taking.
We use leave-taking skills when we are leaving someone.
After we finish this lesson, you will leave and take a break.
It is almost time for you to leave me for a while.
This is a good time to use leave-taking skills.
You need to look at my face, smile, and say “bye”.
Let’s practice.
Ready?
Bye.
(Visuals)- correct response, no response, bye + smile (no eye contact), bye + eye contact (no smile), bye (no smile or eye contact), smile + eye contact (no bye)
Lesson 4: Different Leave-taking Words (bye, goodbye, see you later)

- Hello.
- It’s nice to see you again.
- You have done a great job of practicing leave-taking skills with me.
- Now let’s talk more about leave-taking.
- When I am leaving some one I look at their face, smile, and say bye.
- Sometimes I might use different words for leave-taking.
- Sometimes I might say goodbye.
- Sometimes I might say bye.
- Sometimes I might say see you later.
- These are different leave-taking words.
- I should look at them and smile when I use these different words.
- I should wait for a good time to use these different words.
- I can try to use different words when I am leaving.
- Let’s watch some of my friends using different words when they are leaving.
- Look at the tablet.
- Video
  - We watched my friends using different leave-taking words like bye and goodbye.
  - Sometimes my friends do a great job choosing the right words for leave-taking.
  - Sometimes my friend uses the right word, but not the leave-taking skills like looking at my face and smiling.
  - Sometimes my friends make mistakes.
  - This is okay.
  - Let’s help my friend make the right choice.
- Look at the tablet.
- Video
  - Did my friends do a good job with leave-taking at the end of class?
  - Visuals- yes no

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<tbody>
<tr>
<td>You said <strong>yes</strong>. Great job.</td>
<td>You said <strong>no</strong>. Let’s watch the video again.</td>
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</table>

- It was at the end of class.
- They looked at my friend, smiled, and said bye.
- Let’s watch another friend.
- Look at the tablet.
- Video
  - Did my friend do a good job of leave-taking?

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<td>You said <strong>no</strong>. Let’s watch the video again.</td>
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- My friend showed his friend he was leaving by looking at his face, smiling, and saying see you later.
- This was a great choice.
• You did a good job.
• Let’s help some more friends
• Look at the tablet.
• video
• My friend needed to do something.
• What does he need to do?
• Visuals- smile, say bye, look at friend, see you later, no response

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<td>You said say bye. You’re right.</td>
<td>You said smile, look at friend, or see you later. Let’s watch the video again.</td>
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• When we are leaving a friend, you need to use leave-taking skills.
• We need to look at the friend’s face, smile, and use a leave-taking word.
• We can choose a good leave -taking word like bye, goodbye, or see you later.
• Thanks for playing with me.
• Let’s play again sometime.
Lesson 5: Responding to Other Peoples Leave-taking

- Hello.
- Its nice to see you again.
- Let’s talk about what to do when someone else is leaving.
- Sometimes it is time for my friend to leave.
- My friend is leaving.
- I am not going to leave.
- My friend may say goodbye to me.
- I should use my leave-taking skills even when I am not going to leave.
- I need to look at my friend, smile, and say bye.
- I may not want my friend to leave.
- But I still should say goodbye.
- It might make me sad.
- But I should still say goodbye.
- It is okay to say goodbye.
- I can see my friend again later.
- My friend might not use all of their leave-taking skills.
- My friend might not look at me or smile and say goodbye.
- It is okay.
- Sometimes friends make mistakes.
- I do not need to tell them to do it right.
- It is not very polite to tell my friends to do it right.
- When my friend needs to leave I might be busy.
- It is okay for my friend to interrupt me to tell me he’s leaving.
- I might not want to talk to anyone, but I should still say goodbye.
- I should stop what I am doing, look at my friend, then smile, and say bye.
- Then I can go back to what I am doing.
- This is the polite thing to do when my friend is leaving.
- I stop what I am doing, look at my friend’s face, smile, and use a leaving-taking word like bye, goodbye, or see you later.
- Then I can go back to what I was doing.
- Or I can choose to walk my friend to the door.
- Both of these are okay.
- Let’s watch some friends.
- Look at the tablet.
- Video
- My friend did not do a good job of leave-taking.
- What is the first thing she needs to do?
- Visuals- no response, **stop.** Smile, hello

<table>
<thead>
<tr>
<th>Correct Response</th>
<th>Incorrect Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>You said <strong>stop.</strong> You’re right.</td>
<td>You said <strong>smile or hello.</strong> Let’s watch the video again.</td>
</tr>
</tbody>
</table>
• The first thing she needs to do is stop what she is doing then she can use the rest of her leave-taking skills.
• Let’s watch my friend do it right.
• Look at the tablet.
• Video
• Thanks for helping my friends with leave-taking.
• Let’s help another friend.
• Look at the tablet.
• Video
• My friend did not do a good job of leave-taking.
• What should he say when his friend is leaving?
• Visuals- no response, how are you, goodbye, hello

<table>
<thead>
<tr>
<th>Correct Response</th>
<th>Incorrect Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>You said <strong>goodbye</strong>. You’re right.</td>
<td>You said <strong>how are you or hello</strong>. Let’s watch the video again.</td>
</tr>
</tbody>
</table>

• He needs to tell him goodbye.
• Even when I don’t want friends to leave I still need to tell my friend goodbye.
• Let’s watch him do it right.
• Look at the tablet.
• Video
• Thanks for helping my friend with leave-taking.
• Let’s help another friend.
• Look at the tablet.
• Video
• My friend did not do a good job of leave-taking.
• He did not do something.
• What does my friend need to do?
• Visuals- no response, **look**, smile, say hi, stop

<table>
<thead>
<tr>
<th>Correct Response</th>
<th>Incorrect Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>You said <strong>look</strong>. You’re right.</td>
<td>You said <strong>smile, say hi, or stop</strong>. Let’s watch the video again.</td>
</tr>
</tbody>
</table>

• He did not look at his friend’s face.
• Let’s watch him do it right.
• Look at the tablet.
• Video
• Great work practicing leave-taking with me.
• Let’s play again soon.
Lesson 6: Student Practices Responding to Leave-taking

- Hi.
- You have done a lot of great work with leave-taking.
- We have learned that leave-taking is something I do when I leave someone.
- Good leave-taking is looking at a friend face, smiling, and using a leave-taking word like bye, goodbye, and see you later.
- We also learned that when someone else is leaving we use our leave-taking skills too.
- We stop what we are doing, look at the friend’s face, smile, and say a leave-taking word like bye, goodbye, or see you later.
- Now it is time for you to go.
- I have had a lot of fun with you.
- But now it is time to say goodbye to me.
- Ready?
- Goodbye.
- Visuals- correct response, no response, words smile mot eye contact, words eye contact no smile, smile eye contact not words
- Great leave taking.
- See you next time.
Appendix F

Intervention Data for Greetings (Human Condition)

<table>
<thead>
<tr>
<th>Day 1: November 6, 2018</th>
<th>Lesson 1: Introduction to Greetings (Practice)</th>
<th>Question 1: Incorrect: 1 Correct: 1</th>
<th>Question 2: Incorrect: 2 Correct: 1</th>
<th>Question 3: Incorrect: 2 Correct: 1</th>
<th>Average Score Per Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average: 50%</td>
<td>Average: 33%</td>
<td>Average: 33%</td>
<td>50 + 33 + 33 = 116/3 = 38.66%</td>
</tr>
<tr>
<td></td>
<td>Lesson 1: Introduction to Greetings (Teach)</td>
<td>Question 1: Incorrect: 2 Correct: 1</td>
<td>Question 2: Incorrect: 2 Correct: 1</td>
<td>Question 3: Incorrect: 1 Correct: 1</td>
<td>Average: 33%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average: 33%</td>
<td>Average: 33%</td>
<td>Average: 50%</td>
<td>33 + 33 + 50 = 116/3 = 38.66%</td>
</tr>
<tr>
<td>Day 2: November 8, 2018</td>
<td>Lesson 1: Introduction to Greetings (Practice)</td>
<td>Question 1: Incorrect: 1 Correct: 1</td>
<td>Question 2: Incorrect: 0 Correct: 1</td>
<td>Question 3: Incorrect: 0 Correct: 1</td>
<td>Average: 100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average: 50%</td>
<td>Average: 100%</td>
<td>Average: 100%</td>
<td>50 + 100 + 100 = 250/3 = 83.33%</td>
</tr>
<tr>
<td></td>
<td>Lesson 1: Introduction to Greetings (Teach)</td>
<td>Question 1: Incorrect: 1 Correct: 0</td>
<td>Question 2: Incorrect: 0 Correct: 1</td>
<td>Question 3: Incorrect: 0 Correct: 1</td>
<td>Average: 100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average: 0%</td>
<td>Average: 100%</td>
<td>Average: 100%</td>
<td>0 + 100 + 100 = 200/3 = 66.66%</td>
</tr>
<tr>
<td></td>
<td>Lesson 2: Practice Greeting Me</td>
<td>Question 1: Incorrect: 1 Correct: 0</td>
<td>Question 2: Incorrect: 1 Correct: 1</td>
<td>Question 3: Incorrect: 1 Correct: 1</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average: 0%</td>
<td>Average: 100%</td>
<td>Average: 100%</td>
<td>0%</td>
</tr>
<tr>
<td>Day 3: November 13, 2018</td>
<td>Lesson 3: When to Use Greetings (Teach)</td>
<td>Question 1: Incorrect: 0 Correct: 1</td>
<td>Question 2: Incorrect: 0 Correct: 1</td>
<td>Question 3: Incorrect: 0 Correct: 1</td>
<td>100 + 100 + 100 = 300/3 = 100%</td>
</tr>
</tbody>
</table>
### Mean:

**Lesson 1: Introduction to Greetings (Practice)**

\[
\frac{38.66 + 83.33 + 0.00}{3} = 40.66\%
\]

**Lesson 1: Introduction to Greetings (Teach)**

\[
\frac{38.66 + 66.66}{2} = 52.66\%
\]

**Lesson 2: Practice Greeting Me**

\[
\frac{0 + 0}{2} = 0.00\%
\]

**Lesson 3: When to Use Greetings (Teach)**

100.00%

### Median:

**Lesson 1: Introduction to Greetings (Practice)**

Correct: \[0 + 0 + 0 + 1 + 1 + 1 + 1 + 1 = 1.0\]

Incorrect: \[0 + 0 + 0 + 1 + 1 + 1 + 1 + 2 + 2 = 1.0\]

**Lesson 1: Introduction to Greetings (Teach)**

Correct: \[0 + 1 + 1 + 1 + 1 + 1 = (2/2) = 1.0\]

Incorrect: \[0 + 1 + 1 + 2 + 2 = (2/2) = 1.0\]

**Lesson 2: Practice Greeting Me**

Correct: \[0 + 0 = (0/0) = 0.0\]

Incorrect: \[1 + 1 = (1/1) = 1.0\]

**Lesson 3: When to Use Greetings (Teach)**

Correct: \[1 + 1 + 1 = 1.0\]

Incorrect: \[0 + 0 + 0 = 0.0\]
The Use of Robots

Standard Deviation:

Lesson 1: Introduction to Greetings (Practice)
38.66 – 40.66 = -2.00² = 4.00
83.33 – 40.66 = 42.67² = 1820.72
0.00 – 40.66 = -40.66² = 1653.23
Mean:
4.00 + 1820.72 + 1653.23 = 3477.95/3 = √1159.31 = 34.04

Lesson 1: Introduction to Greetings (Teach)
38.66 – 52.66 = -14.00² = 196.00
66.66 – 52.66 = 14.00² = 196.00
Mean:
196.00 + 196.00 = 392/2 = √196.00 = 14.00

Lesson 2: Practice Greeting Me
0.00 – 0.00 = 0.00² = 0.00
0.00 – 0.00 = 0.00² = 0.00
Mean:
0.0 + 0.00 = √0.00 = 0.00
1.0

Lesson 3: When to Use Greetings (Teach)
100.00 – 100.00 = 0.00² = √0.00 = 0.00
Appendix G

Intervention Data for Leave-taking (Robot Condition)

<table>
<thead>
<tr>
<th>Day 1: November 22, 2018</th>
<th>Lesson 1: Introduction to Leave-taking (Practice)</th>
<th>Question 1:</th>
<th>Question 2:</th>
<th>Question 3:</th>
<th>Average Score Per Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incorrect: 1</td>
<td>Incorrect: 0</td>
<td>Incorrect: 0</td>
<td>Incorrect: 0</td>
<td>$50 + 0 + 0 = 50/3 = 16.66%$</td>
</tr>
<tr>
<td></td>
<td>Correct: 0</td>
<td>Correct: 0</td>
<td>Correct: 0</td>
<td>Correct: 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average: 50%</td>
<td>Average: 0%</td>
<td>Average: 0%</td>
<td>Average: 0%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day 2: November 26, 2018</th>
<th>Lesson 1: Introduction to Leave-taking (Practice)</th>
<th>Question 1:</th>
<th>Question 1:</th>
<th>Question 1:</th>
<th>Average Score Per Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incorrect: 1</td>
<td>Incorrect: 0</td>
<td>Incorrect: 0</td>
<td>Incorrect: 0</td>
<td>$50 + 0 + 0 = 50/3 = 16.66%$</td>
</tr>
<tr>
<td></td>
<td>Correct: 1</td>
<td>Correct: 0</td>
<td>Correct: 0</td>
<td>Correct: 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average: 50%</td>
<td>Average: 0%</td>
<td>Average: 0%</td>
<td>Average: 0%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day 3: December 5, 2018</th>
<th>Lesson 3: Practice Leave-taking with Milo</th>
<th>Question 1:</th>
<th>Question 1:</th>
<th>Question 1:</th>
<th>Average Score Per Lesson</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incorrect: 0</td>
<td>Incorrect: 0</td>
<td>Incorrect: 0</td>
<td>Incorrect: 1</td>
<td>$100 + 100 + 50 = 250/3 = 83.33%$</td>
</tr>
<tr>
<td></td>
<td>Correct: 1</td>
<td>Correct: 1</td>
<td>Correct: 1</td>
<td>Correct: 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average: 100%</td>
<td>Average: 100%</td>
<td>Average: 100%</td>
<td>Average: 50%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$100%$</td>
<td></td>
</tr>
</tbody>
</table>
Mean:
Lesson 1: Introduction to Leave-taking (Practice)
16.66 + 16.66 + 50.00 = 83.32/3 = 27.77%

Lesson 2: When to Use Leave-taking (Practice)
83.33%

Lesson 3: Practice Leave-taking with Milo
100.00%

Median:
Lesson 1: Introduction to Leave-taking (Practice)
Correct:
0 + 0 + 0 + 0 + 0 + 1 + 1 + 1 = 0.0
Incorrect:
0 + 0 + 0 + 0 + 1 + 1 + 1 + 1 = 0.0

Lesson 2: When to Use Leave-taking Skills
Correct:
1 + 1 + 1 = 1.0
Incorrect:
0 + 0 + 1 = 0.0

Lesson 3: Practicing Leave-taking with Milo
Correct:
1 = 1.0
Incorrect:
0 = 0.0

Standard Deviation:
Lesson 1: Introduction to Leave-taking (Practice)
16.66 – 27.77= -11.11²= 123.43
16.66 – 27.77= -11.11²= 123.43
50.00 – 27.77 = 22.23² = 494.17
Mean:
123.43 + 123.43 + 494.17= 741.03/3= √247.01= 15.71

Lesson 2: When to Use Leave-taking Skills
83.33 – 83.33= 0.00² = √0.00= 0.00

Lesson 3: Practice Leave-taking with Milo
100.00- 100.00= 0.00² = √0.00= 0.00
Appendix H
Average Score for Human Condition and Robot Condition During Intervention

Figure 1. Average score under the human condition and robot condition during intervention.