Psychology and Behavioral Sciences
2022; 11(6): 174-184
http://www.sciencepublishinggroup.com/j/pbs
doi: 10.11648/j.pbs.20221106.11
ISSN: 2328-7837 (Print); ISSN: 2328-7845 (Online)

A Mixed Reality Game to Improve Social Skills for Middle School Students with Autism

Xiaofan Zhang

Wuhan Linjie Rehabilitation Medical Center, Wuhan, China

Email address:
xiz227@pitt.edu

To cite this article:
Xiaofan Zhang. A Mixed Reality Game to Improve Social Skills for Middle School Students with Autism. *Psychology and Behavioral Sciences*. Vol. 11, No. 6, 2022, pp. 174-184. doi: 10.11648/j.pbs.20221106.11

Received: October 25, 2022; **Accepted**: November 8, 2022; **Published**: November 14, 2022

Abstract: A social game is designed to fill in the blank of efficient and comprehensive social skills training for middle school students who have been diagnosed with autistic spectrum disorder. The game utilizes augmented-reality technology based on the platform of Microsoft HoloLens with support of the 5G network. The game combines two popular training methodologies and is further developed to include the advantages and eliminating the disadvantages of the two. Supposedly, the student will improve their social skills by interact with the virtual characters programmed with artificial intelligent (AI) with the support of high-resolution graphic by 5G technology and Holograph. Multiple virtual characters will be presented, and some will be engaging in fun activities to motivate the student. The student can start with reading the emotions of the static virtual characters and initiate a conversation or directly jump in an existing social interaction. The environment is simulated based on the real surrounding with the support of augmented reality, so the student can play it potentially anywhere to compensate the generalization deficit in autism. The game will be designed based on the methodology of Applied Behavior Analysis and will be tested for its value starting in typical inclusive classrooms using a multiple baseline design across multiple participants.

Keywords: Autism, Social Skills, Augmented Reality, Inclusion, Artificial Intelligent, Virtual Characters, Multiple Baseline Design

1. Introduction

Problem Statement

By the number from Disease Control and Prevention (CDC) [7], around one percent of world population are on the autism spectrum or having autism spectrum disorder (ASD). In the United States, more than 3.5 million population are on the spectrum or live with ASD [2]. With the increasing awareness of autistic spectrum disorder, more and more infants received intervention in their early age as young as 20 months by different methods of interventions [13].

Researchers utilized various playful activates to increase the learning abilities of the children with autism and decrease their problem behaviors in their early age [36]. With the success of the early intervention, many children with autism could acquire appropriate or even more advanced learning skills comparing with typically developed peers in their early childhood [28]. The National Center for Education Statistics reported that during the academic year of 2008-2009, 88% of institutes of higher education enrolled students with disabilities. Within those institutions, 56% reported enrollment of students identifying as having autism spectrum disorders [26].

Figure 1 shows the studies that have done in the area of social behaviors within the students with autism, which demonstrates the gradual increasing trend of this very hot topic. Research shows that lots of students with autism may be the top of the class in the academic areas including Mathematics and English in the middle school [9, 17, 18]. Though students with autism reported high levels of academic success, they are commonly accompanied with difficulties in social behaviors [19]. According to the fifth edition of Diagnostic and Statistical Manual of Mental Disorders [1], people with autism have deficits in social–emotional reciprocities, deficits in non-verbal communicative behaviors used for social interaction, and deficits in developing, maintaining, and understanding relationships. Studies showed that 50% of students with autism had trouble

obtaining and sustaining friendships. Also, they had difficulties participating in normal social events, which are typically loud and busy [15, 29, 33].

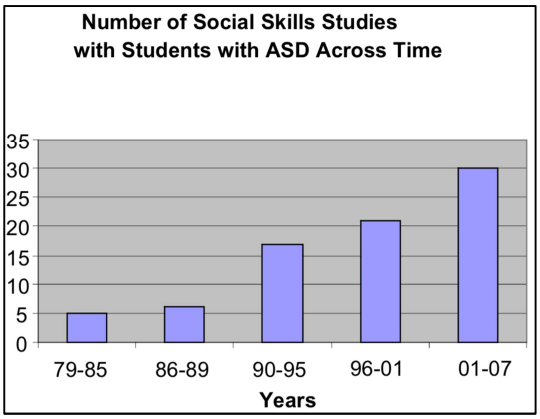

Figure 1. *Number of Social skills Studies with Students with ASD Across Time. (Adapted from [22]).*

From the explanation of neurological development, children with autism have different brain development compared to neuro-typically developed children during the first year of life. Brain overgrowth in the early age was identified as the cause of the pathobiology of autism [11]. During the age of 6-14 months, brains of autistic children grow rapidly and result in excessive neurons, which cause difficulties in neural pattering and wiring [12, 11], which can destroy long-distance interactions between various parts of the brain (i.e., frontal, temporal, and parietal cortices) [11]. The long-distance interactions are the support of socio-emotional and communication behaviors, and therefore the population with autism are commonly identified by having social difficulties.

Researcher then analyzed the biological effects of human interactions. A research showed the levels of oxytocin of the target person before and after social interactions between human. Oxytocin level increased after the target person received positive social reinforcement (i.e., verbal praise, approvals from eye contact, hand shake, hugs, and kisses). This can be regarded as the biological by-product of positive social reinforcement [16]. On the contrary, observing or going through aversive social interactions may cause aggressive behaviors [14]. From the coercive cycle, people learn aggressive behaviors from their family and people in their community [35, 32]. Comparing between positive and negative social interactions, people are largely benefited from the positive social interactions, and these interactions play an indispensable role in the survival, mental development, and the growth of human being [37].

With the transition to middle school from elementary school, students with autism are facing social interactions that are typically more complex and less predictable. When the performance of the students with autism cannot meet the social demand in middle school, students with autism may be isolated and develop mental health issues [25]. In the inclusive classroom with the mixed of typically developed students and students with disabilities, group or class-wide interventions are not effective or enough for students with autism. Alternatively, adult-guided and office-based interventions show poor results of the generalizing acquired skills in other environments [27].

Within an interview with a middle school teacher working in an inclusive classroom, students with disabilities often go to a separate classroom called “resource room” seeking for extra helps. Though resource room could help those students to gain extra help, they were still struggled with social interactions at school. Especially for those high-functioning autistic students, resource room was simply not sufficient to improve their social skills.

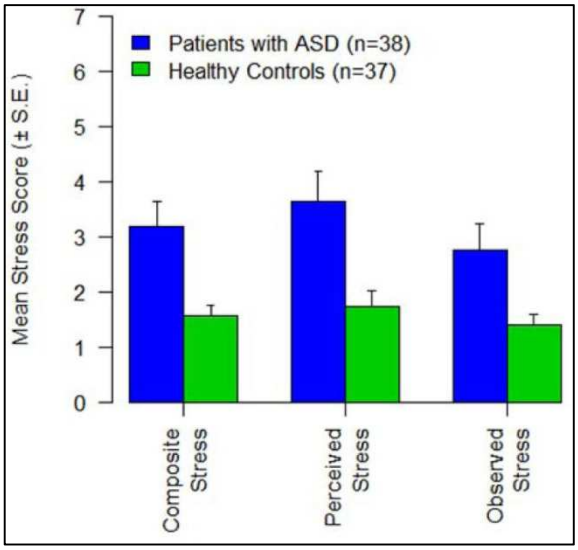

Figure 2. *Bishop-Fitzpatrick, Mazefsky, Minshew, & Eack [6] experiment comparing the social stress of autism and health volunteers.*

Another fact is that students with autism are commonly placed in a very high level of stress in the social interactions. Bishop-Fitzpatrick, Mazefsky, Minshew, & Eack [6] conducted an experiment comparing and contrasting the level of stress across two group of people, where one group contains people who are diagnosed with autism and the other has people who are healthy in the equivalence of age. The result is shown in figure 2, people with autism experienced much high stress in the social interactions compared to healthy volunteers. People with autism also experienced higher perceived stress and greater observed stress in comparison with the healthy volunteers in the experiment.

Parson & Mitchell [34] conducted a research indicating that augmented reality has great potential for developing interactive social skills for the population with autism. In the environment of augmented reality, target user would be able to enjoy real-world environment with stimulation to freely output their responses and behaviors to any objects they are interested. Kuriakose and Lahiri [20] conducted a research to further support augmented reality by showing virtual environment decreases the stress level of people with autism. The data from figure 3 shows that people entered the virtual social game with very high stress, and with the level of difficulty increased, the stress level decreased by the

conclusion of analyzing the three sets of data. In the experiment, users freely navigated throughout the environment and practiced social skills without the requirement of face-to-face interactions with real people.

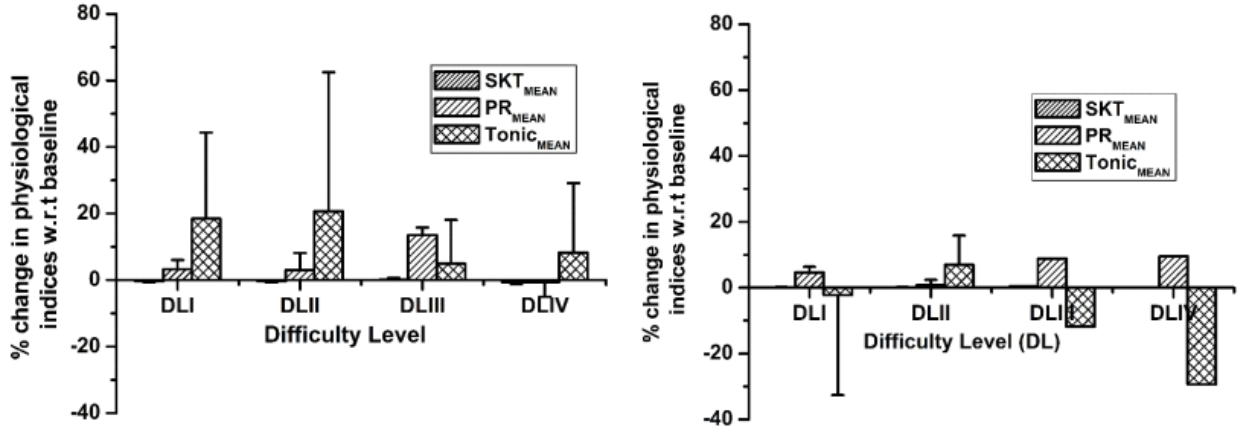

Figure 3. *Kuriakose and Lahiri [20] experiment on comparing three sets of biological data to test the stress level of people with autism in a virtual social game.*

With all the previous researches that have been done, I arrived into a research question that how can augmented reality help middle-school autistic students to improve their social behaviors of initiation and sustain conversations based on the platform of HoloLens appending the technology of 5G.

2. Current Methods to Improve Autistic Middle School Students' Social Skills

2.1. Peer-Coaching

A most prevalent methodology to train social skills at the current year is the method of peer-coaching. Peer-coaching involves a single or multiple typically developed peers who have good social skills to provide academic and social supports to a student with disabilities [8]. Potter [25] conducted an experiment to test the effectiveness of peer-coaching on training the social skills of middle school students with autism. Researcher gathered three participants diagnosed with autism who were also supported by the Individualized Education Programs (IEP) currently working on the objectives of improving social skills. Each of the target student was paired with a coach with similar age placed in the top 15% of communication skills from a group of 115 students.

The training happened in the school cafeteria during a lunch-time period where and when a large number of social interactions would normally occur. Coaches reviewed the social goals of the target students from their IEPs and practice those skills with the targeted students during the lunch period accompanying with consequating verbal/nonverbal reinforcement.

Figure 4 shows the results. Three target participants had very low rates of social behaviors during the baseline, but all of the three had big improvements on social behaviors in the treatment phases. Mike demonstrated the largest improvement going from the average of 7% social interactions in the baseline to the average of 50% social interactions in the treatment phase, which by calculation provided a raise of 43% on the rates of social interactions. Similarly, Billy went from the average of 12% to the average of 34%, and Kelly went from the average of 10% to the average of 21%. From the data, peer-coaching seemed to be very effective.

2.2. Video Modeling

Another mainstream social behavior training methodology is called video modeling. The main approach of video modeling is to show a video or anchor to the student involving the demonstrations of desired behaviors and role playing the behaviors [3]. For students with autism, video modeling increases the chance that the student will attend to the model. The video generally includes a problem, a background, and a solution [38].

According to the experiment conducted by Nikopoulos and Keenan [23], video modeling could enhance social initiations and reciprocal play skills. More importantly, the skills that participants acquired from video modeling were able to be maintained in an observation three months after the treatment. Maintenance of acquired social skill is a big advantage of video modeling, which compensate for a very big drawback of the peer-coaching method.

Ogilvie [24] conducted an experiment to test the effectiveness of video modeling on improving social skills across three middle school students diagnosed with autism. The information of the participants is showed in Table 1. This experiment was conducted in a resource room in the middle school. Four participants went through pre-intervention measurements with the scales of Social Responsiveness Scale (SRS) [10], and the Autism Social Skills Profile (ASSP) (Bellini, 2008) providing the baseline data.

For the treatment, 10 middle school students were volunteered to be recorded in the video for video modeling. Participants were told with five major skills to demonstrate in the video, which were (1) greeting a peer or teacher, (2) participating in a conversation, (3) tracking the talker, (4)

following directions, and (5) asking a question. The video started with a short narrative to show the name of the skill and the steps of completing the task in a socially appropriate manner. The video was then played.

As figure 5 shows, the scores of all three participants went up. Also, worth to note that the scores in maintenance phase did not go down, which inferred those three participants maintained their acquired social skills.

Table 1. *The participants of Ogilvie [24] experiment testing the effectiveness of video modeling on improving social skills for middle school students.*

Primary					
Primary Participants	**Age**	**Gender**	**Ethnicity**	**Grade**	**IQ**
Participant 1	13	Male	Mexican-American	7	87
Participant 1	12	Female	Italian-Ameircan	7	77
Participant 1	12	Male	Caucasian	6	71
Participant 1	12	Male	Hispanic	6	89

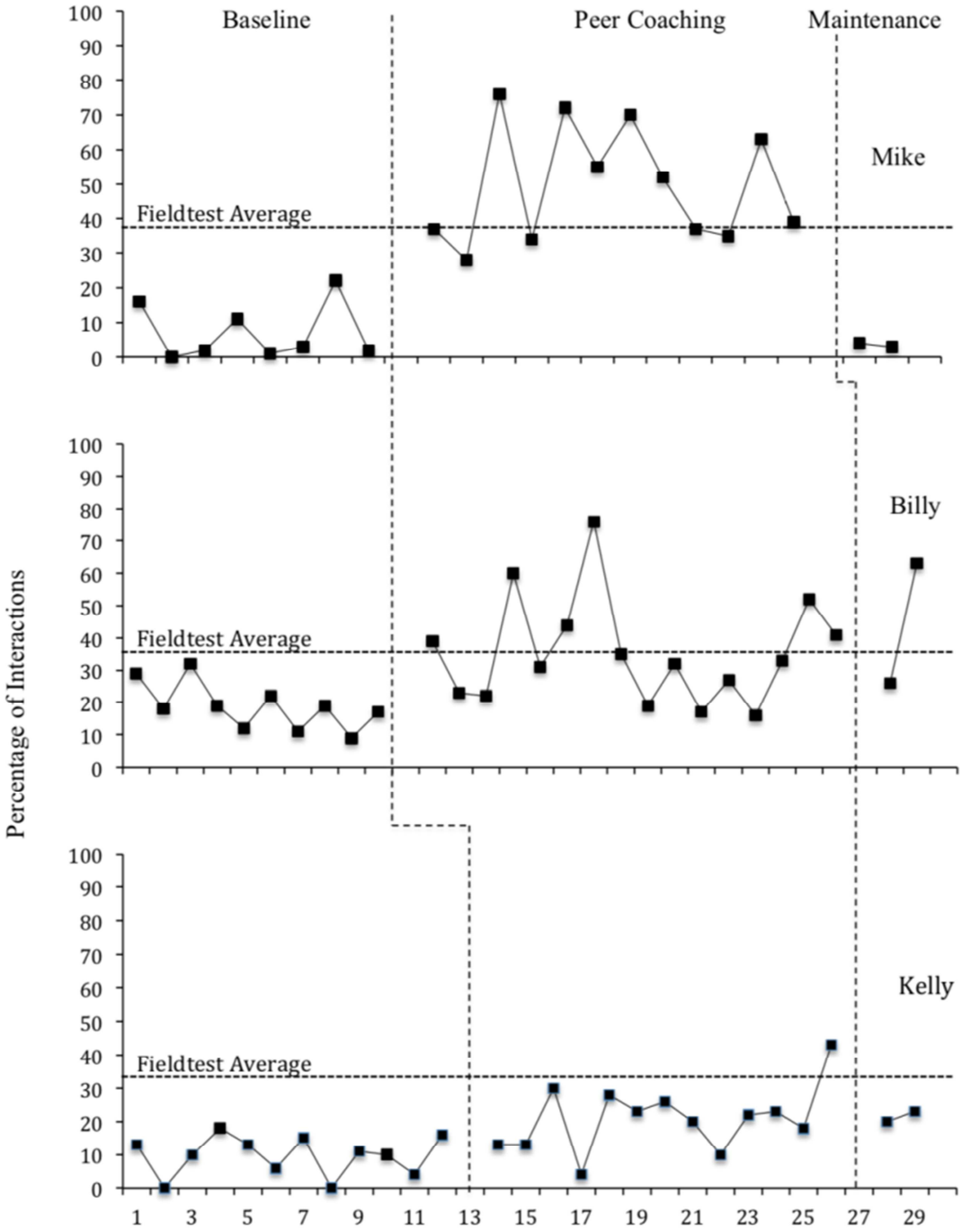

Figure 4. *Potter [25] experiment testing the effectiveness of peer-coaching method for improving social skills of the middle school students with autism using a multiple baseline design.*

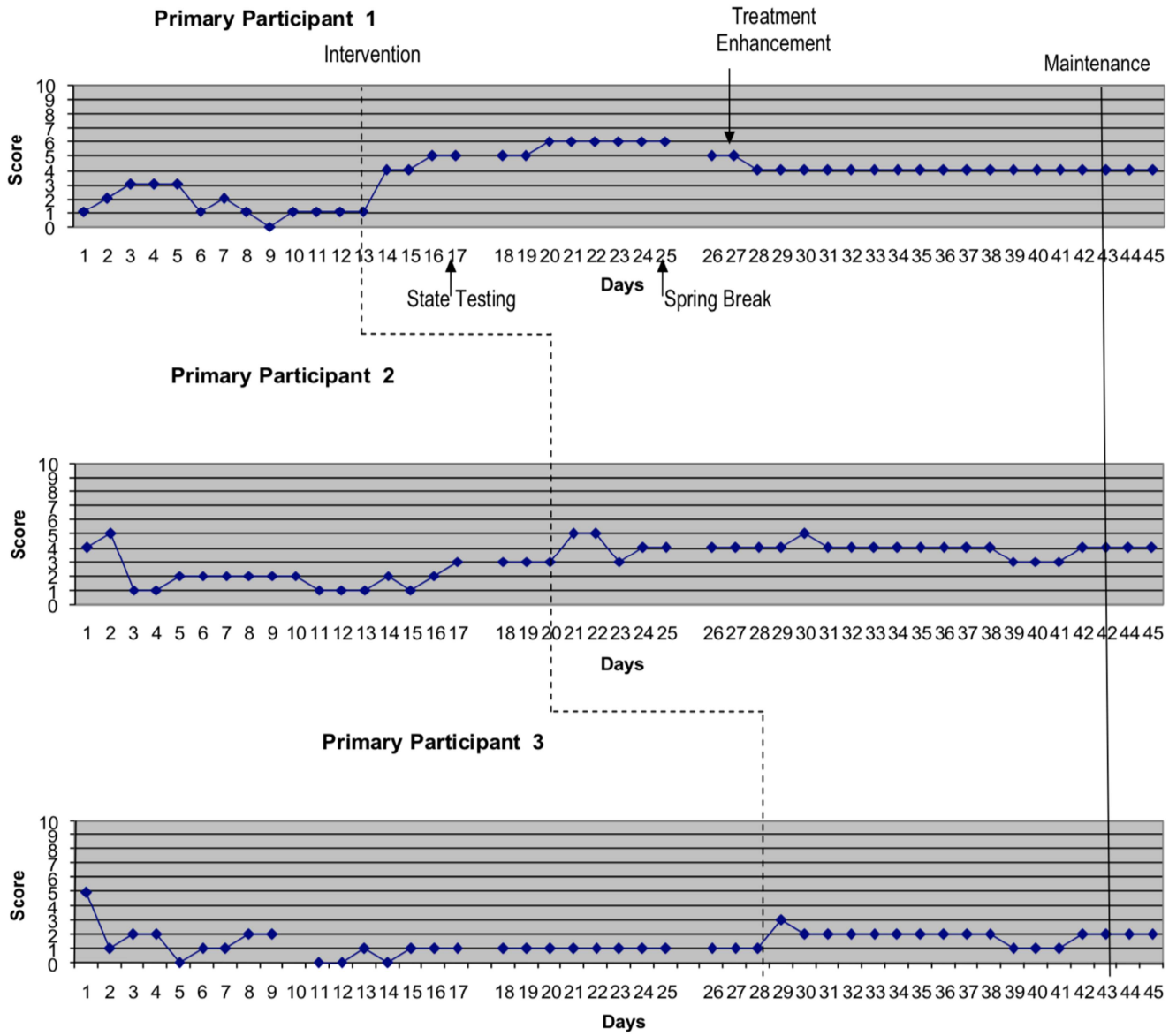

Figure 5. *Ogilvie [24] experiment testing the effectiveness of video modeling on improving social skills for middle school students.*

3. Discussion of the Disadvantages of Current Training Methods

3.1. Peer-Coaching

In the experiment of peer-coaching, the data indeed showed a big increase of average from the baseline to the treatment phase across all participants. However, it is also worth to note the significant drop on the maintenance phase. The graph only showed two data points for each participant in their third phase, but the point value dropped close to the average of the baseline without counting any setting events that may be involved.

Students with autism have low rates of social interactions because they do not know how to initiate conversations with others, or not interested in talking to other people. In the experiment, coaches subjectively approached targeted students. Coaches were good at helping targeted students with their social interactions, but clearly ignore on teaching how to initiate conversations. While the students don't know how to initiate a conversation, the rate of social behaviors dropped significantly after the coach no longer approaches the students.

Another issue was that different coaches had different areas that they were good at. It was not hard to see that all three participants had improvement, but there were absolutely observable differences between the amount of improvement within the three. Mike had 43% of improvement versus Kelly only had 11% of improvement. This happens because Mike might have a very easy task to do and Kelly received a very hard one, or the quality of teaching differed between the two coaches. This variable was hard to control even when the coaches were selected from top 15% according to their social abilities.

The biggest limitation of this method is the generalization issue for autistic students. Koegel & Koegel [21] stated that

students with autism are able to learn huge numbers of new behaviors within the certain environments, but their gains are typically restricted in the scopes and limited to the treatment environment. The place and time for the treatment were thus very essential and need to be varied, but this is very restricted in this method. Coaches have their personal life as well, so it is very hard to train a student with autism using this method across various places and times using a single coach.

3.2. Video Modeling

Video modeling has a very big advantage that is students could maintain their acquired skills after the end of the treatments. However, this method had many disadvantages as well. From the graph, even though the scores went up in the treatment phase across three participants, neither of the three went up a lot. It is easy to see that the average of the scores only improved 1-2 points in any of the participants, which was the result of unindividualized treatment. All participants were shown the same video, which resulted in their specific objectives or needs not been met. Therefore, it was not surprising that their social skills were not improved a lot.

Video modeling also does not deliver consequences in the video. Even the students saw the whole procedures of the skill, students still needed a real person to practice it and be given the corresponding consequences (i.e., positive reinforcement or error correction). A teacher might have functioned as an instructor and required the students to practice among themselves, but it was not efficient considering the resource was consumed to do this and the efforts of hiring peers to model and record the videos.

The most threatening disadvantage of video modeling is that it does not target a specific need of the student. In the population of autism, nearly every student has a different need. Students with autism normally have IEPs specified which social behaviors the teacher is currently working on. Showing a group video does not meet the need of a specific student. It is also meaningless and waste of time to teach a student very advanced social skills because he/she may not possess the prerequisite to learn those skills. Likewise, it is not effective to teach a student something he/she has already mastered.

4. Game Design

With all the elements described above putting in a consideration, I want to propose a social game utilizing augmented reality based on the platform of HoloLens creating virtual environments for middle schoolers with autism to practice their social behaviors including the methods of virtual peer-coaching and video modeling.

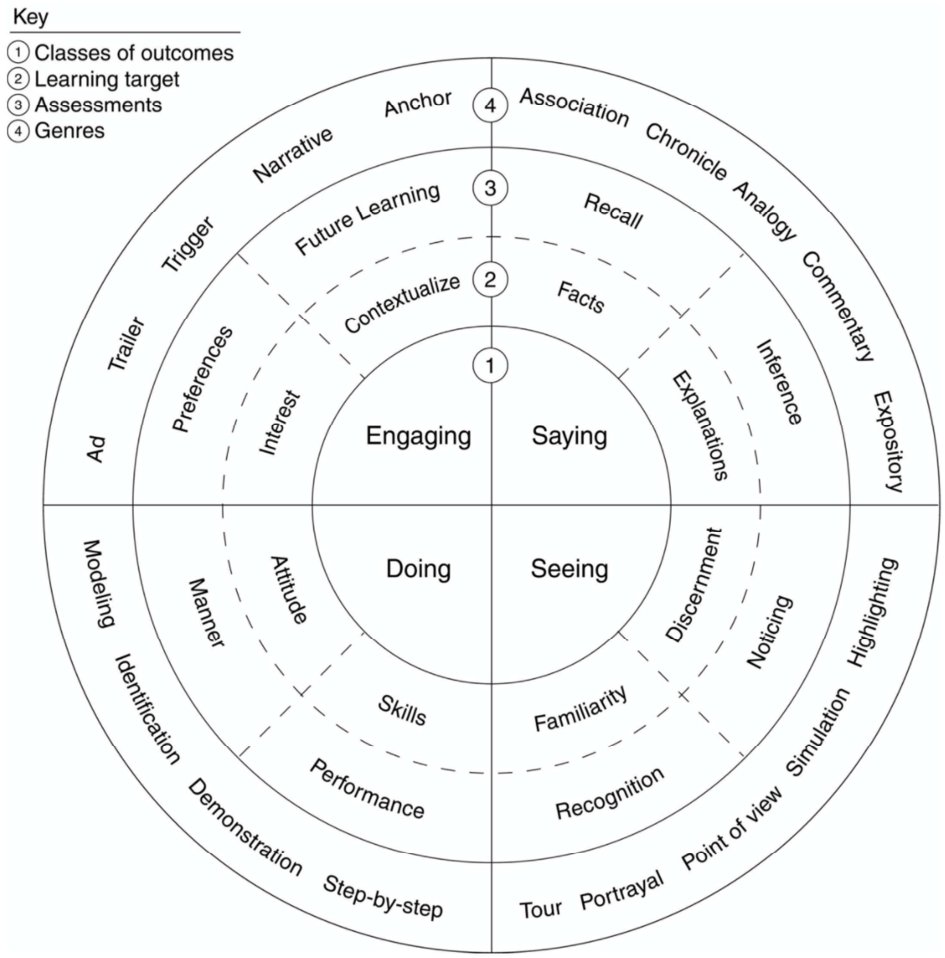

Figure 6. *Szowski Wheel [30].*

From the research of Szowski & Hartman [30], I located my target outcome and learning type based on the Szowski Wheel shown in figure 6. I am targeting the class of outcomes of saying. Ideally, the autistic student will play the game and be able to express the sentence using verbal behaviors with appropriate functions in that specific social setting. The learning type is the explanation of their thoughts based on the understanding of other people's social behavior. My targeted student will learn what is effective social behaviors and are able to initiate and sustain a social conversation with his/her peers.

Design Goal: To improve the social behaviors of middle school students with autism by delivering treatment through virtual characters programmed with artificial intelligent (AI).

Learning objectives:

1) To motivate the targeted student to engage in a social interaction or recover the interest of that student to attend a conversation.
2) To improve specific deficits of the targeted student in the area of social behaviors (e.g., initiate conversations, sustain conversations, understand the functions of the conversations, etc.).
3) To improve the experience of social interactions and help hence help students to make more friends in real life.

Associate objectives:

1) To reduce the consumption of using real peers for social training.
2) To improve resource room management by handing the intervention mostly to the artificial intelligent (AI).

4.1. Target Audience

I am targeting middle school students with autism from the grade of 5 to 9 with the priority of the grade 5 to 6 which contains students who are going through the transition from elementary to middle school and currently experiencing the change of the new social environment with more complicated social behaviors from their peers. Target students should have IEPs stating the specific social goals or objectives that the students are currently working on. In general, the school can be located anywhere within the United States containing autistic students aiming to perform better in their social interactions, but I am starting with a 5G school located near New York city and a middle school practicing special education using the principle of Applied Behavior Analysis (ABA) located in New Jersey and is under the guidelines of Comprehensive Application of Behavior Analysis to Schooling (CABAS). Both schools contain suitable students for my game and have the common interest of improving the quality of their life through better social behaviors. My targeted students should possess the listener and speaker repertoires as the prerequisites for the game, and they should be able to perform simple verbal behaviors to express their needs and ideas.

4.2. Materials and Settings

I will provide each school will with a HoloLens produced by Microsoft cooperation installed with my game programed by a high-performance computer. The game will start to be played by the targeted students in the resource room.

4.3. Global Picture of the Game

Two prototypes of this game will be designed in consecutive time period. I plan to design the game in a simple version as the first prototype as a start and keep designing it after the first prototype is tested. For the first prototype will be designed in a 3 months period, I plan to design the game starting with recognizing the facial emotions of the virtual characters and exchanging conversations with the characters using simple artificial intelligent (AI). Meanwhile, I will also program a couple of virtual peers playing aside to be used as video/peer modeling, where the autistic student can also approach those characters to engage in a conversation. For the measurement, I plan to use two scales (i.e., social responsiveness scale (SRS) 1) & autism social skills profile (ASSP) 2) to measure) to do the pre-test and post-test before and after the game is played.

After the first 3 months, I plan to keep designing it with more comprehensive AI. Ideally, the virtual characters will gather the data from the conversations with the targeted student and analysis which part of the social skills targeted student contain deficits. During this process, the virtual character will give a score based on the quality of the conversation each time the targeted student performed in the game, and these data will be used for creating baselines. In the treatment phase, the virtual character will deliver treatments based on the analysis in the baseline and give a score for the total quality of the conversations in the game, which will be the data for the intervention phase. I will use a multiple-baseline design across multiple students to prove the value of the game.

1) Social Responsiveness Scale is a 65-item Likert scale validated by researches to evaluate the level of social behaviors of people with autism [10].
2) Autism Social Skills Profile is a 5-point Likert scale survey that can be completed by parents, teachers, and anyone knows the targeted person to evaluate the level of social performance for that person [4].

4.4. Design Rationales

Learning objectives:

1) To motivate the targeted student to engage in a social interaction or recover the interest of that student to attend a conversation.

A behavior is formed based on the consequences of the past experience. Students with autism enter the middle school facing a brand-new environment, hence may not perform very well in a social interaction. With the negative social consequences (e.g., verbal abuse, bully, etc.), the chance of the student initiating a social interaction become very slim. In that, my first objective is attempting to recover the interest of the targeted student in area of social interactions.

With video modeling involved, it decreases stimulus overselectivity and use the videos that are highly reinforcing and preferred by the targeted student [5, 31]. People with autism usually have the tendency to consider many visual information that are irrelevant to the topic and are unable to filter that information out. This is called stimulus overselectivity [31]. If the student starts the game seeing a bundle of static virtual characters sitting around the room, they may not know what to do because the game is showing lots of information that the student does not know how to process. With that been concerned, one or two group of virtual characters will be playing in the environment and engaging in social interactions at the different spots in the room to show that social interactions can be enjoyable and demonstrate how to start and sustain a social interaction. This will motivate the student to perform something likewise. With the support of Holograph, the virtual characters will be presented with every detail that a real person may have. The student will have the experience of seeing his/her real-like peers and try some social interactions that the student has failed before with the mindset that those virtual characters are not harmful with the state of low stress. Therefore, the first step of this game is to trigger the interest of the student and motivate the student to jump into a social interaction.

2) To improve specific deficits of the targeted student in the area of social behaviors (e.g., initiate conversations, sustain conversations, understand the functions of the conversations, etc.).

Peer-coaching demonstrated a very promising result on improving a specific social deficit of the targeted student. Based on this methodology, I plan to develop a virtual AI that can analysis the needs of the student identifying precise social behaviors that are needed based on the scale measurements of SRS and ASSP. The virtual AI will replace the role of the real peers and possess more comprehensive ability in analysis the deficits. The ability of the peer coach may vary, but the ability of virtual AI stays the same across multiple users. Virtual AI will have sophisticated ability to analyze the functions of the behaviors and develop a treatment to a specific user accordingly. It also possesses more comprehensive treatment skills that a real student in a typical middle school who may not have any teaching experience.

Students with autism need individualized treatments. The virtual AI will be able to increases the difficulty of the task when the student is performing bad behaviors and decreases the difficulty when the social interaction seems too easy for the student. The adjustment comes with the knowledge programmed in the AI with large amount of the data stored. The AI will make the decision of changing the difficulty base on the current performance of the user in a quick manner according to the programmed algorithm. The AI can choose or change the current treatment to best fit the targeted student in a second, versus real people needs to record the data and analyze them after the treatment. It is also questionable of the analyzing ability of a typical middle school student.

Our game follows strictly through applied behavior analysis (ABA) principle and applied rigorous ABC (Antecedent, Behavior, Consequence) sequence with positive reinforcement and error correction. The virtual AI delivers verbal/nonverbal antecedent to the student (e.g., asking "What did you eat for lunch?", a sad facial expression, etc.). With an appropriate social response elicited by the student (e.g., saying "I had a burger and some fries.", asking "what made you so sad?", etc.), the virtual AI delivers the social reinforcements and try to create an enjoyable social interaction (e.g., saying "I love burger! Did you make it by yourself?", saying "thanks for asking! I was bullied by a student from a higher grade", etc.), or the virtual AI engages in an error correction when the student output inappropriate response or deviates from the conversation (e.g., saying "Uhm, I did not ask for your favorite movie. Could you tell me more about your lunch?"). The AI analyses the social interactions and delivers the treatment that is most appropriate corresponding to the student's current social skills, so the student is receiving the individualized intervention in a time-efficient manner.

3) To improve the experience of social interactions and help hence help students to make more friends in real life.

The ultimate learning objective is to use this game to help targeted student to make more friends, enjoy more coherent social interactions with others, and ultimately improve life quality of the student. Therefore, the student must retain the social skills learned from the game. Video-modeling has a great residue effect after the treatment, which means that students tend to keep the acquired skills after the interventions have been withdrawn. I will utilize the methodology of video modeling (precisely peer modeling) to demonstrate to the student on how to perform the social interactions and restore it to his/her memory. With this method, students will be able to perform the same skill in the same environment that they learned. When they walk into a classroom, they will recall the last experience of playing this game and start to interact with their peers in the class.

Contrastively, improving the rate of social interactions of the student with autism in classroom will not drastically improve their social life because lots of they cannot recall the skills in a different environment, and that is the main reason I use virtual environment. This game will start to be used mainly in the resource room setting at the early stage, but for the second prototype and future development of this game, it can be played in multiple settings. Targeted student can play the game 30 minutes before the lunch time and practice the learned skills with his/her peers while eating food. Targeted student can also play this game after school when he/she goes to the playground where lots of peers are engaging social interactions. Here, some may argue that it may be very odd for that student to wear the device in the playground and the student will be embarrassed by the peers watching him. However, the HoloLens used for this game is the most cutting-edge electronics designed by Microsoft. If the peers from the playground are laughing at the student, the student can show them the device and let them try the game, which coincidentally initiated a social

interaction. With the support of the Holograph and the 5G network in the environment of augmented reality, there is a big chance that this game will blow the mind of a typical middle school student. If the peers from the playground like the game, the student can exchange his/her opinions of playing by starting a conversation and explore the common interest, which can be a start of a friendship.

Associate objectives:

1) To reduce the consumption of using real peers for social training.

In the methodologies of both peer-coaching and video modeling, one very big disadvantage is the large consumption of the human resource. For coaching one student, minimum one student coach and one supervising teacher need to be involved. It takes a lot of time for the teacher to teach the coach understanding the IEP and the specific social deficits of the targeted student. That teacher also needs to monitor if the coach is doing the right procedure with the targeted student, and to teach the coach to record and analysis the data to make treatment decisions is then another lengthy process. Most importantly, the coach has his/her life, and hence the time and location of the treatment are not very flexible. Not to mention that the coach may be mocked by his/her friends to teach someone that is not very welcomed in his/her friend circle, and so influence the mental health of the coach.

In the method of video modeling, it requires minimum two people to be models, one person to film, and another instructor to design the video content. To present a comprehensive treatment, this team needs to film videos targeting each specific social deficit of the student because the need for different student is very different. Meanwhile, the teacher has to spend time to record the data of the social interactions involved with the targeted student and analyze the data to realize which video should be showed to the targeted student. Considering the generalization issue that is commonly occurred in the population of autism, those videos may be needed to be reproduced with different environments.

For playing my game, there is only one person needed to be involved throughout the whole process to simply watch the safety of the targeted student. All the data collections, graph analysis, and decision makings are handled by the AI that is programmed in the game. Also, this game is not constrained in the environment settings because it utilizes the technology of augmented reality, and the virtual characters can be showed on any environments that the student is current surrounded. The student can play it anywhere he/she wants to practice the social behaviors.

2) To improve resource room management by handing the intervention mostly to the artificial intelligent (AI).

In the field of special education, most treatments or interventions require licensed professionals to watch over or physically be part of the intervention. During the resource room time, there will most likely be multiple students with different disabilities. It will be very common for one student practicing the math problem while another student practices the social behaviors. In this case, it requires a lot of attentions from the certified professionals to manage the multiple students. With this game involved, the student can freely play and practice the social skills without a close attention form the professional. The school may not be able to replace the professionals in the resource room with a random person to decrease the expense, but the professional can spend less energy to overwatch the student who is playing the game from a long distance, so the he/she can better manage the resource room.

5. Assessment

Two assessments will be implemented to this game. During the first time period with the first prototype, the two most prevalent measuring scales (SRS & ASSP) will be used. A prior assessment based on these two scales will be done to exam the level of social behaviors of the targeted student before playing the game. ASSP will be done by sending surveys to the people who have close relationships with the student (e.g., parents, teachers, friends, relatives, etc.). SPS is an exam that needs to be handled by professionals through direct observation, so a qualified professional will talk to the student and test the level of social behaviors by using corresponding instruments mentioned in SPS. The student will play this game after the assessment in the normal school days when he/she goes to the resource room. The student will play this game for a month. After a month, the student will be assessed again using SRS and ASSP. The comparison between the two assessments will conclude the effectiveness of this game. However, autistic spectrum disorder is a lifelong disability. A student who has social difficulty for ten more years may not be easily cured within a month playing this game, and that's why there are two phases for this game.

In the second time period with the second prototype containing AI with comprehensive abilities, a multiple-baseline design across individuals will be implemented for assessment. Four participants will be selected from the grade 5 to 6 in the middle school to do this research. Each participant will enter the treatment phase in the game after the baseline of prior participant in a timely manner. To further explain this, I will tag four participants with letter identification called student A, B, C, and D. I will let student A play the game first. Student A will play this game for at least 10 sessions (the whole time the student spent in the resource room playing this game count as 1 session), and AI will deliver a score at the end of each session, which will be my data points for the baseline. If the data appear to be stable across the first 10 sessions, the intervention will be implemented by virtual AI. Alternatively, if the data are not stable and have an observable trend, more sessions will be played until the data are stable. If the data have a trend of increasing and reached the score equivalent or beyond 90% for two consecutive sessions, the social behavior will be identified as acquired. However, this may not happen because AI will adjust the level of difficulty to best suit the level of social behaviors of the student. Student A enters treatment phase after baseline data are stable. In treatment

phase, the AI delivers a score after each session. The scores will be used as the data points of the intervention phase until the total number of sessions including baseline and treatment phase reaches 40, which conclude the assessment for student A. Student B will play this game for at least 15 sessions for the baseline and enter the intervention phase until the game ends when the total number of sessions reaches 40. Student C will play this game for at least 20 sessions for the baseline and enter the intervention phase until the game ends when the total number of sessions reaches 40. Student D will play this game for at least 25 sessions for the baseline and enter the intervention phase until the game ends when the total number of sessions reaches 40. The structure of the multiple baseline design eliminates lots of instabilities and shows the value of the game by assessing multiple students.

References

[1] American Psychiatric Association. (2013) Diagnostic and Statistical Manual of Mental Disorders. 5th ed. Arlington, VA: American Psychiatric Publishing.

[2] Buescher, A. V., Cidav, Z., Knapp, M., & Mandell, D. S. (2014). Costs of Autism Spectrum Disorders in the United Kingdom and the United States. JAMA Pediatrics, 168 (8), 721.

[3] Bandura, A. (1977). Social learning theory. New York, NY: General Learning Press.

[4] Bellini, S. (2008). Building social relationships. Shawnee Mission, KS: Autism Asperger Publishing Company.

[5] Bellini, S. & Akullian, J. (2007). A meta-analysis of video modeling and video self- monitoring interventions for children and adolescents with Autism Spectrum Disorders. Exceptional Children, 73, 264-287.

[6] Bishop-Fitzpatrick, L., Mazefsky, C. A., Minshew, N. J., & Eack, S. M. (2014). The relationship between stress and social functioning in adults with autism spectrum disorder and without intellectual disability. Autism research: official journal of the International Society for Autism Research, 8 (2), 164-73.

[7] CDC. (2014) Prevalence of autism spectrum disorders—ADDM network. MMWR Surveill. Summ, 63. 1-22.

[8] Carter, E. W., Cushing, L. S., Clark, N. M., & Kennedy, C. H. (2005). Effects of peer support interventions on students' access to the general curriculum and social interactions. Research & Practice for Persons with Severe Disabilities 30 (1), 15-25.

[9] Couzens, D., Poed, S., Kataoka, M., Brandon, A., Hartley, J., & Keen, D. (2015). Support for students with hidden disabilities in universities: A case study. International Journal of Disability Development & Education, 62 (1), 24.

[10] Constantino, J. N. & Gruber, C. P. (2005). Social responsiveness scale. Western Psychological Services: Los Angeles, CA.

[11] Courchesne, E., Pierce, K., Schumann, C. M., Redcay, E., Buckwalter, J. A., Kennedy, D. P., & Morgan, J. (2007). Mapping early brain development in autism. Neuron, 56 (2), 399-413.

[12] Courchesne, E., Carper, R. A., & Akshoomoff, N. A. (2003). Evidence of brain overgrowth in the first year of life in autism. Jama, 290 (3), 337–344.

[13] Dawson G, Rogers S, Munson J, et al. (2010) Randomized, controlled trial of an intervention for toddlers with autism: The Early Start Denver Model. Pediatrics. 125 (1).

[14] Dumas, J. E. (1986). Indirect influence of maternal social contacts on mother-child interactions: A setting event analysis. Journal of Abnormal Child Psychology, 14 (2), 205-216.

[15] Fabri, M., Andrews, P., & Pukki, H. (2016). A guide to best practice in supporting higher education students on the autism spectrum—for professionals within and outside of HE.

[16] Feldman, R., Gordon, I., Schneiderman, I., Weisman, O., & Zagoory-Sharon, O. (2010). Natural variations in maternal and paternal care are associated with systematic changes in oxytocin following parent–infant contact. Psychoneuroendocrinology, 35 (8), 1133-1141.

[17] Fleischer, A. S. (2012). Support to students with asperger syndrome in higher education—the perspectives of three relatives and three coordinators. International Journal of Rehabilitation Research, 35 (1), 54–61.

[18] Gobbo, K., & Shmulsky, S. (2014). Faculty experience with college students with autism spectrum disorders: A qualitative study of challenges and solutions. Focus on Autism and Other Developmental Disabilities, 29 (1), 13–22.

[19] Gelbar, N. W., Shefcyk, A., & Reichow, B. (2015). A comprehensive survey of current and former college students with autism spectrum disorders. The Yale Journal of Biology and Medicine, 88 (1), 45–68.

[20] Kuriakose, S., & Lahiri, U. (2017). Design of a physiology-sensitive vr-based social communication platform for children with autism. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 25, 1180-1191.

[21] Koegel, L. K., Singh, A. K., & Koegel, R. L. (2010). Improving Motivation for Academics in Children with Autism. J Autism Dev Disord, 40, 1057- 1066.

[22] Matson, J. L., Matson, M. L., & Rivet, T. T. (2007). Social-skills treatments for children with autism spectrum disorders. Behavior Modification, 31 (5), 682-707.

[23] Nikopoulos, C. K. & Keenan, M. (2004). Effects of video modeling on social initiations by children with autism. Journal of Applied Behavior Analysis, 37 (1), 93-96.

[24] Ogilvie, C. R. (2008). The impact of video modeling and peer mentoring of social skills for middle school students with autism spectrum disorders in inclusive settings. (Order No. 3335359, University of Central Florida). ProQuest Dissertations and Theses, 201.

[25] Potter, J. (2014). The effect of peer-coaching on social skills performance of middle school students with high functioning autism spectrum disorder. (Order No. 3618803, University of Southern Maine). ProQuest Dissertations and Theses, 53.

[26] Raue, K., Lewis, L., & Coopersmith, J. (2011). Students with disabilities at degree-granting postsecondary institutions—2011018. pdf. Retrieved August 16, 2016, from http://nces.ed.gov/ pubs2011/2011018.pdf.

[27] Reichow, B., Volkmar, F. R., & Cicchetti, D. V. (2008). Development of the Evaluative Method for Evaluating and Determining Evidence-Based Practices in Autism. Journal of Autism and Developmental Disorders, 38 (7).

[28] Sarrett, J, C. (2018) Autism and accommodations in higher education: insights from the autism community. Journal of Autism and Developmental Disorder, 48: 679-693.

[29] Sayman, D. M. (2015). I still need my security teddy bear: Experiences of an individual with autism spectrum disorder in higher education. Learning Assistance Review (TLAR), 20 (1), 77–98.

[30] Schwartz, D., & Hartman, K. (2006). It is not television anymore: Designing digital video for learning and assessment. Video research in the learning sciences. Mahwah, NJ: Erlbaum.

[31] Sherer, M., Pierce, K. L., Paredes, S., Kisacky, K. L., Ingersoll, B., & Schreibman, L. (2001). Enhancing conversation skills in children with autism via video technology. Behavior Modification, 25 (1), 140-158.

[32] Smith, J. D., Dishion, T. J., Shaw, D. S., Wilson, M. N., Winter, C. C., & Patterson, G. R. (2014). Coercive family process and early-onset conduct problems from age 2 to school entry. Development and Psychopathology, 26 (4pt1), 917-932.

[33] Taylor, M. J. (2005). Teaching students with autistic spectrum disorders in HE. Education & Training; London, 47 (6/7), 484–495.

[34] Parsons, S., & Mitchell, P. (2002). The potential of virtual reality in social skills training for people with autistic spectrum disorders. Journal of Intellectual Disability Research, 46 (5), 430-443.

[35] Patterson, G. R. (2016). Coercion theory: The study of change. In Dishion, T. J., & Snyder, J. J. (Eds.). (2016). The oxford handbook of coercive relationship dynamics. Oxford University Press. 7-22.

[36] Vivanti G, Paynter J, Duncan E, et al. (2014) Effectiveness and feasibility of the early start denver model implemented in a group-based community childcare setting. J Autism Dev Disord. 44 (12): 3140–3153.

[37] World Health Organization. (2004). The importance of caregiver-child interactions for the survival and healthy development of young children: A review.

[38] Williams Glaser, C., Rieth, H. J., Kinzer, C. K., Colburn, L. K., & Peter, J. (1999). A description of the impact of multimedia anchored instruction on classroom interactions. Journal of Special Education Technology, 14 (2), 27-43.