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MALAYSIAN TEACHERS' VIEWS ON ROBOT-MEDIATED INTERVENTION TO TRAIN AUTISM SPECTRUM DISORDER (ASD) CHILDREN ON EMOTIONAL REGULATION

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ABSTRACT

This qualitative study explored the views of teachers and an occupational therapist about the potential use of humanoid robots as an assistive tool in educating autism spectrum disorder (ASD) children. Seven participants with extensive experience handling early intervention programs for ASD children were selected via purposive sampling. Semi-structured interviews and focus group discussion (FGD) were applied as data collection method. Data gained were analyzed using thematic analysis. Four main themes were identified from the study, they are: (1) Teachers' knowledge about robots, (2) Robots increase children's engagement, (3) Roles of robots in intervention, and (4) advantages and disadvantages of using robots. All participants had observed a robot-mediated intervention involving interactions between ASD children and a humanoid robot. It was observed that most of the children at the center liked interacting with the robot, suggesting that the use of robots could benefit ASD children. However, these interactions must be monitored and limited to a certain period to avoid over-dependence on robot use. This study provides a novel perspective on robotics and a practical example of how to use robots to enhance learning outcomes for ASD children.

Keywords: *ASD children, emotional regulation, humanoid robot, robot-mediated intervention, teachers' view*

INTRODUCTION

Emotional regulation (ER) can be defined as the process by which individuals influence which emotions they have, as well as when and how they experience and express these emotions (Gross, 1998). Individuals with Autism Spectrum Disorder (ASD) may not be able to use adaptive ER strategies and instead react impulsively to emotional stimuli with tantrums, aggression, or self-injury (Sofronoff et al., 2007). ASD is a complex neurodevelopmental condition that is not a learning disability. It can, however, impair learning because most ASD children find it difficult to comprehend abstract concepts which include beliefs, ideas, and other intangible things. The majority of people with autism are concrete thinkers who tend to take words or phrases literally. ASD is characterized by social communication deficits as well as restricted and repetitive interests and behaviors with perpetual and sensory processing

impairments (American Psychiatric Association, 2013). Most of the characteristics exhibited by ASD individuals are due to their impairment in emotional self-regulation (Mazefsky et al., 2013).

Dysregulation of emotion is not a formal criterion for diagnosing ASD. It has been shown that these social communication deficiencies are positively related to higher levels of emotional dysregulation in ASD children (Samson et al., 2016). The development of therapy programs that uses adaptive types of emotion regulation can minimize emotional problems. Some have argued that, based on previous research, it is difficult for medications or drugs to reliably treat autism's core social and communicative disorders (Wink et al., 2010). Therapy programs have shown positive outcomes for ASD children as early as the infant stage. However, no single measures are available that can treat the heterogeneous condition or suit every autistic child.

In recent years, organizations and universities worldwide have undertaken robotic research projects involving clinical studies with ASD children. Robots designed to develop ASD children's social interaction, imitation, and attention skills, have demonstrated some promising outcomes (Chevalier et al., 2017). Most research focuses on the recognition of emotion in others. Therefore, a broader approach that includes emotional reactivity and regulation is needed (Mazefsky, 2015).

Meanwhile. the National Autism Society of Malaysia (NASOM) reported that more Malaysian children are diagnosed with ASD every year and existing, affordable intervention centers are now overutilized (Murad, 2019). New government intervention centers are needed because private centers are very costly for parents earning low to lower-middle-income. The National Early Childhood Intervention Council (NECIC) have also warned that there is a shortage of well-trained staff for early intervention programs (NST Letters, 2019).

In Malaysia, several studies on humanoid robot-based intervention programs for ASD children have been conducted (e.g., Ismail et al., 2012; Shamsuddin et al. 2013; Shamsuddin et al., 2015). Amin et al. (2018) compared the teaching and learning method using robots with the conventional method and found that using a robot increases attentiveness and reduces loss of focus. However, these studies were unclear on what is needed to work towards using robots for ASD children's education. Limited study has explored the views of Malaysian teachers or professionals on the use of robots in autistic learning. The teachers' views as key decision-makers are important for the adoption of new technologies robot-based programs require an in-depth understanding of how to integrate robots into the teaching and learning process (Alcorn et al., 2019). The present study explored the potential use of humanoid robots in autism intervention programs, especially for teaching emotional regulation skills. Thus, its aim is to explore teachers' perspectives on the applications of humanoid robots as a tool for teaching ASD children particularly to regulate their emotions.

LITERATURE REVIEW

Technologies such as artificial intelligence (AI) have been used to help ASD children become independent in their daily life. The Cambridge Dictionary defines AI as "the study of how to produce computers that have some of the qualities of the human mind, such as the ability to understand language, recognize pictures, solve problems, and learn." Although there are many forms of AI, humanoid robots are found to have a substantial impact on children because of their human-like appearance (Alcorn et al., 2019). In developed countries, the use of robots in behavioral and learning-related therapies for ASD children has shown great improvements. Robot-assisted autism therapy (RAT) has steadily gained popularity due to the robots' usefulness in facilitating social contact and joint activities for ASD children. Researchers and clinicians have introduced robot models with a wide range of appearances, features and capabilities, aided by experts from engineering, clinical psychology, and other fields. The robots' appearance, particularly certain types, was also found to significantly influence the clinical benefits (Sartorato et al., 2017).

Previous studies on ASD children's interaction with robots have mostly been based in laboratory settings (e.g., Salvador et al., 2015; Yun et al., 2016). Placing robots from the laboratory into the classroom is

not a straightforward process (Diehl et al., 2012; Huijinen et al., 2016). Studies that explore the teachers and professionals' views on using robots in education were mostly conducted within regular educational settings (Fridin & Belokopytov, 2014; Kennedy et al., 2016), and very few were done within the special education setting. Alcorn et al. (2019) concluded that educators' interviews provide a valuable starting point for understanding how robots might be integrated into existing practices. Some teachers consider sustained engagement as a key indicator of success for many special educational needs students (Hughes-Roberts et al., 2019). Several other studies have highlighted how the robots' predictability and consistency benefit autistic learners (e.g., Rudovic et al. 2017; van Straten et al., 2018), which are based on the theories of autistic perception and information processing (e.g., Pellicano & Burr, 2012; Lawson et al., 2014). Thus, this study aims to investigate the perspectives of Malaysian teachers on robot-mediated intervention for training emotional regulation in ASD children.

METHODOLOGY

Research Design

This study utilized a qualitative case study design to investigate the perspectives of teachers and an occupational therapist regarding the use of robots as a teaching tool for ASD children. The qualitative research method was chosen due to its ability to generate detailed and reliable data based on participant perspectives and interpretations. Moreover, this approach allows in-depth, multi-faceted explorations of complex issues in real-life settings (Atkins & Wallace, 2012; Crowe et al., 2011). The study aligns with an intrinsic case study design, which focuses on gaining an in-depth understanding of a particular case, in this instance, the use of robots as a teaching tool for ASD children. The study's boundary involved the teachers and occupational therapist involved in utilizing robots for teaching ASD children, exploring their perspectives within the real-life context of an educational setting.

Selection of Participants

This study was conducted at an early intervention centre located in the Klang Valley, Malaysia. The centre provides early intervention care and education for ASD children from ages three to nine years old. Six teachers and one occupational therapist were selected to participate in the study. Purposive sampling method was applied in selecting the participants as it focuses on specific characteristics of a population that are of interest, enabling researchers to obtain rich data (Tongco, 2007). The participants in this study have vast experience working with ASD children. They have witnessed two types of humanoid robots, in teaching ASD children, one that is fitted with lights and the second one that has a tablet as a face.

Instrumentation

This study employed a semi-structured interview format as the primary instrument for data collection. The interview protocol, meticulously validated by a team of five researchers, was specifically tailored to focus on exploring teachers' view on the practical applications of robots as a teaching tool for children with ASD. The semi-structured nature of the interviews aligns with the principles endorsed by Teherani et al. (2015), aiming to capture not only a broad spectrum of information but also nuanced insights. By adhering to a semi-structured format, participants were afforded the flexibility to express their perspectives in-depth, a deliberate strategy supporting the recommendations of Sutton & Austin (2015). This approach was designed to foster a more profound understanding of the diverse experiences and interpretations surrounding the integration of robots in the teaching process for ASD children. The main interview questions guiding this exploration are detailed below:

Table 1

List of Interview Questions

Interview Questions	
1.	What are the teachers' roles at the centre?
2.	What is the current intervention program used at the centre?
3.	What is the type of teachers' knowledge in relation to humanoid robots?
4.	What is the teachers' opinion regarding integrating humanoid robots into autism intervention program, especially for regulating emotion?

Data Collection Procedures

A permission letter to conduct research was sent to the principal of the early intervention centre. After getting permission, a one-to-one interview with the principal and a focused group discussion (FGD) involving diverse participants, including five teachers and an occupational therapist, were conducted to gather data. A wide range of knowledge and points of view were gathered for the study during the one-on-one interview and focus group discussions, which each lasted for about an hour. This allowed for the triangulation of informants, which increased the validity and reliability of the data. The interview focused on the teachers' views on the possible use of robots for autistic learning. Each participant was given an informed consent form before the beginning of the interviews.

Data Analysis

Thematic analysis was performed on the verbatim transcription of the interview according to the following steps: familiarization of data; coding, generating themes, reviewing themes, defining the themes, and writing up (Braun & Clarke, 2006). This approach allows for an in-depth investigation of the diverse opinions held by participants. According to Braun and Clarke (2006), thematic analysis is a useful technique for examining the perspectives of various research participants, highlighting similarities and differences, and generating unanticipated findings.

FINDINGS

Analysis of the interview revealed four major themes related to teachers' views on using a robot to train emotional regulation among ASD children at an early intervention center. Table 2 shows the major themes and subthemes. The following discussion includes quotes that were coded according to the participant and the corresponding discourse unit. For example, (B7/DU82) refers to a quote from participant 7 and discourse unit number 82 from the transcript.

Table 2

List of Themes and Sub-Themes Generated from The Study

Research Objective	Themes	Sub-Themes
To explore teachers' perspectives on the applications of humanoid robots as a tool for teaching ASD children particularly to regulate their emotions.	Theme 1: Teachers have knowledge about robot	
	Theme 2: Robot increases children's engagement	• Increase children's interest to learn • Attract Attention, Increase Gaze-Time and Maintain Engagement
	Theme 3: Role of robots in intervention	• Develop Social Skills • Increase motivation to learn
	Theme 4: Advantages and disadvantages of using robot	• Robots are less complex and more predictable • Become too obsessed to Robots • Robots cannot replace therapist

Theme 1: Teachers' Knowledge About Robots

This theme implies that teachers have a level of understanding about humanoid robots. This understanding may encompass familiarity with the technology, knowledge of how robots' function, or a basic awareness of the potential applications of robots within an educational setting. All educators, including the therapist, have witnessed the utilization of robots in training ASD children and unanimously reported that most of the ASD children at their center express a liking for the robots:

"*Previously there were university students who did research using robots to teach ASD children at our center…the results show that the children like the robot, they were interested to communicate with the robot…but some were afraid.*" (B7/DU82)

In the beginning, when the children were first introduced to the robot, they initially felt fear. However, with subsequent interactions, there was a noticeable positive change in the children's emotions:

"*The first time, children were afraid, the second time they were OK…*" (B5/DU90).

This shift in emotional response may be linked to the growing familiarity with the robot, as repeated exposure likely contributed to a deeper understanding and acceptance among the children.

Theme 2: Robot Increases Children's Engagement

The participants observed a positive impact on the ASD children at their center. The children, who often encounter challenges in social interactions, demonstrated an interest in communicating with the robots. This increased interest, in turn, led to greater attentiveness and focus among the children:

"*We noticed that the children were interested, they like to communicate with the robot maybe because robots don't have reaction…they see robots as their friend*" (B7/DU82).

Subthemes 2A: Increase Children's Interest to Learn

According to the participants, the robot is viewed as a valuable therapeutic tool in teaching ASD children. The participants noted that the children derived enjoyment from the images and slideshows displayed on the robot's tablet face:

"*…one of the robots had lights. The other robot had a tab fixed on it, there were pictures on it, so the children liked the robot with pictures. The tab was on its face...*" (B5/DU84)

B7 reinforces the idea that including visual elements contributes to the increased enjoyment and engagement of ASD children with the robot:

"*Children will enjoy if pictures, social stories and slideshow are shown on the tab*" (B7/DU86)

Subthemes 2B: Attract Attention, Increase Gaze-Time and Maintain Engagement

The participants also discussed a common issue faced by children with ASD: difficulties in specific social behaviors such as eye-to-eye contact and facial expressions, which can negatively impact their engagement. In response to this challenge, the interaction between children and robots is considered a promising tool that could effectively address and enhance the development of social skills in these children.

"*The child was able to be more attentive because he/she was attracted to the robot"* (B1/DU104)

Participant B5 further emphasizes this idea by stating:

"*His/her focus, gaze will increase*" (B5/DU108)

Theme 3: Roles of Robots in Autism Intervention

The participants note that the incorporation of robots results in increased student participation and attention. This, in turn, contributes to a more effective learning process for developing both social and academic skills among individuals with ASD.

Subthemes 3A: Develop Social Skills

The integration of robots into autism intervention programs inspired children to develop and apply social skills:

"*With things that are unable to communicate, the ASD children themselves will initiate the conversation*" (B3/DU106)

Additionally, B6 highlighted that:

"*…Robots can facilitate numerous interaction goals, such as capturing and maintaining attention, evoking joint attention, eliciting imitation, and mediating turn-taking*" (B6/DU108)

Subthemes 3B: Increase Motivation to Learn

Children seemed more at ease when engaging with robots, potentially positively influencing their learning experience. Nonetheless, participants expressed concern that ASD children might develop a preference for robots over human interaction:

"*Children will be more motivated to learn or communicate with the robot*" (B6/DU108).

Theme 4: Advantages and Disadvantages of Using Robots

The consensus among participants is that robots are most effective when employed as supportive tools in classrooms. This view was supported by the notion that robots should function as supplementary resources under professional guidance, aligning with the idea that they can be beneficial but should be carefully managed. Additionally, participants acknowledged that while robots hold an appeal for ASD children, a potential drawback could be the children developing excessive attachment and reluctance to separate from the robot.

Subthemes 4A: Robots are less complex and more predictable

Teachers noted that interacting with robots is less intricate compared to human interaction:

"*The robot gives no false hope because it is emotionless. Robots are predictable but when the children socialize with people, they have to face varieties of emotions, so I am afraid that they might be comfortable with robots*" (B7/DU108)

It's crucial to acknowledge the limitations in ASD children's interactions with robots to avoid a preference for robotic interactions over human connections:

"*The disadvantages are the ASD children may get too obsessed and difficult to detach and they might throw tantrums*" (B1/DU106)

In addition, B6 added that:

"*…the disadvantage is maybe the ASD child become too obsessed with the robot, and he/she refuses to socialize with people…refuses to make friends or play with other children*" (B6/DU108)

Subthemes 4B: Become Too Obsessed to Robot

Participants expressed concerns about prolonged interaction with robots leading to children becoming overly attached and potentially rejecting other intervention techniques. For example, B8 emphasized that:

"*The interaction with robots must not be prolonged, the children will become obsessed with the robot which might cause them to reject other techniques… too much exposure leads to infatuation*" (B7/DU118)

Moreover, participants highlighted the importance of generalizing learned skills beyond robot interactions to real-life situations:

"*The learning method for the ASD children must be generalized, they should be able to adapt to all, cannot be too dependent on robots*" (B1/DU120)

Subthemes 4C: Robot Cannot Replace the Therapist

Participants contested the idea that robots could replace the role of a therapist and emphasized the need for a therapist's support in conjunction with robot-assisted teaching:

"*Can be used as a teaching aid but still need the therapist's support…. robot cannot replace the therapist because need a teacher's escort*" (B7/DU130)

Furthermore, B1 emphasized the necessity of producing more therapists, asserting that robots have limitations:

"*(We) have to produce more therapists instead of robots. Robots have limitations*" (B1/DU134)

In addition, participants stressed the importance of supervision, cautioning against leaving ASD children alone with robots without teacher or therapist monitoring:

"*Teachers must supervise, if the child is left with the robot unsupervised, the child might mishandle the robot.....might lead to other problems*" (B3/DU140)

DISCUSSION

The findings offer insights into the use of humanoid robots as an assistive tool in early intervention programs. During the interview, the participants openly shared their ideas on how humanoid robots should be used in autism education at their center as an assistive tool. Many of the views shared by these participants are consistent with the findings from the UK's special education sector (Alcorn et al., 2019). The participants also stated the advantages and disadvantages of using humanoid robots. They argued that robots can help ASD children become more focused and maintain a longer attention span, which is an important aspect of their learning process. This recommendation is consistent with the work of (Huijnen et al., 2016). However, despite the robots' promising efficacy, too much emphasis on short-term learning objectives can interfere with children's capability to generalize the skills they have learned. Therefore, the use of robots in ASD intervention programs must be carefully planned to address its potential long-term implications. Begum, Serna and Yanco (2016) proposed a roadmap for the establishment of robotic-mediated interventions using evidence-based practice (EBP), which is a benchmark in ASD interventions.

Impact of Robots on The Outcome of An Intervention Program

The participants in this study have touched upon the robot's appearance or features. The children were especially attracted to the robot with a tablet face. Many autism-related studies have experimented with many types of robots, including human-like, animal-like, mascot-style, and mechanical-type robots (Arshad et al., 2020), each with its strengths and weaknesses. In particular, human-like robots have been shown to increase levels of interest and happiness among ASD children during trials (van Straten et al., 2018). Humanoid robots provide a human-like appearance, accomplish more complicated social communication tasks than non-humanoid robots (Feng, 2014), and are capable of teaching social skills to ASD children (Barakova et al., 2015).

Facilitate ASD Children in Their Learning Process

The teachers observed that ASD children tended to initiate communication with the robot. They were motivated to interact with it since the robot is colorful and attractive. Chung (2019) found that a robotic intervention program can substantially improve ASD children's eye contact (both frequency and duration) and verbal initiation. Some robots have been designed to improve social interaction, imitation, and joint attention skills in ASD children, with some promising outcomes including increased attention span and increased number of smiles (Chevalier et al., 2017). It is easier for ASD children to interact with robots than with people because robots are more predictable, have fewer states, and smaller range of behaviors (Broadbent, 2017). ASD children should learn about social cues through interactions with robots and then apply that knowledge in their interactions with people.

Robots Can Be Used as An Assistive Tool

The teachers and the therapist suggested that robots should only be used as an assistive tool because of their limitations. For instance, robots are unable to replace the human touch of a therapist or a teacher. Furthermore, ASD children-robot interactions must be monitored because the children might mishandle or break the robots. Earlier, Amin et al. (2018) reported an increase in attention and a decrease in focus inability among special needs children when a robot was used. Arshad et al. (2020) argued that a robot is not intended to replace human teachers in classrooms. In the current situation, robots can help and support ASD students while allowing teachers to spend more time providing detailed care and empathic treatment.

Generalization Of the Skills into The Natural Environment

Humanoid robots can help ASD students acquire generalizability (Alcorn et al., 2019). Generalization is the ability to transfer skills that a student has learned in new and different environments. ASD children tend to have difficulty with generalization. Previous studies have shown that ASD children find it difficult to transfer the skills they have learned from robots in a laboratory into their classroom (Diehl et al., 2012; Huijinen et al., 2016). The participants were concerned that the children might get emotionally attached to or dependent on robots. They also believed that ASD children must be able to generalize the skills they have learned.

Limitations of the Study

This study has few limitations. The findings did not represent the views of all teachers and therapists in Malaysia. The second limitation is the focus on using humanoid robots. The participants might have offered different views if non-humanoid robots such as animal-like or cartoon-like robots were used. In addition, the study was conducted during the Covid-19 pandemic in 2020. Therefore, the data collection process was significantly hampered by government lockdowns, movement control orders (MCOs), social isolation, and work-from-home restrictions imposed to stop the spread of COVID-19 virus.

Recommendations for Future Research

Considerable views have been gathered in this study, however the findings in this study should be interpreted cautiously because of the small sample size. Therefore, larger sample sizes should be used in future research since they will be more representative of the population and thus produce results that are more accurate.

CONCLUSION

The participants see robots as a potential assistive tool for autism education. Their views provide insights valuable for robotic researchers to plan and develop robotic systems or programs that address the needs of ASD education. With the current shortage of therapists, robots can be a useful inclusion. In terms of costs, robots might be the cheaper alternative, which could make intervention programs more affordable. This study provided a novel perspective on robotics and a practical example of how to use robots to enhance learning outcomes for ASD children.

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REFERENCES

Alcorn, A. M., Ainger, E., Charisi, V., Mantinioti, S., Petrovic, S., Schadenberg, B. R., ... and Pellicano, E. (2019). Educators' views on using humanoid robots with autistic learners in special education settings in England. *Frontiers in Robotics and AI, 6*(107), 1-15.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA: Author.

Amin, M. Z., Zamin, N., Ab Rahim, H., Hassan, N. I., & Kamarudin, N. D. (2018). Robo therapist: a sustainable approach to teach basic expressions for special needs children in Malaysia. *International Journal of Engineering & Technology, 7*(3.29), 103-106.

Arshad, N. I., Hashim, A. S., Ariffin, M. M., Aszemi, N. M., Low, H. M., & Norman, A. A. (2020). Robots as assistive technology tools to enhance cognitive abilities and foster valuable learning experiences among young children with autism spectrum disorder. *IEEE Access, 8*, 116279-116291.

Atkins, L., and Wallace, S. (2012). *Qualitative Research in Education*. SAGE Publications.

Barakova, E. I., Bajracharya, P., Willemsen, M., Lourens, T., & Huskens, B. (2015). Long-term LEGO therapy with humanoid robot for children with ASD. *Expert Systems, 32*(6), 698-709.

Broadbent, E. (2017). Interactions with robots: The truths we reveal about ourselves. *Annual review of psychology, 68*(1), 627-652.

Begum, M., Serna, R. W., and Yanco, H. A. (2016). Are robots ready to deliver autism interventions? A comprehensive review. *International Journal of Social Robotics, 8*(2), 157–181. doi:10.1007/ s12369-016-0346-y.

Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology, 3*(2), 77-101.

Chevalier, P., Martin, J. C., Isableu, B., Bazile, C., and Tapus, A. (2017). Impact of sensory preferences of individuals with autism on the recognition of emotions expressed by two robots, an avatar, and a human. *Autonomous Robots, 41*(3), 613-635.

Chung, E. Y. H. (2019). Robotic intervention program for enhancement of social engagement among children with autism spectrum disorder. *Journal of Developmental and Physical Disabilities, 31*(4), 419-434.

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., & Sheikh, A. (2011). The case study approach. *BMC medical research methodology, 11*(1), 1-9.

Diehl, J. J., Schmitt, L. M., Villano, M., & Crowell, C. R. (2012). The clinical use of robots for individuals with autism spectrum disorders: A critical review. *Research in autism spectrum disorders, 6*(1), 249-262.

Feng, H. (2014). *Studying Eye Gaze of Children with Autism Spectrum Disorders in Interaction with a Social Robot* (Doctoral dissertation, University of Denver).

Fridin, M., & Belokopytov, M. (2014). Acceptance of socially assistive humanoid robot by preschool and elementary school teachers. *Computers in Human Behavior, 33*, 23-31. doi: 10.1016/j.chb.2013.12.016

Gross, J. J. (1998). Antecedent-and response-focused emotion regulation: divergent consequences for experience, expression, and physiology. *Journal of personality and social psychology, 74*(1), 224-237.

Gross, J. J., and Thompson, R. A. RA (2007). *Emotion Regulation: Conceptual Foundations*. Handbook of emotion regulation, 3-24.

Hughes-Roberts, T., Brown, D., Standen, P., Desideri, L., Negrini, M., Rouame, A., & Hasson, C. (2019). Examining engagement and achievement in learners with individual needs through robotic-based teaching sessions. *British journal of educational technology, 50*(5), 2736-2750. doi:10.1111/bjet.12722

Huang, A. X., Hughes, T. L., Sutton, L. R., Lawrence, M., Chen, X., Ji, Z., and Zeleke, W. (2017). Understanding the Self in Individuals with Autism Spectrum Disorders (ASD): A Review of Literature. *Frontiers in Psychology, 8*(1422), 1-8.

Huijnen, C. A., Lexis, M. A., & de Witte, L. P. (2016). Matching robot KASPAR to autism spectrum disorder (ASD) therapy and educational goals*. International Journal of Social Robotics, 8*(4), 445-455. doi: 10.1007/s12369-016-0369-4

Ismail, L. I., Shamsudin, S., Yussof, H., Hanapiah, F. A., & Zahari, N. I. (2012). Robot-based intervention program for ASD children with humanoid robot NAO: initial response in stereotyped behavior. *Procedia Engineering, 41*(2012), 1441-1447.

Kennedy, J., Lemaignan, S., and Belpaeme, T. (2016). "The cautious attitude of teachers towards social robots in schools," in Robots 4 Learning Workshop at IEEE RO-MAN 2016, (New York, NY). 2016, IEEE (2016), pp. 231-238, 10.1109/HRI.2016.7451757March

Lawson, R. P., Rees, G., & Friston, K. J. (2014). An aberrant precision account of autism. *Frontiers in human neuroscience, 8*(302), 1-10. doi: 10.3389/fnhum.2014.00302

Mazefsky, C. A. (2015). Emotion regulation and emotional distress in autism spectrum disorder: Foundations and considerations for future research. *Journal of autism and developmental disorders, 45*(11), 3405-3408.

Mazefsky, C. A., Herrington, J., Siegel, M., Scarpa, A., Maddox, B. B., Scahill, L., and White, S. W. (2013). The role of emotion regulation in autism spectrum disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 52*(7), 679-688.

Murad, D. (2019, September 15). More Kids Diagnosed with Autism. The Star Online. Retrieved from https://www.thestar.com.my/news/nation/2019/09/15/more-kidsdiagnosed-with-autism

NST letters (2019, October 11). Effective Practices in Early Intervention for Children with Autism. The New Straits Times. Retrieved from https://www.nst.com.my/opinion/letters/2019/10/529117/effective-practices-earlyintervention-children-autism

Pellicano, E., & Burr, D. (2012). When the world becomes 'too real': a Bayesian explanation of autistic perception. *Trends in cognitive sciences, 16*(10), 504-510.

Rudovic, O., Lee, J., Mascarell-Maricic, L., Schuller, B. W., & Picard, R. W. (2017). Measuring engagement in robot-assisted autism therapy: a cross-cultural study. *Frontiers in Robotics and AI, 4*(36), 1-17.

Salvador, M. J., Silver, S., and Mahoor, M. H. (2015). "An emotion recognition comparative study of autistic and typically-developing children using the Zeno robot" in *2015 IEEE International Conference on Robotics and Automation (ICRA)* (Seattle, WA), 6128–6133. doi: 10.1109/ICRA.2015.7140059

Samson, A. C., Kreibig, S. D., Soderstrom, B., Wade, A. A., & Gross, J. J. (2016). Eliciting positive, negative, and mixed emotional states: A film library for affective scientists. *Cognition and Emotion, 30*(5), 827-856.

Sartorato, F., Przybylowski, L., and Sarko, D. K. (2017). Improving therapeutic outcomes in autism spectrum disorders: Enhancing social communication and sensory processing through the use of interactive robots. *Journal of psychiatric research, 90*, 1-11.

Shamsuddin, S., Yussof, H., Hanapiah, F. A., Mohamed, S., Jamil, N. F. F., and Yunus, F. W. (2015). Robot-assisted learning for communication-care in autism intervention. In *2015 IEEE International Conference on Rehabilitation Robotics (ICORR)* (pp. 822-827). IEEE

Shamsuddin, S., Yussof, H., Miskam, M. A., Hamid, A. C., Malik, N. A., and Hashim, H. (2013). Humanoid robot NAO as HRI mediator to teach emotions using game-centered approach for children with autism. In *HRI 2013 Workshop on Applications for Emotional Robots*.

Sofronoff, K., Attwood, T., Hinton, S., & Levin, I. (2007). A randomized controlled trial of a cognitive behavioural intervention for anger management in children diagnosed with Asperger syndrome. *Journal of Autism and Developmental Disorders, 37*(7), 1203-1214.

Sutton, J., & Austin, Z. (2015). Qualitative Research: Data Collection, Analysis, and Management. *The Canadian journal of hospital pharmacy*, 68(3), 226–231.

Teherani, A., Martimianakis, T., Stenfors-Hayes, T., Wadhwa, A., & Varpio, L. (2015). Choosing a Qualitative Research Approach. *Journal of graduate medical education*, 7(4), 669–670. https://doi.org/10.4300/JGME-D-15-00414.1Thompson, R. A. (1994). Emotion regulation: A theme in search of definition. *Monographs of the society for research in child development, 59*(2-3), 25-52.

Tongco M.D.C. (2007). Purposive sampling as a tool for informant selection. *Ethnobotany Research and Applications 5*, 147-158.

van Straten, C. L., Smeekens, I., Barakova, E., Glennon, J., Buitelaar, J., & Chen, A. (2018). Effects of robots' intonation and bodily appearance on robot-mediated communicative treatment outcomes for children with autism spectrum disorder. *Personal and Ubiquitous Computing, 22*(2), 379-390. doi: 10.1007/s00779-017-1060-y

Wink, L. K., Plawecki, M. H., Erickson, C. A., Stigler, K. A., and McDougle, C. J. (2010). Emerging drugs for the treatment of symptoms associated with autism spectrum disorders. *Expert Opinion on Emerging Drugs, 15*(3), 481-494.

Yun, S. S., Kim, H., Choi, J., & Park, S. K. (2016). A robot-assisted behavioral intervention system for children with autism spectrum disorders. *Robotics and Autonomous Systems, 76*, 58-67. doi: 10.1016/j.robot.2015.11.004