

# An Exploratory Study on Humanoid Robot KASPAR in Supporting Social Skills for Children with ASD in Malaysia

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**Abstract.** Autism Spectrum Disorder (ASD) is a developmental condition that affects many aspects of an individual's life, including social interaction and communication. Its prevalence among children has become a critical concern worldwide, including Malaysia. Existing intervention strategies mainly focus on behavioural therapies or educational support. Technological advancements have gained significant attention from scholars and practitioners to enhance interventions for individuals with ASD. Preliminary findings suggest that the use of social humanoid robots can provide a highly structured environment and non-threatening medium through which children can practice and enhance their interpersonal skills. However, research exploring the intervention of humanoid robots in supporting social skills among ASD children in Malaysia remains sparse. Thus, this study aims to examine the potential benefits of interventions with the humanoid robot, KASPAR, in improving the social skills of children with ASD across three primary schools in Malaysia that are equipped with a special education unit. A total of 25 students participated in this study. Students from each school engaged in three sessions with KASPAR through interactive activities like turn-taking games and imitation tasks over a period of three weeks, between March and April 2024. This study employed the non-parametric Wilcoxon signed-rank test to determine if there were any changes observed before and after the intervention with KASPAR in students' social skills. Results show improvement in participants' social interaction, social communication, emotional intelligence and social behaviour dimensions. The findings confirm the feasibility and effectiveness of humanoid robotic intervention, indicating it as a promising approach to support social skills development in children with ASD.

**Keywords:** Autism Spectrum Disorder (ASD); Humanoid Robot; Social Skills; Special Education; Inclusive Learning

## 1 Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental syndrome often associated with social skill deficiencies [1]. As such, ASD affects a person's ability to function in

school, work, and other areas of life [2]. In 2021, the Ministry of Health Malaysia reported 589 children under 18 years old with ASD, indicating a staggering 500 percent increase from 99 children in 2009 [3]. The lack of trained teachers and resources, particularly to develop facilities and programme that meet the growing needs of children with ASD, imposes a major challenge, both to the children and the parents or caregivers in Malaysia [3,4]. Such a trend signifies the increasing need for effective interventions for children with ASD in the country [4]. The National Autism Society of Malaysia (NASOM) [3] highlighted that intensive early intervention within optimal educational settings can lead to significant improvements in communication, developmental progress, and intellectual performance of children with ASD. A technical report by Kaur et al. [5] featured several interventions that have been used for ASD children in Malaysia, which include education-based, engineering-and-information-technology-based, and medical-based interventions.

Nevertheless, the use of humanoid robots that has gained significant recognition in supporting social learning and interaction among children with ASD, particularly in the West, remains underexplored in Malaysia [6,7]. Despite the relatively scarce academic research, there is growing interest and support from the industries, government and academic institutions to explore robotic interventions for ASD children in Malaysia. Notably, an event under the Program Pendidikan Khas Integrasi (PPKI) (or Special Education Integration Programme) by TM ONE, the enterprise and public sector business solutions arm of Telekom Malaysia Berhad (TM), has highlighted the nation's interest and readiness in experimenting with potential humanoid robots to inculcate social skills among ASD children [8]. Fundamentally, collective efforts underscore a promising trajectory towards integrating humanoid robot technologies into ASD interventions in Malaysia, bridging the gap between limited research and practical applications. Considering the exploratory nature of this research area in Malaysia, the present study aims to partake a collaborative approach to examine the feasibility and effectiveness of applying a social humanoid robot, KASPAR, in supporting the social skills of primary school children (aged between 7-12) with ASD in Malaysia.

## 2 Literature Review

Humanoid robots provide a highly structured environment [9] that may reduce anxiety and enhance engagement in educational settings [10]. Evidence shows that these robots, when used as mediators to interact with children with ASD, can enhance children's social behaviour, interaction, motivation, eye contact, imitation, joint attention [11, 12, 13] leading to positive cognitive outcomes [14]. In fact, studies found that ASD children often respond better to robots than to their parents, siblings, teachers, and human therapists [6, 13]. One of the unique characteristics of robot-assisted therapy is its ability to improve social skills of children with ASD through consistent and repetitive interactions that are essential for their optimal learning [15].

With the use of NAO and ALICE humanoid robots, Grüne [12] observed improvements in the social and cognitive skills among children with ASD in Iran. Takata et al. [16] performed social skills training using multiple humanoid robots among individuals

with ASD and observed significant improvements in engagement, motivation, and empathy skills. Using pre- and post-tests, Mohamad et al. [20] found that NAO effectively improved number-recognition skills, engagement, interaction, and individualised learning among children with ASD in Malaysia. Similarly, interactions with KASPAR have shown significant improvements in non-verbal imitation and attention span among children with ASD compared to interactions with teachers [17]. Enhanced communication functions [18], turn-taking and language skills were also observed with KASPAR when it was used alongside a complementary app [19].

Nevertheless, ongoing debate exists among scholars pertaining to the use of humanoid robots for children with ASD. Some advocate for human-like appearances and mobility to foster better engagement and social competencies, while others caution against potential confusion about the robots' emotional capabilities compared to human interactions [21, 22]. This calls for a more nuanced approach to explore how the interactions between robots and children with ASD lead to the development of social skills [23].

Extant literature concurs that KASPAR, a child-sized robot that features realistic, yet simplified human-like traits, provides a safe, predictable, and reliable communication environment. This makes social interaction less intimidating and more comfortable for a child via therapeutic or educational games [24, 25]. These features allow children to treat KASPAR as a playmate rather than a machine [26].

Despite the critique that KASPAR lacks mobility [22], studies highlighted that children with ASD were more interactive during the sessions with KASPAR compared to other robots [23, 27]. Past literature also indicates that professionals expect KASPAR to be of an added value for goals relating to communication, interpersonal skills, play, and emotional well-being [28]. Thus, this study aims to explore how engaging with KASPAR can facilitate social skills among primary school children with ASD in Malaysia.

### 3 Methods

This exploratory study was approved by the Ethics Committee of Multimedia University (Approval No: EA0232023). Research teams from Multimedia University, Malaysia and University of Hertfordshire, United Kingdom (UK), collaborated to design and execute the study. Three primary schools in Melaka, Malaysia that are equipped with a special education unit were involved in this study. A total of 25 students with ASD from these schools participated in this study. Upon obtaining the written consents from the Ministry of Education, State Education Department, schools, and parents of the children with ASD to participate in the study, the research team worked together with the participating schools to schedule the sessions' dates, time and venue. Children in each school participated in 3 sessions over a period of three weeks, between March and April 2024. In each session, personalised interactions with KASPAR were facilitated through a series of games and activities. Through, structured, yet flexible games comprising standard (introduction), emotions, animal, food and body-parts scenarios [26], the students engaged in a consistent environment with KASPAR to improve their social interaction, communication, emotional intelligence, and social behaviour.

The SS-ASD instrument was adapted from Ibrahim et al. [29] to evaluate social interaction, social communication, emotional intelligence, and social behaviour aspects of respondents in this study. The observation rating value for each item was measured using a 4-point Likert scale (1-Almost Always, 2-Often, 3-Sometimes and 4-Almost Never). Teachers were asked to complete the instrument for each child before the first experiment and again after the final session with KASPAR, allowing for a pre-and post-intervention comparison of each child's social skills development. The collected data provided a basis for analysing the feasibility and potential effectiveness of adopting KASPAR as an intervention for enhancement of social skills in children with ASD.

Prior to analysing the results, the following hypotheses have been formulated for this study:

- H1: There is a difference in students' social interaction before and after the intervention of KASPAR in the learning activities.
- H2: There is a difference in students' social communication before and after the intervention of KASPAR in the learning activities.
- H3: There is a difference in students' emotional intelligence before and after the intervention of KASPAR in the learning activities.
- H4: There is a difference in students' social behaviour before and after the intervention of KASPAR in the learning activities.

## 4 Findings and Discussion

Due to the nature of the data, non-parametric Wilcoxon signed-rank tests have been performed to determine if there were any changes in students' social skills before and after the activities with KASPAR. The findings are discussed in the following.

21 items were tested for the social interaction dimension. Items 2 (*asks for help*), 5 (*ability to wait for short periods of time*), and 10 (*responds to the greetings of others*) show a 10% significance level. Hence, the H1 of this study is partially supported. Consistently, the use of NAO and KASPAR robots has been associated with increased engagement and responsiveness in ASD children [18, 19, 20, 30]. This suggests that while KASPAR can facilitate certain social skills, further exploration is required to identify the specific conditions under which it may be most effective in promoting broader social interaction among children with ASD.

17 items were tested for the social communication dimension. Item 3 (*offering assistance to others*) shows a 10% significance value. Hence, H2 of this study is partially supported. However, past studies have found that humanoid robots can enhance social communication skills in children with ASD [9] by improving eye contact, verbal initiation, and joint attention [12, 20, 31, 32]. This discrepancy highlights the complexity of social skill development in children with ASD due to individual differences, needs and preferences [33], which necessitates longer intervention plan to achieve better results.

Evidence shows that high-functioning children tend to exhibit improved social skills through robot interventions, while low-functioning children experience a decrease in stereotyped behaviours [12]. Hence, clearly defining the varying degrees of severity and support needs of ASD children prior to engaging them with robot interventions is

vital [20, 29]. This warrants a systematic approach to gather data of participants (e.g., mental age, IQ) and stratifying them according to specific spectrum levels based on their skills and needs prior to intervention.

13 items were tested for the emotional intelligence dimension. Items 3 (*labels emotions in pictures*) and 6 (*recognises the facial expressions of others*) are at 10% significance level. Therefore, H3 in this study is partially supported. Similarly, past studies suggest that robotic interventions have small to moderate effects on emotional development among ASD children [34, 35]. For example, the study by Kouroupa et al. [10] demonstrates insignificant improvements ( $g = 0.63$ ) in emotional outcomes among ASD children after experiencing robotic intervention. This calls for more comprehensive approaches to examine emotional intelligence in children with ASD.

6 items were tested for the social behaviour dimension. Item 2 (*gains the attention of others in an appropriate manner*) shows a 10% significance value. Therefore, H4 in this study is partially supported. These results contradict past research that supports the effectiveness of humanoid robots in enhancing social behaviour among ASD children [10, 22]. This inconsistency raises questions about the specific contexts in which robotic assistance is most effective and suggests that further exploration is required to identify factors influencing these varied outcomes. For example, Ibrahim et al. [29] highlighted that higher autistic spectrum (or severity) level is often associated with greater difficulty in social behaviours. Furthermore, different observation styles and preferences of the teachers may also influence the findings of the impact of robot interventions on the ASD children's social skills. Such variability underscores the necessity for standardised training and calibration among educators to ensure consistency in observations.

Despite the limited exposure - just three sessions with KASPAR over three weeks - participants exhibited notable improvements in social skills. This underscores the feasibility and prospect of robot-assisted interventions like KASPAR in supporting children with ASD. Such encouraging outcome from a brief intervention suggests that more sustained and regular use with focused observation could potentially yield greater benefits.

## 5 Limitations and Recommendations

Several limitations of this study need to be taken into consideration. First, ASD children's engagement activities with KASPAR were limited to measuring their social interaction, communication, behaviour and emotional intelligence through a validated scale [29]. However, evidence suggests incorporating measures such as control group, randomisation, blinded assessors, and follow-up assessments to mitigate repeat measurement effects, selection and observer biases [36]. Next, despite the practically low exposure of ASD children to KASPAR in this study, notable improvements were observed in their social skills, indicating the need for more intervention sessions to increase exposure and thus, yield greater benefits [37]. Future research should focus on these factors to gain a deeper understanding of how humanoid robots like KASPAR

can be tailored to support diverse learning styles and social skills developmental trajectories among children with ASD.

## 6 Conclusion

In summary, this research takes an exploratory approach to adopting humanoid robots in improving the social skills of ASD children in Malaysian primary schools. By exploring the intersection between the KASPAR humanoid robot and social skills of children with ASD, this research highlights the potential benefits of robot-assisted therapy and offers avenues for ongoing local and global collaborations between educators, researchers, schools, and technologists to further enhance these interventions for ASD children's social skills development, which is essential for learning. The notable improvements observed after just three sessions in this study underscore KASPAR's feasibility and highlight its positive impact. This paves the way forward for future initiatives to expand the use of humanoid robot, KASPAR in educational settings, offering tailored support to children with ASD and ultimately fostering a more inclusive learning environment.

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