Review Article

Autism Spectrum Disorders: Open Access

Social Robotics for Students with Autism Spectrum Disorder in Upper Secondary School: A Case Study

Ivan Traina*

University of Verona, Department of Human Sciences, Italy

***Corresponding Author**
Ivan Traina, University of Verona, Department of Human Sciences, Italy

Submitted: 2023, Oct 09; **Accepted**: 2023, Nov 01; **Published**: 2023, Nov 21

Citation: Trainca, I. (2023). Social Robotics for Students with Autism Spectrum Disorder in Upper Secondary School: A Case Study. *Auti Spec Disord Open, 3*(1), 43-46.

Abstract

This paper describes reports a case study of social robotics for students with Autism Spectrum Dis-order (ASD) in upper secondary school. The methodology used was a naturalistic observation, aimed at investigating the requirements for a correct introduction of this technology in educational contexts. In particular, what methods can facilitate the adoption of social robotics, as well as what learning, and socialization needs can be addressed. The main result emerged consisted of the under-standing of the need to connect the use of robotics within interventions related to educational and didactic objectives of students, identified through her/his functioning profile. This paper also out-lines possible trajectories of research for future studies focused on the use of social robotics in school contexts.

Keywords: Social robotics, Students with ASD, Upper secondary schools, Case study, ICF

1. Introduction

This paper describes a case study focused on the use of social robotics for students with ASD in secondary school. The intervention was aimed at promoting an inclusive school context, the acces-sibility to such assistive technology and observing how a social robot can contribute for increasing attention, communication, and social skills in students with autism [1]. The data collected through the literature analysis carried out on the role of social robots in teaching skills showed their effec-tiveness in supporting the improvement in (a) the level of attention, (b) communication, (c) imitation and (d) and social behaviors [2-5]. Furthermore, from literature has emerged that interacting with a social robots can stimulate visual contact and attention [6,7]. Moreover, the contribution that social robots can provide in improving social interaction and communication skills is also underlined in the World Health Organization Global Report on Assistive Technology [8].

1.1 The Bots4 Autism Project

Considering these scientific premises, it was designed the project bots4AUTISM in order to under-stand the effectiveness of social robotics in schools for fostering inclusion. Another aim of the pro-ject consisted of creating a team of experts for supporting teachers involved in experimenting an in-novative approach to promote the inclusion of students with autism in the context of secondary school. This was composed by psychotherapists expert in autism (from healthcare), researchers (from university), expert teachers in autism (from special education), teachers in technologies (from Information Technology field). The project was coordinated by the Verona Autism Help Desk in collaboration with the University of Verona - Department of Human Sciences, the Integrated Hospi-tal of Verona, and n. 5 upper secondary schools in the province of Verona. Other objectives of the bots4AUTISM project were a) to observe the social robotics in the process of inclusion of students with autism; b) to promote and develop skills functional for learning.

1.2 The Use of the Social Robot NAO

In literature different kind of social robots have been validated [9,10]. But in order to respond to the needs expressed by the various actors involved in the project, it was decided to use the social robot NAO. This kind of social robot, with anthropomorphic features, has widely demonstrated that it can be effectively used to stimulate social interactions. Also, the robot is equipped with environmental sensors (such as cameras, microphones, etc.) to acquire objective metrics and reproduce articulated movements for motor imitation [11]. The robot NAO is also able to be "aware" of the surrounding environment and act proactively through a conversational engine, sequences of words, and vocal commands that allow a semi-structured dialogue to learn and understand social relationships, as well as read basic emotions and expressing facial expressions, gestures and vocal sequences.

Furthermore, it allows a high level of personalization facilitating interaction with students with autism. As part of the intervention carried out, the A-RAT (Autonomous Robot Assisted Teaching) methodology was used with the NAO robot, which consists of allowing students to interact with the robot through a tablet for responding to robot's instructions.

2. Methodology Adopted to Carry Out the Case Study

In the framework of the project, a case study with different purposes was also conducted in order to propose a critical reflection on interventions with social robots within the educational system. In particular, the study focused on collecting teachers' perspectives on the usefulness and acceptability of the intervention. The method used to carry out this study followed a qualitative approach that through naturalistic observations allowed to collect information on the changes as result of the in-tervention [12-14]. The adoption of this methodology allowed to analyze the insights generated through the exploration of the experiences of students with autism and their support teachers. In this study was important to identify the functioning characteristics of participants. These characteristics, identified through the administration of specific tests, allowed to choose the education objectives and learning activities proposed by the robot.

2.1 Research Questions

To investigate the acceptability of the intervention and the accessibility of social robots in terms of usability, both for the students and support teachers involved, three research questions were elabo-rated:

1. What are the necessary requirements for a correct introduction of social robots in upper sec-ondary school?
2. What method could be adopted for including social robots within individualized teaching proposals?
3. What learning and socialization needs can social robots respond to?

These research questions allowed to observe and collect data to evaluate the effectiveness and use of social robotics in the inclusion process, the potentialities for developing specific skills such as at-tention, communication, imitation of social behaviors, and the level of accessibility of the robot NAO in terms of usability.

2.2 Data Collection and Analysis Tools

The data obtained were collected through observations, compilation of logbooks (drawn up by 2 teachers specialized in assisting people with autism for each school involved), interviews and focus groups. The information collected was analyzed using a qualitative methodology [15-17]. The data collection allowed the exploration of the experiences of teachers, students, and families, and the process of robot introduction and utilization [18-20]. Also, this allowed the gathering of information regarding the outcomes of the intervention in terms of improvement of skills and the replicability of the intervention [21,22].

3. Characteristics of the Intervention

3.1 Profiling Phase and Participants Selection Criteria

The selection of participants to be included in the intervention was based on following criteria: (a) diagnosis of ASD, (b) belonging to different classrooms age, (c) with different levels of severity of the disorder. The profiling phase was carried out by the Verona Integrated Hospital, which also se-lected the tests to be administered to identify a set of initial skills for defining the activities to be delivered by the robot. Families and support teachers were also involved in this phase through inter-views for collecting additional information [23]. Below are reported the characteristics and purposes of test used to assess participants:

- The Psychoeducational profile revised (P.E.P.-R.): it is a functional assessment tool that allows to evaluate different skills, to define the level of development reached in seven developmental areas: imitation, perception, motor skills (fine and global motor skills), eye-hand coordination, cognitive and verbal area.
- The TEACCH Transition Assessment Profile (T.T.A.P.): it is a functional assessment tools in three different contexts through the combination of a direct assessment of skills (direct observation scale) and interviews with parents, teachers and operators for evaluating the performance in domestic (Home observation scale), school and work setting (School and work observation scale). Each of these three evaluation scales examines 6 fundamental functional domains for obtaining an adequate level of independence in adult life (e.g., work attitudes, work behaviors, independent functioning, leisure skills, functional communication, interpersonal behavior).
- The Childhood Autism Rating Scale (C.A.R.S.): it is a diagnostic rating scale composed by 15 items. The purpose of the scale is to score behaviors without using casual explanations. The C.A.R.S. scores can be obtained from different sources: psychological examination, parents' reports and medical history.
- The WAIS-R: consists of 11 subtests. 6 are related on the Verbal Scale (information, comprehen-sion, arithmetic reasoning, analogies, memory and vocabulary), and 5 focused on the performance scale (association of symbols with numbers, completion of figures, drawing with cubes, reordering of figurative stories and reconstruction of objects).
- Leiter International Performance Scale-Revised (Leiter-R.): it is a non-verbal IQ assessment scale, which does not require verbal communication between examiner and subject. Therefore, it is partic-ularly useful for adolescents with verbal language or communication difficulties.

Following the profiling phase n. 11 students with ASD aged between 14 and 17 years were selected (2 students each school). The results of profiling were transformed into ICF scores to define the dif-ferent areas and skills on which concentrate the intervention with the robot.

3.2 Expert Team

For the realization of the project a multidisciplinary team of experts was organized with the aim of supporting teachers involved in the project through consultancy activities. Mainly concerning:
- The features of the robot NAO, including its programming and maintenance during the project.
- The definition and choice of exercises, in order to elaborate activities to be provide by the robot consistent with the educational objectives of students.
- The drafting and preparation of the Individualized Education Plan (IEP), including the connections between ICF functional assessment of students and the skills to be improved through the contribution of social robotics.

3.3 The Process for the Definition of the Activities Delivered by Social Robots

The process adopted for the definition, implementation and evaluation of the activities delivered by the robot NAO consisted of the following phases:
- Profiling of students.
- Analysis of the neuropsychological profiles emerged by profiling.
- Identification of objectives coherent with the ICF functional assessment of students with ASD.
- Meetings with the team of experts for the evaluation of the possibilities offered by the robot, the assessment of the profiled participants, the planning of personalized teaching and learning activities (named tasks) based on the skills to be improved and the characteristics of school context attended.
- Support in defining the individual tasks to be assigned through the robot.
- Monitoring of activities carried out and evaluation of results gained.

Before defining the activities to be delivered by robot, a collection of data and observations was carried out with teachers as a way to elaborate worksheets and exercises based on the objectives identified on an ICF basis. Also, the teaching and learning activities were organized as follow: (1) use of the robot to present the target activity; (2) presentation of some quizzes with multiple choice answers displayed by robot; (3) acquisition of answers (right or wrong), detection of response time, execution of the exercise and number of attempts. Finally, in-depth analysis of the sessions was conducted through verbal and physical robot-participant interactions.

4. Results

Among the main results gained through the intervention emerged the need and opportunity to corre-late the use of the robot and the activities proposed to the functioning characteristics of each stu-dent. For this purpose, the ICF functional assessment resulted very useful to guide the choice of tasks. Furthermore, to correlate the intervention to the IEP was fundamental to orient the interven-tion towards education objectives aimed to develop and strengthen the process to improve attention, communication, imitation, and social skills in order to promote inclusion and self-determination. Another result emerged consisted in understanding the importance of a team of experts to support the introduction and usage of social robots in school contexts, and to facilitate the creation of syner-gies and collaborations between school, teachers, and family.

Other result emerged from the experimentation was the pivotal role of support teachers to help stu-dents with ASD to create a positive relationship with robot and to correlate the activities proposed through robot with IEP. The intervention also highlighted the need to elaborate teaching and learn-ing activities coherent with education objectives, socialization needs, as well as the participant fea-tures emerged by profiling and ICF functional assessment. This coherence was achieved thanks to the contribution of the team of experts that, in collaboration with support teachers, has identified - for each student - the exercises to stimulate attention, concentration and memorization.

Considering what emerged from feedback collected through the focus groups with the support teachers involved, it is useful to underline that such intervention should be replicated in other school contexts, involving other students (classmates). Furthermore, the use of social robot contributed to establish an inclusive climate. Finally, the use of robots resulted to be effective in improving learning process of students with ASD, increasing their interest and fun for learning, stimulating self-determination, as well as contributing to strength social and relationship skills.

5. Conclusions

The general objective of the case study reported in this paper consisted of understanding the effec-tiveness of the use of social robots in upper secondary school contexts to foster inclusion and acqui-sition of skills of students with ASD. In particular, in terms of attention, social and communication skills as well as memorization and concentration skills. The reference to the IEP and the ICF per-spective facilitated the selection and identification of significant education objectives, the planning of teaching and learning activities, and the strengthening of self-determination. Considering the ini-tial questions, it emerged that the necessary requirements for a correct introduction of social robots in educational contexts such as upper secondary schools are organizational and technical aspects. The establishment of a team of experts represented another important aspect for the implementation of the project. Specially to define the correct approach for the inclusion of social robots within indi-vidualized educational proposals designed to respond to learning and socialization needs of students with ASD. Finally, all teachers involved requested the continuation of the project, as demonstration the usefulness and effectiveness of the intervention [24].

5.1 Trajectories of Research

From the analysis of the case study reported, several aspects of interest emerged for possible new trajectories of research and future educational interventions with social robots:
- The usefulness of ICF functional assessment of students with ASD, especially when this evalua-tion is coordinated and shared with the indirect evaluation provided by support teachers and/or fam-ily.
- The need to translate the functional assessments into educational objectives that can help teachers to monitor the progress of skills acquisition through the activities delivered by the robot.
- The importance of expert support and specific training in carrying out interventions using social robots.
- The opportunity to settle specific settings for the implementation of interventions.

5.2 Limitations

Due to the pandemic situation occurred during the intervention, the project had several interruptions and restarts. This caused a limited use of robot (approximately 6 months). This led to the collection and analysis only of qualitative data. Since the short time period between the beginning and the end of the intervention didn't allow to collect significant quantitative data. In fact, the hypothetical dif-ference between the initially data collected (time T0) and the data collected in a second phase (time T1) would not have highlighted substantial changes, that instead were detected through the qualita-tive tools used.

References

1. Besio, S. (2005). Tecnologie assistive per la disabilità. Pensa multimedia, 6, 1-252.
2. Pennisi, P., Tonacci, A., Tartarisco, G., Billeci, L., & Ruta, L. (2016). Autism and social ro-botics: A systematic review. Autism Research, 9(2), 165-183.
3. Scassellati, B., Boccanfuso, L., Huang, C. M., Mademtzi, M., & Qin, M. (2018). Improving social skills in children with ASD using a long-term, in-home social robot. Science Robotics, 3(21), eaat7544.
4. Marino, F., Chilà, P., Sfrazzetto, S. T., Carrozza, C., & Crimi, I. (2020). Outcomes of a ro-bot-assisted social-emotional understanding intervention for young children with autism spectrum disorders. Journal of autism and developmental disorders, 50, 1973-1987.
5. Duradoni, M., Colombini, G., Russo, P. A., & Guazzini, A. (2021). Robotic psychology: a PRISMA systematic review on social-robot-based interventions in psychological domains. J, 4(4), 664-697.
6. Yun, S. S., Choi, J., Park, S. K., Bong, G. Y., & Yoo, H. (2017). Social skills training for children with autism spectrum disorder using a robotic behavioral intervention system. Autism Re-search, 10(7), 1306-1323.
7. Belpaeme, T., Kennedy, J., Ramachandran, A., Scassellati, B., & Tanaka, F. (2018). Social robots for education: A review. Science robotics, 3(21), eaat5954.
8. World Health Organization. (2022). Global report on assistive technology.
9. Puglisi, A., Caprì, T., Pignolo, L., Gismondo, S., & Chilà, P. (2022). Social humanoid robots for children with autism spectrum disorders: A review of modalities, indications, and pit-falls. Children, 9(7), 953.
10. Guggemos, J., Seufert, S., Sonderegger, S., & Burkhard, M. (2022). Social robots in educa-tion: conceptual overview and case study of use. In Orchestration of Learning Environments in the Digital World. Cham: Springer International Publishing, 173-195.
11. Amirova, A., Rakhymbayeva, N., Yadollahi, E., Sandygulova, A., & Johal, W. (2021). 10 years of human-nao interaction research: A scoping review. Frontiers in Robotics and AI, 8, 744526.
12. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology, 3(2), 77-101.
13. Furlong, M. (2010). 'Clear at a distance, jumbled up close': observation, immersion and re-flection in the process that is creative research. In P. Liamputtong (Ed.), Research methods in health: Foundations for evidence-based practice, South Melbourne, Australia, Victoria Oxford Uni-versity Press, 153-169.
14. Morgan, S. J., Pullon, S. R., Macdonald, L. M., McKinlay, E. M., & Gray, B. V. (2017). Case study observational research: A framework for conducting case study research where observa-tion data are the focus. Qualitative health research, 27(7), 1060-1068.
15. Cipriani, R. (Ed.). (2008). L'analisi qualitativa. Teorie, metodi, applicazioni. Armando Editore.
16. Northcutt, N., & McCoy, D. (2004). Interactive qualitative analysis: A systems method for qualitative research. Sage, 472.
17. Kearney, M. H. (2001). Levels and applications of qualitative research evidence. Research in nursing & health, 24(2), 45-153.
18. Charron, N., Lewis, L., & Craig, M. (2017). A robotic therapy case study: Developing joint attention skills with a student on the autism spectrum. Journal of Educational Technology Sys-tems, 46(1), 137-148.
19. Chung, E.Y. H. (2019). Robotic intervention program for enhancement of social engagement among children with autism spectrum disorder. Journal of Developmental and Physical Disabili-ties, 31(4), 419-434.
20. Kim, E. S., Berkovits, L. D., Bernier, E. P., Leyzberg, D., & Shic, F., et al. (2013). Social ro-bots as embedded reinforcers of social behavior in children with autism. Journal of autism and de-velopmental disorders, 43, 1038-1049.
21. Kumazaki, H., Yoshikawa, Y., Yoshimura, Y., Ikeda, T., & Hasegawa, C. (2018). The im-pact of robotic intervention on joint attention in children with autism spectrum disorders. Molecular autism, 9(1), 1-10.
22. Zhang, Y., Song, W., Tan, Z., Wang, Y., & Lam, C. M. (2019). Theory of robot mind: false belief attribution to social robots in children with and without autism. Frontiers in psychology, 10, 1732.
23. Craig, P., Diepe, P., & Macintyre, S. (2006). Medical Research Council (MRC) developing and evaluating complex interventions. London: MRC.
24. Orsmond, G. I., & Cohn, E. S. (2015). The distinctive features of a feasibility study: objec-tives and guiding questions. OTJR: occupation, participation and health, 35(3), 169-177.