

## ROBOTS AND STUDENTS WITH AUTISM SPECTRUM DISORDER IN THE EDUCATIONAL CONTEXT

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### Abstract

The development during the last decade of Information and Communication Technologies (ITC) has provided many mechanisms for the intervention of people with autism spectrum disorders (ASD). Currently, among these types of ICT, a growing intervention method based on Social Assistance Robots (SAR) is being developed. Robotic assisted therapy not only perfectly aligns with the methodological principles that should guide the teaching-learning process of these students (individualized intervention, sequence of activities, active experiences and predictive environments), but also with the educational needs of these students. This rapid advance in robotics, its good results, the complexity of the educational need and the increase in cases of ASD, make it necessary to include this type of intervention in educational contexts. In this sense, the main aim of the current research was to identify a state of arts of robots in an education context and to provide an overview of skills worked. The current bibliometric study has been carried out through the Web of Science (WOS). The results showed that the number of empirical applications in the educational context is limited. Only 5 studies were adjusted to the previously established criteria, such as age of the participants (between 2 and 16 years), purpose of articles (academic) or the years of publication (between the years 2005 and 2017). Overall, all the studies demonstrate the great potential of robots as support tools in the education of students with ASD. Nevertheless, the analysis emphasizes the methodological limitations of these studies that make it difficult to generalize the results from these studies to other contexts.

**Keywords:** *Autism spectrum disorder, robots, intervention, social and communication skills.*

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### 1. Introduction

The prevalence of cases of people with autism spectrum disorders (ASD) has increased significantly over the past 40 years (Aresti-Bartolome & Garcia-Zapirain, 2014). According to the Diagnostic and Statistical Manual of Mental Disorders (SDM-5) (American Psychiatric Association, 2013) autism spectrum disorder (ASD) is a developmental disorder characterized by deficits in two areas: (1) social and communication interaction and (2) repetitive patterns of behaviors, interests or activities.

Currently, early intervention and different educational approaches improve the quality of life of people with ASD. In this sense, following Tárraga-Mínguez and Sanz-Cervera (2018), there are different types of educational interventions with students with ASD such as: Applied Behavioral Analysis (Makryianni, Gena, Katoudi & Galanis, 2018), TEACCH methodology (Sanz-Cervera, Fernández-Andrés, Pastor-Cerezuela & Tárraga-Mínguez, 2018), interventions based on social histories (McGill, Baker & Busse, 2014), child-based play therapy (Hillman, 2018) or intervention based on new technologies (Pinel, Aguiló & Adrover-Roig, 2018). In this sense, the intervention with people with ASD must be based on specific methodological principles, such as: to organizer space, time and sequences of events in the environment so that learning activities are clearer and easier to conducted; to use visual information to promote engagement in productive activities and to reduce the confusion; to use special interests of students to engage them; and to use symbols to promote communication (Mesibov y Shea, 2005). There is a growing demand for resources for children with ASD (Kim et al. 2018). In this regards, Information and Communication Technologies (ICTs) perfectly aligns with the methodological principles that should guide the teaching-learning process of these students. This type of technology can, in general terms, lead to more effective diagnoses (Liu, Wu, Zhao & Luo ,2017), and, on the other hand, act as a support tool for the intervention and education of these students (Aresti-Bartolomé & García-Zapirain, 2014). More specifically, ICTs have a number of characteristics, such as predictability, visual support and sequential presentation of information, which are aligned with the needs of people with ASD, making them ideal tools for working on social and communication skills with that student body (Grossard et al.

2018). In this sense, ICT in the intervention of students with ASD can be classified into three large groups according to their use (Grossard et al. 2018). First, the applications for Ipad and Ipad, secondly, educational games. And, finally, social assistive robotics (SAR). SARs are a young and developing field (Scasellati, Admoni and Mataric, 2012). This term is used to describe robots whose main task is to help through social interaction (Feil-Seifer and Mataric, 2005). Several reasons have been proposed for why the use of SAR could be beneficial for the intervention with children with ASD. Firstly, children with ASD have a great affinity with robots and their great interest may provide them a high level of motivation (Diehl, et al., 2012, Aresti-Bartolome, Garcia-Zapirain, 2014). Furthermore, robots could be used as tools to reduce impairments of children with ASD, due to robots produce controlled social situations where children with ASD can practice and learn. Because of that, children feel less anxious in these situations since robots are more predictable and simpler than humans (Huskens et al., 2013; Goodrich et al., 2012). According to Short, Deng, Feil-Seifer & Mataric (2017) this would entail the development of their social skills in a more comfortable way, since the SARs will not unexpectedly exhibit complex behaviors, which are natural of human interactions. Notably, the work of Short et al. (2017) showed great levels of attention when children interact with robots.

## 2. Search questions

To summarize, the research aims to show the current state of art in SAR as educational tool in the intervention with students with ASD. The present work has been conducted by the members of the IncluTIC Research group. To obtain this main purpose we have established the following research questions:

- How many researches involve interventions with ASD children using SAR as a tool of learning in an educational context?
- Which are the areas studied in these researches?
- What are the features of the participants used in the sample?
- Which are the most important results obtained in these researches?

## 3. Method

The research has been based on the descriptive-retrospective bibliometric design. This design allows the selection and organization of the documents involved in an area of study (Montero and León, 2002). Specifically, the steps to follow would be the following: search and selection of the information; secondly, classification according to the descriptors of the documents found and, finally, the analysis of the data (Rosa, Huertas and Blanco, 1996).

### 3.1. Participants

The sample consisted of 5 articles published between 2005 and 2017 in the Web of Science database. A search, selection and individual reading and analysis study of the data was conducted from September 2018 to November 2018. The units of analysis used were English articles aimed at studying robots as learning tools for intervention with students with Autistic Spectrum Disorder (ASD).

### 3.2. Design and process

The phases conducted in the search for information are listed below.

Phase 1. For the selection of the items included in the sample, the following code lines were used in a first phase: TS=("autism" AND "robots") OR TI=("autism" AND "robots") OR TS = ("autism" AND "robots" AND "Education") OR TI = ("autism" AND "robots" AND "Education") OR TS=("autism" AND "emotions" AND "robots") OR TI=("autism" AND "emotions" AND "robots") OR TS=("autism" AND "social skills" AND "robots") OR TI=("autism" AND "social skills" AND "robots") OR TS=("autism spectrum disorder" AND "social assistive robots") OR TI=("autism spectrum disorder" AND "social assistive robots") OR TS= ("case study" AND "autism spectrum disorder" AND "social assistive robots") OR TI= ("case study" AND "autism spectrum disorder" AND "social assistive robots"). Moreover, the language selected was English, because this language is the most used (Lorenzo, Lledó, Pomares and Roig, 2016). Furthermore, it has been chosen the period 2005-2017, because the majority of studies related to socially assistive robotics (SAR) has divulged over the last decade (Diehl, Schmitt, Villano, and Crowell. 2012) due to the rapid development of technology. Finally, all de indexes were selected (SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC). Searching results were 262 papers.

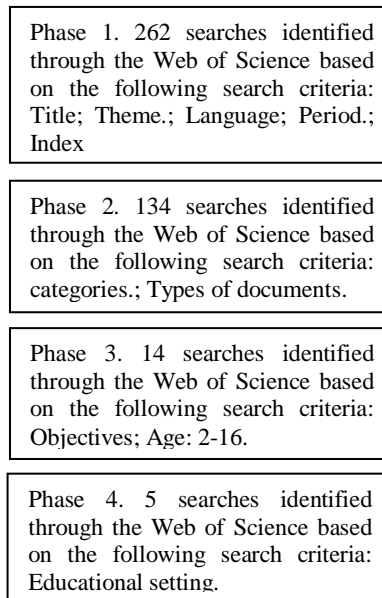
Phase 2. Then, for a second phase, the search was refined using 3 categories from the Web of science. These categories are directly related to the objective of the research: robotics (121 papers), education educational research (9 papers) and education special (5 papers). And, on the other hand, 3 types of documents were selected: proceedings paper (96), articles (37) and reviews (2). A sample of 134 was obtained.

Phase 3. Following Scasellati, Admoni and Mataric (2012), the field of robotics encompasses a multitude of studies based on different methods and objectives. However, research can be divided into three main groups: robot design, design of human-robot interaction and validation of robots in trials. In this sense, the studies that pursued this last objective were selected. In addition, the intervention with robots is carried out with children aged between 2 and 6 years. As a result, a sample of 14 papers was obtained.

Phase 4. And finally, the studies are conducted in educational settings. As a result, a sample of 5 papers was obtained.

In this way, the phases described are reflected in figure 1.

Figure 1. Procedure process.



#### 4. Results

The results show five investigations. The research carried out by Robins, Dautenhahn, Te Boekhorts and Billard (2005) is from the year 2005. Second, Duquette, Michaud and Mercier's (2008) research is from 2008. And, the rest of the research (Wainer, Dautenhahn, Robins and Amirabdollahian, 2017; Bharatharaj, Huang, Al-Jumaily, Rajesh and Krägeloh, 2017; and, Boccanfuso et al., 2017) are from the year 2017.

In addition, the number of participants in all studies does not exceed 8. The research conducted by Boccanfuso et al. (2017) is the one with the most participants. On contrast, the minimum number of participants is 4 (Robins et al., 2005; Duquette et al., 2008).

The diagnosis of all ASD participants. Specifically, the study conducted by Duquette et al. (2008) specifies that participants have low functioning autism. The diagnosis of all ASD participants. Specifically, the study conducted by Duquette et al. (2008) specifies that participants have low functioning autism. In addition, in the study conducted by Boccafuso et al., (2017) children present speech deficiency.

Furthermore, the age of the sample ranges from 3 to 16 years. The study conducted by Boccafusso et al. (2017) includes 3-year-olds. On the other hand, the study that includes older adolescents is that conducted by Bharatharaj et al. (2017).

In terms of the area worked on, the most of studies were focused on subareas related to social skills. imitation and eye-contact (Robins et al., 2005), attention and engagement (Duquette et al., 2008), joint attention, imitation, eye-contact and positive affect (Wainer et al., 2017) and spontaneous speech and joint attention (Boccanfuso et al., 2017). And, on the other hand, there is one research focused on stress.

Finally, the results of Robins et al (2005) showed an improvement of basic social interaction skills in children with ASD after the repeated exposure to *Robota*. In a similar way, Duquette et al. (2008) showed an increase of joint attention when the child interacts with the robot *TITO*. Moreover, Wainer et al. (2017) the robot *KASPAR* acts as a mediator in the social interaction between the adult and the child. Furthermore, Bharatharaj et al. (2017) showed the effectiveness of their robot to low stress level of children with ASD that often characterize them. And, finally, as regards to spontaneous speech, social interaction and joint attention the investigation conducted by Boccanfuso et al. (2017) showed an increase of these after the interaction with the robot *CHARLIE*.

Table 1. Overview of researchers that use a robot as a tool.

References	Participants			ROBOT	Area	Conclusions
	No.	Diagn.	Age			
Robins et al., 2005	4	ASD	5-10	ROBOTA	Imitation and eye-contact.	An improvement of interaction skills after the interaction of children with Robota.
Duquette et al., 2008.	4	Low-functioning autism	5	TITO	Attention and engagement.	A greater interest in robot, but showed more imitation improvement on several variables when they interacted with the human.
Wainer et al., 2017	6	ASD	6-8	KASPAR	Join attention, imitation, eye-contact and positive affect	The results showed that children found the activity more entertaining.
Bharatharaj et al., 2017	7	ASD	6-16	KILIRO	Less stress	The results showed the efficacy and validity of Kiliro to low the stress level of children with ASD.
Boccanfuso et al., 2017	8	ASD and speech deficiency	3-6	CHARLIE	Spontaneous speech and joint attention.	An increase in spontaneous speech, social interaction, joint attention and requesting behaviors.

## 5. Conclusions

The following conclusions can be drawn from the proposed research questions and by answering them:

- We found 5 studies which used a robot as a tool to learning social skills in an educational context.
- The areas studied in these researches are related to social skills which include social initiation, social interaction rules, emotion production and recognition.
- All of participants had between 3 and 16 years old. They were all of school age.
- In line with previous studies, show that robots have been used in the intervention with children with ASD being more used and effective as a tool to promote communicative interaction while there is no evidence of intervention in curricular contents. As a consequence, a significant advance in this field could be to devote efforts to the study of the application of robots with a view to improving curricular aspects in this type of students.

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