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ARTICLE / ARTÍCULO

Educational interventions with robots for students on the autism spectrum. A systematic review

Intervenciones didácticas con robots para alumnado en el espectro del autismo. Una revisión sistemática

Itsaso Arozena, Asier Huegun-Burgos e Itziar Rekalde-Rodríguez

Abstract: This article describes the quantitative results of a study whose objective is to identify trends and opportunities for innovation in the field of socio-educational robotics to work with students with autism spectrum disorders. For the systematic review, those experiences and interventions where the protagonist is the student body have been considered. The focus is on their needs, not on the robot. Interventions that have been carried out where robots have been used as a teaching tool, whose design is aimed at the specific learning needs of this group. In order to find out if these interventions are integrative or segregating, both the characteristics of an excellent didactic practice aimed at this specific group and the inclusive point of view have been taken into account when making the analysis. For this, a systematic literature review has been carried out using a rigorously defined search strategy. This search has been carried out in the following databases; Web of Science, Eric and Dialnet, since they are the most used and relevant in education. In the results obtained, it is possible to identify the advances in didactic models based on the use of robotics as an educational tool. Pedagogical activities carried out in recent years, and didactic resources; evaluation criteria, strategies and instruments, as well as application experiences in real school contexts.

Keywords: Systematic Review, Autism Spectrum Disorders, Socio-Educational Robotics, Intervention, Inclusion.

Resumen: Este artículo describe los resultados cuantitativos de un estudio cuyo objetivo es identificar las tendencias y oportunidades de innovación en el campo de la robótica socioeducativa para trabajar con alumnado con trastornos en el espectro del autismo. Para la revisión sistemática se han tenido en cuenta aquellas experiencias e intervenciones donde el protagonista es el alumnado, y el foco está en sus necesidades, no en el robot. Intervenciones que han sido llevadas a cabo donde los robots han sido utilizados como herramienta didáctica, cuyo diseño sea dirigido a las necesidades específicas de aprendizaje que presenta este colectivo. Con el fin de averiguar si estas intervenciones son integradoras o segregadoras, y se han teniendo en cuenta tanto las características de una buena práctica didáctica dirigida a este colectivo concreto como el punto de vista inclusivo a la hora de hacer el análisis. Para ello se ha realizado una revisión sistemática de la literatura, mediante una estrategia de búsqueda rigurosamente definida. Esta búsqueda se ha realizado en las siguientes bases de datos; Web of Science, Eric y Dialnet, ya que son las más utilizadas y relevantes en el área de la educación. En Los resultados obtenidos permiten identificar los avances en cuanto a modelos didácticos basados en el uso de la robótica como herramienta educativa, actividades pedagógicas realizadas en los últimos años, y recursos didácticos; criterios, estrategias e instrumentos de evaluación tanto como experiencias de aplicación en contextos escolares reales.

Palabras clave: Revisión sistemática, Trastornos del espectro de autismo, Robótica Socio-Educativa, Intervención, Inclusión.

1. Introduction

The reasons that cause a child to be on the spectrum will not be addressed in this article. The main explanatory theories of ASD will be explained, and the educational methodologies mainly being used to treat students on the spectrum. As educators, our focus is on didactics and teaching different skills to students with this specific need. Before we go into the history and evolution of the autism spectrum disorders or ASD terminology, what this disorder involves will be explained. ASD is a neurodevelopmental disorder whose main characteristics are an atypical development in communication and social interaction skills, as well as a highly restricted repertoire of activities and interests (Arias-Pujol & Mestres-Martorell, 2012).

When we talk about ASD, we talk about disorders on the autism spectrum since it is not a disease but a behavior disorder. We use the term spectrum because people in it can be very diverse, with different capacities and very different abilities, and require more or less support depending on their circumstances. However, there are some factors that these individuals will be likely to have in common. These factors make us understand all of them together, and we collect them into a fan, called the autism spectrum (Valdez, 2001). The word autism was first used in 1943 by Leo Kanner in his article *Autistic disturbances of affective contact*. Although he researched the subject in depth over the next several years, Kanner wrote in the German language, so his research did not expand outside his native Germany. In 1944 Hans Asperger picked up the term and used it too; this was the most significant impact his work had, up to four decades later (Artigas-Pallarés & Paula, 2012).

In the 80s, the term autism was gathered for the first time in the Diagnostic and Statistical Manual of Mental Disorders, or DSM, in its third version. DSM is the official guide written by the American Psychiatric Association and used as a reference by healthcare professionals worldwide. DSM provides a common language for professionals to communicate about their patients and established diagnostic criteria (Artigas-Pallarés, 2011). Since the first publication of this guide in 1952, several updates have been made to it. The current version of the DSM is DSM-V. This version represents a significant change for professionals who work with people with ASD since a new way to understand and conceptualize this disorder is introduced (Artigas-Pallarés & Paula 2012).

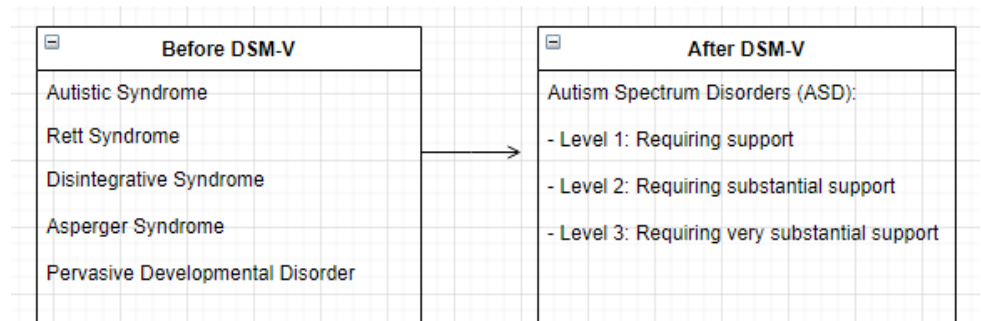


Figure 1. DSM-V manual: Main changes. Prepared by the author based on Artigas-Pallarés, 2011.

As we can see in figure 1, in the first versions of the DSM, we could find different disorders, or behavioral disorders, grouped due to their similarities. These disorders are autistic syndrome, Rett syndrome, disintegrative syndrome, Asperger syndrome, and pervasive developmental disorder. However, in the DSM-V, we see a significant change when these disorders are collected together, and they become autism spectrum disorders. Therefore Rett syndrome, Asperger syndrome, disintegrative syndrome, and pervasive developmental disorders have disappeared from the medical and scientific language in recent years, using autism spectrum disorders instead (De la Iglesia & Olivar, 2012).

1.1. Educational inclusion

The right to education has been both a struggle and a conquest for our society since it is commonly accepted that if the population has equal educational possibilities, it will have equal opportunities in life for its realization (Parra-Dussan, 2010). The United Nations Educational, Scientific and Cultural Organization, UNESCO (2009) defines inclusion as the process of strengthening the capacity of the education system to reach all learners; therefore, it should guide all educational policies and practices, based on the fact that education is a fundamental human right and that foundation of a fairer and more egalitarian society. Echeita & Ainscow (2011) propose four elements present in all-inclusive education processes:

Inclusion is a process	Inclusion is about learning to live with the difference and at the same time studying how we can take advantage of this difference. In this sense, the differences can be appreciated more positively and stimulate learning processes between children and adults
Inclusion seeks the participation and success of all students	This term refers to the quality of their experiences while in school; therefore, it must incorporate the students' points of view, their voices and opinions, and assess their personal and social well-being
Inclusion applies to all spaces	Every student has the right to receive an education, which implies a rethinking of the entire educational system since all spaces should be accessible to any student, thus adapting the center to the needs of its students and not the other way around
Inclusion requires the identification and removal of barriers	Generically, we must understand as barriers those beliefs and attitudes that people have regarding this process. These beliefs are influenced by cultures, policies, and school practices applied at the local, regional, or national levels. Specific social or cultural activities aimed at these particular students or groups of students generate exclusion, marginalization, or school failure

Figure 2. Inclusive education elements. Prepared by the author based on Echeita & Ainscow, 2011; Rapanta, Garcia-Mila, Remesal & Gonçalves, 2021

Inclusion must be seen as a constant search for better ways to respond to the diversity of our students. When talking about the process, then, we must assume that time is a factor that must be counted on, that changes are not implemented overnight, and that, in the meantime, confusing situations can happen (Arnaiz, Escarbajal & Caballero, 2017). We will have to understand and manage those situations to generate

sustainable changes. Spaces are essential but interdependent with the before mentioned other three variables. This element has a structural character. The importance of this element lies in the accessibility to education that it brings to the students or the inaccessibility that it may imply (Echeita & Ainscow, 2011).

Participation has to do with learning, concerning the curriculum of each country, not only with tests or results of standardized assessments. Students are the protagonist of their educational processes. The education system must listen to their concerns and adapt to their needs (Verdugo, Amor, Fernandez, Navas & Calvo, 2018). The concept of barriers is nuclear to the perspective that we want to share insofar as the barriers that prevent the effective exercise of rights, in this case, to inclusive education. Therefore, it is strategic and essential to collect and evaluate information from various sources to detect which experiences could become barriers to improving inclusion. In which levels of school life are they located, what they are to project immediately afterward, improvement plans in education policies, and innovation practices (Arnaiz et al., 2017).

1.2. History of educational inclusion.

Between the 1970s and 1990s, the European Union promoted the idea of inclusion and considered it an established concept in European politics. The literature on inclusion covers various areas: social, political, organizational, educational, or health; and a great diversity of topics, such as poverty, multiculturalism, inclusive education or people with mental and physical disabilities (Parra-Dussan, 2010; Rapanta, Garcia-Mila, Remesal & Gonçalves, 2021). One of the first milestones in the history of inclusive education is the Warnock report. This report was commissioned by the Secretary of Education of the United Kingdom to an expert commission, chaired by Mary Warnock, in 1974 and published in 1978. It convulsed the schemes and popularized a different conception of special education (Aguilar, 1991). The committee began its work shortly after the entry into force of the Education Act for Handicapped children of 1970. According to this mentioned law, any disabled person, regardless of the severity of their difficulty, is included in the special education framework, so no children should be considered ineducable. Education is a good to which everyone is entitled. Therefore the aims of education are the same for everyone, regardless of the advantages or disadvantages, each one is facing (Perazzo & Gargiulo, 2009).

The next appointed moment in educational inclusion is the 1990 World Conference on Education for All in Jomtien, Thailand. This conference marked a new beginning to universalizing primary education and eradicating illiteracy. With the Jomtien Declaration and Framework for Action, commitments were made, and guidelines were set for a decade of sustained and large-scale efforts. Agreements were adopted between the countries, intergovernmental organizations, and NGOs to work together throughout the decade (Duk & Murillo, 2018). The Education for All Forum was created to guide and coordinate work, monitor progress, and evaluate achievements. Following this, in 1993, the United Nations Decade for Disabled Persons wrote the Standard Rules on equal opportunities for people with disabilities. The Standard Rules represent the moral and political commitment of the governments regarding the adoption of measures aimed at achieving equality of opportunities for people with disabilities (Mreisat & Rusnac, 2018). The Standards are an instrument to formulate practical policies and serve as a basis for technical and economic cooperation. The Standard Rules consist of 22 rules that summarize the message of the Global Program

of Action, and they incorporate the human rights perspective that has developed throughout the Decade. As Kanter explains (2019), these rules are divided into four chapters: (1) Equal participation requirement; (2) Equal participation envisaged areas; (3) Supervisory mechanism measures implementation; y (4) Enclose every aspect of the lives of persons with disabilities.

The Standard Rules on the Equalization of Opportunities for Persons with Disabilities provide for the assignment of a Special Reporter in charge of supervising the application of the Norms (Kanter, 2019). Years later, in 1994, the Salamanca statement took place. This meeting took place in Salamanca (Spain). It was a crucial act in reaffirming the right to education of all people within an educational system, with an inclusive and integrative perspective and rejection of school organizations implementing segregation and separation of students based on intellectual coefficients or certain potentialities (Ainscow, Slee & Best, 2019). Based on these criteria, the meeting attendees signed a statement where, among other issues, firstly, the need and urgency of all people (both children, youth, and adults) with specific educational needs to receive quality education was recognized. Secondly, access to ordinary schools for students with specific education was recognized, integrating them with a pedagogy adapted to their unique characteristics or learning problems and capable of meeting their needs. Thirdly, it was agreed that educational systems must be designed and implemented, taking into account the full range of different characteristics and needs of each student. Finally, it was accepted that ordinary schools with an inclusive orientation should be promoted, as they are the most effective means of combating discriminatory attitudes (Ainscow et al., 2019).

In 2000 the international community met again at the World Forum on Education in Dakar, Senegal. The forum was a continuation of the previously mentioned World Conference on Education for All, celebrated in 1990 in Jomtien. It took stock of the fact that many countries are far from having accomplished the goals established in that previous conference. The participants reaffirmed their commitment to achieving Education for Everyone in 2015 and identified six key objectives of measurable education for that year; Improve and extend childhood education, implement free elementary school for boys and girls, meet all the learning needs of young and adult people, preparing them for active life, increase by 2015 by 50% the number of literate adults, especially women and facilitate access to permanent education, and finally, achieve gender equality in education by 2015, ensuring the girls' access to quality primary education, with particular emphasis on literacy and math (Winzer & Mazurek, 2017). On December 13, 2006, the International Convention on the Rights of People with Disabilities was approved. This Convention resulted from a long process in which several actors participated: United Nations member states, United Nations Observers, Special Reporters on Disability, national human rights institutions, and non-governmental organizations. Governmental organizations, among which the organizations of people with disabilities and their families, played a central role.

The approval by the United Nations of the Convention on the Rights of People with Disabilities supposes the materialization of an old and sustained demand of the associative movement of disability, presented to international bodies intending to advance in recognition of society in general information on the aspirations, demands, and concerns of people with disabilities and their families (Rapanta et al., 2021). In recent times, the way of understanding disability as a medical model has been overcome, in which charitable considerations were added to purely health and welfare

aspects, to a model based on the concept of human rights, where the accent is in equal opportunities and non-discrimination of the person with disabilities as rights holders (Duk & Murillo, 2018).

People with disabilities are subjects, citizens with rights, participatory and responsible, who assume the whole direction of their personal and social life. This paradigm shift that we are witnessing in disability has been mainly determined by the role played by the associative movement of people with disabilities. Moreover, the United Nations Convention is soundproof of this, as the process launched in 2002 has shown the representatives of the different administrations at the same table with civil society to debate, reach a consensus and draft an International Convention with the seal of the United Nations (Kanter, 2019).

There is no doubt that the achievement of a legally binding international instrument, which protects the rights of people with disabilities, completes the legal basis necessary for this social group with disabilities, which currently continues to suffer multiple discriminations, can finally dispose of a legal weapon that obliges States and other subjects of International Law to ensure their rights and freedoms (Degener & Begg, 2017). This new legal instrument has had significant consequences for people with disabilities. The main ones include the visibility of this citizen group within the United Nations human rights protection system, the irreversible assumption of the phenomenon of disability as a human rights issue, and having a binding legal tool when enforcing the rights of these people (Degener & Begg, 2017; Ainscow et al., 2019). Spain signed and ratified this Convention, plus its Optional Protocol, so that since May 3, 2008, this international body of law is entirely part of the Spanish legal system.

1.3. Intervention in students with autism spectrum disorders

There is no universal protocol when designing educational interventions for students with autism spectrum disorders; what does exist are several guides, designed by specialized organizations in the area, that collect good practices regarding this type of student, based on treatments with scientific evidence, which we will break down below. According to the USA National Institute of Mental Health (NIHM), research shows that intensive therapy in the first few years of life improves cognitive and language skills (Mulas, Ros-Cervera, Millá, Etchepareborda, Abad & Téllez de Meneses, 2010). There is no single treatment for ASD, but there are common characteristics in successful interventions that should include: (a) Start as soon as possible; (b) 25 hours a week 12 months a year; (c) Small classrooms, individualized instruction; (4) Training for parents and relatives; (5) Measure progress and adjust intervention according to progress; (6) Provide structure, routines, and visual aids; (7) Curriculum focused on: Language and communication, social skills, autonomy, disruptive behavior and cognition.

As stated by the UK National Institute for Health and Care Excellence (NICE), the following requirements must be met when designing a successful intervention for students with ASD (Silva, Correia, Lima, Magalhães & de Sousa, 2011): (a) A maximum period of 3 months for evaluation is recommended for suspected ASD students. (b) ASDs often have other associated disorders. These disorders must be identified and addressed as they can have a severe impact. Evaluate comorbidities. (c) Personalized intervention plan. (d) Have a professional reference assigned. (e) Receive documented information on the benefits of participating in psychosocial intervention programs. (f)

Do not administer drugs to treat the main symptoms, since after reviewing the literature, they are ineffective for these symptoms and pose a health risk. And (g) Do not receive antipsychotic medication unless psychosocial interventions or other treatments are insufficient.

On the report of the Spanish Carlos III research group, the common elements of effective intervention programs (Fuentes-Biggi, Ferrari-Arroyo, Boada-Muñoz, Touriño-Aguilera, Artigas-Pallarés, Belinchón-Carmona & Díez-Cuervo, 2006) are: (1) Intervention for ASDs must be individualized; (2) intervention must be structured; (3) intervention must be intensive and extensive to the students' whole context and reality; and (4) the participation of parents and other family members has been identified as a critical factor for the success.

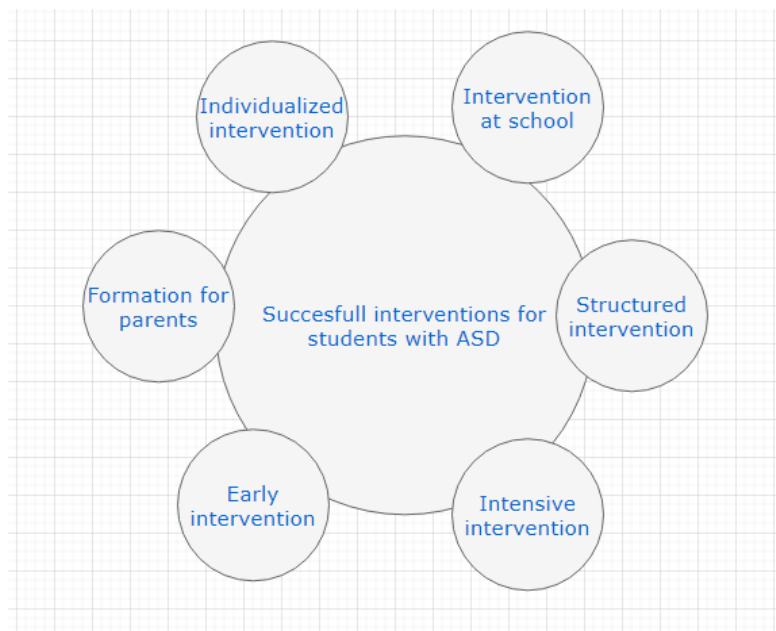


Figure 3. Indicators for a successful intervention. Prepared by the author based on Fuentes-Biggi et al., 2006; Mulas et al., 2010, Silva et al., 2011

1.4. Social robotics as educational intervention tools

Understanding and using social skills is the most challenging developmental area for people with autism spectrum disorders (Weiss and Harris, 2016). They feel, live and express their affection and emotions in a different and personal ways, making communicative exchanges complicated, which can cause frustration on the participants of said communicative actions. During the last decades, various types of educational interventions using animals have emerged, especially for people with functional diversity. The value of these interventions assisted by animals is commonly accepted; the contact with an animal positively influences the self-perception of the human being and stimulates their social behavior. This effect is called social catalyst since it facilitates interpersonal interactions (Beetz, Uvnäs-Moberg, Julius & Kotrschal, 2012). Dealing with animals makes people with ASD trust others more easily, develop greater empathy and increase their self-esteem, as they feel able to do something that is difficult for them (Simut, Vanderfaeillie, Peca, Van de Perre & Vanderborght, 2016).

The animals that have proven to be most effective are dogs, but we can also find studies conducted with horses, cats, etc., which show beneficial effects of this type of intervention in people with ASD (Silva, Correia, Lima, Magalhães & de Sousa, 2011). The biggest difference between using animals and using robots as a social catalyst lies in the control of the situation. Pets can be trained to be great therapists, but an animal will always have a series of unexpected behaviors facing a situation, which we can not completely control. However, we can fully program a robot and adapt it to respond to the needs that arise during an interaction. This gives us flexibility and a greater ability to reach all users, regardless of their circumstances (Beetz et al., 2012).

Recent studies show that people with ASD tend to feel comfortable interacting with social robots, due to their low emotional stimulation (Huijnen, Lexis, Jansens & de Witte, 2016; Kumazaki, Warren, Swanson, Yoshikawa, Matsumoto, Ishiguro & Kikuchi, 2018). Interacting with robots can be particularly enriching for a child with autism spectrum disorder, as it can overcome the barriers experienced in face-to-face interaction with other people. However, there is always a person behind the robot, who must design the objective of the intervention and all the appropriate didactic sequence to achieve it (Hashim and Yussuf 2017; Huijnen et al., 2016).

The purpose of this study is to provide a systematic review of the scientific literature about the use of robotics as a tool in educational intervention with people with ASD, in order to fulfill the following goals:

- 1) Determine the number of articles that have been published in ERIC, WOS and Scopus databases.
- 2) Identify the main objectives to be developed through robotics.
- 3) Describe the scenario where the interventions have been made.
- 4) Establish the participant number on the interventions.
- 5) Identify the duration of the intervention.
- 6) Detect the main robot models used and their characteristics.

2. Materials and methods

This study aims to deepen the field of science that combines social robotics and learning difficulties, specifically autism spectrum disorders, from an educational point of view. To do so, the most relevant databases for research in the socio-educational field were chosen; Web of Science (WOS), Scopus and Education Resources Information Center (ERIC). The method chosen was systematic review. Kitchenham, Brereton, Budgen, Turner, Bailey, & Linkman (2009) claim: «Researchers performing a systematic review must make every effort to identify and report research that does not support their preferred research hypothesis as well as identifying and reporting research that supports it» (p.5).

The keywords chosen were autism and robotics. By using the thesaurus the data-base provides us with, we could make a wider research using the next keywords:

on the one hand autism, asperger syndrome and behavior disorders; on the other hand social robotics, cybernetics and electronics. Taking into account that our focus and interest is on primary education and secondary education, all other educational levels were excluded, leaving us with the final figure of 28 studies in ERIC, 10 studies in WOS and 7 studies in Scopus.

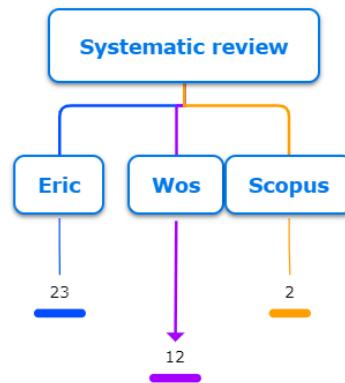


Figure 4. Visualization of the research process.

The analysis started through ERIC database because it is a reference in the field of education, continued with WOS and ended up with Scopus. As the work progressed, we noticed that some articles were repeated in the three databases. These repeated articles were manually discarded, leaving us with a final figure of 37 articles to analyze. We are aware that the number of articles found in this search will vary from when the article was written until its publication date, since socio-educational robotics is a field that is now emerging.

In order to keep these articles organized, an index file was created (Díaz-Posada, Varela-Londoño & Rodríguez-Burgos, 2017). The selected articles were sorted according to the date, from the oldest to the newest. In addition, the following data was also collected in the files; name of the article, journal, type of publication, country of publication and name and surname of the authors. Those files were encrypted with code names and added to other files according to the items analyzed.

3. Results

First of all objectives of the articles chosen were analyzed. Then, they were classified into three areas; those that aim to acquire or produce knowledge about the issue, those that aim to develop the participants' abilities and skills, and finally, those articles which aim to compare situations.

Watching Figure 5 gives us the feeling that it is commonly accepted that social robotics can be used to improve different skills in people on the autism spectrum since most of the interventions had this goal. Most of the works aim to develop the skills of the participant. Many of them seek to gain knowledge in this area, and some aim to compare how their participants would react in the same situation but compare between working with a human or working with a robot. The vast majority of comparative works base their comparison on the same scenario; the same intervention

is repeated with both a human and a robot. However, only one of the analyzed works compares the effectiveness of the robot against a traditional toy. Next, the works in which socio-educational interventions were carried out were analyzed. Specifically, we focused on whether these interventions were carried out in the participants' natural environment or occurred in an artificially created environment.

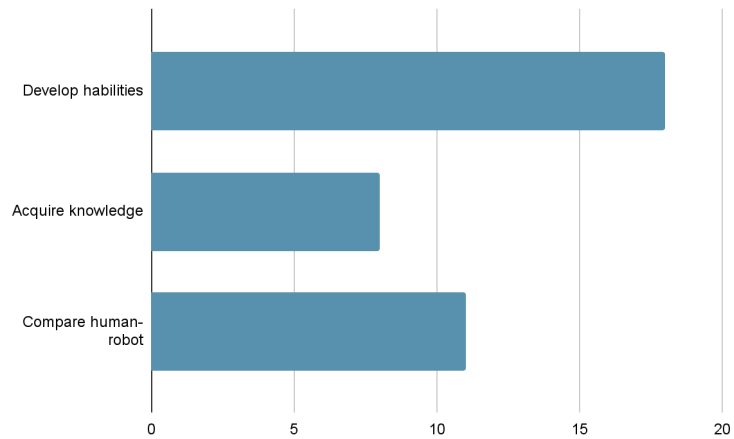


Figure 5. Objetivos.

As shown in Figure 6, most of the interventions were carried out in artificial environments, such as; a research center, an isolated room inside a school, a laboratory, etc. Few of them were made on natural scenarios for the participants, such as their school, ordinary classroom or even their own homes.

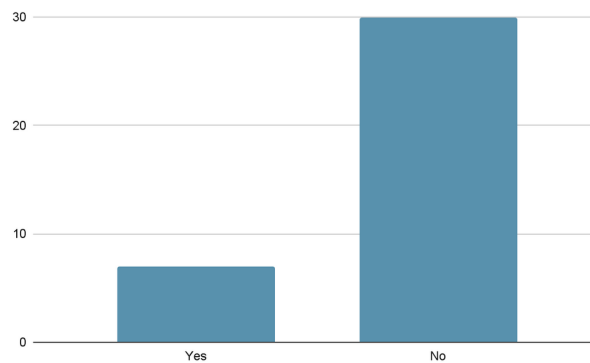


Figure 6. Scenario.

Figure 7 shows that more than half of the interventions analyzed were carried out with less than 10 participants, and less than a quarter was accomplished with more than 30 participants. All the articles were analyzed to explain the process of selection of the participants and the sample of participants in detail. However, only six of the articles mention the selection criteria used, that is, what they were based on to choose the intervention participants.

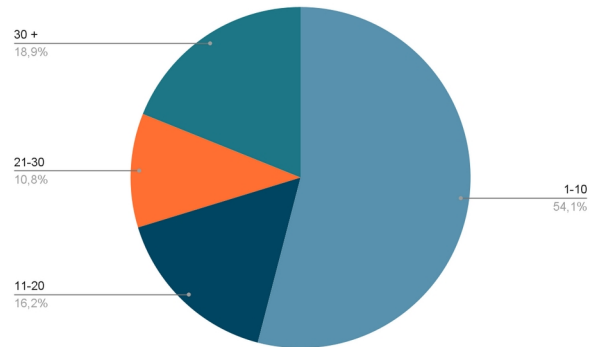


Figure 7. Participant number.

The next item analyzed was the duration of the interventions. 81,1% of the interventions examined lasted less than one month, 13,5% lasted between 1 and 3 months. Finally, a small 5,4% of the interventions lasted beyond 3 months (Figure 8).

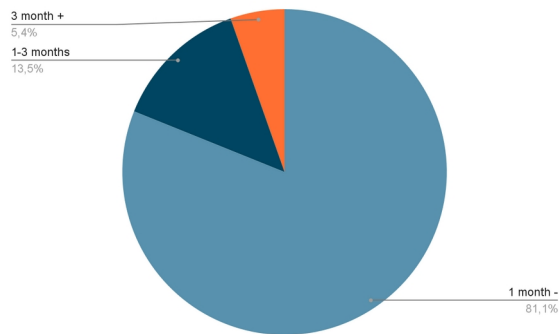


Figure 8. Intervention duration.

Hence, we check if the interventions analyzed include the fathers and mothers of the users and if they receive training to continue with these interventions from their homes and thus give them continuity. As we can see in figure 9, only some of the 37 interventions analyzed include the parents of the users in the intervention process.

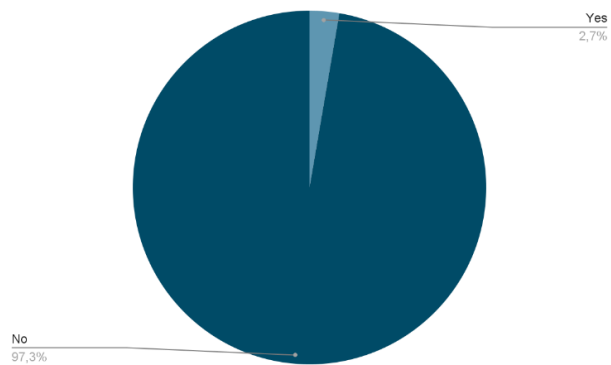


Figure 9. Parent training.

As we can see in Figure 10, the most used robot among the analyzed works was Nao, closely followed by Popchilla, Pepper, Kaspar and Probo. The other section refers to non-commercial robots. This means that the researchers who have carried out these interventions have not bought existing robots on the market but have designed and built their robots.

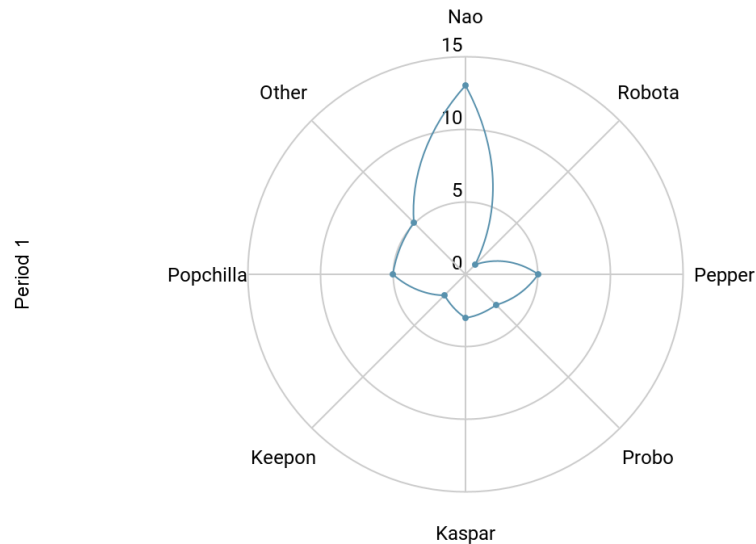


Figure 10. Robot model

All the works were carried out to explain the characteristics of the robot that they chose to carry out the intervention. However, only four of them justify this choice. These characteristics mentioned above that make researchers choose a robot model or another are mostly programmability, accessibility, the humanoid form or the shape of a stuffed toy. Depending on the objectives of the intervention, one or the other form was chosen.

4. Discussion

The American Psychiatric Association in the fifth edition of its diagnosis and statistical manual of mental disorders calls the condition so far known as ASD more precisely; disorders of the autism spectrum (American Psychiatric Association, 2013). Being accurate we could not even talk about disorder, we would talk about people who are within the spectrum of autism. We call it that because it is a very wide range, where each person is totally different to the rest, each one of them with their strengths and their weaknesses.

If we look at what a good practice aimed at people on the autism spectrum should be, we will see that a significant part is the setting in which it takes place. Educational interventions aimed at both this group and others must always be inclusive (Ainscow, 2011). The ultimate goal of these interventions must be to include the person in society and their environment, being both a participant in their community and a protagonist in their own lives. However, only seven of the 37

interventions analyzed in this review have been carried out in the natural context of the participating students. The rest have been produced in artificial settings, such as laboratories or research centers.

The individual with ASD condition likes things to stay the same, with no changes. Often, the person with ASD has difficulty moving from one thing to another. In the case of children, this is shown as stress when a transition is necessary (Taylor, Vasquez & Donehower, 2017). Taking this into account, we can expect that bringing the child to an experimental room where he/she has not been before, his/her behavior will not be the same as it usually is.

It will take a while for them to accustom to this new situation, we will have to establish a routine where we carry out the same sessions at the same hours for a while, so that the results obtained are conclusive (Ghiglino, Chevalier, Floris, Priolo & Wykowska, 2021). Moreover, the goal of a robot should be to provide educational support in the classroom, never to replace the teacher. Despite this information being commonly accepted (Artigas-Pallarés, 2012; Gena, Mattutino, Brighenti, Meirone, Petriglia, Mazotta & Piccini, 2022), the vast majority of the researches have not taken place in the natural environment of the kids (home, school...) but they were carried out in experimental rooms. In addition, in many cases they made less than 5 sessions total, so we consider that the results shown by these experiments are inconclusive.

Continuing with the number of participants of the analyzed interventions, we can see that most interventions work with 10 participants or less. We say that someone is within this spectrum when it picks up some common characteristics such as those mentioned up to now (Simut et al., 2016). For all this we consider that an investigation with less than 10 participants in it can not be considered transferable to other environments, nor can generalizable conclusions be drawn from it.

In addition to the scenario, if we analyze the duration of the interventions carried out, we see that more than half of them have lasted less than a month. Related to everything mentioned above, as many authors affirm (Van der Berk-Smeekens, de Korte, van Dongen-Boomsma, Oosterling, den Boer, Barakova & Buitelaar, 2021; Chung, 2021) routines are essential for people on the autism spectrum, so an educational intervention must be adapted to their school schedule and become a routine. This goal cannot be achieved in less than a month.

Finally, we were surprised by the fact that only one of the articles analyzed mentioned the families of the participating students. We know that a key to success when working with students on the autism spectrum is the implication of the different actors involved in their lives (Kumazaki et al., 2018). Thus, involving and training parents guarantees continuity in the intervention, which would not be obtained by working alone from school.

5. Conclusion

The total number of articles that we have found in the three databases on the use of educational robotics with people with disorders on the autism spectrum is 37 articles. As this is a current and booming issue, we expected to find many more but were not so. This low number could be because among the keywords, in addition to robotics, we

sought primary education and secondary education since we wanted to see how robotics was being used in schools.

In terms of objectives, the majority of the analyzed articles aimed to increase the vocal production of the participants, followed closely by those articles that aimed to improve the communicative skills of the participants. Considering that communicating with their environment is one of the most significant difficulties that people with autism face in their daily lives, looking at improving these capabilities seems coherent. On the one hand, the use of robotics in people on the spectrum of autism is a subject that arouses interest in the scientific community since there are many works whose objective is to delve into existing knowledge. However, on the other hand, there are many works whose objective focuses on the robot. This means that the child is not the protagonist but a way to test the robot. Finally, we see the same amount of work that explains a work methodology or an intervention. As educators, we think that the representation of research projects with educational purposes is shallow.

Next, we will focus on the scenario in which the selected interventions were put through. Unfortunately, almost all of the interventions were carried out in a fictitious scenario, created for the intervention itself, and not in the real scenario of the participant, such as students' classroom or even students' own home. This does not seem appropriate since people with autism suffer from changes and uncertain situations while they feel comfortable within tight spaces and routines. Almost half of the studies carried out were accomplished with less than 10 participants. In addition, almost all of the selected works lasted less than a month. We believe that more accurate data would be obtained by performing a more extensive intervention and with more participants. In addition, the inclusion criteria used when choosing the participants of the intervention are not substantiated. Some articles mention some required characteristics when choosing participants, such as age or intellectual quotient. However, there is no justification for why these attributes make these participants more appropriate for such interventions.

Finally, we will focus on the robot model used in the selected interventions. The most used robot is Nao, followed by Popchilla, Pepper and Probo. Research teams from different universities created many of the robots used. We can conclude from this that there is no agreement in the scientific community on the characteristics that make a robot better than the others to work with people on the spectrum of autism. Although robotics is not a recent issue, its application in education is. We are living the boom of social and educational robotics right now, and it is time to join forces and investigate where this path leads us.

6. References

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