

# *Current situation of the use of inclusive software as support to the treatments of Autism Spectrum Disorder in Spanish-speaking countries*

*A view from systematic mapping*

Gustavo Eduardo Constain Moreno  
School of Basic Sciences, Tech., and Engineering  
National Open and Distance University  
Popayán, Colombia  
gustavo.constain@unad.edu.co

Fernando Moreira  
Science and Technology Department  
Portucalense University  
Porto, Portugal  
fmoreira@uportu.pt

César A. Collazos O.  
Fac. Ing. Electronics and Telecommunications  
University of Cauca  
Popayán, Colombia  
ccollazo@unicauca.edu.co

Susana Bautista Blasco  
Francisco de Vitoria University  
Madrid, Spain  
susana.bautista@ufv.es

**Abstract** — This article seeks to show the findings in relation to the use of inclusive software within the treatments of Autism Spectrum Disorder (ASD) in Spanish-speaking countries, especially in Latin America, by reviewing the studies published in journals, books or working documents and that are found in a systematic mapping of literature. This document is the product of a doctoral research project that seeks to propose a framework for the design of inclusive applications focused on supporting the treatment of autism.

This mapping seeks to have a broader vision of how we are in Latin America and Spanish-speaking countries in terms of linking inclusive software in ASD treatments. The literature exploration seeks to identify the most relevant authors in this area of knowledge, the journals and conferences that publish the most on the subject, as well as the current trends and future challenges of the use of inclusive software in treatments of this disorder.

**Keywords** - *Inclusive software; Autism Spectrum Disorder; Latin America; Software applications.*

## I. INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that can appear from the moment a person is born and becomes more evident during their first years of life. This disorder can affect some motor functions of a person, their ability to perceive the environment and their ability to communicate with others.

According to [1], current ASD treatments focus on controlling emotions and training in aspects such as collaborative learning, social adaptation, decision-making, the ability to cope with conflicts, that is, management of emotional intelligence. Likewise, the characteristic of very little existence

of adequate software tools for therapeutic management that could strengthen the interest of children with autism in working with images (pictograms) to strengthen the expected skills is highlighted [2].

In the doctoral study "Framework for the design of inclusive software that supports the achievement of social skills in children with autism", which has been developed from the University of Cauca (Colombia), with co-direction from the Portucalense University (Portugal) and Francisco de Vitoria University (Spain), it has recently been found that the use of technologies to improve and stimulate the communication of children with ASD has increased in recent times, where these tools have been increasingly used in therapeutic contexts, enabling the generalization of a more natural behavior of the child with ASD. However, the design of these software tools does not obey, in a general way, an inclusive design centered on the user with notions of Human-Computer Interaction but has often been the product of isolated or personal initiatives of those who have a relative. close (usually a son or a brother) with suffering from this neurological disorder [3].

The most important findings have ended in a list of existing computational tools in Apple store and Play store databases, validated for their formal link to clinical treatment processes for autism spectrum disorder; Likewise, a base of user-centered design recommendations for inclusive applications is achieved that includes the design process, a gamification model and a software architecture proposal.

In the same way, the requirements engineering models are analyzed for the case of inclusive applications for the treatment of autism, which allows mentioning new factors to consider, this should guarantee the development of applications with better

functionality, that is, from its usability and its accessibility for children with ASD.

Now, this doctoral project seeks to complement the information on how we are in Latin America and Spanish-speaking countries in terms of the acceptance of inclusive software in the formal treatments of ASD, for this it has been proposed to review relevant publications with specific information on development of inclusive software focused on autism spectrum disorder authored from Spanish-speaking countries. At the end of this article, it is expected to have a rough idea about the current state of development of inclusive software focused on autism spectrum disorder that has been essentially developed within research processes or transdisciplinary studies in Spanish-speaking countries and Latin America.

## II. METHODOLOGY

To carry out the tracking of publications made about the development of inclusive software focused directly on the treatment of Autism Spectrum Disorder, a systematic literature mapping was carried out, focused directly on the most important concepts for this study.

The phases applied for the mapping of literature related to the study topic were the definition of keywords and research questions, the selection of databases for consultation, definition of inclusion and exclusion criteria, the reading of documents and, finally, the writing of the paper with the findings found.

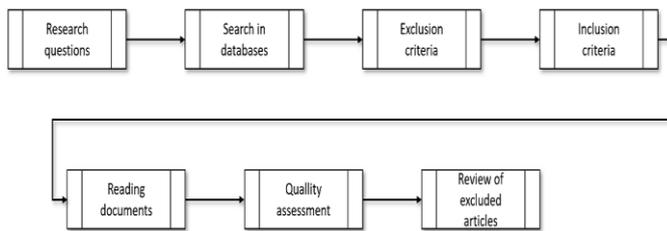


Figure 1. Systematic Mapping Process (own elaboration)

### A. Research questions and mapping questions

Research Questions (RQ) and Systematic Mapping Questions (MQ):

RQ1: Do current treatments for ASD in Latin America contemplate the use of inclusive software?

RQ2: What type of inclusive software architecture is the most common in ASD treatments in Latin America?

RQ3: What is the current usability level in Latin America of inclusive software focused on treating ASD?

MQ1: How many studies have been published in the last 5 years?

MQ2: Who are the most relevant or published authors on the subject?

MQ3: What types of publications are the most common in scientific production in the use of inclusive software in the treatment of ASD?

MQ4: What databases regularly publish studies in this area of HCI and Health?

Keywords:

Inclusive software, Autism Spectrum Disorder, Latin America, Software Applications.

### B. Context of the literature review

Starting from the defined research and mapping questions, the PICOC method [4] is applied to define the scope of the review.

- POPULATION (P): Typology of inclusive software developed or adapted to ASD treatments in Latin America and Spanish-speaking countries.
- INTERVENTION (I): Latin American and Spanish-speaking countries that have demonstrated the use of inclusive software in ASD treatments.
- COMPARISON (C): Comparative table between Latin American countries regarding the use of inclusive software.
- RESULTS (O - Outputs): Categorization of inclusive software tools found in ASD treatments.
- CONTEXT (C): Aspects of types of studies developed, or corroboration of findings from most software in personal and non-academic-clinical contexts.

### C. Inclusion and exclusion criteria

Inclusion criteria:

- 1) Publications of maximum 5 years (2016-2020)
- 2) Publications in Spanish or English languages
- 3) Publications in internationally recognized and indexed journals
- 4) Publications found in peer-reviewed journals, books, conferences or workshops

Exclusion criteria:

- 1) Publications older than 5 years
- 2) Publications in languages other than Spanish or English
- 3) Gray literature or publications in non-indexed journals

### D. Database selection

- 1) SCOPUS
- 2) IEEE
- 3) ScienceDirect
- 4) Springer

### E. Search string

Spanish:

("software inclusivo\*" OR "arquitectura de software\*" OR "aplicaciones de software\*" AND "tratamiento" AND "trastorno de espectro autista" AND "Latinoamérica" OR "países de habla hispana")

English:

("inclusive software" OR "software architecture" OR "software application" AND "treatment" AND "autism spectrum disorder" AND "Latin America" OR "Spanish speaking countries")

**F. Data extraction**

For the selection of relevant articles about study, the PRISMA flow [5] was followed, where the queries in the previously defined databases are executed, duplicate records are eliminated, and the resulting articles are reviewed of each one such as its title, abstract and keywords, applying the inclusion and exclusion criteria for the selection of final articles to be considered in the study.

**G. Search process**

Initially, 3574 articles related to the keywords applied in the consultation were found, of which, once the inclusion and exclusion criteria had been applied, 82 of them were defined for the initial review process. The reading begins with the title, abstract and keywords of each article to identify the affinity with the proposed study, at this stage other documents are filtered to keep 40 documents. These articles were reviewed in detail within the framework of the purpose of inquiry, finding an affinity of 29 documents that were finally analyzed in greater detail. Finally, a quick review is made of the excluded documents to identify some that may contain information of interest to the project, adding 2 more articles for our purpose.

The search process results with the applied systematic mapping method can be seen in "Fig. 1".

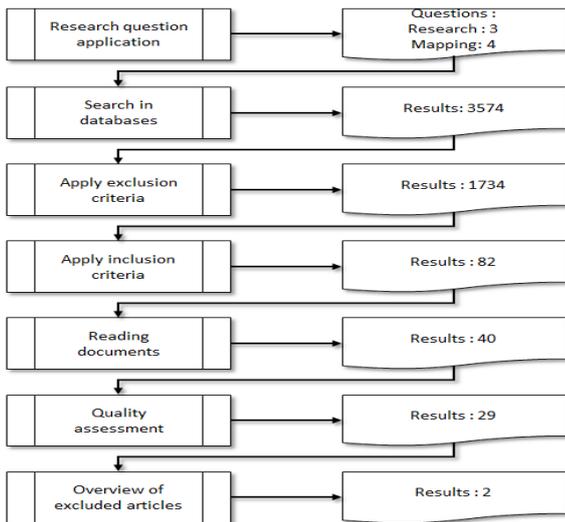


Figure 2 Application of systematic mapping (Own elaboration)

**III. TEA TREATMENTS WITH INCLUSIVE USE OF SOFTWARE IN LATIN AMERICA**

The literature mapping was carried out specifically looking for documents and studies originated by authors from Latin

American or Spanish-speaking countries, to identify with some precision the types of Autism Spectrum Disorder treatments applied, especially those that imply the use of some type of technology.

In this sense, most of the documents found have been created from countries other than Spanish (15), followed mainly by publications by researchers from Brazil (5), Colombia (4), Chile (2), Argentina (2), Spain (2) and Mexico (1).

This list of publications resulting from the mapping of literature can be seen in "Fig. 3" and "Fig. 4".

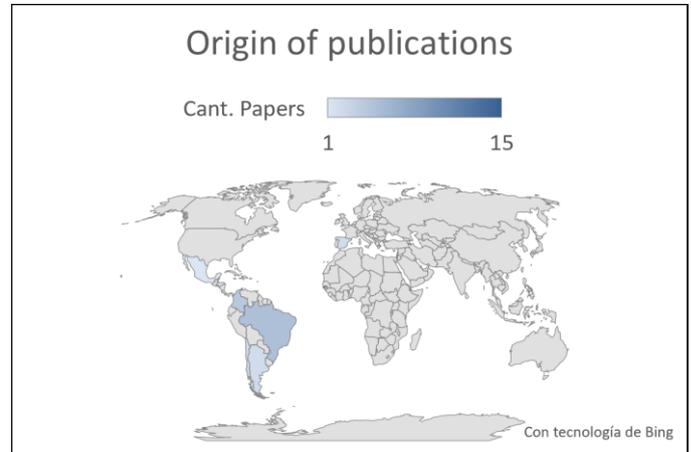


Figure 3 Countries of origin of the selected publications (Own elaboration)

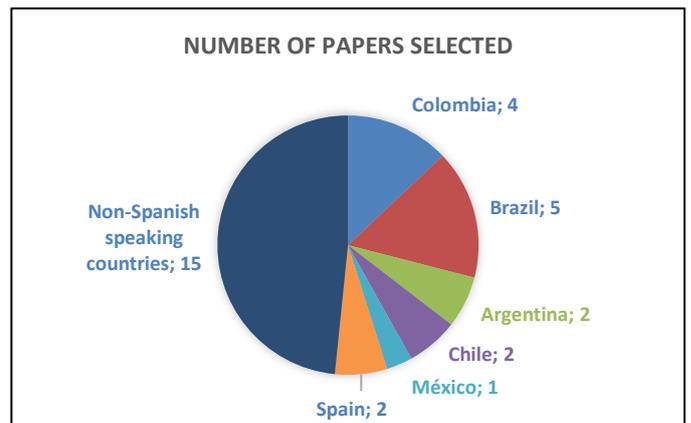


Figure 4 Number of papers selected by Country of the author (Own elaboration)

The review of these documents finds that the Theory of Mind (ToM) is mentioned by some authors in [7] and [8] from Brazil and Colombia, who refer treatments based on Applied Behavior Analysis (ABA) as one of the most effective strategies for monitoring the development of social and emotional skills in children with ASD. This experience shows the use of assistive technologies, such as the use of gamification techniques, software applications, computer-based training (Web), and robotics to provide a standardized method of implementing ABA techniques.

The experiences studied were focused on technologies such as Distributed Systems, Image Processing, Gamification and Robotics for patients with ASD. The main objectives of these tools sought to improve social behavior, attention, communication and reading skills.

Of the data of greatest interest referred to in this study is the correlation between the type of technology used in ASD treatments and the contribution to the development of specific skills by users, that is, children with ASD linked to the study. This relationship can be seen in “Fig. 5”.

According to these findings, of the possibilities of acceptance of inclusive technology in the most effective treatments for the development of emotional and social skills in people with Autism Spectrum Disorder, are the strategies of Gamification and Applied Behavior Analysis (ABA), and in a more diversified way the use of robotics could be included.



Figure 6 Interaction with the Portraits App (Taken from [6])

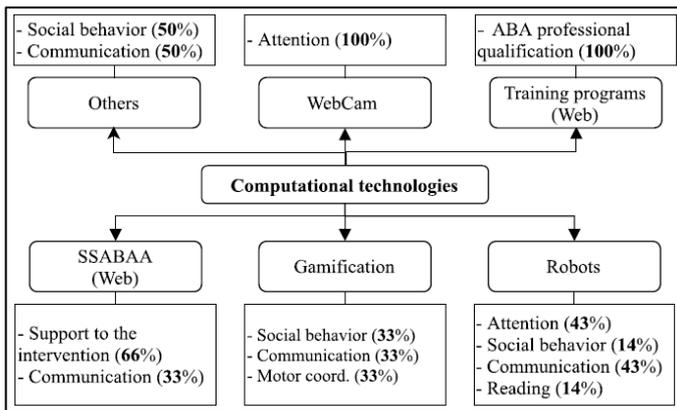


Figure 5 Knowledge domain vs. applied technology base in ASD patients (Taken from [7])

Another aspect that coincides between [1] [6] and [7] is the classification of ASD into three basic levels according to their level of needs for accompaniment and support: Mild ASD (Level 1), Moderate ASD (Level 2) and Severe ASD (Level 3). This classification is related to the amount of support that a child with Autism Disorder may need, according to which children diagnosed as mild need little support to perform basic tasks; those diagnosed as moderate need more constant support and those diagnosed as severe need a high level of support.

For example, in [6] the experience of developing the application for mobile devices Portraits, presented in “Fig. 6”, aimed at supporting professionals who intend to develop skills related to empathy based on the theory of mind, in children diagnosed with Autism Spectrum Disorder. In the tests carried out with experts, they managed to obtain an adequate application both in content and in usability for these people, stating that the users with whom it was validated felt comfortable with the application and achieving the development of the proposed activities without difficulty.

Using usability tests, the results show that users managed to complete tasks with some time differences. The application was validated by conducting several tests with experts and end users with promising results.

This study determines that technology can be of great support in the development of different skills of people with ASD, however, most of the applications that exist are aimed at users who do not speak Spanish; this presents a disadvantage for the Spanish-speaking user since foreign applications are in a different context than that found in Latin America. Due to this, the research team presents the development of a support application for social skills in children with ASD developed from the perspective of therapists and having children with ASD as the main user. The proposed solution was developed with low-cost criteria for multi-touch devices and also focuses on Theory of Mind (ToM) seeking the development of social skills.

Now, in the same way that this application was designed and in agreement with what was presented in [3], we can obtain a series of functional and non-functional characteristics that an inclusive application must contain so that it is valid to use in contexts treatment of Autism Spectrum Disorder. Thus, for example, it could be argued that technology can help behavioral analysis interventions that support different educational agents (for example, psychologists, parents, and teachers) as well as patients [8].

This study highlights that Autism Disorder interventions based on the use of technology in Latin America are in the early stages of development, due to the methodological limitations in many of the studies analyzed and the simplistic nature of many of the applications they have developed (for example, the inability to customize the software to meet the individual needs of ASD users). The same study reveals that people are increasingly relying on digital and computing technologies, where these technologies range from hardware (tablets, smartphones, touch screens, and computers) to software (web portals, social media, digital games, and applications) [9].

In computing, 'technology' generally refers to algorithms, software, hardware, or any approach to data processing. The use of computational technologies in ABA intervention has become increasingly common, as well as the production of specific programs to assist ABA sessions, including the use of computers, smartphones, and specific hardware (robots and sensors). This specification can be seen in “Fig. 7”.

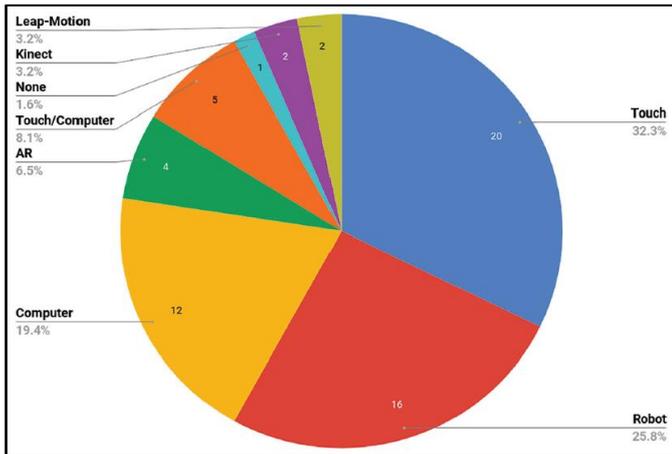


Figure 7 Technology used in ABA treatments (Taken from [8])

According to this, the technology with the greatest usability in ABA techniques have been Leap Motion, Microsoft Kinect, theoretical study / no technology (none), a combination of personal computer and touch devices (touch / computer), augmented reality (AR), desktop computers (computers), robots and touch screen devices (Touch).

It can be pointed out then that the use of these technologies can make the therapeutic supports of children with ASD more precise, dynamic, and efficient, in addition to optimizing and standardizing the process of application of the ABA intervention technique in people with this type of disorders. The creation of computer applications enabled by ABA (inclusive software) may also be relevant for daily use, beyond therapy sessions without the presence of the therapist, such as those carried out at home by parents or caregivers [10].

#### IV. SOFTWARE ARCHITECTURES IMPLEMENTED FOR APP DESIGN FOR ASD

The inclusive software design focused on users who suffer from any spectrum disorder is complicated by their differential condition between one case and another. The wide range of symptoms and the intra- and inter-individual heterogeneity of Autism Spectrum Disorder means that each diagnosed case is unique and must be treated differently; therefore, the activities and daily interventions carried out in the treatments must be adapted to favor their development and expand the capacities for success in the development of specific skills, such as emotional skills or social skills.

Consequently, inclusive software that is developed for adequately diagnosed ASD cases should facilitate the adaptation of the user (patient) and allow activities to be personalized and broken down into steps that are manageable by them and defined through routines or levels.

Some studies, such as the one developed in [1] and the one detailed in [11], consider the functional and non-functional characteristics that inclusive software should have that intends

to be considered within the therapies of children with Autism Spectrum Disorder.

For the case of the study developed by [1], the importance of having a framework for the design of inclusive software applications for the treatment of ASD is highlighted, which can start from the use of existing software architecture patterns; however, these must be adjusted to the extent that the therapeutic and technical conditions require it. Specifically, the MPI u+a Model [12] is highlighted as a guide model for the usability and accessibility engineering process for its realization, however, cases of disability it could require some methodological adjustment to achieve desired objectives.

The "Fig. 8" presents the application scheme of the MPI u+a model.

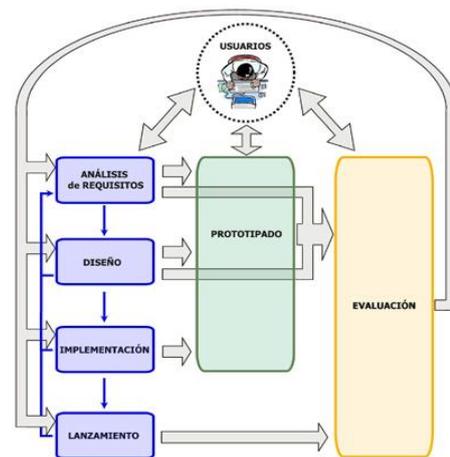


Figure 8 Engineering Process Model for Usability and Accessibility

In addition, the design models of computational applications are contrasted, such as MDA, 6D and MPI u+a, which provide help for autism, but which have generally been used autonomously and without rigorous follow-up by the clinical specialist or without the link of the child's family in the follow-up of the treatment.

These same models, especially MDA and 6D, facilitate the development of computer applications for contexts of application of gamified elements, but considering the end user for whom they should be designed, that is, children with autistic disorder. Regarding the design of these specialized software applications, there are generalized models, patterns, and recommendations for the design of inclusive software, but these lack some elements for the treatment of syndromes such as ASD.

The state of the art and of the technique, finds the existence of inclusive application design models (for example MPI u+a) from which the proposal to create a specific framework can be started, based on human-computer interaction, for the adaptation of inclusive computational applications, suitable for the support of autism treatment. This model for integrating inclusive software and elements of autism treatment must be developed step by step and with a consequent validation of results from the most relevant usability and accessibility heuristics.

Likewise, the design of computer applications focused on clinical treatments such as ASD, must be adjusted to existing quality standards. Likewise, it is recommended to explore with the use of game techniques (Gamification) that can result in a motivating factor for interactivity between the autistic child and the software applications that are used as therapeutic support [13].

This study ends with the proposal of a framework of recommendations for the design of inclusive applications that can be evidenced in "Fig. 9".

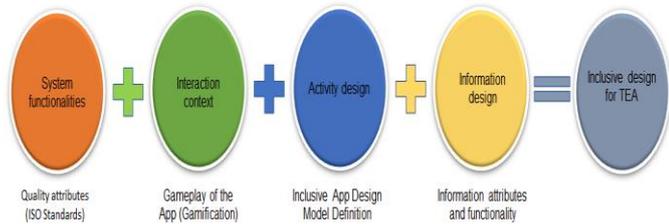


Figure 9 Logical process of inclusive application design for TEA (Taken from [13])

Likewise, this study proposes software development patterns that can be useful for the development of inclusive applications. These patterns can be seen in "Fig. 10".

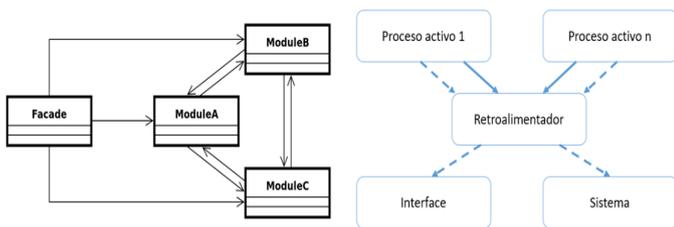


Figure 10 Use of Facade (Facade) and Feedback (Feedback) pattern for usability and accessibility.

On the other hand, the authors in [11] present a set of specific recommendations for the development of software solutions adapted to users with ASD that they have called "AutismGuide". Based on a systematic literature review, the recommendations suggested by various authors for the design of inclusive applications aimed at patients (users) diagnosed with ASD are chosen.

The final recommendations proposed can be grouped into the following aspects:

- 1) Proper user interface (Simplicity)
- 2) Personalization (Adjustment of sizes, fonts, images, indications and reinforcements)
- 3) Adaptability (Ease of change over time)
- 4) Simplicity in design (aesthetic and minimalist design)
- 5) Navigation and intuitive help.
- 6) Development recommendations: "Reuse", "Robustness"
- 7) Domain Specific Recommendations -Multimedia: "Robust Microphone Configuration" and "Pronunciation"

- 8) Use images to describe concepts and eliminate unnecessary reading
- 9) Language appropriate for the type of user
- 10) Logical and intuitive navigation structure
- 11) User feedback
- 12) Approach to applying appropriate methods and practices for ASD
- 13) Application of HCI principles for the design of mobile applications, usability and accessibility criteria for educational games and for the web, and accessibility for children with ASD.

These design suggestions coincide with [14], who present a computer game developed to help children with autism spectrum disorder (ASD) to recognize the facial expressions associated with the four basic emotions: joy, sadness, anger, and surprise. This game called ALTRIRAS is a role-playing game, a kind of game indicated by literature as the most suitable for these children because it is more social than competitive.

The game is designed with recreational environments built with 2D graphical interface to keep the attention of children, an access control, and a registration mechanism to allow the monitoring of the child's progress.

The design of ALTRIRAS applies the recommendations regarding the levels of development of the game (navigation environments) which are accessed because of the achievement of the expected skills as part of the management of the interface objects, the points of item for each activity and the feedback mechanisms provided. These aspects can be seen in "Fig. 11".

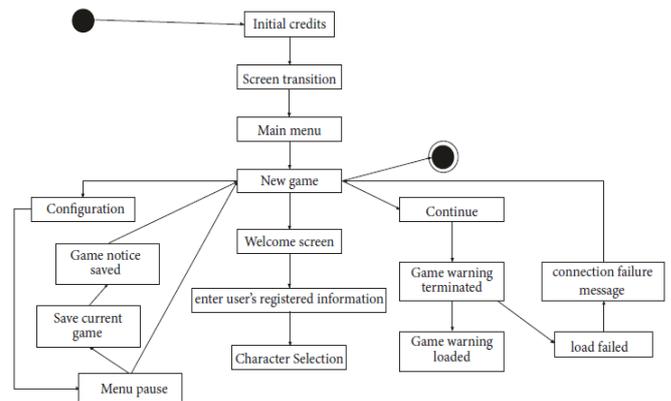


Figure 11 Altriras software activity diagram (Taken from [14])

The "Fig. 12" presents the navigation scheme established according to the user-centered design, that is, children with Autism Spectrum Disorder.

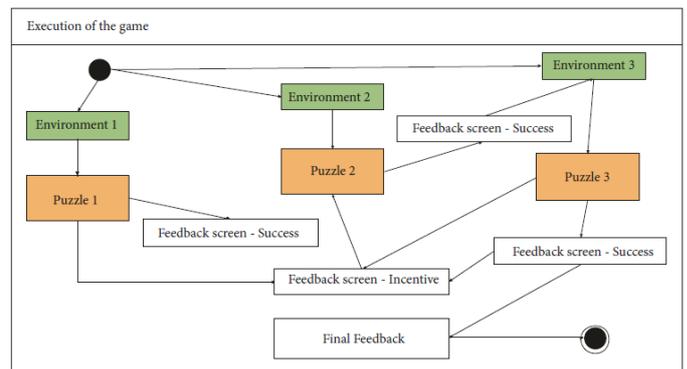


Figure 12 Execution diagram of the game Altriras (Taken from [14])

## V. MEASURING THE BEHAVIOR OF ASD CHILDREN FROM THE USE OF INCLUSIVE SOFTWARE

The aspect of assessing the results of linking inclusive software to the therapeutic processes of children with ASD is considered a challenge for both therapists and computer professionals. In this sense, the experiences presented in [8], [9] and [14] mention the processes of use of technology from the initial moment, that is, the collection of informed consent for relatives or guardians of ASD patients and a consent accepted from the same children with Autism Spectrum Disorder through their acceptable emotional recognition and visualized as "smile" emoticons. Similarly, for the validation of technological designs, heuristic evaluation methods are recurrent where experts in the clinical area and in the development of software applications present their assessment because of the usability tests carried out on the products produced [2].

It is noteworthy, once again, that it is difficult to find two similar cases of autistic disorder and therefore there is talk of a "spectrum" in the suffering of this syndrome. In this sense, it is essential to consider the characteristics of flexibility and adaptation that must be carried out to the tests with users to be more accurate when issuing a formal evaluation.

Let us remember then that "Heuristic Evaluation" is a usability inspection method for software that helps to identify usability problems in the design of user interfaces [15]. This type of assessment specifically involves evaluators (experts in interface design, software development and the discipline for which the application is designed) who examine the interface and verify its compliance with recognized usability principles, such as those of Nielsen [16].

The most applied principles for heuristic evaluation can be seen in "Fig. 13".

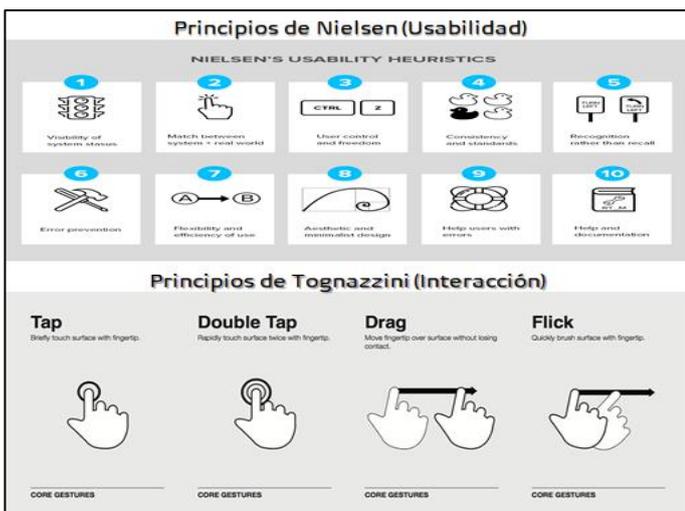


Figure 13 Usability and Interaction Principles applied in children with ASD (Taken from [13])

Likewise, from the area of psychology, specific instruments are used to measure the development of social skills achieved by children with ASD according to the development of

programmed activities with the use of inclusive technologies. Among the instruments most mentioned in the mapping of literature carried out for this work are the 'Tables of achievements' such as the one presented in "Fig. 14" and other basic instruments of psychology such as the 'Social skills test' like the one presented in "Fig. 15".

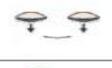
QUÉ?	COMO?	DÍA
 BOLA ADOS A MAMÁ	 MAMA	
 JUGAR CON MI HERMANA	1. ALFOMBRA  2. JUGUETES  3. TURNOS 	
 ESCONDITE CON LOS PAPÁS	1. CERRAR OJOS  2. CONTAR  3. BUSCAR 	
<b>PREMIOS</b>	     	3

Figure 14 Table of achievements for social skills of children ASD (Own elaboration)

HABILIDADES SOCIALES (HH.SS)							
A continuación te presentamos una tabla con diferentes aspectos de las "Habilidades Sociales Básicas". A través de ella podrás determinar el grado de desarrollo de la "Competencia Social" (conjunto de HH.SS necesarias para desenvolverte eficazmente en el contexto social). Señala el grado en que te ocurre lo que indican cada una de las cuestiones, teniendo para ello en cuenta:							
1	→ Me sucede MUY POCAS veces	2	→ Me sucede ALGUNAS veces				
3	→ Me sucede BASTANTES veces	4	→ Me sucede MUCHAS veces				
HABILIDADES SOCIALES				1	2	3	4
1	Prestas atención a la persona que te está hablando y haces un esfuerzo para comprender lo que te está diciendo						
2	Hablas con los demás de temas poco importantes para pasar luego a los más importantes						
3	Hablas con otras personas sobre cosas que interesan a ambas						
4	Clarificas la información que necesitas y se la pides a la persona adecuada						
5	Permites que los demás sepan que les agradeces los favores						
6	Te das a conocer a los demás por propia iniciativa						
7	Ayudas a que los demás se conozcan entre sí						
8	Dices que te gusta algún aspecto de la otra persona o alguna de las actividades que realiza						
9	Pides que te ayuden cuando tienes alguna dificultad						
10	Eliges la mejor forma para integrarte en un grupo o para participar en una determinada actividad						
11	Explicas con claridad a los demás cómo hacer una tarea específica						
12	Prestas atención a las instrucciones, pides explicaciones y llevas adelante las instrucciones correctamente						
13	Pides disculpas a los demás por haber hecho algo mal						
14	Intentas persuadir a los demás de que tus ideas son mejores y que serán de mayor utilidad que las de la otra persona						
15	Intentas reconocer las emociones que experimentas						
16	Permites que los demás conozcan lo que sientes						
17	Intentas comprender lo que sienten los demás						
18	Intentas comprender el estado de la otra persona						
19	Permites que los demás sepan que te interesan o preocupan por ellos						
20	Preguntas cuándo están ansioso y haces algo para disminuir su estado						
21	Te disculpas a ti mismo o haces cosas agradables cuando te mereces una recompensa						
22	Reconoces cuando es necesario pedir permiso para hacer algo y luego lo pides a la persona indicada						

Figure 15 Social skills test for children ASD (Own elaboration)

Likewise, the assessment of the development results of the expected skills in children with ASD, once they have advanced in the use of inclusive technologies, resort to the use of some instruments according to their cognitive and motor level. Thus, for example, experiences mentioned slightly in [9] and [14] are found, in addition to the process of measuring emotional reactions carried out by [13] where children with ASD are linked to this process so that as users of inclusive applications may express, in some way, their acceptance or rejection of these therapeutic supports.

Consequently, the use of emotional assessment scales through emoticons, such as those found in [9] and [14], such as those presented in "Fig. 16", where the same child with ASD expresses what he feels when interacting with a technological instrument.



Figure 16 Inclusive software rating scale for people with ASD

Another alternative is the one presented by [13] where facial expression recognition techniques are used to identify the emotion generated from the use of inclusive software. This can be seen in “Fig. 17”.

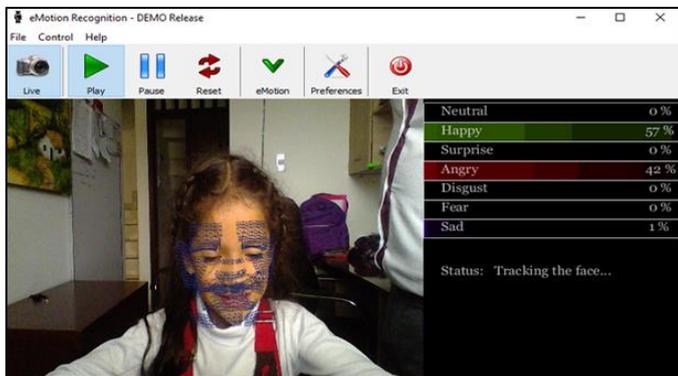


Figure 17 Facial recognition of emotions (Particular experience)

## VI. RESULTS

The realization of a systematic mapping on the design of inclusive software applications focused directly on the treatment of Autism Spectrum Disorder confirms the findings previously found about the importance of technology linkage as a factor that facilitates the development of emotional and social skills in people with ASD, especially in its first levels of suffering from this syndrome.

Likewise, it can be concluded that through the co-design of inclusive software applications with the participation of users (ASD patients) and health professionals, appropriate applications can be obtained in terms of content and usability for children with ASD, which it allows the user to feel comfortable with the software application and, furthermore, that the software can be integrated into daily activities seamlessly.

Likewise, heuristic evaluation is found as the most widely used method for evaluating the usability of inclusive software in the cases of Latin American countries. The design criteria have generally been based on the use of pictograms for all stages, from the "form" of informed assent of the children with ASD, to the development of recreational and educational activities, generally carried out through mobile devices.

As user-centered design recommendations for inclusive software applications, the design of images (pictograms) could be generalized with clarity and digital quality, as close to the object they represent in real life and without adding distractions, so that the user can identify them in a simple way.

In addition, it is important to emphasize the importance of technologies in the work of people with ASD, since these allow the expansion of work methods when used outside of traditional clinical or therapeutic settings and, in addition, facilitate their reach by of the families of people with ASD. Similarly, the importance of collaborative work between different disciplines is highlighted as a primary factor for the achievement of effective solutions that really contribute to the improvement of the quality of life of people with Autism Spectrum Disorder.

Regarding the concerns that gave rise to this mapping, it is found that relatively few interdisciplinary research studies carried out in Spanish-speaking countries, including Latin America, have documented the use of inclusive software tools as part of the treatment of children with Autism Disorder (RQ1), therefore for the exploration of these issues it is necessary to inquire in other countries and languages of publication to find a favorable state of the art.

In relation to inclusive software architecture models for use in users with ASD, it is viable to apply traditional software design patterns, but with the importance of adaptation in terms of functionality and flexibility according to the cognitive levels of this population. There are design model recommendations focused on the development of inclusive applications, such as MPI u+a, which, when conceived from the accessibility approach, facilitate the analysis of functional and non-functional requirements for the software that can be developed (RQ2).

To know the current usability level in Latin America of inclusive software focused on the treatment of ASD (RQ3), Figures 4 and 7 were presented, highlighting the impulse in this area of knowledge from a few countries, especially Brazil, Colombia, Argentina, Chile and Mexico in Latin America, and Spain in the case of Europe. It should be clarified that as criteria for the literature search, the Spanish and English languages were applied, ruling out other languages such as Portuguese or Italian that could increase the findings but were not considered as they were not languages commonly used by Spanish-speakers.

From everything stated above, the formal aspects of the information mapping carried out can be defined. In this sense, we were able to find many publications (3574) related to the correlational themes of this study, technology, and therapies for ASD, of which, after applying the formal criteria defined for the mapping of literature, resulted in a considerably lower amount than expected (31) of articles to analyze (MQ1).

On the other hand, the perhaps recent initiative to link disciplines such as Informatics and clinical aspects through methods of Human-Computer interaction, has meant that in Latin America and even Spain, recurring authors or authors with great proliferation in studies have not yet been seen serious immersion of inclusive technology in therapeutic settings for Autism Spectrum Disorder; In this sense, of the 62 selected authors, only 4 of them were repeated in the different articles reviewed (MQ2), this despite the fact that scientific journals and events that generate impact publications at an international level already link the area of Human-Computer Interaction (HCI) among its topics of interest (MQ3).

Regarding the publication mechanisms, we can mention that, of the databases consulted, Scopus (1,753), Science Direct (841)

and IEEE (627) are the ones with the largest number of articles found in relation to the topics of interest consulted (MQ4). The above can be seen in Table I.

TABLE I. TABLE OF FREQUENCY OF RESULTS

Item	Data		
	Query criteria	Quantity	Percentage
1	MQ1 – Number of studies found.	31/3574	0,86%
2	MQ2 – Most relevant authors	4/62	6,4%
3	MQ3 – Most recurring publications on ASD and technology.	ELSEVIER [45]	72,5%
		IEEE [6]	9,6%
		Otros [11]	17,9%
4	MQ4 – DB with major publications in HCI and Health.	Scopus [1753]	49%
		Science Direct [841]	23,5%
		IEEE [627]	17,5%

Finally, from our point of view, for the area of Latin America and other Spanish-speaking countries, if it is necessary to delve into the issue of the benefits of technology linkage, especially inclusive software in the therapeutic processes of Autism spectrum, but for this, the formal aspects of user-centered design, accessibility and inclusive software quality, as well as the software architecture for the construction of applications suitable for use by people with special cognitive abilities must be carefully addressed. In this sense, advancing in the formulation of a framework that contributes to the community of software developers in the significant construction of inclusive applications would considerably favor the scientific community that works to improve the quality of life of hundreds of children diagnosed with this neurological disorder.

## REFERENCES

[1] G. E. Constain M., F. Moreira y C. A. Collazos, «Recommendations for the design of inclusive apps for the treatment of autism : An approach to design focused on inclusive users,» *15th Iberian Conference on Information Systems and Technologies (CISTI)*, pp. 1-6, 2020.

[2] G. E. Constain M., C. A. Collazos, H. M. Fardoun y D. M. Alghazzawi, «Heuristic Evaluation for the Assessment of Inclusive Tools in the Autism Treatment,» *Universal Access and Inclusive Design - HCI International 2020*, vol. 12426, 2020.

[3] G. E. Constain M., «Study of functional characteristics of inclusive software to support the treatment of autism spectrum disorder.,» *CLEI*, p. 13, 2020.

[4] H. A. Mohamed Shaffril, S. F. Samsuddin y A. Abu Samah, «The ABC of systematic literature review: the basic methodological guidance for beginners,» *Qual Quant*, 2020.

[5] N. P. Caicedo Vaca, «Systematic review of legislation related to veterinary medicine in Ecuador through the use of a prism flow diagram,» Universidad de las Américas, 2019.

[6] F. J. Alves, E. Assis de Carvalho, J. Aguiar, L. Lacerda de Brito y G. Sousa Bastos, «Applied Behavior Analysis for the Treatment of Autism: A Systematic Review of Assistive Technologies,» *IEEE Access*, 2020.

[7] R. Muñoz, C. Morales, R. Villarroel, Á. Quezada y V. H. De Albuquerque, «Developing a Software That Supports the Improvement of the Theory of Mind in Children With Autism Spectrum Disorder,» *PERSPECTIVES AND PROSPECTS OF MACHINE LEARNING*, 2019.

[8] D. F. Trevisan, L. Becerra, P. Benitez, T. S. Higbee y J. P. Gois, «A review of the use of computational technology in applied behavior analysis,» *Adaptive Behavior*, 2019.

[9] Z. I. Rodriguez, B. C. da Cunha, C. C. Viel, A. F. Orlando, O. J. Machado Neto y D. G. Pimentel M., «ESPIM: An ubiquitous data collection and programmed intervention system using esm and mobile devices,» *Proceedings of the 22Nd Brazilian Symposium on*, pp. 13-14, 2016.

[10] A. Constantin, H. Johnson, E. Smith y D. Lengyel, «Designing computer-based rewards with,» *Computers in Human Behavior*, pp. 404-414, 2017.

[11] Y. P. Costa Aguiar, E. Galy, A. Godde, M. Trémaud y C. Tardif, «AutismGuide: a usability guidelines to design,» *Behaviour & Information Technology*, 2020.

[12] T. Grannollers, MPIu + a A methodology that integrates software engineering, human-computer interaction and accessibility in the context of multidisciplinary development teams, Lleida-Spain: Universitat de Lleida, 2015.

[13] G. E. Constain Moreno, «Recommendations for the design of inclusive computer applications to support the treatment of autism spectrum disorder,» from CLEI 2020, Montevideo - Uruguay, 2020.

[14] L. M. Alemeida, D. P. da Silva, D. P. Theodório, W. W. Silva, S. C. Rodrigues, T. A. Scardovelli, A. P. da Silva y M. A. Bissaco, «ALTRIRAS: A Computer Game for Training Children with,» *International Journal of Computer Games Technology*, p. 16, 2019.

[15] J. F. Sánchez-Alvarez, C. M. Zapata Jaramillo and J. Jimenez-Builes, «Heuristic evaluation of the usability of software to facilitate the use of computers by people with motor disabilities,» *EIA Magazine*, vol. 14, no. 27, pp. 63-72, 2017.

[16] M. G. Macías Morales and K. E. Aguirre Intriago, «Technological proposal for the design of a WEB page using the usability principles of Jakob Nielsen to optimize the shipping process of the company TUCHOK S.A.,» Guayaquil, 2017.