

Comparative study of alternative communication systems in the development of communication boards for children with Autism Spectrum Disorder (ASD)



Estudio comparativo de los sistemas de comunicación alternativa en el desarrollo de tableros comunicacionales para niños con el trastorno del espectro autista

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Abstract

An exhaustive research was conducted on the communication systems used by people diagnosed with autism spectrum disorder (ASD). The objective of this article is to identify the systems that allow the development of communication boards in order to identify the one that provides the best environment for the development of communicative language in children with Autism Spectrum Disorder (ASD). A literature review was used to analyze information from the most relevant articles related to communication systems and a matrix was elaborated to evaluate related characteristics. As a result, a list of dimensions and metrics of the communicational systems was obtained and a comparative table with indicators and a measurement scale was established. A through a technical evaluation

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of 3 types of users, it was identified that the optimal communicational system for the creation of a dashboard is the TEACCH System with a considerable satisfaction index in design, content, pedagogy and characteristics.

Key words: Communicative Systems, ASD, ICT, Communicative Dashboard, SAAC.

Resumen

Se realizó una investigación exhaustiva sobre los sistemas de comunicación que utilizan las personas diagnosticadas con el trastorno del espectro autista. El objetivo del presente artículo implica identificar los sistemas que permiten desarrollar tableros comunicacionales para lograr identificar el que provee un mejor entorno para el desarrollo del lenguaje comunicativo en niños con el Trastorno del Espectro Autista (TEA). Se utilizó la revisión de la literatura para analizar la información de los artículos más relevantes, relacionados a los sistemas comunicacionales y se elaboró una matriz para evaluar características afines. Como resultado se pudo obtener un listado de dimensiones y métricas de los sistemas comunicacionales, con ello se procedió a establecer un cuadro comparativo con indicadores y una escala de medición. A través de una evaluación técnica de 3 tipos de usuarios, se identificó que el sistema comunicacional óptimo para la creación de un tablero es el Sistema TEACCH con un índice de satisfacción considerable en diseño, contenido, pedagogía y características.

Palabras clave: Sistemas Comunicacionales, TEA, TIC, Tablero Comunicacional, SAAC.

Introduction

Individuals with ASD (Autism Spectrum Disorder) may experience or present difficulties in social interaction, frustration and/or anxiety when using functional language and nonverbal communication.

People with ASD have two relationship patterns: a more inhibited one, who has difficulties in initiating social interaction and remains more isolated with their interests; and another profile, who seeks contact and relationship with others, but often does not use appropriate strategies and also has complications in the social environment. Therefore, it is advisable to develop social skills from daily life situations, for example, through Role Playing methods, both individually and in groups.

It is extremely necessary to deal with social rules with children with ASD, which are difficult for them to understand. Somehow, they need to be given the facility to memorize and interact, even if they do not fully understand the why of some things, so that they can incorporate those contents in daily life.

One of the complications faced by some people on the spectrum is social interaction and communication. They are often unaware that they are engaging in inappropriate behavior and the impact their actions have on others.

The person with autism must understand that there are turns of words in a dialogue between two people in order to maintain an interpersonal distance both in games and in conversation. The communication boards can help us understand the importance of controlling the impulse of wanting to explain everything continuously without realizing that the other person also needs his or her space.

It is complex to communicate with people diagnosed with autism spectrum disorder; however, it could be considered a process to get to have that connection with the child who has this profile and behavior, which is why the use of tools such as communication boards is established, which allow greater development in adopting assertive skills for an appropriate communicative language according to their age.

Autism Spectrum Disorder

ASD is four times more common in boys than in girls and occurs in every racial, ethnic and socioeconomic group. About 1 in 66 children are diagnosed with this disorder. According to Fonseca et al, (2020) a diagnosis of autism at 2 or 3 years of age is stable and reliable. More and more children receive an early diagnosis of this condition. ASD children require clinical support, and although in some countries there are no fixed data on the causes of its onset, this is one of the main reasons for consultation to neuropediatrics and child psychiatrist (Fonseca et al., 2020).

Autism is a neurodevelopmental disorder that appears and develops in childhood. Complications with social interaction, communication problems, limiting and repetitive interests and behaviors identify it. Currently, therapeutic approaches approach communication difficulties from a conceptual axis, defining two different approaches depending on the educational and therapeutic objectives. According to the theoretical framework that supports them, related

to cognitive behavioral theory and psychoanalytic-based theories, the importance of disciplinary and social connections is introduced (Maddalleno, 2023).

The communication skills of children with this disorder depend on their level of intellectual and social development. Some of them show a restricted use of language, which includes aspects such as gestures, intonation and emphasis when speaking. These difficulties complicate their ability to relate, particularly with other children of the same age (Carvajal & Naranjo, 2024).

Complexity in social relationships and communication, as well as flexibility in behavior and thinking, are characteristics of ASD. Diagnosis is based on the clinical aspect, as there are no biological markers. Symptoms and signs appear in different ways; they begin at 18 months and develop at 36 months, it may be related to a history of epilepsy and perinatal neurological risk, as well as to family histories of developmental disorders; the cause is uncertain and multifactorial.

Infants with ASD develop several clinical variants that cause communication problems and complications in various social relationships, as well as repetitive behavior patterns. This disorder does not allow the individual to fully communicate with the environment and the people around them, so people with this disorder need constant psychoeducational intervention to learn to understand and act in various areas of life. This is achieved through the use of photographs, pictograms, real objects and other materials understandable to children (Paredes and Ponguillo, 2022). They possess a notable limitation in the ability to process new or complex information, as well as to acquire and use new skills, which implies intellectual impairment. This affects autonomy in daily life and social functioning, manifesting before adulthood and with permanent developmental consequences (Jimpikit et al., 2023).

Hyperactivity, pervasive developmental delay, oppositional and challenging behavior, anxiety and behavioral changes and mood processes are behavioral factors that affect the quality of family life. It has been identified that tools such as communication boards associated with their comprehension skills can be significantly supportive for the development of greater understanding in children with ASD (Garrido et al., 2020).

A more detailed understanding of changes related to ASD developmental trajectories as well as practitioner approaches is needed. These deviations affect diagnostic practice. On the other

hand, it is estimated that more than 70% of people with ASD have other disorders, the most common being: attention deficit hyperactivity disorder and anxiety disorder with or without hyperactivity disorder (ADHD), with prevalence rates of 28% and 20%, respectively (Zeidan et al., 2022).

The prevalence of ASD increases more in boys than, in girls, with a ratio of 15-20/10,000. Autism begins to be evident at 18 months, with the following characteristics:

When social interactions experience difficulties, which implies that they do not share attention, do not imitate or repeat gestures, do not bring objects to show them, among other characteristics. In social interaction, non-verbal behaviors are used such as: unusual and limited facial expressions, non-verbal responses to physical contact, cannot hold gaze or gaze is not related to other perspectives to communicate social concern (they do not look at adults or eyes).

Failure to establish age-appropriate peer relationships, putting oneself in another person's perspective is difficult, due to complex understanding of what they are going to do, no understanding of why people do things.

They interact with other infants, but insufficiently (they seek developmental activities such as physical contact such as wrestling or tickling).

They limit social relationships to things they need, such as food, and adopt inappropriate social behaviors, such as hugging a child too much, among others, this means that they do not comply with social norms (García et al., 2016).

Not only the mental foundation can explain ASD, there are other models or theories, such as, for example:

Hobson's social theory of emotions: Proposes that autistic children from birth are unable to control their emotions in their immediate environment and mood. In addition, it mentions that the deficits of autistic children are related to their emotional nature. He also explains the natural ability of children to express and perceive these feelings that adults transmit to them, but for a child with autism these abilities do not exist and symbolic play is difficult for him/her (Rodríguez, 2021).

Intersubjectivity theory: Colwyn Trevarthen refers to the lack of intersubjectivity or social expression of feelings: from the primary stage (2-9 months) to the secondary stage, there is lack of interest,

no interaction (pointing, approaching to give or accept something, manipulation). In this case, children with ASD have problems in the second stage, which prevents them from learning or understanding meaning, making communication difficult (Rodriguez, 2021).

The "central coherence" theory: Uta Frith drew on several real-life examples and evidence to develop his explanation: the central coherence theory. In it, Frith presented her first version and supported the tendency of children to process meaning and the big picture of information. People with ASD have impaired central coherence, meaning that they have difficulty integrating sensory information to make sense of social situations and gain the perspective of others (Rodriguez, 2021).

James Russell proposed the theory of executive action deficits in people with ASD; it is one of the most studied theories because it seeks to explain the main deficits in people with disorders such as ASD, Tourette syndrome, obsessive-compulsive disorder and schizophrenia. They have difficulties with skills, impulsivity, flexibility, initiative, self-regulation and maintenance of an independent life, decision making, problem solving, emotion regulation, generalization of learning and adaptation to different situations (Rodriguez, 2021).

ASD has two variations: pervasive developmental disorder and Asperger syndrome. When we speak of autism, we refer to a similar set of transformations; however, the manifestations vary in degree and form depending on the person. Recognizing that we use common terms to talk about very different people helps us to understand that autism is neither a continuum nor a single category.

It is possible that the differences in autism are even greater, as there are currently enormous differences between patients with other disorders. Therefore, it can be stated that "autism" exists because each individual is different. However, in summary, a group of disorders that are characterized by severe developmental disorders are autistic disorders. They sometimes cause pathological or repetitive behaviors and affect planning, emotional reciprocity and social interaction.

Autism does not have specific characteristics, so each child or young person with this condition will develop differently, depending on where they grew up and their life experiences, especially the educational system in which they were prepared. Currently, without a doubt, the educational system has proposed several reforms that will benefit not only students with autism, but also those without

autism, and will create an inclusive environment with the ultimate goal of building and developing a respectful society (Morán, 2021).

Any intervention to be applied to a child with ASD should be tailored to the particular characteristics of each individual. In order to prioritize goals during the intervention, it is necessary to assess their abilities and question the parents. Students with autism pay excessive attention to small details and show great resistance to change, so it is necessary to use different situations or environments and use different options to increase their flexibility to change. Automated tools can awaken their attention and motivation.

The purpose of speech and language rehabilitation for individuals with ASD is to improve understanding, speech and use of speech. Some individuals with ASD can communicate verbally; others, through video or electronic communication, can use gestures, gestures, pictures and images. With respect to occupational-level scenarios, this includes skills that will enable them to live as autonomously as possible, such as interacting with others, eating, bathing and dressing. Sensory integration therapy may also be included as it helps to improve response to soothing or limiting sensory stimulation.

Being able to read and write gives people on the autism spectrum a great deal of independence and autonomy. In addition to being a means of communication, reading and writing are also considered fundamental elements of the learning process and socio-cognitive development. Today's society is deeply linked to writing, so enhancing writing skills in children, regardless of their level, is essential for their personal development. Although some students require alternative supports, such as images or pictograms, it is equally important to strengthen their skills. The teaching of literacy should be guided by respecting individual differences, avoiding the standardization of methods that may be detrimental to academic performance. In particular, for children with ASD, teachers face the challenge of adapting literacy strategies, as a one-size-fits-all approach does not always respond to their specific needs. Therefore, teachers need to be trained in different methods and specific educational needs, and they need the support of professionals (e.g., occupational therapists, speech therapists, etc.) to guide their educational work (Gonzalez, 2023).

To decrease stereotyped behaviors in students with autism, it is necessary to implement physical education programs, particularly those based on psychomotor activities and team games, reinforced

by adequate verbal interaction from teachers and focused on positive reinforcement and reflection (Hortal-Quesada & Sanchis-Sanchis, 2022).

It has been found that the development of this work has a remarkable relevance both for the theoretical understanding and for the practical application of methodologies specifically oriented to people with cognitive limitations, particularly those diagnosed with Autism. This approach enables the expansion of fundamental knowledge and the promotion of skills adjusted to the particular needs of this population, contributing significantly to the field of research on the implementation of Augmentative and Alternative Communication (AAC), Augmentative and Alternative Communication Systems (AACS) and Information and Communication Technologies (ICT) in subjects with difficulties in verbal expression. Likewise, it allows assessing the impact and advances derived from the application of specialized techniques, aimed at enhancing the communicative and linguistic abilities of these individuals, favoring a more effective and emotionally meaningful interaction with their immediate social environment (Zapata & Gómez, 2021).

Studies on the sports performance of children with ASD denote a functional impairment in aspects such as control, balance and manual dexterity. Regarding gait pattern, problems including "shorter strides, postural asymmetry and difficulty performing a heel-to-toe pattern" have been reported. These deficits lead to limited participation in physical activity (PA), which is related to a higher prevalence of obesity in children with ASD. However, to achieve a healthy and active lifestyle, participation in PA is essential. Reduction and loss of personal autonomy (Mariño et al., 2021).

The need to find solutions to the reality experienced in our environment arises after discovering and noticing the lack of training and interest in presenting children (ASD). Therefore, it is necessary to motivate teachers, who, together with parents, are the pillars of this path. Be prepared and feel competent in any educational situation, because the teacher's performance and the implementation of a set of actions and strategies will be aimed at achieving the goals set with these students (Vazquez-Vazquez et al., 2020).

A previous study systematically analyzed the results obtained in studies that employed behavioral strategies as intervention methods for individuals with ASD over a 10-year period. Multiple studies coincide in suggesting behavioral interventions as those with the greatest results of effectiveness in children with ASD, as they show

significant improvements in the different areas of intervention (Trejos et al., 2023).

Educational inclusion of students with ASD

The educational inclusion of students with ASD is usually limited to their presence in educational centers intended for their care. However, due to their difficulties in social and communication skills, many must adapt to environments that are not very inclusive, closer to a model of integration than true inclusion. Among the current measures proposed by the educational system to attend to students with ASD according to their level of impairment, there are, from lower to higher level of inclusion, the following schooling modalities: specific center for autism, specific center, special education classrooms located in regular centers, combined schooling, regular center (López et al., 2022). The evaluation of students with intellectual disabilities can be carried out through teamwork projects, written exams using clear and accessible language, and avoiding forcing the student to participate in oral evaluations if he/she does not feel comfortable. In addition, it is important to provide the academic material in video format, allowing the student to listen to it as many times as needed to reinforce their learning, since in certain cases repetition is essential to consolidate knowledge (Naranjo, 2022).

Two important factors have contributed to the global awareness of ASD. The first is related to the positive results of educational and behavioral interventions, whose impact is notable in the first years of life, with historically notable improvements in adaptive, cognitive and language skills. The second factor is the remarkable increase in the number of people diagnosed with autism worldwide. Currently, the estimate has increased from 0.04% in the 1970s to 1-2% (Buffle and Naranjo, 2021).

Among the factors contributing to the explanation for this increase in prevalence would be improved diagnostic practices, the increase in the number of trained professionals, the inclusion in studies of individuals without intellectual disabilities, and the changes in diagnostic criteria in the fourth edition of the revised Diagnostic and Statistical Manual of Mental Disorders. (Buffle and Naranjo, 2021, p. 21).

It is determined that the psycho-pedagogical proposals based on the PECS system are effective because they help children with ASD to develop communication skills and social interaction, which improves their interpersonal relationships and fosters their greater

independence, especially in the educational setting. As a general objective, implementing the PECS picture exchange communication system served to improve communication and social interaction skills in a student with ASD (Espinosa et al., 2023).

A nonverbal child is an individual who does not correlate speech. The term "nonverbal" is often used, but in our opinion it is incorrect, as it does not refer to "nonverbal" children, but to individuals who do not speak and who are sometimes dependent on their environment and caregivers due to certain cognitive deficits. Medicine considers all children with this syndrome as part of "ASD", an "umbrella" idea that covers all grades without taking into account individual differences. Traditionally, pictures or images have served as a link between what the child with autism wishes to connote and the outside world for communication in nonverbal people. According to more traditional linguistics, certain social conventions mediate the handling of symbols; these types of conventions, in addition to being functional in allowing us to act in the world, allow us to express and realize desires, ideas, feelings, and beliefs (Villaruel, 2019).

Aids are required for the first uses of SAACs; figures, such as drawings, graphs, pictograms, words, or letters; gestural, such as mime, gestures, or hand signs; and a variety of figure matrix. These resources include technology, such as artificial speech communicators or personal computers or tablets with specific programs, which allow different forms of access adapted for people with reduced mobility, and facilitate the incorporation of the different pictographic and orthographic sign systems, as well as different forms of output including voice output (Luz, 2023).

To better understand the psychological and neuropsychological functioning of autistic children, the varied theories on autism and current knowledge allow us to understand what are the relationships between the brain and cognitive and executive functions; with a particular focus on memory, attention, planning ability and action vigilance, these functions are more affected. The areas of the brain devoted to visual processing are often used to solve any type of need, even those without a visual component. It is important to always keep in mind that people with ASD achieve greater autonomy goals if they have a clear and stable visual structure that allows them to understand from their perspective at all times (Solis and Barcia, 2021).

A four-phase protocol is proposed for the creation and implementation of psychosocial interventions for people with ASD.

First, it is necessary to consider initial research on the effectiveness of a specific technique or intervention. To determine the feasibility of a particular intervention, intervention manuals must be created and pilot tested. Subsequently, they analyze the importance of implementing the intervention on a large scale, monitoring the circumstances surrounding the study and evaluating the results obtained to assess effectiveness. Finally, despite the difficulties involved in this type of study, since the conditions of the researchers and the context can be very diverse, it is possible to evaluate the effectiveness of the intervention in community contexts (Bru et al., 2020).

It is necessary to engage with educators who are trained in the use of ICT as an educational tool to improve the socio-communicative skills of students. The family should be part of this action, since it is the environment in which the child grows and develops, and where he/she begins to develop his/her first skills. Therefore, it can be an ally to collaborate with educators in this field (Marzal et al., 2023).

Interventions should be tailored to the needs of the individual, including age, ability, and other factors, because each case of ASD is different due to the broad combination of abilities and severity. Intelligence and certain areas are affected. The child's autonomy and ability to adapt to the environment will improve with early intervention (between 2 and 3 years of age). In order for infants to achieve their potential and succeed, early intervention fosters plasticity in their brain. However, long waiting times and high medical costs make early evaluation difficult. Inconveniences often delay interventions, negatively affecting effective techniques to improve children's quality of life and opportunities for progress. Conventional intervention plans also depend on therapist expertise (Alcañiz et al., 2022).

To increase the participation of students with ASD, it is also advisable to organize activities and present messages verbally with visual support; visual timelines can be used physically, as proposed in picture books, as they support the social stories being told; and new technologies, such as iPads, can be used, as they address topics of common interest to students with ASD. Activities that foster inclusion and avoid boredom (Guasch and Gavaldà, 2020).

Technology for Autism Spectrum Disorder

Technology currently represents an alternative to support and strengthen interaction with ASD children, some emerging technologies such as virtual reality (VR) are attracting increasing

attention for applications in research and intervention fields. Through the use of software, VR allows individuals to join a virtual world and interact with electronic devices in an environment that represents an imaginary or real experience. These applications give access to each virtual or imaginary reality taking into account the requirements of each person, so there are two fundamental concepts to keep in mind when talking about these virtual spaces. One is interaction, which reflects the active role of the subject in the visualization of virtual reality graphics projection, the other is immersion, that is, the feeling that the body exists in the virtual world, which results as a "real" experience (Delgado et al., 2020), so each time the technology continues to raise alternatives for teachers and thus facilitate the inclusion of each of the students in the course.

In recent years, several initiatives linked to ICT have provided support to people with ASD. Educational research has demonstrated the benefits of these tools in the management of the teaching-learning process for these students. ICTs are distinguished by their adaptability, flexibility and versatility. They adjust to the characteristics of students with autism spectrum disorder, encouraging more individualized learning and varied learning rhythms. As a result, they are a part of learning that includes significant motivations and reinforcements in the learning development process. ICTs provide students with multiple opportunities to teach in the classroom. They are very useful and motivating tools for children to acquire new knowledge, coordination and stroke skills, and also serve to reinforce previously acquired knowledge (Durán, 2021), contribute to semantic association and visual processing skills (Fernández and Onandia, 2022).

Material more adapted to the needs of children with ASD and more versatile is provided through ICTs. Advancement and highlighting social skills are some of the benefits of using ICTs with individuals on the autism spectrum. However, they not only improve emotional and social aspects, but also increase motivation to perform those tasks. The use of technology to improve and stimulate communication in children with ASD has grown exponentially in recent years and provides opportunities to develop other deficit skills such as attention, anticipation, executive functions and work capacity (Gallardo-Montes et al., 2021).

According to experts, the use of materials or technological options with a perspective of inclusive academic practices can generate important contributions in the field of education and

psychopedagogy. Preliminary findings on the educational situation of children with autism spectrum disorder under conditions of inclusion, as well as technological innovations that have helped their education, are adequate (Solórzano et al., 2022).

Alternative Communication Systems

Alternative communication systems comprise a set of tools and devices designed to transmit, receive and emit different types of signals, whether voice, data, audio, video, in digital or analog format. In the case of children with autism, the use of visual aids such as images, pictograms and other graphic resources is essential to favor language comprehension and expression. Likewise, the implementation of visual routines contributes to provide structure and predictability, key aspects for their well-being and adaptation.

PECS System

The PECS system (Picture Exchange Communication System) was created in 1985 as a unique, complementary and alternative learning experience to help anyone with autism and other communication disorders to participate in communication. The exchange of symbols occurs between a non-speaking person and his or her interlocutor. Symbols are a way of initiating a process, making a decision, providing data or clarifying. This method has five progressive stages. The images used can be objects, textures, pictures, drawings and printed words. In general, all tools to promote linguistic harmonization should, in the first place, be used in the clearest and most transparent way, taking into account the child's abilities. It is worth emphasizing that this process does not make a difference in the way the infant perceives, but rather changes the child's perception so that he/she understands how to translate what he/she receives according to the structure of everyday language (Espinosa et al., 2023).

SAAC

The SAACs (Augmentative and Alternative Communication Systems) integrate all forms of communication (other than speech) designed to determine thoughts, needs, desires and ideas. When we express through gestures, facial expressions, symbols, illustrations and/or writing, we use all these forms of communication. To combine residual speech or as an alternative to non-functional speech, people with severe speech limitations or of expression require augmentative communication. The goal of communicating with others and expressing their ideas can be achieved with other

communication tools, such as message boards with pictures and symbols, this can improve social interactions, academic performance and feelings of self-worth.

TEACCH

TEACCH whose meaning in Spanish refers to "The treatment and education of children with autism and related communication problems (TEACCH)" (Panerai et al., 2002, p. 1) is based on a methodology that prioritizes structured experience through visual stimulation. This method was designed in the 1970's by Dr. Eric Sholper for the state government of Northern California, USA, with the main purpose of avoiding the inadequate institutionalization that was practiced in that period in school environments for people with ASD and "maximizing the adaptation of materials and structuring the environment to improve the functional skills and abilities of the students who use it" (Guzmán, 2023, p. 37).

The TEACCH approach is one of the most effective ways of working with people with ASD, the system recommends structured training, focusing on social and cognitive skills, communication and language needs and, always, on their performance. Thanks to its policies and working methods, TEACCH has achieved satisfactory results in its applications. It is based on simple, ordered and structured tasks and is designed to promote autonomy and independence (Once and Pando, 2022).

SPC

Pictographic communication system (SPC). It is one of "the most widely used systems for the social integration of people with communication difficulties" (Benito, 2018, para. 3). It is quickly understood what one wants to communicate thanks to the icons, so it is very easy to decipher. In 1981, Roxana Mayer Johnson created 300 drawings representing concepts that were used in everyday life and were part of a fundamental communicative repertoire that offered a useful and practical response to communication. Currently, there are more than 3,000 symbols available for free in image banks such as Board Maker, Plaphoons and Arasaac, all in digital pictogram format. According to the sensory integration model, the central nervous system organizes and interprets the sensations it receives to generate adaptive responses.

Communication Boards

The communication board can often be based or used with elements such as images, drawings, pictograms, words, letters or gestures.

Technologies such as electronic communication boards, systems or applications that read the words that are written and programs with pictograms are frequently used to communicate. An exchange can provide these communication systems through the exchange of pictures; in this case, giving and receiving pictograms to another person as needed is a form of alternative and augmentative or aided communication.

One form of communication is through words that go together with gestures according to the scenario or what you want to express, the communicational board is widely used by children with autism, intellectual and cognitive disabilities, it is determined as a bimodal communication, since it involves a board with images of gestures which you want to express along with hand gestures through signs.

A communication system with figures that tend to resemble words, as the basis of a communication board is very useful for people who have complications in expressing their needs when communicating. In addition, a board where several pictograms can be combined is the initial part to connect much bigger ideas, in this way it is an alternative and augmentative system; since the final idea that one wants to express will be according to the combination of its pictograms, this board by having several scenarios with the same image can be expanded with more than one meaning and it adjusts to the scenario in which it is found.

Materials and methods

The methodology used is based in first instance on the review of existing literature related to communication systems for children with ASD, from which relevant information related to the most used systems in the development of communication boards was extracted.

In addition, a comparative table was structured in which the elements and variables to be compared could be visualized, the communication systems to be contrasted were incorporated; identifying the dimensions, metrics and indicators on the compared systems, the elements and quantitative scales to be used in the evaluation of the systems were established.

As a data collection technique, questionnaires and checklist were used to identify the elements to be evaluated in the alternative communication systems useful for the creation of communication boards for children with ASD, by the experts. An evaluation model

was established, which resulted from the consensus of the experts, therapists, teachers and computer technicians.

With these criteria, the comparative table was elaborated, defining the key aspects and a template of indicators that allowed quantitatively measuring the best communicational system that would facilitate the creation of communication boards according to the established metrics.

The analysis of different communication boards was carried out, two for each alternative communication system under study, considering applicable parameters for the use of children with autism spectrum disorder. Additionally, parameters and indicators taken from the research of the referenced articles were considered, adapted with metrics and the use of the systems was evaluated.

Results

To evaluate an alternative communication system for children with ASD, four dimensions were considered: pedagogy, content, design, features. A template of indicators was detailed, correlated in 4 dimensions that are the aspects that can be evaluated in a communicational system to obtain the optimal board for the understanding of children with ASD. The first dimension is given under the scope of design and form, where availability can be detected as the main indicator, along with usability, popularity, accessibility and ergonomics. The second dimension is content with its main indicator sound quality, reading quality, notifications and tutorials with its secondary indicators written format and audio. The third dimension based on pedagogy with its main indicators Interactivity, learning, monitoring, evaluation and progress. The last dimension of characteristics evaluates the communicational systems under aspects such as: clarity, coherence, relevance, objectivity and understanding. In order to obtain a better visualization of the fulfillment of the indicators of each of the selected communicational systems. Each dimension was evaluated with a percentage of 25% respectively, adding up to a total of 100% in order to obtain a score of 100 points.

Measurement Scale

The measurement scale established is shown in Table 1, with which the evaluators rated 4 dimensions of each of the systems on a 100-point basis.

Table 1. Satisfaction criteria

Final Rating	Satisfaction Criteria
100 a 85	Excellent
84 a 75	Good
74 a 65	Fair
64 a 55	Poor
<54	Very bad

With the ranges in Table 1, it can be determined whether the communication system was evaluated as excellent if the range of the score obtained is between 85 to 100; good if it is between 75 to 84; regular between 65 to 74; bad between 55 to 64 and very bad if it is less than 54.

Table 2. Communication Systems Evaluation Table.

		Systems													
		SAAC		SCT		PECS		SPC		MINSPEAK		BLIS S		TEACCH	
Design Dimension	Availability	4	21	4	22	4	21	4	21	4	21	3	19	5	23
	Usability	3		4		4		4		4		3		4	
	Popularity	4		4		3		3		3		3		4	
	Accessibility	5		5		5		5		5		5		5	
	Ergonomics	5		5		5		5		5		5		5	
Content Dimension	Sound	3	17	4	19	4	20	5	24	5	24	5	24	4	23
	Reading	3		4		4		5		5		5		5	
	Contents	3		3		4		4		4		4		5	
	Notifications	4		4		4		5		5		5		4	
	Tutorials	4		4		4		5		5		5		5	
Pedagogy Dimension	Interactivity	4	21	4	21	4	21	4	21	4	20	4	20	4	22
	Apprenticeships	5		5		5		5		5		5		4	

	Follow-up	4	4	4	4	3	3	5							
	Evaluation	4	4	4	4	4	4	5							
	Progress	4	4	4	4	4	4	4							
Characteristics Dimension	Clarity	4	17	4	17	4	19	4	19	4	18	4	17	5	22
	Consistency	3		3		4		4		4		3		4	
	Relevance	4		4		4		4		4		4		5	
	Objectivity	3		3		3		3		3		3		4	
	Understanding	3		3		4		4		3		3		4	
TOTALS			76		79		81		85		83		80		90

Note. Adapted from Design of a system of indicators for the evaluation and selection of applications for people with Autism Spectrum Disorder, by Gallardo-Montes et al., 2021.

Table 2 shows that each sub-indicator was evaluated on a scale of 1 to 5 and each dimension represented 25%, adding all the dimensions a total of 100 points was obtained as a rating of the Communication System.

Table 3. Communication Systems Rating Table.

<i>System</i>	<i>Score</i>
<i>SAAC.</i>	76
<i>SCT.</i>	79
<i>PECS.</i>	81
<i>SPC.</i>	85
<i>MINSPEAK</i>	83
<i>Bliss System</i>	80
<i>TEACCH</i>	90

Table 3 shows the final results of the comparative table, based on the scores given by the experts. It was determined that the SAAC communication system obtained 76 points, categorized as Good, the

Total Communication System obtained 79 points, categorized as Good, PECS obtained 81 points categorized as Good, SPC obtained 85 points categorized as Excellent, MINSPEAK obtained 83 points categorized as Good, Sistema Bliss obtained 80 points categorized as Good and finally TEACCH obtained one of the best results with 90 points categorized as Excellent. The TEACCH system differs from the others by denoting greater availability as it is present in most of the boards used for communication with children with ASD. In the area of reading, content and tutorials, TEACCH also stood out for a greater focus of perspective on details, monitoring and evaluation with the pedagogy dimension and, as a last aspect, clarity and relevance stand out as the most representative characteristics compared to the other systems.

Discussion

The present research focused on identifying the best communicational system by selecting criteria that allow comparisons to be made on a score of 100 points.

One of the key pillars for the identification of the best system is the ease with which it can be used to create communication boards.

The results achieved were significant, since it was corroborated that thanks to the indicators determined it was possible to establish the most appropriate system for the development of a communication board, which will enable children with ASD to internalize information in a more efficient way, they will be able to have greater concentration and focus, and in the future they will show better progress in communication skills, as mentioned in (Gallardo-Montes, et al., 2021) (Carvajal & Naranjo, 2024).

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