Software de apoyo logopédico mediante PECS orientado a entornos digitales de aprendizaje para niños con TEA moderado.

Chicaiza Jaque, Jorge Luis y Herrera Vela, Jefferson Stalin

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Ing. Escobar Sánchez, Milton Eduardo

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SOFTWARE FOR SPEECH THERAPY SUPPORT THROUGH PECS ORIENTED TO DIGITAL LEARNING ENVIRONMENTS FOR CHILDREN WITH MODERATE ASD

Jorge Chicaiza-Jaque [1][0009-0001-2254-2762], Jefferson Herrera-Vela [2][0009-0007-0382-379X], Milton Escobar-Sánchez [3][0000-0017-1055-7545] and Franklin Montaluisa-Yugla [4][0000-0002-9816-1990]

[1] Universidad de las Fuerzas Armadas ESPE, Latacunga, Ecuador
[2] Universidad de las Fuerzas Armadas ESPE, Latacunga, Ecuador
[3] Universidad de las Fuerzas Armadas ESPE, Latacunga, Ecuador
[4] Universidad de las Fuerzas Armadas ESPE, Latacunga, Ecuador

(jlchicaiza4, jsherrera2, meesacobar1, fjmontaluisa)@espe.edu.ec

Abstract. Autism Spectrum Disorder (ASD) is a condition of neurobiological origin that greatly affects communicative-social development, causing difficulties for special children in their adaptation, communication, and interaction with their surrounding environment. Speech therapy rehabilitation is an important support for the education of these children, allowing them to develop their verbal, non-verbal, and learning skills. There are disadvantages to using traditional methods in the teaching-learning process. The difficulty of information processing due to their attention deficit is highlighted. The present work focuses on the use of information and communication technologies (ICTs) through personalized digital environments, developing the Picture Exchange Communication System (PECS). This tool is oriented to improve the existing pedagogical process in the San Miguel Foundation for special children in the city of Salcedo, reducing the difficulties that arise when providing therapeutic sessions to infants between four and six years of age. The results of the study show that there is 25% more efficiency when using PECS, reflecting an improvement in the response time of the infants at the time of performing the speech therapy activities and their teaching-learning process.

Keywords: Autism, Software, PECS, Digital environments. ICTS, Therapy, Speech therapy.

1 Introduction

Autism Spectrum Disorder (ASD) is a condition of neurobiological origin that greatly affects communicative and social development, it shows repetitive patterns in the behavior of the person, accompanied by possible fixed and restricted interests, causing problems in the adaptation of a child with autism to his or her surrounding environment [1, 2], it also hinders his or her ability to communicate with other individuals. To treat these symptoms specialized support is required, speech therapy rehabilitation is a beneficial support for such problems, allowing special children to develop their communication and language learning skills, helping them to integrate into the environments they inhabit, improving their socialization with the people around them while performing their daily activities [3].

The use of traditional methods for learning-teaching processes in children with ASD often presents difficulties, since it is difficult to capture their attention and their impairments at the time of processing the information presented to them, and this encourages the search for options that facilitate their interaction through the use of information and communication technologies (ICTs), taking advantage of the use of images, audio, video and tactile systems that allow children with autism to improve their communicative, social and cognitive abilities [4, 5].

In addition, it is important to note that people with ASD should be oriented in handling technology that includes multimedia systems [2], improving their therapeutic processes through the use of video games, and complementing traditional treatment methods. This increases their motivation and commitment to their behavior, contributing to their learning process, evidenced by their willingness to complete the proposed activities [6], minimizing the inconveniences that existed without the intervention of technologies.

The use of games produced in digital environments for autistic children are employed to increase the rate of learning, ensure effective monitoring, and improve the pedagogical, social, and behavioral sense [2], it should be considered that ASD has a variety of symptoms that range from mild, moderate, to severe, which affects the rate of learning, as well as the type of support required [7, 2]. For the creation of such digital environments, the use of technological tools that must be adjusted to the capabilities and needs of those who will be the end users is required. It is important to emphasize that discomfort, stress, and learning barriers should be avoided when using the program to be developed [1, 2], analyzing the resources and methodologies that can favorably support the therapeutic processes of speech therapy.

The Picture Exchange Communication System (PECS) is an approach for the training of communication, relying on images or symbols to gradually stimulate speech, it presents advantages when applied in the teaching of children with ASD. It should be noted that no support is needed for the understanding of the tasks that infants perform during therapy, and it is important to clarify that no intervention by other people is

required [8]. Studies conducted on PECS and comparisons with other systems have yielded favorable results for those who use it, due to the playful support it provides through the use of multimedia elements, thus stimulating concentration and retention of information [9], demonstrating its effectiveness when used in educational and therapeutic processes.

The article is organized as follows: section 2 describes the development of the proposal and the methods used for its implementation, section 3 states the results obtained with the execution of the proposal, section 4 shows the discussions, and finally, section 5 determines the conclusions based on the results obtained.

The development of the proposal aims to benefit patients and therapists in the following ways: (a) to engage children's attention more effectively, (b) to provide an interactive environment in which speech therapy-related activities are encouraged, (c) to promote the development of social and communication skills, (d) to reduce barriers to information acquisition.

2 Methods

2.1 Development of the proposal

For the construction of the software proposed in this research, we had the support of specialized personnel in the speech therapy area, which interacts with children who have moderate-level autism spectrum pathologies, at the "San Miguel" Foundation for Special Children in Salcedo canton.

The proposal is based on the use of technologies aimed at supporting speech therapy. In this case, the development of a web system supported by PECS is proposed as an alternative method of communication and learning, taking advantage of the reception of visual stimuli presented by infants and compensating for the deficit in communication and socialization skills through the use of multimedia elements such as images and sounds [10,11], through immersion in digital environments [12].

2.2 Multimedia and Hypermedia Object-Oriented Methodology (MHOOM)

The implementation of the system proposed in this research, known as "TEASSISTANT", uses the framework of the engineering methodology for developing MHOOM educational software [13], which has a life cycle divided into 4 stages. [13], which has a life cycle divided into 4 stages, which are detailed below:

Stage 1 (Requirements): the primary requirements of the children and their therapists concerning the need for speech therapy treatment focused on moderate symptoms of ASD are obtained.

The main needs according to the therapists are: to be able to captivate the infants' attention when performing the activities, to catch their interest to perform the tasks and complete them, to simplify the teaching of different tasks, to provide didactic material that is attractive for their learning, to provide enthusiasm to the children while interacting with the digital environments and finally the therapist needs to follow up the development when using the system.

The requirements will be prioritized depending on the effort required for its development to obtain a correct integration with the system to be developed, thus allowing a successful operation of the system [14].

Stage 2 (Analysis): The modeling of the requirements obtained is proposed, distributing them in activities to be carried out [15], which allows a reorganization according to the established objectives [16], as well as the analysis about how to couple the PECS system to the requirements and its use for the different activities included in the speech therapy for children with moderate autism.

Stage 3 (Design): proposes the elaboration of a functional prototype of the system [14]. It involves evaluating the usability, safety, and viability of the application, as well as the interaction of the environments between the children and their therapists [15, 17], emphasizing that it is necessary to verify that the methodologies and materials used are adequate and do not negatively affect the users.

Stage 4 (Implementation): as the final stage, the resources, technical equipment, and therapists necessary for the development of the software are selected [18], establishing a direct line of communication with the specialists in charge of providing the corresponding therapies to obtain feedback [14] and proactively optimize the setbacks presented in the teaching-learning process [19].

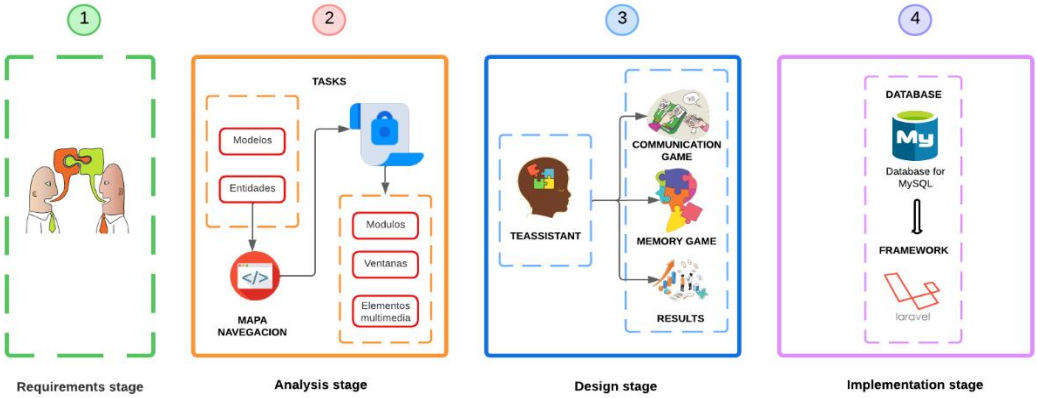

Fig. 1. Diagram of the MHOOM Methodology

2.3 The System TEASSISTANT

TEASSISTANT is developed in PHP alongside the Laravel framework, the application uses digital environments developed in conjunction with professionals in the speech therapy area, these environments integrate the PECS system and are adjusted to the activities that the therapists in charge apply with children who have autism with moderate symptomatology. The aim is to dynamize the control over the environment through a balanced and adaptive environment [20], thus facilitating the learning of the therapeutic activities proposed to them.

PECS is a pictorial method that was developed for children with social communication deficits [21]. It highlights the use of different pictures on cards, related to different categories to develop functional communication [11], with emphasis on teaching a child the initiation of requests for a given object through the use of pictures [22].

TEASSISTANT is supported by PECS in the use of picture cards for the development of communication, these cards are the primary means through which infants will be able to interact with the system when performing their speech therapy activities, each card represents a person, animal, thing or action, illustrated cards are used to take advantage of the fact that autistic children have better concentration and retention of information when visual media that attracts their attention are used, especially when applied through a screen in the format of a game [9].

It should be noted that sounds were used to complement the stimulation of the children, when an infant interacts with the cards, the name of what is represented in the drawing is reproduced to help the child learn to relate the image with the pronunciation of its respective name, while the children interact with the cards they will learn the pronunciation of the objects represented, also if the patient performs an activity correctly the system will reproduce a sound of approval and will congratulate the patient, on the other hand, if the patient makes a mistake the sound will indicate an error and the patient will be encouraged to try again, this function was implemented to maintain the motivation of the children to continue using the system until they finish their assigned tasks since the therapists emphasize the importance of encouraging the children so that they do not abandon the activity.

The main tasks that speech therapists have been applying with children with moderate autism are focused on making requests and choices, forming short sentences, and answering simple questions, so this list of activities was implemented within the TEASSISTANT environments to be used by infants, the design for the execution of the mentioned activities is adapted to the simple way in which PECS works through the interaction of the cards, as can be seen in Fig. 2. It should be noted that the application works alongside the therapist so that the child can be guided when performing the activities due to the difficulties that the infant may have when handling the peripherals.

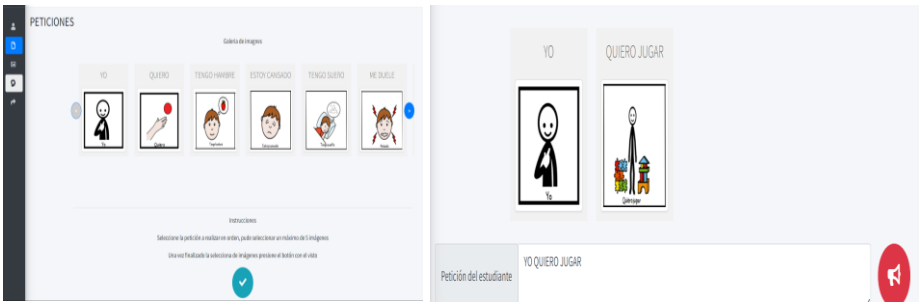

Fig. 2. Activities within digital environments

The application has a screen for registering patients where they will be asked to enter their basic information as shown in Fig. 3, to be able to follow up on the results obtained when using the system.

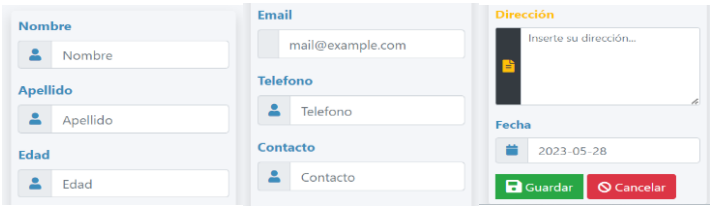

Fig. 3. Patient registration screen

The system can display a table with the results of the active patient at that time, this table includes the number of therapies, the date on which they were performed, and the estimated response time to perform the programmed activity in the form of points as shown in Fig. 4.

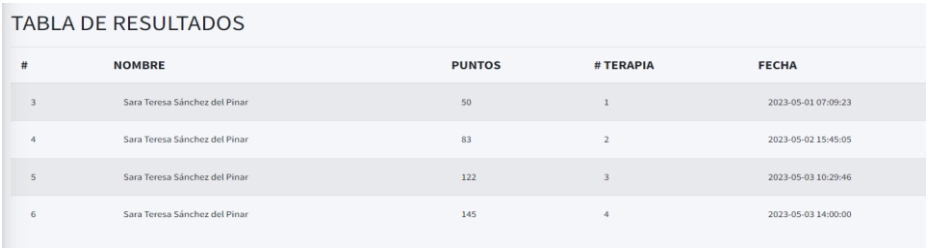

Fig. 4. Results and scores screen

3 Results

Table 1. Demographic data of participants

Patient	*Gender*	*Age*	*Primary diagnosis*
Sara	Female	4	Autism Spectrum Disorder (ASD)
Efrain	Male	5	Autism Spectrum Disorder (ASD)
Julieta	Female	4	Autism Spectrum Disorder (ASD)
Antonnella	Female	6	Autism Spectrum Disorder (ASD)

For the validation of the web system as a speech therapy support for children with moderate ASD, tests were performed on a group of four infants between the ages of four and six years old with symptoms of moderate autism, as shown in Table 1. By subjecting the patients to therapeutic sessions where the system is used, a quantitative analysis is used to evaluate the time it takes to perform the speech therapy activities, and then compare these times with those obtained in sessions where the system was not used. PECS was used as a methodology in the interventions in which the software was not used to compare and evaluate the results equally, considering that the results will be more accurate when the same methodology is used in a traditional way and a technological tool.

Table 2. PECS(Traditional) and TEASSISTANT sample statistics.

		Mean	*# Of therapies*	*Standard deviation*	*Error*
Part 1	PECS (Traditional)	1.47	4	0.1493	0.1977
	TEASSISTANT	1.03	4	0.8244	0.1611

The statistical sample resulting from the application of PECS in the traditional way contrasted with the use of TEASSISTANT can be seen in Table 2. In this regard, the mean result obtained when using PECS (traditional) was completely different from that obtained with the TEASSISTANT intervention (a difference of 25%), there is a difference in the standard deviations of the results for PECS (traditional) and TEASSISTANT. The standard error of the mean of a PECS (traditional) hard copy was larger than that of the TEASSISTANT data by mean, the coding for correct inspection is 1 and for incorrect inspection is 2. The mean correct PECS (traditional) recognition is 1.47 and for TEASSISTANT immersion in digital learning environments is 1.03 (closer to 1).

Through a qualitative analysis carried out in conjunction with the therapists, it was possible to observe how the children showed better concentration and dedication to carry out the activities when using the software, in addition to eliminating the problem of children sometimes throwing away the physical cards or not being interested in using them, while in the system they liked interacting with them because of the drawings and the sounds they reproduced, for the therapists it was easier to guide the children to carry

out the therapeutic tasks when the children were aware of what was happening on the screen in front of them.

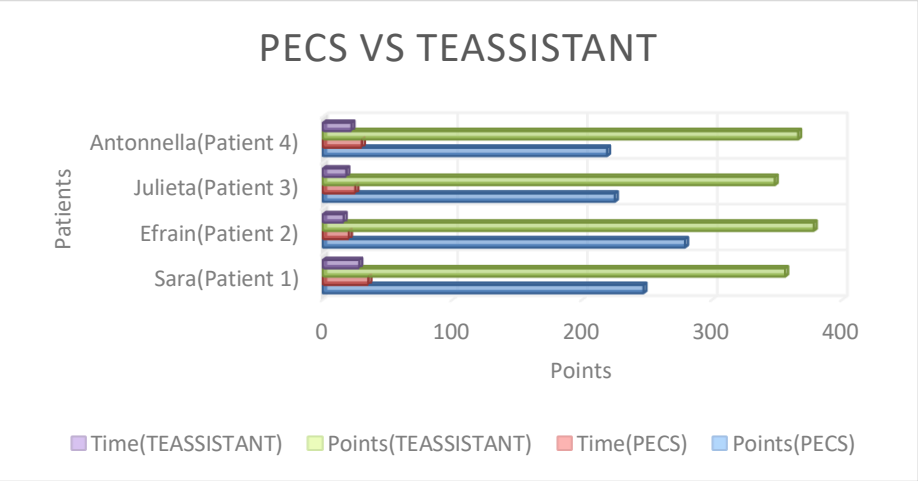

Fig. 5. TEASSISTANT results before and after patient treatment in the application.

As shown in Fig. 5, a patient was followed for a full month (4 weeks), divided into 4 treatment sessions (20 - 30 minutes) per session, in the first week there was an improvement of 33.34%, in the second week 47.78%, in the third week 17.22% and finally in the fourth week 58%, obtaining better results from the third session of the second week, thus demonstrating a better response time to the activities proposed in the treatment after having used the system and thus enabling a better social interaction.

4 Discussion

While the children were testing the software during the therapeutic sessions, important information was gathered. First, there was no great difficulty in understanding the activities assigned to them, due to the interest they showed in interacting with the multimedia elements of the digital environments presented on a screen, in addition to the ease and simplicity of learning that was provided to them through the digital environments.

However, some children required help from the therapist to handle the peripherals that they were not used to using such as the mouse, also during the initial stages of the tests some children had behavioral problems that were reduced thanks to the therapists and constant exposure to the software, the hyperactivity they presented was reduced and they gradually became interested in what was shown on the computer screen.

The application takes advantage of the motivation and ability to strengthen social and cognitive skills through video games and aims to make the most of the visual

stimulation through the cards and sounds they reproduce so that while interacting they learn pronunciation and relate the images in different environments.

5 Conclusions

The web system proposed in this research was successful in reducing the problems of concentration, behavior, and participation presented by the infants when attending speech therapy.

With the integration of PECS in the digital environments of the software, an improvement was obtained in the children's learning process while performing the therapy activities, due to the simple and interactive way in which it is based for teaching through illustrated cards. The use of interfaces with interactive multimedia elements together with the use of PECS was feasible for patients, allowing better stimulation through visual stimulation to process the information required to perform the therapeutic activities proposed within the digital environments.

The use of the TEASSISTANT web system as a speech therapy support in the therapeutic sessions of children with moderate autism has been validated, thanks to the results obtained from the active participation of the children and the guidance of the therapists during the development of the proposal.

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