Gamifying the teaching of facial expressions for children with autistic spectrum disorder

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Gamificação no ensino de expressões faciais em crianças com transtorno do espectro autista

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Gamificación en la enseñanza de expresiones faciales en niños con trastorno del espectro autista

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Resumo: O game é uma ferramenta educacional desenvolvida pela equipe multidisciplinar do Instituto Federal de Educação Ciência e Tecnologia do Maranhão, composta de docentes, discentes e voluntários, para ser aplicado no cotidiano das crianças com Transtorno do Espectro Autista. Segue o modelo de ensino diferenciado, pois tem o intuito de auxiliar no tratamento de crianças autistas através do reconhecimento e interpretações de expressões faciais, nos seus diversos espectros (leve, moderado ou severo), exercitando seus estímulos e capacidade cognitiva de reconhecer expressões faciais distintas, através de dispositivos móveis em um ambiente de múltipla escolha, possibilitando o aumento gradativo da sensibilidade do autista aos estímulos exteriores, predileção por imagens faciais que se manuseiam de forma repetitiva, desenvolvendo a motricidade do portador, melhorando seu relacionamento interpessoal. A metodologia utilizada é Applied Behavior Analysis (ABA), comumente associado ao tratamento de pessoas portadoras de Distúrbios do Espectro do Autismo utilizando reforços positivos, contribuindo, dessa forma, para o ensino e prática efetivamente baseada em evidências, por ser constituída de pesquisa básica, aplicada e teórica, através dos comportamentos e padrões sociais. A pesquisa destacou-se, no meio acadêmico e científico com três trabalhos publicados em eventos internacionais.

Palavras-chave: Autismo. Ensino. Expressões faciais. Motricidade. Reforço positivo.

Abstract: The game is an educational tool developed by the multidisciplinary team of the Federal Institute of Education Science and Technology of Maranhão, composed of professors, students and volunteers, to be applied in the daily life of children with disorder of Autistic Spectre. It follows the differentiated teaching model, because it aims to assist in the treatment of autistic children through the recognition and interpretations of facial expressions, in their various spectra (mild, moderate or severe), exercising their stimuli and Cognitive ability to recognize distinct facial expressions through mobile devices in a multiple choice environment, allowing the gradual increase of the autistic's sensitivity to external stimuli, a predilection for facial images that are They handle repetitively, developing the wearer's motricity, improving

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their interpersonal relationship. The methodology used is Applied Behavior Analysis (ABA), commonly associated with the treatment of people with autism spectrum disorders using positive reinforcements, thus contributing to the teaching and practice effectively based on Evidence, because it consists of basic, applied and theoretical research, through social behaviors and patterns. The research was distinguished, in the academic and scientific environment, with three works published in international events.

Keywords: *Autism. Facial expressions. Motricity. Positive reinforcement. Teaching.*

Resumen: *El juego es una herramienta educativa desarrollada por el equipo multidisciplinario del Instituto Federal de Ciencia y Tecnología de Maranhão, compuesto por maestros, estudiantes y voluntarios, para ser aplicado en la vida cotidiana de los niños con trastorno del espectro autista. Sigue el modelo de enseñanza diferenciado, ya que tiene como objetivo ayudar en el tratamiento de niños autistas a través del reconocimiento e interpretación de expresiones faciales, en sus diversos espectros (leves, moderados o severos), ejercitando sus estímulos y la capacidad cognitiva para reconocer diferentes expresiones faciales. , a través de dispositivos móviles en un entorno de opción múltiple, lo que permite el aumento gradual de la sensibilidad del autismo a estímulos externos, predilección por las imágenes faciales que se manejan repetidamente, desarrollando la motricidad del portador, mejorando su relación interpersonal. La metodología utilizada es Applied Behavior Analysis (ABA), comúnmente asociada con el tratamiento de personas con Trastornos del espectro autista utilizando refuerzos positivos, lo que contribuye a una enseñanza y práctica basada en evidencia, ya que consiste en prácticas básicas, aplicadas y teórico, a través de comportamientos y estándares sociales. La investigación se destacó, en el ámbito académico y científico con tres artículos publicados en eventos internacionales.*

Palabras clave: *autismo. Docencia Expresiones faciales Motricidad Refuerzo positivo.*

INTRODUÇÃO

Autism comes from the Greek word autos, which means myself, expresses the notion of oneself, of oneself. It is a neurodevelopmental disorder characterized by persistent difficulty in the interaction sound, communication and presence of restrictive and repetitive patterns (American Psychiatric Association, 2013).

Autism Spectrum Disorder (ASD) encompasses different conditions marked by neurological developmental disorders, all related to difficulty in social relationships. ASD encompasses different conditions marked by neurodevelopmental disorders with three fundamental characteristics, which can manifest themselves together or in isolation. They are: difficulty of communication by disability in the domain of language and in the use of imagination to deal with symbolic games, difficulty of socialization and pattern of restrictive and repetitive behavior. The effects of ASD and the severity of symptoms are different in each person (Dráuzio, 2010).

Due to the lack of clinical uniformity presented, the understanding and diagnosis of ASD are complex, since the characteristics may vary depending on the level of developmental severity and age of the child. The essential parameters for diagnosing involvement are the significant commitment to the development of areas of interaction and social communication (ranging from verbal and nonverbal changes) associated with patterns of behavior and restrictive and repetitive interests. The changes cause damage to personal, social and/or academic functioning (American Psychiatric Association, 2013). Symptoms vary widely and impairments may be mild to severe, which is why we currently refer to autism as a spectrum of disorders (Cavaco, 2017).

The new information and communication technologies represent a possibility for innovation in teaching resources, especially when it comes to the development of people in need of special learning measures. This enables technologies to create key resources that influence better cognitive development

and treatment through the recognition and interpretation of facial expressions and enable communication between people with special educational needs. Technologically, the most used methods are educational games, used not only as entertainment, but in several areas with multiple purposes, but with the aim of helping and facilitating the teaching-learning process of special children (Neto; Sousa, Batista, Santana, 2013).

As a consequence, their moments of communication or interaction, as well as personal development, social and professional integration are compromised. In this sense, the game was designed for children with the most severe level of the autistic spectrum but can be applied to all levels of the spectrum.

The present work, presents the game entitled Face-ABA, developed with the objective of helping the teaching-learning process of autistic children with difficulties in recognizing and interpreting facial expressions. In the development of the game we rely on the methodology Applied Behavior Analysis(ABA) as an approach to behavioral intervention in the treatment of autism symptoms.

2 METHODS

Aiming to propose a computational tool to assist professionals in the area of Education and Psychology. The methodology adopted consists of Applied Behavior Analysis (ABA), The expression refers to a theoretical line of psychology that works with behaviors that can be observed and modified, commonly associated with the treatment of people with Autism Spectrum Disorders (ASD), the ABA therapy proposes interventions in the teaching of emotional skills, and can be used teaching interpretation and recognition of facial expressions for children with ASD.

By the way, a game was developed that effectively enables autistic learning of facial expression. In accordance with the methodological procedures, in this study, a bibliographic research was carried out on teaching models applied to ASD patients and computational tools used in the teaching of autistic children and the description of the software.

3 LEARNING MODELS

According to the Center for Behavioral Therapies, teaching through discrete attempts is a specific methodology used to maximize learning. Thus, the methodology that adopts this strategy is called Applied Behavior Analysis (ABA) and is a process used in the development of various skills, such as cognition, communication and socialization (Correia; Freitas-Magalhães, 2014). As a rule, the technique involves dividing the capacity into smaller parts, teaching each capacity individually until it is learned, allowing repeated practice over a concentrated period of time, providing help and extinguishing it as needed, and resorting to reinforcement procedures (Correia; Freitas-Magalhães, 2014). ABA therapy has been the one with the best results, because it relies on the observation and evaluation of the individual's behavior, in order to enhance their learning and promote their development and autonomy (Freitas-Magalhães, 2007).

The model Treatment and Education of Autistic and Related Communications Handicapped Children (TEACCH) is specially designed to work with children affected by autism spectrum disorders. The model TEACCH has as its main basis the ability to help children with autism and provide them with better living conditions, to grow, to improve their performance and adaptive skills, in order to achieve more autonomy throughout their lives (Freitas-Magalhães, 2007). The TEACCH provides, through a well-structured and organized environment, the guarantee of reference standards, standards that are very important for autistic children, such as children with cognitive difficulties (Golan; Cohen, 2008).

Picture Exchange Communication System (PECS)is a teaching model developed for

people with autism and other communication disorders, which uses concrete objects, miniatures, photos, and/or pictograms, to establish communication through the exchange, i.e., the person delivers a card symbolizing what they want, and receives what they requested. This method aims to help people who have no communicative intention, such as autistic people, because it works with the intention demanding the approach of the other, followed by a request, thus establishing communication (Rump et al. 2009). The methodology PECS can be applied not only to children, but at different stages of development and in different disorders.

4 THEORETICAL FOUNDATION

Gobbo, Barbosa, Morandini, Mafort e Mioni (2018) developed a literacy game for children with Autistic Spectrum Disorder. For this purpose, effective forms of literacy were investigated, as well as methods, recommendations and techniques for creating interfaces for this specific user group.

Barbosa (2009), developed an application based on a model for acquiring knowledge of colors. Thus, the software aims to develop cognitive ability in the acquisition of basic colors and their names. Making available to users a simple screen with a graphic design designed for people with ASD, so as not to disperse their attention, so the colors are arranged in the form of pieces of puzzles, where the pieces represent the colors.

Neto, Sousa, Batista, Santana (2013) developed the G-TEA as an important tool in helping psychology professionals to solve color learning difficulties in children with Autistic Spectrum Disorder. They also concluded that G-TEA reached its goal of helping the professional in the teaching of colors for autistic children, due to arouse the interest of learning as if they were playing.

The ZAC Browser, Zone for Autistic Children, has a simple navigation interface and adapted to the needs of autistic children. The ZAC-Browser is available in English, French and Spanish and makes the usual task of surfing the Internet more accessible to autistic children. The tool e-kids consists of a special keyboard, developed to be coupled to a computer for interaction with a software developed with the purpose of applying the ABA methodology of discrete attempts.

Drab e Artner (2005), developed an Augmented Reality Environment for teaching-learning of Diabetes Mellitus (AREDM), which was performed by means of three-dimensional, interactive and real-time representations of its main anatomical and pathophysiological aspects.

The game is a multi-platform mobile application developed in C# language, based on the ABA methodology dividing into small tasks the learning and interpretation of the chosen facial expression, followed by positive reinforcement every time it is right and there are no negative interactions, and the professional can infer when necessary to stimulate / motivate learning of the child. In order to achieve the objectives proposed in this work, we developed the game Face-ABA: a computational tool to assist professionals in the area of Education and Psychology, in teaching the recognition of facial expressions to children with autistic spectrum.

5 THE GAME

The game starts with a certain character that represents an emotion (Happiness, Sadness, Surprise, etc.), enabling access at the first level of the game so you can start the practical part, as you go through the levels acquire experiences and visual information presented, when you reach the end all other characters, total of 6 (six), are unlocked as a way to reward and stimulate the child who managed to perform the task to play with the new characters that were acquired, which represent other emotions so you can intersperse and vary between them.

In the initial screen of the game, Figure 1 (a), the educator will define the game settings Figure 1 (b), selecting the facial expression to be worked with the child.

Figure 1 - Start screen of the game and Game configuration
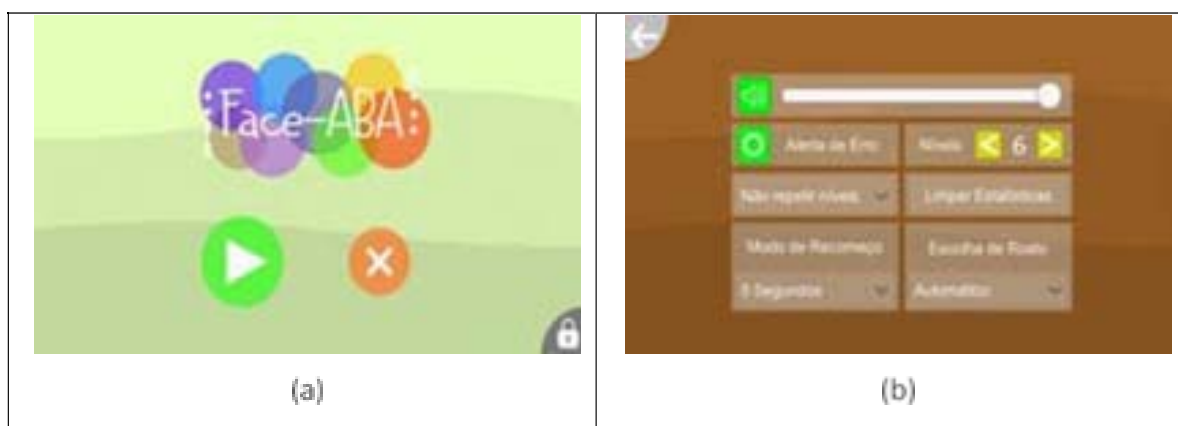
Defining the game settings and selecting the facial expression to be worked with the child, a screen will be displayed containing the sample of the chosen image, starting the interaction of the child with the game, in which will be presented a screen with n positions with m interactions determined according to the formula (1).

$$M = n + 1 \qquad\qquad (1)$$

We determined the number of m interactions in order to reinforce the learning of the desired facial expression. After the child has gone through all the positions on the screen, one more interaction will be added in order to reinforce the learning process. At each phase, a new position on the screen will be added, representing different levels in the game. This process is repeated during all phases of the game.

At the end, the game will present a screen containing the score, as a positive reinforcement for the stimulation of the child, working on his emotional cognitive. Educators will have access to a screen of results corresponding to each phase of the game, containing the number of interactions, the number of touches on other buttons, the number of touches outside the buttons, the total number of touches and the time spent to complete each phase.

5.1 LEVEL COMBINATIONS

When entering the first phase of the game, with a single character option, the player begins his interaction with the game fixing the facial expression to be worked. Clicking on the character will automatically direct the second phase which is consistent with the same number and quantity of characters to be interacted, in this case two. The player must remember the facial expression and the face of your character to make the correct choice, ie, between the two options only one of them will send you to the third stage of the game. If the player interact with the wrong character nothing will happen and when interacting with the correct will be taken to the next stage of the game, the following stages follow the same dynamics of the previous, so the third stage is composed of three characters with only one correct interaction and so on, going through the fourth and fifth stages, ending with the sixth stage composed of six characters. Allowing the player to choose among several options, the character that represents the facial expressions initially configured by the educator, see Figure. 2.

Figure 2   Stages of the game
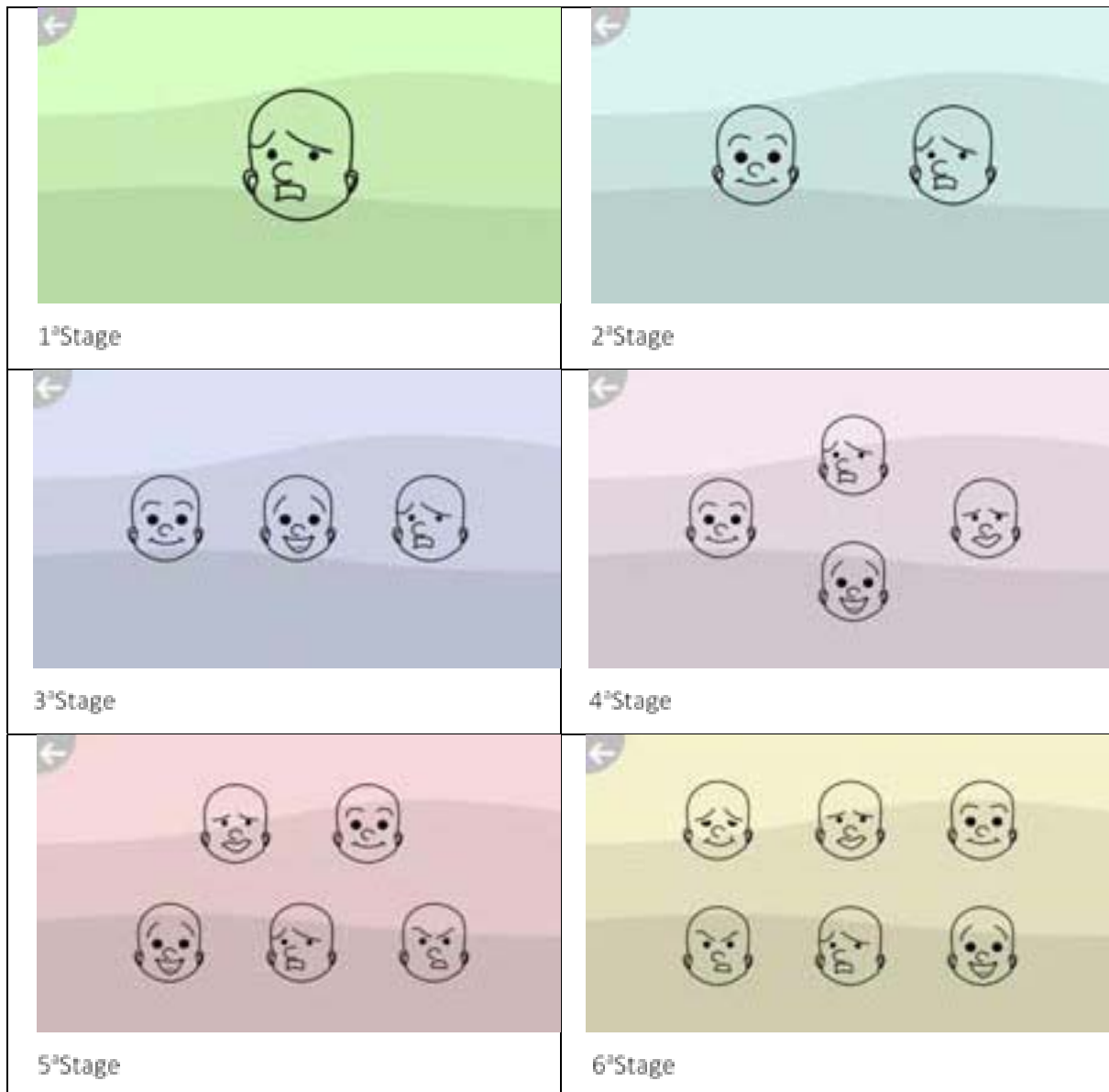
Source: Authors (2019).

The possibilities of the appearance of the images and the chances of correct answers for each of the Stages are given by the expressions below:

Stage 1: $c_{2,1} = \dfrac{2}{(2-1)!1!} = 2$, that is, there will be six possibilities for arrangements of the images and $\dfrac{1}{2} = 1 = 100\%$ of chance of success in choosing the correct image.

Stage 2: $C_{5,1} = \dfrac{5!}{(5-1)!1!} = 5$, that is, there **will** be five possibilities for arrangements of the images and $\dfrac{1}{2} = 0,5 = 50\%$ of chance of success **in** choosing the correct image.

Stage 3: $C_{5,2} = \dfrac{5!}{(5-2)!2!} = 10$, that is, there **will** be ten possibilities for arranging the images and $\dfrac{1}{3} = 0,3333 = 33,33\%$ of chance of success in choosing the correct image.

Stage 4: $C_{5,3} = \dfrac{5!}{(5-3)!3!} = 10$, that is, there **will** be ten possibilities for arranging the images and $\dfrac{1}{4} = 0,25 = 25\%$ of chance of success **in** choosing the correct image.

Stage 5: $C_{5,4} = \dfrac{5!}{(5-4)!4!} = 5$, that is, there will be five possibilities for arrangements of the images and $\dfrac{1}{5} = 0,2 = 20\%$ of chance of success **in** choosing the correct image.

Stage 6: $C_{5,5} = \dfrac{5!}{(5-5)!5!} = 1$, that is, will be a possibility to dispose of the images and $\dfrac{1}{6} = 0,1667 = 16,67\%$ of chance of success in choosing the correct image .

The possibilities for decomposition of the images in each of the phases is treated as a problem of combinatorial analysis, more specifically, a problem of simple combination, whose Formula 2 is defined by:

$$\dfrac{n!}{(n-p)!p!} = \{2\}$$

Where $1 \leq n \leq 6$ **and** $p \geq 1$, with $n,\ p$ ∈ ℕ

Where n is the number of images and p number of phase images to be arranged.

To calculate the chances of success **in** each phase, we use probability whose definition is given by Formula 3:

$$P_n = \dfrac{1}{n} = (3)$$

Where n is a natural number that represents the stage.

Choosing at random the images and not admitting mistakes, have the following chances of chance to reach each of the stages:

Stage **1:** 1=100%.

Stage 2: $1 \times \frac{1}{2} = \frac{1}{2} = 0.5 = 50\%$.

Stage 3: $1 \times \frac{1}{2} \times \frac{1}{3} = \frac{1}{6} = 0.1667 = 16.67\%$.

Stage 4: $1 \times \frac{1}{2} \times \frac{1}{3} \times \frac{1}{4} = \frac{1}{24} = 0.0417 = 4.17\%$.

Stage 5: $1 \times \frac{1}{2} \times \frac{1}{3} \times \frac{1}{4} \times \frac{1}{5} = \frac{1}{120} = 0.0083 = 0.83\%$.

Stage 6: $1 \times \frac{1}{2} \times \frac{1}{3} \times \frac{1}{4} \times \frac{1}{5} \times \frac{1}{6} = \frac{1}{720} = 0.0013 = 0.13\%$.

At the end of his first experience with the game the player is directed to a new screen containing positive reinforcement, Figure 3 (a) and an image with the six characters and their specific facial emotional characteristics, Figure 3 (b), so that he can play with everyone and enjoy the experience that each character provides the player.

Figure 3 - Positive reinforcement and characterization of facial expressions

(a)   (b)
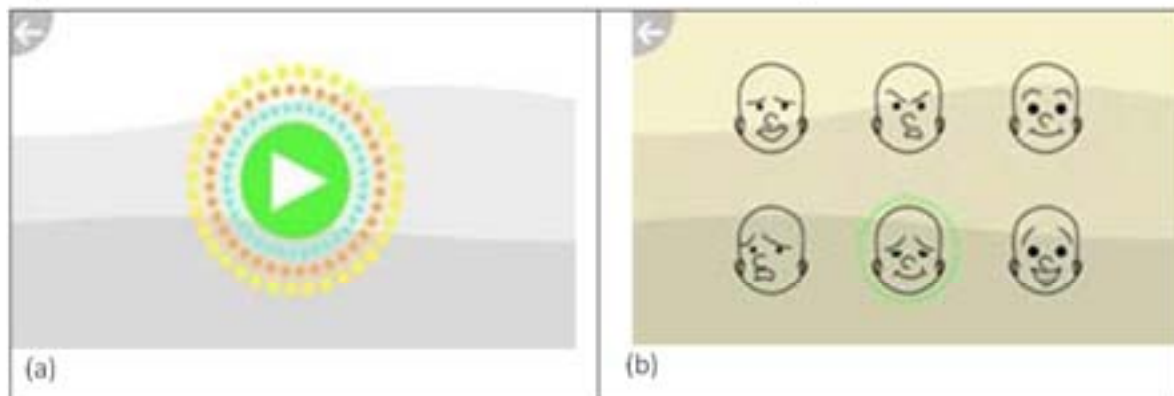
Source: Authors (2019).

The educators will have access to two reports, the first one containing the statistics of the game, Figure 4 (a) and the second with the amount of interactions, of touches on other buttons, of touches outside the buttons, total of touches and the time spent for completion of each phase Figure 4 (b).

Figure 4 - Statistics and number of interactions, touches on other buttons, off-button touches, total number of touches and the time taken to complete each phase
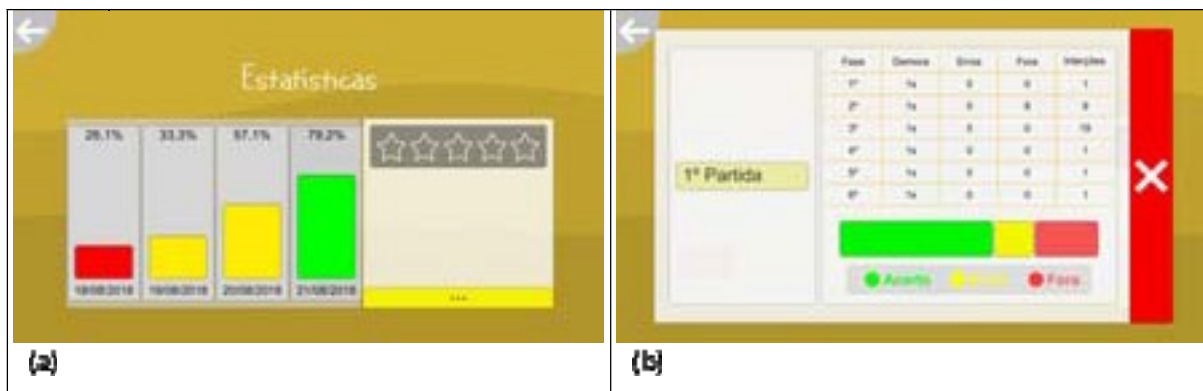
6 RESULTS

The project stood out in the academic and scientific community with three papers accepted in international events, the first article "Mobile computing tool to help treat autistic children with difficulties in recognizing and interpreting facial expressions", presented and published at the 12th International Conference on Smart Learning and Smart Technologies, held in Cairo - Egypt; the second paper "Overcoming educational perspectives of children with Autism Spectrum Disorder (ASD)", was presented and published in the proceedings of the IV SLBEI - SeminárioLuso-Brasileiro de Educação de Infância& I CLABIE, of the University of Aveiro - Portugal; the third study "Educational application applied in the daily life of children with autistic spectrum disorder", presented and published in the proceedings of the 14th Iberian Conference on Information Systems and Technologies (CISTI'2019), in Coimbra - Portugal.In addition, the game won second place on Planet Play, the IFMA 2018 Universe games competition, which is an event of integration of the Deaneries of Teaching, Research and Extension of the Federal Institute, Education and Science and Technology of Maranhão, with the support of the National Council for Scientific and Technological Development (CNPq) and the Foundation for Research Support to Scientific and Technological Development of Maranhão (FAPEMA), which is an annual occurrence.The event aims to disseminate and promote an environment of interaction, with the exchange of experiences related to research projects, extension and innovation developed in all twenty nine campuses of IFMA, as well as to present potential contributions to the community through the results of research developed.

7 CONCLUSION

This article presented the Face-ABA application, a tool to assist in the treatment of autistic children through the recognition and interpretation of facial expressions, in their various spectra (mild, moderate or severe), exercising their stimuli and ability to recognize different facial expressions. The App is available for free download from the Google Play Store: https://play. google.com-/store/apps/details?id=ifma.faceaba, having with public children up to five years old.

To learn more about the applications and techniques in this area, literary reviews of the main multidisciplinary databases indexed to the CAPES portal, such as ASTM, Scopus and Web of Science, were carried out. From the literature review and software requirements, the development of the tool began.

Initially, tests such as the application were carried out at the Federal Institute of Science and Technology Education of Maranhão (IFMA) - Codó Campus, by professionals specialized in serving people with special educational needs.In the second stage, with teachers and psychologists from the Pestalozzi

Association, located in the municipality of Codó in the state of Maranhão. The Pestalozzi Foundation serves children and adults with special educational needs, childrenwithautisticspectrumdisorder, and is a reference in the Codoense municipality for providing this service.

At the same time, questionnaires were applied to the tests with the teachers, psychologists and parents of the students who will use the game. Aiming to do, a quantitative-qualitative analysis of the results and survey of the real benefits and possible options for improvements, augments and corrections to the application App

It is hoped that, with this App it can provide professionals in the areas of Education and Psychology and other areas of interest, a tool to assist in the treatment of autistic children with difficulties i n the recognition and interpretation of facial expressions. Thus, these professionals can achieve significant and adequate results, taking into account the stimulus/motivation of the game in the treatment of people with special educational needs, specifically children with autistic spectrum disorder.

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