Autisdata: Software to Help the Development of People with ASD based on TEACCH and PECS Methodologies

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Abstract: Through years, teaching and learning techniques have been studied a lot, trying to find better ways to make it more effective for people. Even with many studies, it is necessary to rethink a lot of our recent used methodologies, trying to make the educational process more accessible and inclusive. In this paper, we will present Autisdata, a mobile application solution developed to help children with Autism Spectrum Disorders to improve their cognitive and communicative skills, based on TEACCH and PECS methodologies, which are already used to help these people.

1 INTRODUCTION

Recent studies from the World Health Organization (WHO) point that 1 in every 160 children has Autism Spectrum Disorders (ASD). WHO defines ASD as a "range of conditions characterized by some degree of impaired social behavior, communication, and language", beginning in the childhood and tending to persist through adulthood (WHO, 2017).

Furthermore, WHO also shows that people with ASD are commonly subject to discrimination and human rights violations, without supporting and accessible environments to perform their daily activities. Sometimes, they are deprived of health, education, and opportunities to engage and improve their social skills.

Nowadays, Information and Communications Technology (ICT) has been widely used to broadcast information and knowledge. These technologies provide different channels and ways of communication, which contribute to ensuring digital accessibility on access to information. Some resources used on TV channels and devices to assist people with visual or hearing impairment are video and audio description, high contrast, visual sign language and subtitles (ITU, 2011), as well as visual and interactive approach improves ASD children to learn better than traditional method (Kamaruzaman, et al., 2016).

Man is first and foremost, a being who establishes relationships. This is confirmed in early childhood, where since he was little he seeks to make friends, gather people around him and share moments and experiences, developing their skills.

The educational process is one of the keys to achieve personal development, improving people's affective, social and cognitive structure. This reality to a child who has communication and interaction deficit needs to be different, applying different methodologies trying to stimulate them to engage in the learning process (Oliveira, 2018).

In order to help people with ASD on the educational process, a few methodologies bring more effective ways to guarantee their communication and development, helping them to evolve citizenship and to engage with other people.

Treatment and Education of Autistic and Communication related handicapped Children (TEACCH) and Picture Exchange Communication System (PECS) are examples of methodologies used to educate these people.

TEACCH is a learning technique to children with ASD or difficulties to communicate based on elements such as different environments, climate, and objects, using activities to develop social behavior, cognitive and psychological skills (Kalyva and Avramids, 2005). On the other hand, PECS is a method, which improves visual communication where images are used to express needs and desires

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even without speech, developing social interactions and communication skills (Bondy and Frost, 2011).

This paper presents Autisdata, a software solution guided on TEACCH and PECS methodologies helping not only people with ASD but also parents and teachers. The software application allows users to handle activities, modulate tasks and show how each one of them can be performed.

2 AUTISM SPECTRUM DISORDERS (ASD)

This section presents concepts about ASD in order to legitimate the importance of teaching approaches appropriate for students with ASD as well as to detail its practicals and strategies.

The term autism originates from the Greek "autos", which means "self, one's own". It was first used by the Swiss psychiatrist E. Bleuler, 1911, who sought to describe the escape from reality and the internal withdrawal of patients with schizophrenia. Autism comprises the observation of a set of behaviors grouped into the main triad: communication impairments, difficulties in social interaction, and restricted-repetitive activities (Cunha, 2011).

Autism can be also considered as a developmental disorder characterized by a peculiar behavioral framework that involves fields related to social interaction, communication, and behavior varying in degrees of severity (Assumpção and Pimentel, 2000). Therefore, to achieve a diagnosis of autism, there must be symptoms in these three domains.

Early diagnosis is relevant to start specialized education process as soon as possible. The diagnosis of children with autism is increasing, so, knowing how to teach these children and which strategies to use is extremely important. Teaching approaches that are effective for all students can also be used in implementing education programmes for students with ASD, but facing the difficulties in develop communication and social interactions, it is appropriate to encourage some way alternative teaching strategy (Oliveira, 2018).

2.1 Teaching Approaches for ASD Children

In the face of the difficulties faced by people with ASD to develop their communication and social interactions, it is appropriate to encourage some form of alternative communication. The choice of which technique to use depends greatly on the child's skills and limitations, as well as the degree of commitment of the child and theirs responsible. This work deals with two systems of teaching, both characterized by their simplicity in not demanding elaborate skills, in relation to linguistics, comprehension or memory.

Cunha (2011) relates that even without a unanimous approach, there are appropriated techniques for dealing with autism, due to different symptoms and factors that interfere in the natural development. Some behavior interventions have been effective on autism treatment, such as TEACCH and PECS methods.

2.2.1 TEACCH

The TEACCH teaching methodology is, by definition, a Treatment and Education of Autistic and related Communication Handicapped Children developed at North Carolina, United States, in the 1970s (Panerai et al., 2009). Starting from the premise that people with autism are predominantly visual learners (Mesibov et al., 2004), TEACCH was designed specifically for children with autism, which it can (and should) be used in a collaboration between parents and professionals. The TEACHH system was originally designed for children with Autism. However, it can be used with children with a range of needs.

TEACCH demonstrates the importance of environmental organization (Bosa, 2006), without distractions for the child, the use of visual cues, and the individualized evaluation. In order to set up a structured teaching and learning environment, it is necessary to be physically organized with a specific and predetermined place for the child to perform a certain activity, in this way he/she already knows the exact place where they should work.

TEACCH is a strategy worried about to develop schedules and work system with visual times that show the student the order of the activities and when they will do it, besides exposing the quantity to be fulfilled; and the modeling of activities, visually describing step-by-step of each task.

2.1.2 PECS

Picture Exchange Communication System (PECS) is a visual communication method that stimulates verbal communication, whose children and adults can make requests and comments, engage with others, and build communication skills such as vocabulary, syntax, receptive and expressive language (Bondy and Frost, 2011).

PECS technique works as a framework with different steps. Each step corresponds to a phase. There are six phases, which go on to teach discrimination of pictures until how to put them together in order to create simple sentences. In the more advanced phases, individuals are taught to use modifiers, answer questions and comments (PEC, 2011).

The first phase consists of introducing the exchange picture technique as a way of communication between the children and his/her "communicative partner". The child shows a picture to his/her communicative partner and receives back items or activities they want.

The second phase is the distance and persistence strategy. It aims to stimulate children to be more persistent communicators by using pictures of the items or activities across different distances, people and/or environments.

Third, children will develop picture discrimination selecting his/her favorite thing from a group of pictures. Afterward, they will place the picture in the PECS communication book - a ringed binder with self-adhesive hook fastener strips where pictures are stored and easily removed for communication (Bondy and Frost, 2011).

Fourth, fifth and sixth phases are related to creating sentences starting with simple sentences as "I want…" and then expanding it by adding adjectives, verbs, and prepositions. Finally, individuals will be able to answer questions and make comments.

2.2 Related Works

There are some works related to the teaching process of special children. Most of them intend to prove the effectiveness of specific teaching approaches for ASD children.

Charlop Christy et al. (2002), in their paper "Using the picture exchange communication system with children with autism: Assessment of PECS acquisition, speech, social-communicative behavior, and problem behavior", report that the results of their study which provides empirical evidence and adds experimental data to support the use of PECS, indicate that children's social communicative behaviors increased after learning to use PECS. It also indicates the increased communication skills occurred in conjunction with decreases in problem behaviors.

On the other hand, D'Elia et al. (2014) conducted a longitudinal study of 30 preschool children with ASD to evaluate the potential benefits of TEACCH. Findings suggest that a low-intensity home and school TEACCH program may provide benefits for children with ASD by reducing autistic symptoms and maladaptive behaviors.

Many researches were made regarding human-computer interaction (HCI) for children with autism. Mangafa et al. (2015) explored primary school teachers' experiences of developing joint attention skills in children with autism using strategies and iPads. The observations showed that teachers used a variety of evidence-based strategies to engage their pupils with autism in joint attention opportunities but that there was little use of iPads.

Kamaruzaman et al. (2016) developed an application to be used by parents and special educators to teach basic numeracy and calculation skills to children with autism, which complements the traditional method such as cue cards and flash cards that are implemented over a touchscreen device.

Therefore, beyond researches about teaching techniques and their results in ASD children, it is possible and promising to promote future independence and self-determination in the education of these children (Kamaruzaman et al., 2016).

Every aspect that may contribute to the teaching and learning process of ASD children was taken into considerations in developing the software presented in this paper, such as the study of ASD teaching and learning techniques and examples of softwares that were developed aiming to help in their education.

3 METHODOLOGY

This section presents the steps and tools used to develop Autisdata. Figure 1 reveals how the propose was created since its conception until its last release.

Autisdata's propose begins with studies to recognize how informatics can be used to improve on quality education, searching for Information and Communication Technologies, Learning Objects and special education.

After these researches, it was possible to realize that, even existing amounts of people who need some special attention, there is a lack of tools helping to include them in an educational process. Then, among studies about autism, the questions about how can technological knowledge help people with ASD begin to be answered, using all of these theoretical bases. After gathering all these pieces of information, was possible to proceed in the software development stage.
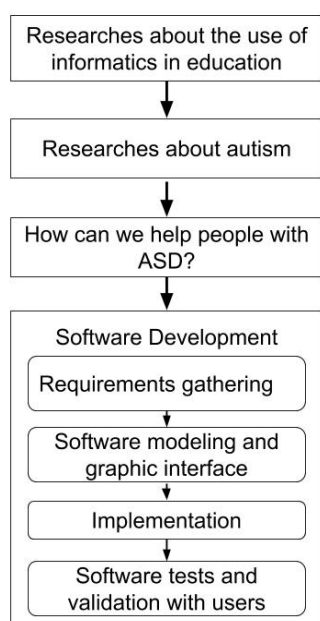
Figure 1: Autisdata's development methodology.

According to Sommerville (2007), software development is a sequence of activities that are used to build a software. Sommerville (2007) also says that four core activities are imprescindible on software development regardless of the software process used, such as specification, development, validation, and evolution.

These activities are connected with the software methodology used in Figure 1. With requirements gathering, software modeling and graphic interface were possible to **specify** the software, while the implementation step represents the process of development. Finally, with software tests and user experiences was possible to **validate** Autisdata. In the following subsections will be described each one of these activities.

Sommerville (2007) introduces that software validation intends not only to show if it is appropriated according to its specifications but also, according to the user's expectations.

The software developed needed to be constantly tested by its team, to ensure the accuracy on its operation. Always when a new functionality was finished, a test routine was performed to realize if the functionality was working as planned and if it was working integrated with the rest of the system.

Finally, when all requirements and use cases were developed, Autisdata was released to their final users. To validate Autisdata, the tool was presented to professionals and people with experience in special education that works on a specialized place for people

with autism spectrum located in Feira de Santana in Brazil.

Using qualitative research, through interviews and questionnaires was possible to validate Autisdata from the user's point of view.

4 AUTISDATA: SOFTWARE OPERATION

Beyond the lack of social interaction and communication with ASD children, it is very important to choose the appropriate teaching technique, which will develop their skills and work on their limitations. This paper reaches two educational systems featured by its methodologies related to communication and behavior.

Autisdata was developed gathering PECS and TEACCH strategies, for that, the software was divided into two modules, the first screen of the software is just two buttons, each one directs to a specific module (Figure 2).
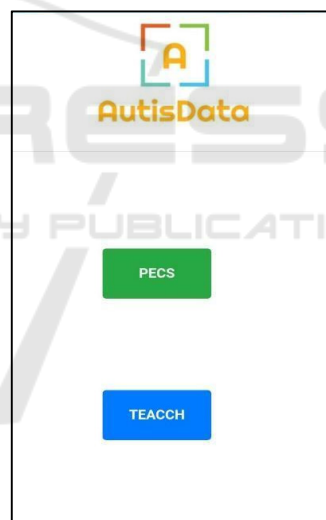

Figure 2: Autisdata - First screen.

The following sections explain how the software was developed in order to support and improve the learning process of an ASD student.

4.1 Module One: PECS

Module one, also known as Module PECS, named after the teaching methodology PECS, aims to teach functional communication.

Children and young people on the autism spectrum often do not develop social and

communication skills in the same way as their peers. Similar to the handmade communication book, this approach leads ASD children to independent communication by automatizing their functions and giving to both children and teachers, the opportunity to have another tool of communication easily in hands.

Combining the PECS phases, Autisdata contents three phases adapted to a software environment. It works as a picture database, where users can add new pictures, delete or edit it. The pictures are presented in categories: food, beverage, activities, and objects. Therefore, it starts practicing the picture discrimination feature among the user of the software.

The first interaction inside PECS module is the discrimination of the pictures where the user needs to choose in which category is the item that he/she wants to. The pictures were first divided into categories in order to organize and to facilitate the search. Then, after deciding the category, by clicking on the picture related to it, it will appear another screen with the pictures of that category. This screen simulates the communication book using the same design of the strips where pictures are stored (Figure 3).

Figure 3: Autisdata - First screen.

There are some pictures natives from Autisdata; these pictures are from Soy Visual (Fundación Orange, 2002), a website which allows the use of all images in its collection, beyond citation of the source. However, the user can add new pictures according to the children interests. They can also delete or edit the pictures in the system.

The user will continue to practice the discrimination of pictures, but now they are in the same group of content. In this phase, after the user touches the picture wanted, it will move directly to the strip on the top of the page, against the fixed sentence "I want" (Figure 4).
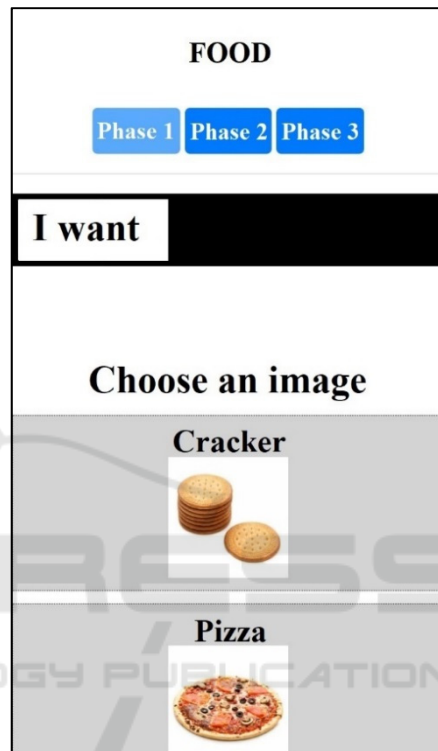

Figure 4: PECS Module - Categories screen.

In the second phase, the user needs to select the picture, then hold, and drop the picture in the right position in the strip and next to the pre-fixed sentence. This strategy simulates the distance and persistence real technique has.

The third phase intends to stimulate the user to create simple sentences and place them in the right order, so there are no pre-fixed sentences on the top of the page, now the user needs to place all the sentences, and also the picture wanted in the black strip.

4.2 Module Two: TEACCH

This module is based on the TEACCH technique, which aims to create the best environment for the learning process of ASD children. For these children is difficult to make transitions between activities and

places without schedules. The strategy used in TEACCH to reduce this dilemma is named by Mesibov et al. (2004) as physical and visual structures, schedules, work systems, and task organization.

The features presented in this module were developed thinking of the user as the teacher because its functions are related to creating schedules and diary activities for ASD students.

So, basically, the user creates activities and then sets a schedule with the number of activities he/she thinks is necessary for the student. Each activity is based on the needs of the students and it is required the existence of pictures and description with the instructions of the activity. Besides the action, in order to create a schedule for the routine of the student, it is necessary to set a name for it.

The student will use the same interface to visualize his/her routine and activities of the day. As long as they are finishing one activity, they can mark in the software by clicking on the "Done" button. Therefore, by the end of the routine, the student can follow his/her development and conclusion of activities. The Figure 5 illustrates this module.
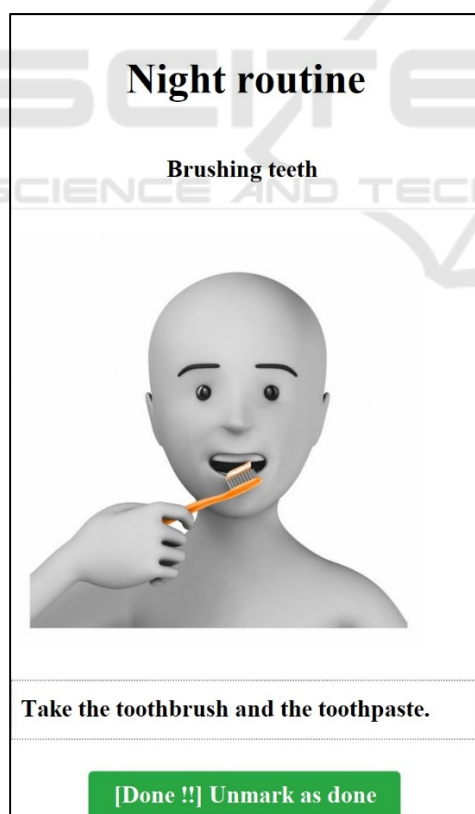

Figure 5: TEACCH activity.

5 VALIDATION

According to Sommerville (2007), software validation, also known as verification and validation (V & V), intends to show software is built based on its specifications while it satisfies the customer's specifications about the system. Therefore, it is very important to conclude the software validation to be sure that it is worth and if it will please their users.

This section shows how was the V&V process of Autisdata since the study of the possible natural environment of occurrence of this phenomenon and the analysis of the material collected including its results.

After the study of teaching methodologies in the cognitive, communicative and social development of autistic children (TEACCH and PECS), plus automating its manual tools, the objective of this research was to compare how the educators of ASD children deal with their students nowadays, and what would change if they start using Autisdata? This research also aims to test the prototype of the application, considering its ease of use and understanding by educators, and also the similarity with the manual tools, utility and possible improvements and addition of other functions.

There were 9 people joining in the research, they were professionals who work directly with ASD children at the Specialized Nucleus for People with Autism Spectrum (NEPEA - Núcleo Especializado para Pessoas com Espectro do Autismo), located in Feira de Santana, Bahia, Brazil. This research was carried out in a relatively small group of potential users of the computational technology presented in this paper, through a combination of interview and questionnaire.

The interview worked as an icebreaker and it was started with an introduction to the software's purpose and also some personal questions such as "How long have you been working with ASD children; "Have you received special training to work with these children?"; "How do you plan and/or organize the activities you do with these children?".

During the interview, there was also room for the interviewee to test the tool, handle the application and also make comments and suggestions about new features that could help in the use of software in the daily life of autistic children.

Following, they had to fill in the questionnaire about Autisdata. The questions were about what did they think is useful on the software, as well as what did they think it is necessary to add in.

According to the data collected from the questionnaire survey, it was verified that at least one

of the teaching methodologies directed to autistic children is already known to all interviewees; some of them already knew about PECS and others about TEACCH. It was identified as a favorable similarity to the techniques used in TEACCH and PECS manually, and all interviewees agree that the software resembles the manual tools. They also responded positively in terms of ease, comprehension, and usability.

The software developed in this project aims to assist and repair these two main questions related with ASD, the first one, communication, which is related to PECS methodology. It was used in the software aiming to stimulate children's principles of conversation, through the exchange of symbols.

The second issue is the child's concentration, which can be minimized with the use of Autisdata software, because it is a technological tool and calls the child's interest. Children with autism spectrum disorder have an affinity with tablets and similars, which is recognized by the autism research community with many studies gradually emerging in this field (Mangafa et al, 2015). The results of the questionnaires and interview report that all the children who attend the institution are fascinated by electronic instruments, such as, tablets and cell phones, and confirmed that, when they are in contact with these technologies, they focus their attention, and concentrate only on the device.

Since all the steps of this research were performed and the problems were identified from the analysis of the results obtained through the data collected in questionnaires and interviews, it was possible to carry out the validation of the software described in this work.

5 CONCLUSIONS

Education is one of the most important tools on people's development, responsible for getting information and transforming them into beings capable to contribute to society.

Even with difficulties, all people should be embraced on this process to evolve their abilities becoming citizens with an active political, economic and cultural role.

On this context, this paper presented the first version of a software tool to help people with Autism Spectrum Disorders (ASD), to overcome some of the difficulties in the educational process, helping them to develop their social and cognitive skills.

The developed tool, Autisdata, in complementing the traditional methods (PECS and TEACCH) by supporting the process of teaching and learning for children with autism, use digital technology to contribute on accessibility and society's evolution. However, digital methods may not exist to completely replace the traditional method but to complement the existing methods by providing users with ease of use and mobility.

According to questionnaires and interviews made with professionals responsible to help these people show that was possible to concretize Autisdata as a satisfactory tool, to help people with ASD.

Autisdata can be applied to help children with ASD in the educational process, reducing their difficulties of communicating and learning, another technology to support them daily. Besides, it can be used to help both teachers and family with the communication process with ASD children and organization of tasks for them.

As future works to Austisdata's development is expected the implementation of some new functionalities, such as: (a) audio feedback, helping children's development with audio commands; (b) new categories creation, to educators and helpers expand the possibilities of Autisdata; (c) the usage of more than one image to describe each step of a full routines; and (d) the creation of an administrator user to help educators sharing information about routines to different users and/or devices.

We also expect to extend Autisdata's validation through researches with other professionals and also with its target public, analyzing how users will interact with the tool, and the evolution of their communication skills through its use.

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