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Mobile Applications for autisticchildren: An analysis of the Google Play Store platform

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Abstract**—***This study aims to categorize mobile applications for autistic children available on the Google Play Store platform, analyzing how these applications are arranged on the platform and how to best facilitate the search function for parents and professionals working with autistic children. The process should ease search and access of specific applications for parents and professionals working with autistic children by arranging applications from diverse areas in a table format rather than requiring that apps be checked individually in the search engine on Google Play Store. Methods: the survey was conducted in three stages: identification of all applications for autistic children; mapping and categorization of the 10 most installed applications; analysis of the features and benefits of the two applications selected. The survey qualifies as qualitative, since it proposes a survey of mobile applications for children with ASD, arranged on the Google Play Store platform. Thus, we describe the main characteristics of the selected applications, their purpose, features and benefits for use with autistic children. Conclusion: at the end of the survey, it was concluded that the 249 applications found were poorly organized and that only 44 were specific to autistic children. Of these, 10 applications were selected and arranged in a table to facilitate search for parents and professionals working with autistic children. In addition, 2 mobile applications were selected and analyzed for their purpose, functionality and benefits.*

Keywords**—Mobile Applications, Autism, Children, Google Play Store**.

I. INTRODUCTION

If your child was within the autistic spectrum, would you consider using a mobile application to help him/her? And how would you search for this application? The answer seems obvious and practical but it's not that simple.

Given this scenario, the objective of this research is to check all applications specific to autistic individuals available on the *Google Play Store* platform, in order to categorize them and identify the 10 most installed overall. Of these, the first two identified will be more carefully analyzed. By identifying and categorizing applications available on the *Google Play Store* platform in a single table, rather than having to search for applications individually, parents and professionals working with autistic children will be able to access these applications more efficiently and further select individual applications that best suit their specific needs.

This study is justified given the growing number of ASD cases in Brazil and around the world. In addition, when using the platform to identify applications that are appropriate for autistic children, parents and professionals are currently confronted by a disorganized platform with a high number of apps across different areas. Under these conditions, it is challenging to find specific or suitable applications by potential users who may not fully understand the functionality or appropriateness of certain applications.

Thus, the search conducted in December 2019, with the words *"Autism"* and *"Applications"*, in the *Google Play Store* platform search engine, identified 249 applications. An initial analysis was carried out for each application in order to identify the first characteristics which would make it possible to categorize them by topic. Among the more than two hundred applications found, the 10 most installed by users were selected, and then a more careful analysis

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was carried out on two of these applications identifying their purpose, features and benefits.

II. AUTISM SPECTRUM DISORDER AND MOBILE APPLICATIONS

The World Health Organization (WHO) has pointed to alarming statistical data on Autism Spectrum Disorder (ASD). According to the organization, ASD affects one in every 160 children in the world and it is estimated that one percent of the world population is affected by the disorder (UN News, 2017).

In Brazil, although there isno available official statistical data, it is estimated that there are around twomillion cases, considering a population of approximately 200 million people (Brazilian Institute of Geography and Statistics - IBGE, 2016) and the prevalence of the disorder in the world population.

The Diagnostic and Statistical Manual of Mental Disorders (DSM-V, 2014) defines the following characteristics of ASD: i) inadequate social interaction; ii) deficits in verbal or non-verbal communication; iii) behaviors with restricted, repetitive and stereotyped patterns, with unusual sensory responses.

The "Autism Primer: Guidance for Parents", of the Ministry of Health (2000, p. 10), describes the signs that may appear, together or separately, in individuals with ASD: "they present mental isolation; this isolation resists, excludes, and ignores what comes from the external world; they have an obsessive insistence on repetition, with repetitive and stereotyped movements and noises; they adopt elaborate rituals and routines; they have highly directed and intense fixations and fascinations; they present limited facial expressions and gestures; they do not look directly at people; they have an abnormal use of language; they displaygood relationships with objects; they present excessive anxiety; they do not acquire speech or may lose previously acquired speech". In this sense, it is possible that specific mobile applications geared towards autistic individuals available onthe *Google Play Store* platform, are important tools in supporting those with ASD. Digital environments, and information and communication technologies can be important resources for improving social interaction for those with disorders that hinder functional relationships with the outside world (Caminha et al., 2016). According to Caminha (et al., 2016, p.125), "[...] it is fundamental to reflect on the potential of these resources, especially as mediators that benefit communication and expression of these people". Thus, mobile applications can be a resource that potentially promotes the autonomy of autistic individuals.

Therefore, since technology is clearly a resource that helps children and adolescents learn, autistic individuals also learn to write and to communicate this way, making this virtual universe more collaborative by means ofa variety of available applications, in addition to other emerging tools and resources in the field (Cunha, 2012).

Technological resources such as tablets can become indispensable and extremely relevant when working with autistic people, considering that games and applications help in the most diverse forms of expression and communication; and, also offers an attractive interface, with colors and animation, stimulating concentration (Orrú, 2016).

According to several authors (Aragão et al., 2019); (Mello and Sganzerla, 2013); (Farias and Cunha, 2015), mobile applications can help autistic children in the development of motor skills, autonomy, and improved interaction with others. The authors state that such applications can help children with this type of disorder to express themselves better, in addition to facilitating gains in cognitive skills and logical reasoning. Thus, it is relevant to analyze which specific characteristics of the available applications will result in developmental gains for these individuals.

Authors Alda and Leffa (2014, p. 86), affirm that mobile applications "are software, work as computer programs, offering some advantages of use. Applications tend to be more interactive and enjoyable to use, as they are able to cover and integrate several types of activities into one - for example, instead of using SMS, internet, audio player, and video player functionalities separately, one application is able to unify several functions into a single program". Therefore, mobile applications usually have a simple interface with an interesting layout, making it easier for ASD children to understand and interact with it. The features on these applications create activities that are more attractive to children with ASD compared to conventional methods of learning. In addition, it may be possible that the use of mobile applications facilitates or motivates these individuals to communicate with their surroundings, arousing interest in speech and learning. A user's interest in these activities may enable professionals working with these children to obtain a better assessment of their cognitive level and understanding of their thought process.

III. METHODS

This is an applied scientific study, as it generates knowledge for practical application, aimed at solving a specific problem: assisting parents, therapists and teachers

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of children with ASD, in the selection of mobile applications available on the *Google Play Store* platform. The main contribution of the present research is the establishment of parameters for selecting mobile applications, i.e., a grouping that highlights the main purpose, benefits and functionalities of applications available for children with ASD on the *Google Play Store* platform.

Regarding the approach to the problem, the research is qualitative, since it deals with the interpretation of phenomena and assignment of meaning, as clarified by Kauark (et al., 2010, p. 26): "the interpretation of phenomena and assignment of meaning are basic in the process of qualitative research. It does not require the use of statistical methods and techniques". Therefore, the researchis considered qualitative, since it proposes a survey of mobile applications for children with ASD, arranged on the *Google Play Store* platform.

Regarding the objectives, the research is descriptive. From its level of interpretation, the survey can be considered descriptive because, according to Gil (2002, p. 42), "descriptive surveys have as their primary objective the description of the characteristics of a given population or phenomenon, or the establishment of relationships between variables. Accordingly, we attempted to describe the main characteristics of the selected applications, their purpose, functionalities, and benefits for use with autistic children.

Regarding technical procedures, this research can be classified as bibliographic, as it was based on several materials previously published, such as books, magazines, newspapers, journal articles, and materials available on the Internet (Kauark, Manhães e Medeiros, 2010).

As far as methodology of the current study, the research stages on the *Google Play Store* platform, its context, and description are detailed, as well as the purpose, features, and benefits of the two applications selected, according to the following steps:

1- Identification of all applications for autistic children; 2- Mapping and grouping of the 10 most installed applications; 3- Analysis of functionalities and benefits of the two selected applications.

IV. RESULTS AND DISCUSSION

The *Google Play* virtual store offers applications that use the Android system. Research done by the *International Data Corporation* - IDC (2015), an American research company in digital technology, revealed that the Android system leads the market as the system most used by smartphone users, showing a significant number of 82.2% of users, followed by iOS with 13.9% and Windows Phone with 2.6%. In 2018, IDC conducted a new survey showing that the Android system maintained its position as market leader with 85.1% of users, followed by the iOS with 14.9%. Thus, in view of the statistical data on the predominance of Android system usage, the use of the *Google Play Store* platform is justified for this research.

The *Google Play Store* search took place in December 2019, with the purpose of mapping and categorizing all applications aimed at children with ASD. The initial proposal was to conduct a survey based on the analysis of applications for autistic children available on the platform. The research was conducted in three stages, described below.

Stage 1: Identification of all applications for autistic children

To refine the search, the keyword *"Autism"* was used under *"Applications"*, a function available on *Google Play* virtual store site search engine**.** It is worth mentioning that the term *"Autism Spectrum Disorder"* was also used, but the result was the same as when using the single keyword *"Autism"*.

After applying an initial filter aimed at searching applications that had been extensively installed, it was established that of the 249 applications available on the *Google Play Store* platform, only 193 had more than five thousand installations.

The increase in the number of ASD cases, explicit in the statistical data performed by renowned institutions identified in the body of this study, coupled withthe verification of the 249 mobile applications supporting ASD individuals available on the *Google Play Store*, can configure a possible correlation between the growth in the number of cases of the disorder and the use of applications specifically aimed at ASD thus showing a possible demand for these tools in supporting individuals with ASD.

A previous search conducted in November 2019 on the *Google Play Store* platform, aimedate stablishing a quantitative visualization of mobile applications for children with ASD, identified 235 available applications. This data shows that there has been an increase in the availability of these applications, since the same search, when conducted in December 2019, identified249 applications.

During the present research, it was observed that applications are randomly arranged on the platform, making it difficult for users to understand the functions

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and features of selected individual tools in advance. Searching for the most appropriate application ina specific area in which an autistic child may need support is also more challenging given the random arrangement of applications.

Mobile applications developed specifically for autistic children, provide parents and professionals who work with these children the possibility to be users, and to further create opportunities that help these individuals become more independent in their choices. This makes the use of mobile applications for autistic children an interesting field of study.

Of the 249 applications available on *Google Play Store*, the 193 most installed were identified, and individually analyzed and classified according to inclusion and exclusion criteria, as described in the table below.

Table 1 - Inclusion and Exclusion Criteria

Inclusion	Exclusion
-specific applications for autistic children; -applications in Portuguese; -applications for children up to 8 years old.	-duplicated applications; -applications without relevant research correlations.

Source: Elaborated by the researcher (2020)

Following the analysis of each of the 193 most installed applications, 44 mobile applications in Portuguese, specifically for autistic children up to eight years old, were identified.

Stage 2: Mapping and categorization of the 10 most installed applications

In this second phase, the 10 most installed applications were selected, including how they are identified and their main characteristics. The categorization took into account factors such as: application use, number of installations, cost and recognized awards**.** Thus, of the 44 applications identified in the previous step, 10 were selected according to the following criteria: 1) application area: Informative or Educational; 2) greater number of installations.

"Educational" applications are aimed at instruction, such as teaching reading and writing. "Informative" applications consist of several games with the objective of developing the cognitive functions of autistic children, thus meeting a greater variety of user interests.

Therefore, the 10 most installed applications were selected because they are available on the *Google Play Store* platform, under “Informative" and "Educational" applications and are then categorized and presented in “Table2” (Appendix I).

The application area (classification used in this search, to identify the field of each application), appears when clicking on the selectedapplication on the*Google Play Store* platform. There isno clear specification if this information is made available by the system itself or if it is one of the options provided bythe product developer. In a subsequent search, two of the 10 applications arranged in “Table 2” were analyzed in more detail regarding their purpose, functionalities and benefits, as described in stage 3, below.

Stage 3: Analysis of the functionalities and benefits of the two selected applications

In this phase, functionalities and benefits of the two selected applications were analyzed, based on the previous selection of the 10 applications shown in “Table 2”. The two selected applications were studied in more detail, in order to identify their purpose, functionalities and benefits.

For an even more detailed approach with regard to the purpose, functionalities and benefits of mobile applications for children with ASD, the following criteria were established as guidelines for the selection and analysis of the applications:

i. Cost; ii. Applications previously awarded by recognized institutions.

Regarding the "cost" criterion, only 3 applications were found to be free of charge. Although the PictoTEA application presented more than 50,000 installations and is free of charge, it was not considered as a reference in this research. It has received no awards and does not specify the methodology, if any, it uses in the treatment of autistic children. In this sense, the applications *"ABC Autism"* and *"Jade Autism"*, have a high number of facilities, are free, and can be used more independently by the child, because they are based on the TEACCH and ABA method that do not induce error.

In the second criterion, “awards" received in national events that are globally recognized, only two applications stood out: *"ABC Autism*" and *"Jade Autism"*. Therefore, among the 10 applications with the highest number of installations selected, as per “Table 2”, only the two applications mentioned met all the criteria of items "i" and "ii" described above.

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The following is an analysis of the purpose, functionalities, and benefits of the two selected applications. It should be noted that the selected mobile applications cover fields such as: reading, writing, memory, logical reasoning, motor coordination, temporal and spatial aspects, emotions, among others.

ABC Autism" Application

"ABC Autism" was created by Wellison Souza and Ezequiel Batista, students at the Information Systems College of the Federal Institute of Alagoas (IFAL). Before becoming available to the public, the application was tested by the Association of Autism Friends (AMA) of Alagoas. It can be downloaded free of charge in Portuguese and English on smartphones and tablets; it has an Android operating system and is available on *Google Play Store*.

It should be noted that the "*ABC Autism"* application was developed based on the principles of the Treatment and Education for Autism and Children with Communication Deficits (TEACCH) program, a system developed by Eric Schopplerat the University of North Carolina (USA) in 1964.

The application won first place in the "product creation" category in the Apps.edu contest, held during the Brazilian Congress of Information Technology in Education (CBIE, 2015), in Maceió-AL. The *"ABC Autism"* is a software created by technology professionals in cooperation with professionals who work with autistic individuals.

ABC Autism: Purposes

*"ABC Autism"*is an application that aims to facilitate the development of reading and writing skills in autistic children based on behavioral psychology and psycholinguistic approaches**.**

The application was tested through a study conducted with 21 autistic children and results were analyzed to validate its effectiveness. Autistic children were organized into two groups. The first group was composed of autistic children with verbal language, which are usually at a more advanced cognitive level. The second group was composed of autistic children who did not present verbal language and who were in the initial levels of treatment.

According to Farias (et al., 2014, p. 468), the results of the *"ABC Autism "application* with autistic children from AMA-Alagoas, were promising. The authors stated that "the results obtained are encouraging. All of the application's functionalities, as well as the process of creating original screen models and subsequent design of the elements used in the interface, were fundamental for wide-spread acceptance by children who used the application". An application with the potential to establish an automatic process that is already internalized by children represents a significant differential for intervention and treatment. In the future, it mayprovide statistical information that can be more effectively used to monitor achild's development and possibly facilitate diagnosis of the degree of cognitive impairment of the child within the TEACCH dynamic. Subsequently, additional benefits from the use of *"ABC Autism"* could emerge.

Therefore, the application's functions that lead to improved literacy are represented in the complexity of each phase and its varying levels, which support the autistic child's cognitive development through individually tailored learning. In this study, it was concluded that the tool can support the treatment of autistic children, especially with regard to reading and writing skills. Furthermore, this tool provides teachers and therapists with a time saving resource in elaborating materials or tasks for the optimal learning of these individuals (Farias; Silva; Cunha, 2014).

The application has been tried with several specific activities directed at autistic children making it possible to replace adaptive tasks teachers needs to prepare, thus allowing professionalsto dedicate more timeto the individual child.

ABC Autism: Features and Benefits

By using the application, children with ASD come into contact with a visually organized structure in order to work on concrete skills activities more effectively, using simple figures (Farias; Silva; Cunha, 2014).

The application has four levels of difficulty. The application allows children to make letters and syllables,and convert figures and geometric shapes from levels one to four. In addition, the application helps in learning word formation and in identifying vowels and letters in the alphabet.

The*"ABC Autism"* application also offers a clean and unencumbered interface to prevent distraction by autistic users. As the application itself states, "the elements used in the storage area, aside from being simple, contain only one representation to favor the transportation of stimuli" (Farias; Silva; Cunha, 2014).

In order to respond to challenges found in the application, elements are arranged with few options as far as variety of size, favoring a correct response. This application layout is organized so as to optimize the therapist's job; the child's

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performance is enhanced while simultaneously avoiding their possible frustration with behavioral disorganization. In addition, the tool initially presents, large drawings and areas which are graduallyreduced, according to the child's progress in facing the challenges proposed in the application.

The application's functionalities are based on the TEACCH method (Treatment and Education for Autistic People and Children with Communication Deficits), therefore, all levels of activity follow this methodology. *"ABC Autism"* presents 40interactive phases, distributed in four different levels of difficulty. Its phases are composed of tasks in which of figures are relocated from an area called *Storage Area* (left half of the screen), to the *Execution Area* (right half of the screen).

The methodology presents specific elements, such as: increasing levels of difficulty; differentiation between size, shape and color of represented objects; randomized position of elements on the screen; use of letters; learning without error, so that the child can only advance levels by dragging the answer to the correct option. In addition, the application allows the user to visualize the concrete object by dragging figures of diverse shapes and sizes on the screen, an essential technique in intervention activities with autistic children (Farias; Silva; Cunha, 2014).

Thus, the child is stimulated in several ways, from the recognition of shapes and colors to motor skills coordination. Children come into contact with the objects in a conventional way according to the TEACCH program methodology; the application is only used in addition to intervention procedures already in use with autistic children (Farias; Silva; Cunha, 2014).

Jade Autism" Application

The application *"Jade Autism"* was created by Ronaldo Cohin, a Computer Science student atthe University of Vila Velha, who has an autistic child. The project was developed with the purpose of helping his son and other children diagnosed with ASD in their cognitive development.

Cohin conceived *"Jade Autism"* after searching for quality applications for parents of autistic children and failing to find anythat specifically and satisfactorily were aimed at the challenges faced by his six-year old son, Lucas. *"Jade Autism"* is a game that can record behavioral data of autistic children to efficiently assist in their treatment. From the onset, Cohin collaborated with therapists and professionals specializing in Autism Spectrum Disorder (ASD) from the Association of Parents and Friends of the Exceptionals of the Holy Spirit (APAE-ES).

The application won the Mobile Campus Award (2019), a program conducted by the NET Claro Embratel Institute in conjunction with the University of São Paulo (USP), which aims to identify and stimulate the development of university talent who work in content creation and innovation in mobile telephony services. In addition to a financial award, the creators of *"Jade Autism"* won a trip to Silicon Valley (United States), to participate in a full immersion workshop atGoogle, Facebook, Twitter, and Stanford University in order to further improve the application. Recently, the application received an award from Tele. Synthesis Yearbook of Innovation in Communications (2020), in the "Application Developers" category. The award seeks to encourage innovative projects with a total of twenty awards given out in seven different categories: Communication Service Providers, Regional Operators, Product Providers, Software and Service Providers, Apps and Content Developers, and the Tecnologia Nacional e Soluçõesem IoT.

"Jade Autism" has been implemented in the 42 APAEs of the State of Espírito Santo, Brazil and is in the process of being implemented in APAEs of other states throughout the country. Cohin reports on the *"Jade Autism"* website that the application sparked the interest of the English government: "we participated in an event in Florianopolis organized by the government of England, which after learning of the application contacted us directly. We were in Florianopolis for 10 days holding meetings and presenting the project after which time we were invited to implement the project in England where it will be used in the public health sector. We are working towards making the application standard use by autistic children in England". This year (2020), the application was selected to be implemented in the region of Abu Dhabi (United Arab Emirates), by a group of technology companies called HUB 71 founded in 1971, and whose main objective is to foster development and investment in the field of technological innovation.

Jade Autism: Purposes

The *"Jade Autism"* application was designed to help the cognitive development of autistic children, and is based on association games of colors, numbers, letters, animals, and objects, which are part of a child's everyday life. Thus, the application aims to stimulate the child's cognitive development in order to improve his/ herpotential and work on the weaknesses inherent to the disorder. The application is also available in English.

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Jade Autism: Features and Benefits

Considering that the *"Jade Autism"* application is based on association games of colors, numbers, letters, animals, and objects, which are part of the child's everyday life, one of its main features is that it generates reports that reveal the child's performance when playing. The data from the reports are clearly presented and can help therapists improve their approach to autistic children.

The application has no advertisements and does not allow external grouping, therefore no third-party contact can be made with the child from outside the application. The functionalities of *"Jade Autism"* are based on algorithms that analyze a child's behavior during play. Therefore, the application evaluates the autistic child's reaction to a certain action, for example, the time it takes to click and start the different phases. With this, the game generates follow-up reports of the child's abilities, according to the text published in the *Folha Vitória Newspaper*.

The *"Jade Autism"* model was based on the Applied Behavior Analysis (ABA) methodology, which helps to increase the ASD child's behavioral repertoire. Through a discrete series of individual attempts, the application follows a gradual order from simple to complex, enabling the user to develop relations of identity, linking stimuli and learning.

There are four available navigation options on the application's main screen:

- Play - which opens available game options on the screen;

- Results - which allows access to performance reports;

- About the App - which contains information about the application's specifications, and

- Contact - which provides the user with support information for proper use of the application.

The application has more than 732 exercises in game format. There are several thematic fields, divided into categories, which can promote learning and fun for autistic children. The application also offers the opportunity to work on pairing and separating objects. This game expands the child's knowledge and vocabulary on issues of daily life, since objects are grouped in a simple way allowing the child to connect, for example, animals to their food. This type of activity allows the user to classify and categorize food, a fundamental step for the child's sensory-motor development.

Therefore, to use the application, the user must first select one of the available options at the top of the screen, click on the icon, then look for the corresponding image in the available options, clicking again to perform the action. The application's layout is built to allow activities to be performed easily and intuitively. In this context, the *"Jade Autism"* application can be considered as a game with therapeutic validation which presents important features and benefits.

Aside from the specific benefits for a child's cognitive development, the application *"Jade Autism"* has the *"Results"*option, which helps the therapist determine intervention approaches. At the end of each game there is the option of sending reports detailing the child's performance in the respective activity.

This feature aids the therapist and those working with autistic children by allowing them to observe the number of errors and hits in each category the child has played, as well as the length of time of play, leading to a better understanding of the child's cognitive development.

A brief comparison between the analyzed applications

The following is a brief comparison between the *"ABC Autism"* and *"Jade Autism"* applications, reinforcing that these mobile applications have already been tested on autistic children, and can favor their cognitive development and learning.

Aragão (et al.,2019, p. 55), states that "the use of applications with autistic children can help in the development of motor skills, increasing independence, reducing barriers of interaction with other individuals," corroborating authors Mello & Sganzerla (2013) andFarias & Cunha (2015). Thus, such applications can help autistic children to better express themselves, providing gains and abilities weakened by the disorder.

In order to better visualize the purposes, functionalities and benefits of the selected mobile applications, "Table 3" presents a comparative analysis of the applications. The comparison serves to highlight the most important items to be considered when selecting the most appropriate application according to the area of weakness caused by ASD, therefore allowing the reader to more efficiently apply the tool to a child's specific needs.

Table 3 - Comparative Summary of "ABC Autism" and "Jade Autism" Applications

Categories	ABC Autism	JADE Autism
Purposes	Facilitate learning of autistic children in their reading and writing process.	Stimulate the child's cognitive development, tracking its development.

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Features	- has a storage and a response area (error-free learning); - the storage area contains a single representation; - few elements arranged in the response area, with variety of size;	- allows capturing data on children's behavior; - based on association games of color, numbers, letters, animals and objects, which are part of the child's everyday life;
	- begins with large areas, which decrease as the child succeeds in the task; - distinguish and list elements in the execution of the activities; - offers a greater number of stimuli as the child changes levels in the application; - image pairing activities, with combination of sound x element, image x image, action x image, letter x letter, number x number; - activitiesfocusedonliteracy;	- generates reports that reveal the child's performance when playing; - has algorithms that analyze how the child behaves during play; - arranges objects in a simple way, so that the child connects, for example, animals to their food; - the application is a game with therapeutic validation;

Benefits	- prevents the child from advancing if you drag the answer to the wrong option or invalid field; - facilitates the therapist's work, as it avoids possible frustration and consequent mental disorganization of the child; - provides contact with the concrete object by means of the figures dragged on the screen that are presented in the most diverse shapes and sizes. - based on the TEACCH model; - favors motor coordination and visual and motor perception; - increase of challenges, benefiting the cognitive development of the child; - allows the distinction of colors, shapes and sizes of the elements, and the relationship between them; - Provides greater cognitive effort in defining criteria for discerning elements among	- helps in the treatment, because it allows the capture of data on the child's behavior during the game; - facilitates the association of the elements of the game with the child's daily life, providing greater motivation and better recognition of these elements; - stimulates cognitive development, memory, reasoning, ability and performance of the child; - based on the ABA methodology; - helps the therapist in the use of more effective techniques, based on the data that are clearly presented by the application; - generates results by analyzing the autistic child's reaction to that action. For example: the time it takes for the child to click and start the phases; - favors the therapist and those who work with autistic children, through the analysis of

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	themselves and in their correct selection. - works sequencing, pairing and logical reasoning; - helps to improve abstraction and symbolism; - promotes the learning of basic literacy skills, word composition and number sequencing.	reports, to observe the number of errors and hits in each category played by the child, the total time of play, allowing better understanding of the child's cognitive development. - works on pairing, distinction of objects, broadens the knowledge and vocabulary of the child with regard to issues of daily life; - allows the user to classify and categorize food, these steps being fundamental for the child's sensory-motor development.

Source: Elaborated by the author (2020)

Thus, according to the layout of "Table 3", parents and professionals working with autistic children can better evaluate the appropriate application by understanding the objectives, functions and benefits of each application. This would further allow them to understand which would better support these children in their development and learning.

As presented, we studied each one of the skills flagged in the specifications of mobile applications contained in the *Google Play Store* site, as well as those that emphasize the development of skills of autistic individuals which are not clearly explained on the site, but are present in the application's functions.

It was also observed that not all applications available on the *Google Play Store* platform display complete specifications, such as the date of creation or even whether it is free of charge or not, and in many cases, the information contained on the site has insufficient details about the cognitive goals to be achieved by autistic children.

V. CONCLUSION

At the end of this research, it was evident that the topic of ASD and mobile applications is broad, and that there is a range of possibilities for future studies in the field. Therefore, there is a clear need to further study, learn, and investigate the subject, which due to its interdisciplinary nature, provides insight into the areas of both education and health creating important links to the available technologies for ASD diagnosis and treatment.

ASD has affected a significant number of children worldwide and the inherent inabilities caused by the disorder create a need for research on how mobile applications and other technologies can contribute to improving the quality of life, learning and development of autistic children.

The methodology used met the main objective of this work, which was to conduct a search on the *Google Play Store* platform, regarding mobile applications for autistic children. Thus, a description of the functionalities of the most frequently installed applications was given, highlighting their purpose and benefits, presented through the preparation of comparative "Table 3", in order to help parents and professionals who work with these children to more efficiently select the most appropriate application for the areas the child needs to work on.

Thus, in accordance with the authors cited in the body of this work, the research proves that mobile applications can support the learning and development of autistic children by helping parents and professionals who work with these children in their daily lives, both in terms of assessment and intervention. In addition, the use of mobile applications can help to improve various skills (logical reasoning, fine and gross motor coordination, auditory perception and visual perception in the exploration of size, colors, shapes), further promoting challenging experiences that support the development and learning of these individuals.

Thus, in order to improve the quality of life of autistic children by helping them become more functional and independent, it is necessary to contemplate new evaluation and intervention alternatives using mobile technology, especially mobile applications.

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VI. APENDIX I

Table 2 - Ranking of the ten most installed applications for autistic users on the Google Play Store platform

Apps	Apps Area	Instalat.	Free	Award
Child'smemory game - Food	Educative Puzzle	1.000.000	No *Paywall**	No
ABC Autism	Educational	100.000.	Yes	1st place in Brazilian Congress of Information Technology in Education, 2015
MITA Language and Cognition Therapy	Educative Puzzle	100.000.	No	No
PictoTEA	Educacional	50.000.	Yes	No
Autism Image Discussion	Educaçional	50.000.	No	No
Jade Autism	Educative	10.000.	Yes	1st place in the Facilities category of the Mobile 2018 Campus Award, an award held at USP in São Paulo and will be taken to implementation in England.
AutApp Autism	Educative	10.000.	No tspecified	No
AutismCPM - Game for children with autism	Educative	10.000.	No tspecified	No
Auts	Educative	10.000.	No tspecified	No
Learning from Biel and his Friends	Educative	10.000.	No	No

Source: Elaborated by the researcher (2020)

REFERENCES

[1] Alda, L. S.; Leffa, V. J. Entre a carência e a profusão: aprendizagem de línguas mediada por telefone celular. Conexão – Comunicação e Cultura (UCS), v. 13, p. 75-97, 2014.

[2] Aragão, M. C. M.; Bottentuit, J. B. J.; Zaqueu, L. C. C. O uso de aplicativos para auxiliar no desenvolvimento de crianças com transtorno do espectro autista. Olhares&Trilhas. Uberlândia, vol.21, n. 1. Jan/abril, 2019 - ISSN 1983-3857, p. 44-58.

[3] Antunes, C. Jogos para estimulação das múltiplasinteligências. 12ª ed. Petrópoles: Vozes, 1998.

[4] Barbosa, H.F.A.; Castro, A.A.V.C.E. Análise do recurso a novas tecnologias no ensino de autistas. Engenharia Informática. Instituto Politécnico do Porto. Instituto Superior de Engenharia do Porto., Portugal, 2009. Disponível em: https://bit.ly/2DbpBCm . Acesso em: 17 de jul. 2019.

[5] Caminha, V.L.P.S.; Huguenin, J.; Assis, L.M.; Alves, P.P. Autismo: vivências e caminhos. São Paulo: Blucher, 2016.

https://dx.doi.org/10.22161/ijaers.79.55 *ISSN: 2349-6495(P) | 2456-1908(O)*

[6] Cybis, W.; Betiol, A. H.; Faust, R. Ergonomia e Usabilidade: conhecimentos, métodos e aplicações. São Paulo: Novatec, 2007.
[7] Cunha, Eugênio. Autismo e Inclusão: psicopedagogia e práticas educativas na escola e na família. Rio de Janeiro: WakEditora, 2012.
[8] Farias, E. B.; Cunha, M. X. C.; Souza, J. W. S. ABC Autismo? Um a Aplicação Mobile para Auxiliar no Processo Alfabetizador de Crianças com Autismo. In: IV Congresso Brasileiro de Informática na Educação, 2015, Maceió. Anais dos Workshops do IV Congresso Brasileiro de Informática na Educação (CBIE 2015), 2015.
[9] Gil, A. C. Como elaborar projetos de pesquisa. São Paulo: Atlas, 2002.
[10] Google Play Store. Aplicativo para o sistema operacional Android. Disponível em:https://play.google.com/store/search?q=autismo&c=apps &price=1. Acessoem 05/10/2019.
[11] Instituto Brasileiro de Geografia e Estatística – IBGE. Projeção da população do Brasil e das Unidades da Federação. 2016. Acesso em 20.08.2019. Disponível em: http://www.ibge.gov.br/apps/populacao/projecao/
[12] Instituto Federal de Alagoas (IFAL). https://www2.ifal.edu.br/noticias/aplicativo-abc-autismo-conquista-1o-lugar-em-congresso-brasileiro-de-informatica-na-educacao Acesso em 05.08.2019.
[13] International Data Corporation – IDC. Smartphone os market share. 2018. Disponível em: http://www.idc.com/prodserv/smartphone-os-mar- ket-share.jsp. Acesso em: 20.08.2019.
[14] Jade Autismo. Disponível em https://jadeautism.com/quem-somos/ Acesso em 05.08.2019.
[15] Kauark, F. S.; Manhães, F. C.; Medeiros, C. H. Metodologia da pesquisa: um guia prático. Itabuna: Via Litterarum, 2010.
[16] Lucian, B. O.; Stumpf, A. Análise de aplicativos destinados ao aprendizado de crianças com transtorno do espectro autista. Design e Tecnologia, v. 9, n. 19, p. 43-65, 30 dez. 2019.
[17] Manual Diagnóstico e Estatístico de Transtornos Mentais: DSM-5 / [American PsychiatricAssociation, tradução Maria Inês Corrêa Nascimento ... et al.]; revisão técnica: Aristides VolpatoCordioli... [et al.]. - . e . Porto Alegre: Artmed, 2014. xliv, 948 p.; 25 cm.
[18] Mello, C. M. C.; Sganzerla, Maria Adelina Raupp. Proposta de aplicativo Android para auxiliar no desenvolvimento matemático de pessoas com autismo. In: VI Congresso Internacional de Ensino da Matemática, 2013, Canoas. VI Congresso Internacional de Ensino da Matemática, 2013.
[19] Ministério da Saúde. Cartilha Autismo: orientação para os pais. Casa do Autista - Brasília, 2000.
[20] Organização Mundial de Saúde - OMS. Classificação de Transtornos Mentais e de Comportamento – CID-10 (versão em português da sigla ICD, do inglês International Statistical Classification of Diseases and Related Health Problems); Porto Alegre: ArtMed, 1993.
[21] Organização das Nações Unidas – ONU. News de Nova Yorque, 2017. Disponível em: https://news.un.org/pt/story/2017/04/1581881-oms-afirma-que-autismo-afeta-uma-em-cada-160-criancas-no-mundo. Acessoem: 29.07.2019
[22] Orrú, Sílvia Ester. Aprendizes com autismo: aprendizagem por eixo de interesses em espaços não excludentes. Petrópolis, RJ: Vozes, 2016.
[23] Pereira, N. M.; Vieira, N. J. O Transtorno do Espectro Autista e a Utilização de Aplicativos para Dispositivos Móveis como Ferramenta Educacional. Revista P@rtes. ISSN 1678-8419. Disponível em: https://www.partes.com.br/2020/01/29/o-transtorno-do-espectro-autista-e-a-utilizacao-de-aplicativos-para-dispositivos-moveis-como-ferramenta-educacional/ Acesso em 25/05/2020.
[24] Redação Folha de Vitória-ES. https://folhavitoria.com.br/geral/noticia/09/2019/aplicativo-criado-por-capixaba-sera-implementado-na-inglaterra-jogo-ajuda-criancas-autistas Acesso em 16/09/2019.