

Mr. Pizza: An Educational Game for Inclusion of Children with Autism Spectrum Disorder

Lucas Gomes Pereira¹, Matheus Santiago França¹, Victor Helfstein Piccoli¹, Willi Takeshi Rodriguez¹, Maria Amelia Eliseo¹

¹Mackenzie Presbyterian University

{lucasgomesp22, francamatheus97, victorhelfstein178, willitakeshi}@gmail.com

mariaamelia.eliseo@mackenzie.br

Abstract. Digital games have been widely explored in our daily lives, not only as recreational use, but also as learning resources, thus shaping education using technology, far beyond just entertainment. The present work aimed to study and analyze accessibility guidelines to create a digital and educational game to help developing the social and cognitive skills of children between 6 and 9 years old with Autism Spectrum Disorder. In this context, a game called Mr. Pizza was developed, based on ABA (Applied Behavior Analysis) therapy with health professionals, who gave suggestions for improvements.

Keywords: Autism, Games, Education

1 Introduction

Play is fundamental to child development. In addition to being something geared towards entertainment and leisure, it provides children with unique moments, where they encounter challenges of interaction with the world, granting clarity that it is full of opportunities and challenges, aiding learning and improving cognitive abilities. Digital games, which in the past were considered only hobbies, today can be used as educational objectives, enabling the development of cognitive skills [1]. Regarding the cybernetic interaction provided by technologies for children with Autism Spectrum Disorder (ASD), they point out significant transformations in the areas: cognitive, affective, emotional and in communication.

Autism Spectrum Disorder (ASD) encompasses different categories for classification, according to the individual's need for help or degree of independence. ASD is divided into five categories: Asperger's Syndrome, Invasive Development Disorder, Autistic Disorder, Rett Syndrome and Childhood Disintegrative Disorder, each category has its peculiarity, but the symptoms related to the difficulty of communication due to language deficiency and in the use of imagination to deal with symbolic games, difficulty in socializing and a pattern of restrictive behavior are very

similar, varying only in the degree: mild (level 1), moderate (level 2) and severe (level 3) [2].

Very little is thought about the concepts of accessibility during the development of digital games in the educational setting, which impairs the accessibility of people who have special needs diagnosed with ASD, thus creating a negative experience and compromising learning. This paper aims to study and analyze accessibility in games aimed at learning, in order to provide guidelines for the construction of educational games for children with ASD. To validate the studied guidelines, the game “Mr. Pizza” was implemented. Mr. Pizza's purpose is to help developing the cognitive and communicative skills of children with ASD, through simple activities such as choosing the ingredients they like and organizing the ingredients in the order of making a pizza.

People with this diagnosis are sometimes rejected, according to the United Nations secretary-general, Ban Ki-moon [3]. This rejection is a huge waste of potential, as many of these people have many talents, whether visual, artistic or academic, showing that the inclusion of these children is something that should start to be done by institutions, helping them to use their talents during life.

Institutions and developers of digital educational games, be it web, mobile, videogame, among others, create their applications without thinking about all possible users and without giving much attention to children with autism. Thus, this paper aims to show the possibility of creating accessible and educational games for children diagnosed with ASD.

This paper is organized into five sections. In addition to this introduction, section 2 presents concepts about ASD and educational games. Section 3 presents the methodology and guidelines used in the implementation of Mr. Pizza. Section 4 presents the results obtained after implementation. Section 5 presents the limitations of the study and possible future work.

2 Theoretical background

In this section, subjects about the characteristics of Autism Spectrum Disorder (ASD) and their severity levels will be addressed. Accessibility concepts will be shown, in addition to presenting specific correlated works for ASD.

2.1 Autism Spectrum Disorder (ASD)

Autism Spectrum Disorder is a neurodevelopmental disorder that has been present since childhood, with a deficit in the socio-communicative and behavioral dimensions [4]. The so-called “spectrum” refers to a series of symptoms that can be identified, which include difficulties in social interaction, communication, repetitive behaviors and for showing interests in some restricted subjects, also being able to present a degree of sensory sensitivity [5].

According to [6], "the current use of the Autism Spectrum Disorder nomenclature makes it possible to cover different levels of the disorder, classifying them as mild, moderate and severe". Therefore, we cannot match a patient with ASD, seeing that

they are different subjects, with different degrees of intellectuality. Deficits manifestations: Communication and Language - absence or delay in the development of oral language; Social interaction - lack of reciprocity, difficulty in socializing and the difficulty of contact with others; Behavioral - establish a routine, repetitive movements.

Autism Spectrum Disorder is not sequenced, as there is no standard that can be followed to point out some symptoms related to autism. Identifying a patient with autism is complicated, since the manifestations of deficits can be clear or not, varying only in the severity level. Symptoms do not usually appear equally for patients diagnosed with ASD, that is, each diagnosis is private, no subject is the same.

Autism Spectrum Disorder is categorized into three levels of severity, according to [2]:

- Level 1 - “Demanding support”: as for social communication, there is a severe deficit in verbal and non-verbal social skills; great limitation in initiating social interactions and minimal response to social openings that come from others; inflexibility of behavior; extreme difficulty in dealing with change and restricted / repetitive behaviors that interfere with functioning in all spheres; great suffering / difficulty to change the focus or actions.

- Level 2 - “Demanding substantial support”: in relation to social communication, it presents a serious deficit in verbal and non-verbal social skills; apparent social damage even in the presence of support; limitation in initiating social interactions and reduced or abnormal response to social openings that come from others; inflexibility of behavior; difficulty dealing with change or other restricted / repetitive behaviors appear often enough to be obvious to the observer; suffering / difficulty to change focus or actions.

- Level 3 - “Demanding very substantial support”: in the absence of support, deficits in the media bring notable losses; difficulty in initiating social interactions and atypical or unsuccessful responses to the social openings of others; it may appear to have reduced interest in social interactions; inflexibility of behavior causes interference with functioning in one or more contexts; difficulty in changing activities; problems with organization and planning are obstacles to independence.

Some therapies help people with ASD, such as ABA (Applied Behavior Analysis) therapy used in Brazil to treat children with ASD diagnosis. ABA applies behavioral principles, to everyday situations, that will, over time, increase or decrease targeted behaviors to help individuals acquire different skills, such as language skills, self-help skills, and play skills [7].

2.2 Accessibility

Unlike other technologies, digital games provide a high level of player engagement with the world, the immersion experience is much more complete and requires a greater level of interaction. This is not only a result of the evolution of consoles, hardware resources, image and sound, but also by the increase in connectivity and form of interaction between geographically distant users, where solo games give way to those of multiplayer, points out [8].

Even so, digital games collaborate with the development of several types of important skills, although not always planned to serve this purpose. In accordance with [8], through them it is possible to develop the necessary mental structures so that it is possible to adapt and use new technologies that accompany an individual's life, not only forming a sociocultural space, but also allowing socialization between different ages, ethnicity, gender and economic situation. In the view of [9], the main challenge is how to design truly inclusive digital games that promote inviting gameplay experiences, without technological barriers that inhibit or prevent the interaction and consumption of potential players.

Thus, research to promote accessibility points out basic principles and guidelines for the standardization of accessible content, such as the well-known structure proposed by [8]. In addition, there are WCAG 2.0 recommendations (accessibility guidelines for web content) [10], and the current version of the document, WCAG 2.1 [11].

For the web to be usable by any type of user, it is necessary to comply with four necessary principles that establish content accessible by anyone [11]:

- **Perceivable:** users must be able to perceive information presented.
- **Operable:** the interface must provide full user operation.
- **Understandable:** both operation and interface information presented must be understandable.
- **Robust:** content must be accessible as new technologies emerge.

An accessible browsing experience is not only the responsibility of applying content based on the accessibility guidelines, as there are also other components involved in the use of the web that relate in a compatible and joint way, points out [11]. Therefore, the relationship between:

- Content: information (text, images, sounds) through a presentation (code or markup)
 - User agents: web browsers and media players
 - Assistive technologies: screen readers, alternative keyboards, scanning applications, etc.
 - Users: users
 - Developers: designers, programmers, etc.
 - Authoring tools: website creation tools
 - Evaluation tools: HTML, CSS validators, etc.

In fact, insufficient accessibility in one component cannot reasonably be overcome by other components and the result is inaccessibility, making it impossible for some people with disabilities to use a website, page or resource [11]. Thus, it is necessary to establish a specific condition, equal to all available interactions, without restrictions and ensuring the same opportunities for consumption, socialization and entertainment [9].

In this sense, the initiatives that promote accessibility are costly efforts to implement and validate the successful integration of the recommendations represented in the restricted literature on accessibility in games, while new technologies are emerging. Despite the consideration of the market as a prospect of implementation feasibility, approaches that include educational initiatives aimed at learning from a playful approach provided by games are not excluded [9].

2.3 Related works

As related work, Doctor Tea stands out, which is a game developed by Fundación Orange [12] that aims to facilitate medical visits by people with Autism Spectrum Disorder (ASD), providing information to patients about the most common medical practices for who can understand and anticipate them, in addition to providing doctors with information about the characteristics of these patients and practical advice for families, as well as many other features to assist them in visits. As a result, daily clinical practice demonstrates that, when there has been prior anticipation, specific training, systematic desensitization or simple habituation to the procedures, the patient's anxiety decreases considerably before, during and after medical consultations.

The Brainy Mouse game, available on Android and iOS platforms, was made aiming at the literacy of children with ASD and attention deficit [13]. The game works with reading from left to right; word formation using syllables; interaction with colors; sounds and other “cognitive devices”, which help the user to work on their development in a playful way. In a very interactive way, the child can customize his mouse. In addition to being challenged to get “cheesecoin”, a kind of virtual currency.

Another related work is Happy Geese, a special version of a board game [14]. The idea and usefulness of this game is to enhance the digital leisure of children with special needs, helping to improve different skills such as learning the vowels, number, shapes and colors. For this, it has data without numbers, four adaptable trays and, above all, an intuitive and easy to use interface. The game was applied to three children at a specialized ASD clinic in São Paulo, Brazil, who were entertained, as well as learned colors and vowels, repeating as the game taught.

A literature review that analyzes the relationship between the development of skills inherent to emotional intelligence, and its usefulness in the improvement of treatments for ASD, using human computer interaction is shown in [15]. They highlighted the needs of new alternatives of digital applications that be adequate and easily adaptable to a variety of characteristics of children with ASD in order to improve their emotional and social conditions.

Like the three first games presented in this section, Mr. Pizza is a game aimed at children with ASD in order to help them in communication and organization by choosing the ingredients they like and organizing them in the order of making a pizza. Mr. Pizza was developed based on accessibility guidelines to serve children with ASD.

3 Development methodology

For the development of this research, theoretical studies on ASD were carried out to identify children's needs with this disorder. Accessibility guidelines for the development of games for children with ASD were studied and then a prototype of the accessible game was developed for this target audience.

The game was developed for children aged 6 to 9 years with ASD Level 1 Severity, where the diagnosed person has difficulty changing activities, problems related to organization and planning, difficulty initiating social interactions and

reduced interest in social interactions [2]. To play, it is necessary that the child has verbal communication skills to understand the dialogues and dynamics of the game, as well as preserved intelligence in relation to visual working memory. Once the profile of children with ASD was identified, the necessary requirements for the implementation of an accessible game that meets the needs of this public were gathered. Table 1 shows the accessibility guidelines used in the development of Mr. Pizza, based on [8] and [10].

Table 1. Accessibility guidelines for children with ASD based on [8] and [10].

Guidelines	Description
Compatible	Maximize compatibility with current and future user agents, including assistive technologies
Alternative texts	Provide alternative texts for any non-text content so that it can be changed in other ways that people need (speech synthesis, symbols, among others)
Time-based media	Provide alternatives to time-based media (pre-recorded audio or video) such as subtitles, audio description or other alternative media
Adaptable	Create content that can be presented in different ways (simpler layout, for example) without losing information or structure
Distinguishable	Make it easier for users to see and hear content, including separating foreground from background
Keyboard accessibility	Make all features available and operable using a keyboard
Enough time	Provide users with sufficient time to read and use the content
Seizures and physical reactions	Do not design the content in a way that is known to cause epileptic seizures
Navigable	Provide ways to help users navigate, find content and determine where they are
Configurable	Allow the player to adjust, simplify and save controls for the game
Input modes	Allow users to operate with multiple inputs in addition to the keyboard
Readable	Make content readable and understandable
Predictable	Make pages appear and operate in predictable ways
Insert assistance'	Help users avoid and correct mistakes and errors
Documentation	Provide accessible documentation in multiple formats
Learning and challenge	Provide training modes and manual challenge level adjustment

For the design of the game, the setting of a pizzeria was chosen, in order to establish communication with the child using commonly consumed products, approaching the whole process of creating a pizza. Thus, the main purpose of the game is to explore and develop some aspects such as the ability to interact, memorize, the ability to listen, understand and execute a command, as well as stimulate planning and organization.

Unity, a development platform for the creation of multiplatform games in 2D and 3D and interactive experiences, was used to implement the game. Regarding the execution of the game, the following minimum requirements are necessary:

- Operating system: Windows 7 SP1+, macOS 10.12+, Ubuntu 16.04+

- Graphics card with DX10 features (shader model 4.0).
- CPU: support for SSE2 instruction set.
- WebGL: any recent version of Firefox, Chrome, Edge or Safari.

4 Discussion and Results

Based on the studied accessibility guidelines and ABA therapy, was developed the game “Mr. Pizza” with the intention to improve social skills, interaction and memorization, as well as stimulate the planning and organization of children with ASD. On the game's home screen, users can start the game by clicking on the Play button. They can see the tutorial and the game's credits. The user can also enable or disable the game's background music and the monitoring of game texts via audio by clicking on the respective icon.



Fig. 1. Ingredients Selection Screen.

When starting the game, the Ingredients Selection screen appears (Fig. 1) showing to users some ingredients options for assembling the pizza. This screen allows to select the favorite ingredients, respecting the following rule: it is necessary to select at least 2 ingredients out of 8 possible, except for pasta and sauce, which are essential and mandatory.

After choosing the ingredients, the user moves to the next screen “Assembly Order” to check the order of ingredients previously selected in which the pizza will be assembled and their respective quantities. On this screen, the player must memorize the sequence for assembling the pizza that will be made on the next screen.

Then, users interact with their favorite ingredients and their respective quantities to assemble the pizza. The assembly must respect the order of the ingredients selected in the previous screen (Fig. 2). After assembling the pizza respecting the correct order of ingredients and quantities, the user returns to the previous screen that will show a new sequence of ingredients and will add another unit of ingredient at random, challenging the child's memory, who must assemble a new pizza following the new order. The game ends when the quantity of each ingredient selected by the child is equal to 10 or when the child forgets the assembly order. At the end, the final screen shows player's name and his game rating are stored.



Fig. 2. Assemble the Pizza screen.

Based on the 16 accessibility guidelines, basic goals for implementing accessibility, presented in Table 1 of section 3, some were used in the game “Mr. Pizza”, among them we have the Alternative Text guideline that aims to provide textual alternatives for all non-text content (ASCII art that consists of a character pattern), emoticons, leetspeak (which uses character substitution) and images that represent text) in a way that can be changed to different forms such as speech or symbols.

Still based on the guidelines, the Time-based media guidelines were applied: Subtitles (pre-recorded) and Descriptive Subtitles (pre-recorded), these subtitles are used for spoken content (speech, narration) and for audio content (sound effects, description of music type in animations), both can be enabled or disabled.

When creating the screen layout, concepts from the Adaptive guideline were used, which is based on the creation of content and interfaces that can be presented in different ways without losing essential application information, making the layout simpler and with just the necessary buttons of action and with the look of the pizzeria

organized. Some graphic elements were used to improve the visual structure of the application, such as pointers and marks (change in the size of the pointer, even if it impairs the graphic resolution a little), and the reduction of details in order to decrease some elements and actions that take the focus off the main goal user.

Regarding time, the Sufficient Time guideline assumes to provide players with enough time to read, understand, use the contents and features that have been implemented. Thus, due to the characteristics of the game and the target audience, it is desirable do not use time limitation, as the interpretation and response time of the user may vary according to the degree of ASD. Related to the game language, the Legible guideline was implemented to make the information clearer and easier to be interpreted and understood by the user. Simple language was used, where all textual content was written in a simple, objective and succinct language (limiting phrases up to 50 characters). Still related to language, it is worth mentioning the implementation of a mechanism to explain the meaning of complicated or unusual words, this also serves for abbreviations and acronyms.

To help users avoid some errors and correct mistakes, the Assistance guideline has been implemented. Help in the application must be available to be called at any time to assist the player with instructions, reminders or tips on how to go through a challenge. Still thinking about the auxiliary part, it is desirable to create a step by step to configure the game controls, letting the user customize the settings so that it is appropriate and more comfortable, thus facilitating and increasing the immersion in the game.

Considering the target audience chosen for the development and implementation of the game, some difficulties were encountered. Considering that each diagnosis is different, the guidelines that were implemented in the application had to be thought out and structured to meet all the needs of the public and ensure an adequate playful interaction for cases of ASD, as pointed out [15]. In the development process, it is important to pay attention to the limitations of users and the appropriate accessibility guidelines to build a game that, in addition to meeting the objectives, can promote the social inclusion of children with ASD.

5 Final considerations and future work

After a review of the literature on Autism Spectrum Disorder and the guidelines for accessibility in games, this article resulted in the development of an accessible game for children with ASD, "Mr. Pizza". The game implemented is intended to support the development of communication, memorization, the ability to listen, understand and execute a command, as well as stimulate planning and organization. Educational games prioritize objectivity, visual appeal, the use of a friendly and safe environment, which provides security for the user, promoting a more specific and non-generalized view.

Regarding accessibility, the guidelines for Time-based media, Seizures and physical reactions, Navigable, Configurable, Readable and Predictable were implemented to meet the needs of a child diagnosed with ASD. These guidelines consider the limitations in communicate and expression skills in social environment in

which he lives. In addition to making the mechanics of the game clearer and maintaining the focus on the means of organization and planning.

As future work, we suggest users' tests to verify the usability of the game "Mr. Pizza". In addition, we suggest to improving the mechanics of the game so that the teaching and learning capacity is expanded by studies more in-depth, enabling customization of the application, making the game increasingly adaptable and practical.

This research contributes to studies on accessibility in games, in order to help and facilitate the understanding and application of these guidelines in the construction of accessible digital games. It is intended to strengthen the theme of accessibility in games, understanding that this study and effort stimulate the development of inclusive games.

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