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AUGMENTED REALITY FOR LEARNING CHILDREN WITH ASD

GUADALUPE ESMERALDA RIVERA GARCÍA[1], MIRIAM JANET CERVANTES LÓPEZ[2], JUAN CARLOS RAMÍREZ VÁZQUEZ[1], ARTURO LLANES CASTILLO[2], JAIME CRUZ CASADOS[2]

[1]National Technological of Mexico, Higher Technological Institute of Pánuco, Pánuco, Veracruz
[2]Autonomous University of Tamaulipas, Tampico School of Medicine "Dr. Alberto Romo Caballero", Tampico, Tamaulipas

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ABSTRACT

The objective of this research is to develop an augmented reality mobile application for learning mathematics and reading for children between 5 and 7 years of age who suffer from autism spectrum disorders. An own methodology for the development of the mobile application is presented and as results the finished mobile application is shown, which was evaluated by the tutors of the autistic children. 90% of the tutors affirmed that augmented reality facilitated educational understanding, 80% assured that learning through augmented reality applications is more attractive for children and finally 90% affirmed that they would recommend the use of the mobile application to tutors with similar situations

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1. Introduction

Autism Spectrum Disorder (ASD) is a neurobiological condition that affects brain development and is characterized by difficulties in social communication, repetitive behavior patterns, and restrictions on interests and activities, which vary widely from person to person. symptoms and severity (Alcalá & Ochoa, 2022; Escobar, 2023). Among the most common symptoms of ASD are difficulties in social interaction, communication problems, repetitive and routine behaviors, as well as restricted interests and activities (Martínez & Piqueras, 2019).

It is important to note that each individual with ASD is unique and may experience these symptoms to varying degrees, some people with ASD may have special abilities in specific areas, such as memory or math, while others may have additional intellectual or developmental disabilities (Alonso & Esquisábel, 2020). ASD is generally diagnosed in childhood, although in some cases it may go unnoticed for a long time in life. The diagnosis is based on the observation and evaluation of the individual's behaviors and symptoms by health professionals, such as psychologists, psychiatrists or neurologists (Zuñiga et al., 2020).

ASD is a disability that affects one in every 115 children in Mexico (Fombonne & Marcin, 2016). There are various types of ASD, however, the vast majority of these create certain complications in children, one of these is difficulty understanding topics through common learning strategies in schools, people who suffer from these disorders usually have a greater ease of learning through visual methods (Gandía, Nieto & Márquez, 2020). In recent years, technology has played an increasingly important role in the learning and development of autistic children, providing new opportunities and tools to improve their skills and abilities (Maldonado, 2020).

There is research regarding technology and its impact on autistic children, such as the research by Grantham, Jarvis and Linstead (2017), where researchers evaluated the impact of software on the learning and communication skills of children with ASD and concluded that had positive effects on their social communication and educational outcomes. Another investigation is the systematic review of interventions based on the cognitive model of theory of mind (ToM) for children with ASD by Fletcher-Watson, McConnell, Manola & McConachie (2014), includes studies that incorporate computer programs as part of the intervention, evaluating its effectiveness in improving social communication skills and ToM in children with ASD. In the same way, the contribution of Golan & Baron-Cohen (2006), who developed multimedia interactive software to teach adults with Asperger syndrome or high-functioning autism (HFA) to recognize complex emotions in faces and voices. The results show significant improvements in the participants' ability to identify and understand emotions. The research by Hourcade, Williams & Miller (2013) focuses on the evaluation of tablet applications (apps) designed to promote social interaction in children with autism spectrum disorders, in which the researchers evaluated the usability, engagement and impact of apps on social behavior and found that certain apps were effective in increasing social engagement and communication skills in children.

Another contribution is the exploration of the use of virtual environments as a tool for social skills training of adolescents with autism by Parsons, Leonard & Mitchell (2006), in which the experiences and perspectives of two people with autism who used a program of virtual environment to develop social skills. The findings highlight the potential benefits of virtual environments in providing a safe and controlled environment for practicing social skills. O'Reilly, Lancioni & Sigafoos (2007), in their research, describe in a general way several interactive computer technologies that are used for people with autism, in which they review the effectiveness of computer interventions to improve communication, academic skills and social interaction in children with autism, in addition it also analyzes the considerations for selecting and implementing educational software.

Hourcade, Williams & Miller (2018), Turpo, Aguaded, Barros (2022) conducted a systematic review on the use of tangible user interfaces (TUI) in educational interventions for children with autism spectrum disorder (ASD), who investigated the impact of TUI on communication skills. Social communication and participation in children with ASD, finding as a result that TUI have the potential to improve social interaction and communication in children with ASD. Likewise, the investigation of the evaluation of the effectiveness of an intervention based on iPad aimed at social communication skills in children with autism by Fletcher et al. (2016), carried out a randomized controlled trial that compared the intervention group with a control group; The resulting findings demonstrate improvements in the social communication skills of the children who received the iPad intervention. As a result of the bibliographic review, it was found that the development of applications for children with autism has been a growing field with a focus on the creation of interactive and personalized tools that adapt to the individual needs of children (Gutierrez, 2019), considering important aspects such as setting clear objectives, an adaptable application with an intuitive and easy-to-use interface, it must offer interactive activities that maintain interest and motivation, as well as include functions for monitoring and recording the progress of minors (Fernández & Espinoza, 2019 ; Arias, 2022). Derived from the above, an augmented reality mobile application was developed, which allows children with ASD to learn school subjects visually and interactively for first and second grade of primary education.

2. Methodology

For the development of the mobile application, it was decided to use the mobile and desktop application engine, Unity AR, which allows creating experiences in augmented reality and virtual reality for users. In order to use this tool, it is necessary to have access to a computer with upper-middle-range features, as well as to acquire a user license that allows us to unlock all the functions of the Unity development environment, unlike using its free student version. The graphical interface is a key part of the application, it must be attractive to children with ADD, and in turn, be easy to use, for this reason it was decided to use images instead of text, in order to call more attention and that children associate with these images the content they want to study. For the development of the graphic interfaces of the application, there are multiple layout designer options that are available in the market, some of them can be Sketch, Adobe XD and Figma, the latter being the one that is taken as the optimal option to carry out the design of the application. Application interfaces, all derived from the compatibility that this platform has with the augmented reality development environment used to develop the application. Figma allows you to develop interfaces for mobile applications and has dozens of libraries available, which can be exported to different formats and/or programming environments. Figure 1 shows the designs of the augmented reality mobile application, designed on the Figma computing platform.

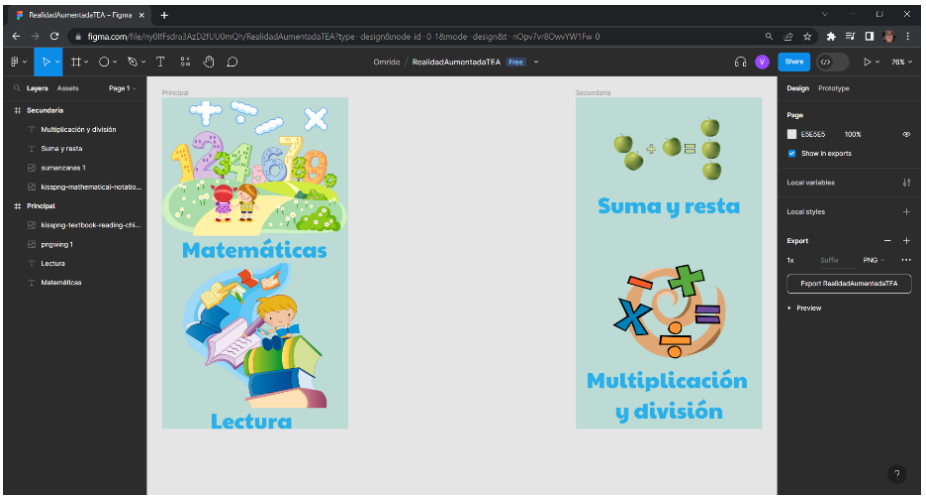

Figure 1. Application interface design in Figma

On the internet there are repositories with hundreds of thousands of objects designed in 3D that are compatible with the vast majority of augmented reality programming environments, however, based on the specific monitoring of the range of colors designated for the realization of this application, it was necessary the elaboration of our own three-dimensional models, for this, multiple 3D modeling programs were analyzed, being the one chosen for this task, Blender, which is an open source multiplatform application that allows us to design 3D objects and export them for use in various applications. The software generates FBX (Filmbox) type files, a standard used since its introduction in 2006 by Autodesk and which helps to exchange 3D geometric information, this format being compatible with the vast majority of current applications, including the Unity AR environment. A total of 21 three-dimensional objects were made, including numbers and some animals and/or objects, which will be used as an overlay in our augmented reality mobile application. Figure 2 shows the Blender platform for modeling objects and numbers.

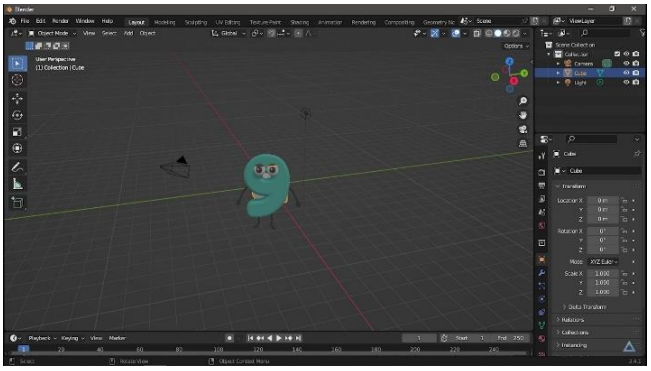

Figure 2. Blender platform, used for 3D object modeling

Once we have the necessary elements for the design of the application for learning in children with ASD, the development process begins, for which it is necessary to install Unity AR, as well as the 3D Mobile library, which It will allow the creation of augmented reality applications on mobile devices, giving us the possibility of exporting all the content created to mobile programming languages such as Android Studio or Swift, making the application compatible with the two most used mobile operating systems in the world. The integration of the graphic interface in Unity AR begins, for this we use the MRKT Figma Bridge as a library to import the interface design previously made. Figure 3 shows the Unity AR platform, which allows giving functionality to the images that serve as buttons, which is done from the programming environment.

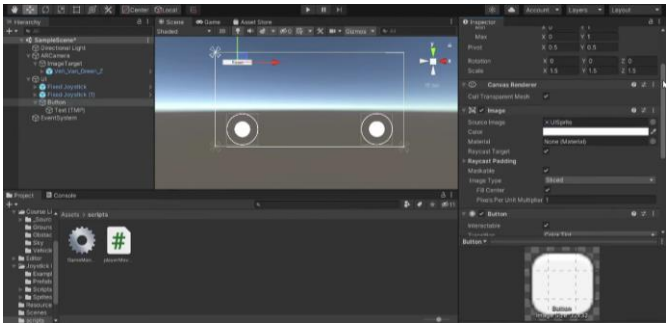

Figure 3. Unity programming environment

The application has two areas of knowledge: mathematics and reading. In the case of the mathematics area, it has a section on multiplications, divisions, additions, and subtractions, from which in an interactive way and interspersing objects, numbers, and animals, children will be able to learn and test their knowledge in the area of mathematics. , as shown in figure 4. You can choose any of the 3 levels of complexity.

On the other hand, in the area of reading, the application is based on the reproduction and reading of phrases and stories depending on the level of complexity chosen, where the child observes on his screen certain objects according to the phrase, which help him to associate words in a simpler way. The functionality of the application is based on the C# language, a language from the Microsoft company that arises as an evolution of C and C++, but with syntax bases similar to these. The proposed application requires the coding of many activities, such as the randomization of levels, the change between 3D objects when changing a level, among other aspects, for which it is necessary to program each of these points in the programming environment of Unity AR.

Once the development of the application is finished, it proceeds with the compilation and exports it to a device. The selected operating system was Android, due to the ease of installing the application. The application was put to the test during a period of 2 weeks in 10 autistic children from the School of Special Education in Pánuco, Ver, supported by their tutors at home, with the aim of knowing the performance and results of the use of augmented reality. For learning in children with ADD. The tutors were entrusted to the participating children to carry out during those two weeks, a minimum of 5 daily exercises in mathematics and 5 in reading using the application, with the aim of progressing in their understanding of each of the areas that represents them a difficulty.

Parents will be able to monitor their children's progress through an indicator on the right side of the application, where the number of levels completed during the day will be displayed. In this way, tutors or teachers can set goals that allow children to have a steady progress.

After 2 weeks, a survey exercise was carried out with the 10 tutors to find out about the general performance of the application before the children.

The questions asked in the exercise were the following:

- Do you consider that the use of augmented reality applications facilitated the child's educational comprehension in the area of reading and mathematics?
- Do you think that learning through augmented reality applications is more attractive for your children?
- Would you continue using the mobile application and/or would you recommend it to someone you know in a similar situation?

The following results: 90% of those surveyed affirmed that augmented reality facilitated educational understanding in their children thanks to the use of the application, in turn 80% assured that learning through augmented reality applications It is more attractive to your children compared to common learning methods. Finally, 90% confirmed that they would recommend the use of the mobile application to acquaintances with similar situations.

3. Conclusions

The development of learning applications for children with autism offers unique opportunities to personalize and enhance their educational experience by considering aspects such as clear objectives, adaptability, intuitive interface, interactivity, visual support, and progress tracking. Mobile applications can provide an interactive and structured environment that facilitates learning for autistic children, motivates them, maintains their interest and adapts to the specific preferences and abilities of each child, achieving a more focused and effective approach. In addition, they offer immediate feedback and the ability to track a child's progress, allowing tutors, teachers and even health professionals to assess their development.

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