Original Article

Mobile Application for Children with Asperger's Syndrome that Improves Social Interaction with Augmented Reality

Misael Lazo Amado[1], Laberiano Andrade-Arenas[2]

[1,2]*Faculty of Science and Engineering, University of Sciences and Humanities, Lima, Perú.*

[2]*Corresponding Author: landrade@uch.edu.pe*

Abstract *- Asperger's Syndrome is a disorder that affects neurological development with inefficiency in social interaction, verbal skills and nonverbal communication; being considered an Autism Spectrum Disorder, so a mobile application for children with Asperger's Syndrome that improves social interaction with augmented reality should be developed. As a methodology, ADDIE was used, which has five phases (Analysis, Design, Development, Implementation, and Evaluation) in charge of analyzing the problems and developing the proposal in a short time. The results show the solution of each phase of the methodology, showing the analysis of the resources to implement the development, the design of the architecture to develop the product, and the product development, which is the mobile application with augmented reality that tries to learn the organs of the human body, animals and human skeleton, the approval of the developers and specialists in charge of these disorders affirming its effectiveness and satisfaction of the project.*

Keywords *- Augmented Reality, Asperger Syndrome, Mobile Application, Unity, Vuforia.*

1. Introduction

Asperger's syndrome is a disorder that affects neurodevelopment, forming difficulties in social interaction, activity interests, verbal ability and difficulty in nonverbal communication, considered an autism spectrum disorder (ASD) [1][2]. The main problems that are known about this syndrome are atypical communication as well as social isolation because they have the difficulty of having friends, as well as the anxiety and stress that can be generated by hearing a lot of noise. This condition is pursued throughout the life of the person. However, they can present improvements with appropriate treatments and develop skills to adapt to society by controlling anxiety and stress, communication and other problems. It should take into account that the development of some people with Asperger Syndrome can improve rapidly as others have difficulty adapting. It is considered that having a diagnosis at an early age is very effective in making a list of strategies to improve communication and emotions [3][4]. In the year of Covid 19 in, people with Asperger's Syndrome have been very affected, facing new additional challenges and new adaptability, changes in routine, and adaptation to technology; also, those who already carried a therapy before the pandemic lose social iteration, increasing further stress. People with ASD in the world is very common in boys and girls; for every 4 males, there is a female; the symptoms are usually very evident between 12 to 14 months of age, among them may include significant delays in their language or social development, also indicate that 11% who have these disorders do not develop their skills properly becoming hospitalized until before reaching adulthood [5][6].

In Latin America, Asperger's Syndrome treatment and support may vary from country to country and is available only from mental health professionals as well as specialized clinics and child development centers [7]. However, the main problem is that it has limited attention because some areas do not have the availability of resources [8][9]. The culture and traditions towards mental health may vary in each country, and some Latin American regions do not show school inclusion and many families are not prepared to face these challenges due to low resources since children with Asperger Syndrome need specialized services, which are very expensive [10][11].

In the departments of Peru, there are limited services for the treatment of Asperger Syndrome. However, they are found in major cities such as Lima, which has specialized professionals and clinics to perform evaluations for people with ASD [12][13]. Educational inclusion is very difficult to find in some schools in Peru since informality, as well as not having specialized teachers, is a very serious problem; it is also indicated that discrimination against people with autism affects self-esteem [14][15].

Adults with ASD show challenges in seeking employment as a lack of understanding about their abilities is limited to obtaining any job opportunities; it is important to note that early diagnosis is one of the methods to prepare people with ASD for a future and independent life [16][17]. The importance of this introduction is to show the main problems in our introduction, showing the little efficiency in the world, and especially in Latin America, of not having the necessary resources to be willing to get a specialist for Asperger Syndrome; it is proposed to realize as an objective a mobile application for children with Asperger Syndrome to improve their learning in Anatomy and social interaction using augmented reality in order to optimize educational processes showing school inclusion as well as in the Peruvian community to obtain effective and interactive solutions with technology.

2. Literature Review

The autism spectrum disorder shows, from the mildest to the most severe, sharing the characteristics of communication, limited interests and repetitive behaviors; according to the variety of studies, autism is a condition that can be controlled, so these authors propose to perform augmented reality with artificial intelligence to reduce anxiety and interact with society [18]. It also shows that augmented reality is one of the specialties to solve any kind of problem; that is why this author presents "FaceMe", a social game based on augmented reality (AR) designed to help in the emotional development of children with autism, this game shows a virtual agent and tools that teach easy expressions for social contexts to improve communication and emotions [19].

This study shows that augmented reality applications have a massive impact on these children with autism problems, improving their verbal and physical activity; the author's project shows an application called "Maher" to teach self-care through augmented reality using 3D objects [20]. This research shows the development of an augmented reality application for the Android operating system, showing the learning of art and culture for musical notations in schools for product development using Vuforia SDK with Unity 3D for augmented reality and design tools that are coupled to the design as Adobe Photoshop CC 2021, Adobe XD CC, Blender 3D and Cubase 12 pro, this study guaranteed 96.7% effectiveness for music education [21]. Complementing the previous author, this author develops a game with augmented reality using the Unity engine and Vuforia to improve the interaction between the player and the game in order to improve the concentration and reaction capacity of children [22]. The development of mobile applications is very complementary to the use of augmented reality to show an interactive design and obtain records for the database of the child's progress is why it is the authors choose to investigate and develop mobile applications. There are a variety of ways to develop a mobile application; the author points out a project to make records and optimize the process of locating students

in such a way that performs a web and mobile implementation using a programming languages such as PHP, JavaScript, Ajax and CSS following with a methodology Extreme Programming (XP), refining the development with the frameword Ionic for mobile application uses the web connection services for the web system mobile app [23] Likewise, in the Covid 19 era, communication between teachers and students was a serious problem for social development, which is why this author developed an application called "SeniorHouse" that allows sharing study publications, this was developed with Firebase and Android Studio using the Java programming language [24]. This next author shows the development of a mobile application for music students to play songs with the same chords and shows a detailed report of each piece of music found. This was developed using Android Studio with Java and Kotlin programming languages with SQLite database manager and XML as the markup language for the graphical interface [25]. Finally, this author shows the development of a mobile application to learn English for children with autism by learning the correct pronunciation being a social and interactive application is why this application was developed with Google's Flutter Framework with the programming language Dart [26].

These authors show the importance of the development of the mobile application with augmented reality, showing techniques and methods different from this project, generating a great effective impact on education as a treatment for children with Asperger Syndrome, and providing solutions related to the proposal in this work. Likewise, it is assumed that this work will obtain better results than the other authors since, with the help of the methodology, it will show a detailed analysis of the tools and difficulties that are presented for its implementation with the purpose of finishing the development of the mobile application with augmented reality.

3. Methodology

This section shows the explanation of the main methodology for the development of the proposed objective as well as the tools used for its development.
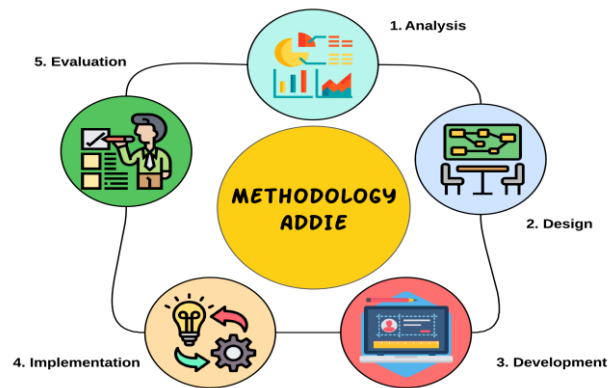
Fig. 1 Methodology addie

3.1. ADDIE

This methodology has five phases, which represent each letter (Analysis, Design, Development, Implementation, Evaluation), providing a systematic and structured approach to software design and development [27][28].

Its flexibility stands out since it adapts to the needs of the training and approach of the solution, it contains feedback in all its phases in order to make optimizations in its development [29]. Collaborative work is a fundamental part of this methodology since it accepts and integrates specialists in any field in order to achieve the established objectives [30]; Figure 1 shows the graph of the methodology.

3.1.1. Analysis

This is the initial stage, which is responsible for identifying learning needs gathering information on publication, resources, constraints and limitations, and project objectives [31].

3.1.2. Design

This is the second stage indicating the instructional plan according to the results of the analysis, showing the creation of the objectives as well as understanding the design of the architecture to provide an easy understanding of the project [32].

3.1.3. Development

This is the third stage that develops the creation of the project using the planned resources to meet the objective and establish best practices, working between designers and developers to build the project [33][34].

3.1.4. Implementation

This fourth stage shows the delivery of the product to the participants in order to give the point of view of those involved, showing approvals or new configurations to optimize the project [35].

3.1.5. Evaluation

This fifth stage is in charge of evaluating the objective accomplished, identifying the main problems as well as detailed approval of the work accomplished in order to finalize the methodology [36].

3.2. Technological tools
3.2.1. C-Sharp

It is a Microsoft programming language used in the development of desktop applications, web applications and games that also specializes mostly in the Unity game engine [37]. C-Sharp is an object-oriented language that is designed to work with object concepts and classes containing a good structuring of code; it can also be used in other operating systems through .NET Core, which facilitates development on Windows, Linux and macOS [38][39].

3.2.2. Unity

Unity is an engine dedicated to the development of video games as well as the creation of 2D, 3D, virtual reality or augmented reality applications. It is also responsible for making simulations of architecture, medicine and education [40][41]. It has ease of use with a user interface that is very intuitive compared to other game engines that are very accessible to developers with basic to expert levels.

Unity has a multiplatform for the development of games and applications, including operating systems such as Windows, macOS, iOS, Android, Xbox, and PlayStation, among others [42][43].

3.2.3. Vuforia

Vuforia is a platform for developing augmented reality displaying 3D graphics or developing a mobile device or tablet; it can identify or track objects in the real world how to identify QR codes, allowing you to create applications that interact with physical objects [44][45]. Vuforia is cross-platform, including iOS, Android, Unity and others, making it easy for developers to create augmented reality for various slides [46].

4. Results

This section shows the results of the methodology completed with the developed objective of a mobile application with augmented reality.

4.1. Results of the Analysis

The resources available for the project are planned with the developers, and an analysis is provided in Table 1, indicating the comfort they have based on their experience to be able to develop the product.

These results show the effectiveness of the resources available to developers to get the most out of their application development and also the experience each developer has with the tools selected to meet the augmented reality objective.

4.2. Results of Design

It is designed the process of how to perform the proposed objective, which is a mobile application with augmented reality, as shown in Figure 2, in which the application is responsible for demonstrating the real scene in which the Vuforia tracker is responsible for processing and recognizing objects in order to provide augmented reality with the help of unity for better graphics in their 3D presentations.

4.3. Results of Development

This stage is dedicated to the development of the mobile application with augmented reality. Figure 3 shows the first development of the mobile application in which the user must click on the screen to log in as shown in (a) and finally log in with your registered account as shown in (b).

Table 1. Results of the analysis

Resources Analysis	Developer 1	Developer 2	Developer 3	Developer 4	Developer 5
Figma	1.00	0.99	0.98	1.00	1.00
Vuforia	1.00	0.95	0.90	0.97	1.00
Unity	0.85	0.90	0.90	1.00	1.00
ARCrowd	0.40	0.30	0.50	0.70	0.50
Augmented Class	0.50	0.50	0.50	0.50	0.50
Roar	0.30	0.50	0.40	0.30	1.00
Andorid Studio	1.00	0.80	0.30	0.40	0.50
Flutter	0.90	0.40	0.50	0.70	0.50
Windowns	1.00	1.00	1.00	1.00	1.00
Linux	0.80	0.70	0.50	0.60	0.50
maCOS	0.50	0.40	0.40	0.40	0.20
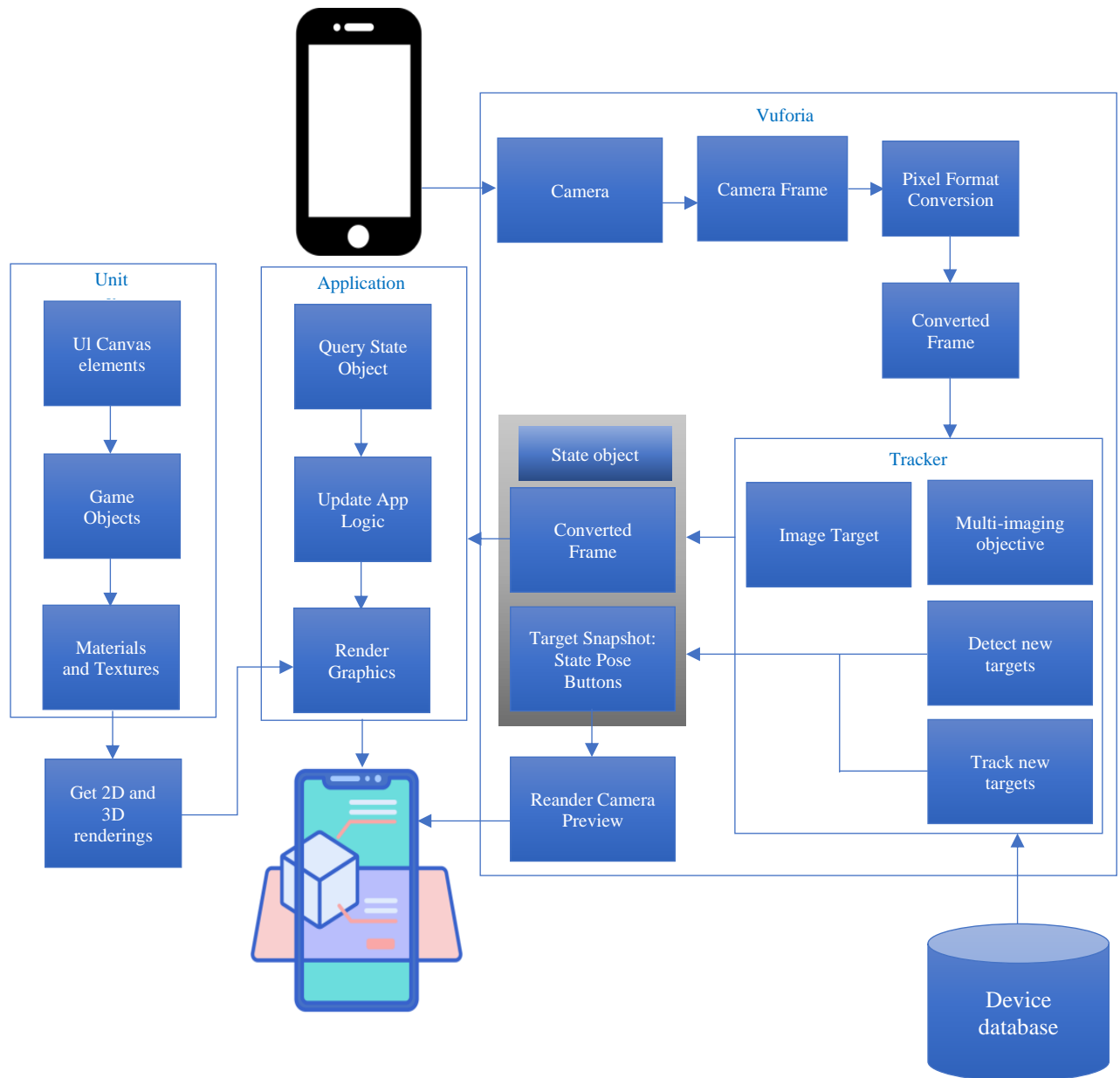
Fig. 2 Design of the augmented reality development process

(a)   **(b)**
Fig. 3 APP Home: (a) Start application (b) Login

(a)   **(b)**
Fig. 5 Password recovery: (a) User Mail (b) New password

This stage is dedicated to the development of Figure 4 shows the correct way for the new user to register, entering the requested data such as name, password, email, country, cell phone number, and age.
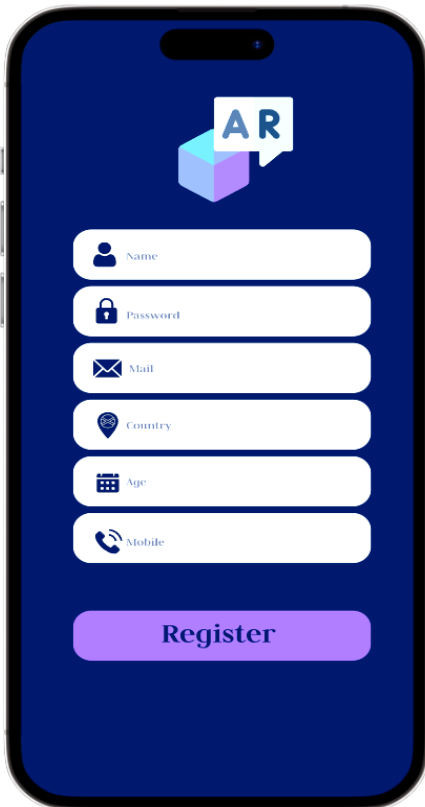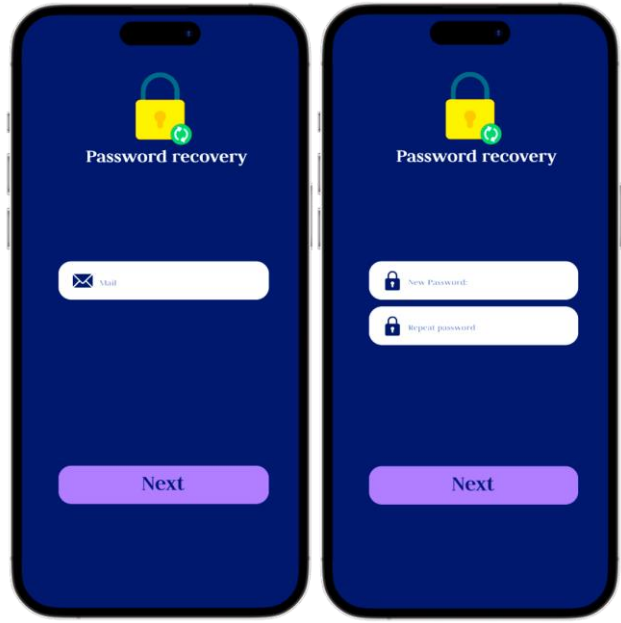
Figure 5 shows the facility to reset the password when the user forgets it so that there is no inconvenience in the loss of their information; in (a) the user must enter the registered email, and in (b) the user must enter their new password. Figure 6 shows the start of the application, showing the main options (Learn the organs of the human body, Visualize and learn the skull with augmented reality, Visualize and learn the skeleton with augmented reality, Visualize and learn about the animal with augmented reality), the user must select the option that interests him to put into practice the augmented reality.
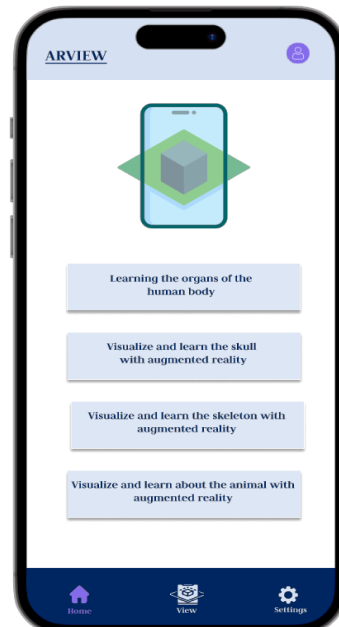

Fig. 4 Register user

Fig. 6 Selecting augmented reality options

(a)   (b)
Fig. 7 Augmented reality application: (a) Organs of the human body (b) Heart

Figure 7 shows the development to apply the body sciences for students or children with Asperger Syndrome to understand the organs of the human body as shown in (a), as well as the heart of the human body is also visualized to learn the parts of the cardiovascular system using technology as shown in (b). In Figure 8, augmented reality is made with the parts of the human skull (a) and skeleton (b) so that students or children with Asperger Syndrome can visualize the main bones.
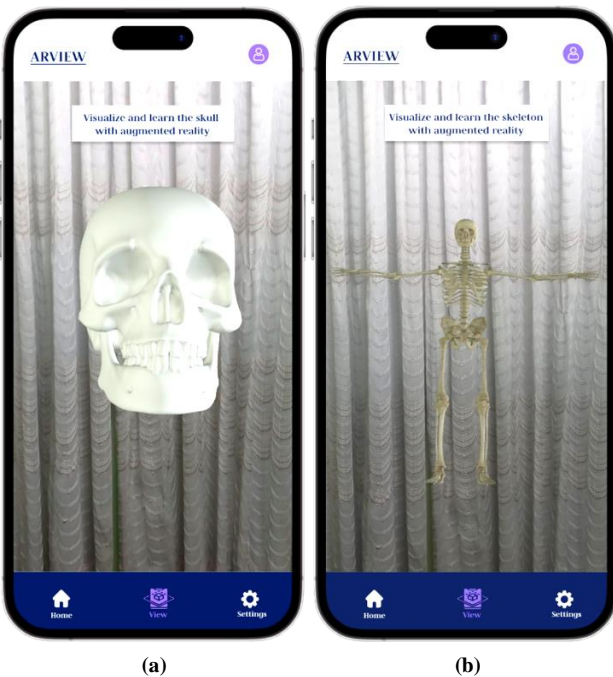
(a)   (b)
Fig. 8 Augmented reality application: (a) Cranium (b) Human skeleton

(a)   (b)
Fig. 9 Augmented reality application: (a) Dolphin (b) Deer

This part shows the identification of the animals of the planet as shown in Figure 9 with augmented reality where students or children with Asperger Syndrome can visualize and learn the animals, in (a) the child knows the dolphin and in (b) the child knows the deer.

4.4. Results of Implementation
For this part of the results, the developers give their point of view on what has been developed, indicating the efficiency of the product to fulfill the objective, as shown in Table 2.

These results show the efficiency of the resources that developers have to make the most of their implementation and also the experience that each developer has with the selected tools in order to fulfill the augmented reality objective.

4.5. Results of the Evaluation
Finally, what was accepted in the previous phase allows us to verify with the following stakeholders since they are in charge of supporting the child with Asperger Syndrome in improving his skills, giving their approval and satisfaction, as shown in Table 3. These evaluation results do not show their satisfaction by the specialists indicating a high level of percentage in interactive games, reiterating that augmented reality is the best way to be applied in children with autism learning disabilities or as also be used for schools in such a way to better understand the science subjects, since this type of learning with technology prevents the child from stressing.

Table 2. Results of Implementation

Developer	Learning the organs of the human body	Visualize and learn the human skeleton and skull with augmented reality	Visualize and learn about the animal with augmented reality
Developer 1	0.95	1.00	1.00
Developer 2	1.00	0.95	1.00
Developer 3	1.00	0.93	1.00
Developer 4	1.00	0.97	0.99
Developer 5	0.90	1.00	0.99

Table 3. Results of the Evaluation

Involved	Does it improve the concentration of the child with Asperger's syndrome?	Is this augmented reality ideal for any type of education or learning disabilities?	Is the social interaction with the activities efficient?	Does the application of augmented reality reduce the child's stress?
Teachers	0.98	0.97	0.99	1.00
Neurologist	0.88	0.89	0.88	0.88
Clinical Psychologist or Psychiatrist	0.92	0.85	0.93	0.92
Speech and Language Therapist	0.95	0.95	0.88	0.95
Occupational Therapist	0.97	0.98	0.97	0.98
Special Education Specialist	0.95	0.95	0.93	0.95
Parents	0.94	0.95	0.99	0.98

4.6. About the Methodology

4.6.1. Advantages

The ADDIE methodology has the main advantage that it has a structured approach which means that it facilitates orderly development as it is also based on results since it identifies a clear objective from the beginning of this methodology with a continuous evaluation and improvement for feedback, involving developers and specialist for the fulfillment of the objective.

4.6.2. Disadvantages

The disadvantage of this methodology is the rigidity that also shows a slow process and is sometimes inadequate for projects of constant changes, as well as being a methodology with costly investment since they depend on specialized professionals. It must also be combined with other methodologies to optimize the project development processes.

4.6.3. Comparison

The ADDIE methodology is dedicated to instructional design and development of training projects compared to Design Thinking, which is applied to problem-solving by providing innovative solutions that are flexible and interactive according to the needs of users and is mainly dedicated to design, as well as the Design Sprint methodology that shows a rapid resolution of problems and also generates a decision making and prototyping according to the proposed solution, considering that both methodologies are excellent, but are applied to different objectives.

5. Discussion

This project has the objective of making a mobile application with augmented reality for children with Asperger syndrome who are considered children with autism. These projects resemble different authors as the solution shows the

author [21], which indicates the development of augmented reality with Vuforia SDK and Unity 3D, which ensures efficiency to 96.7% for education, also states that this study is very nice for children, capturing their attention with technologies. Similarly, this next author [20] indicates that 3D objects improve their verbal and physical activity, showing selfcare classes and are applied for all Android operating systems, generating a great passive impact for children with autism. Finally, the author [19], shows that this type of augmented reality and even more with artificial intelligence is the best proposal for society demonstrating emotional development for children with autism, teaching facial expressions to improve their communication. The authors agree with this work, indicating the efficiency and satisfaction that augmented reality counts as the mobile application is able to solve big problems in education or any kind of learning problem.

6. Conclusion and Future Word

This project is dedicated to children with Asperger's Syndrome or autism and meets its objective of developing a plan to develop their social skills and their integration with the community. This project is carried out with the ADDIE methodology, giving the best results for its analysis in the resources that the development team has to implement the project and the understanding of the problem as well as work with specialists and developers who implement the mobile application and augmented reality in order to propose solutions to exercise the child's ability with interactive games (Learn the organs of the human body, Visualize, Learn the skeleton, human skull, Visualize and learn about the animal) with augmented reality that was developed with unity and Vuforia giving satisfaction to the user with this development concluding that the proposed objective meets the needs of children with Asperger syndrome, autism, learning disabilities as well as children who need this technology to learn the subject of science being evaluated by neuroscience specialists, parents and teachers. The main limitation of this project is that they are more specific in the costs and time that resulted in the project since the methodology is not dedicated to planning or time management. In future work, artificial intelligence should be added, which is currently one of the research or developments that have the greatest impact on society.

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