Original Article

Mobile Design for Disciplining Children with Attention Deficit Hyperactivity Disorder using Augmented Reality

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Abstract - Attention Deficit Hyperactivity Disorder (ADHD) is considered the most common problem in the world in children as they have difficulty being attentive and are impulsive by not solving any activity that is presented to them, which is why the main objective is to design a mobile application with augmented reality for children with ADHD to improve their attention and education. To develop the mobile application with augmented reality, the Design Thinking methodology must be applied, which consists of five phases (Empathize, Define, Ideate, Prototype and Test), which is responsible for analyzing the problems of users and showing the quick solution in the short term, with the help of tools such as Figma which is responsible for the design of the mobile, Tinkercad to design 3D models and import them into the application MetaClass Studio to visualize it in augmented reality as results show the solution of the applied methodology proposing to design the mobile application with augmented reality, being endorsed by the experts who approve it satisfactorily with 93%.

Keywords - Design thinking, Figma, Hyperactivity, Metaclass studio, Tinkercad.

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is the most common problem in childhood, with difficulty maintaining attention in a way that contributes to hyperactivity and impulsive behavior, interfering with social and academic activities and affecting 2% to 7% of children worldwide. When it comes to rest, children have more sleep problems, and these types of problems are between 25% to 70% of those affected. These types of problems change over time, such as sleep anxiety, bedtime resistance, nocturnal awakenings and parasomnias. [1] [2]. In Ireland, children with ADHD have suffered a drastic change in their routine due to the onset of the covid-19 pandemic, affecting their learning process and having fewer opportunities to perform their activities and worsening sleep problems, as staying isolated and at home is more stressful, affecting parents or people close to home [3]. ADHD is considered one of the most common mental disorders among children and adolescents and in China, represents 6.26%, stating that in the 1940s, families had great challenges disciplining their children experiencing symptoms and negative emotions during covid-19 and those with ADHD had no control, having serious problems with the use of digital media [4][5].

Students in Latin America have math problems with scores ranging from 49.4% to 70.3% due to schools not providing good quality teaching with a lack of interest and attention, frustrating the ADHD child by failing to perform their activities. Industrial, mining and agricultural problems are also big problems for children, affecting their health and causing neurodevelopmental delays, so more than 300 million children are affected [6][7]. In Brazil, it indicates that people with these disorders have difficulties in learning, communication and social iteration, demonstrating that technologies such as mobile applications are of great importance for developing and managing to capture their attention [8][9].

Covid-19 in the Peruvian state was a hard blow to education, and the change of habits with technology was difficult to relate to. However, years passed, and they adapted to these kinds of changes bringing a great advantage in society, increasing the opportunity to work. The treatment of children with ADHD was very effective because, being safe with their families, they remained confident to continue their activities with specialists [10][11].

There is also a variety of problems that affect the child who is diagnosed during the short time of his life with ADHD and given the opportunity to find effective solutions for their early stimulation; that is why the proposed solution is to analyze the problems of the users and give solutions according to their problem which is Attention Deficit Hyperactivity Disorder, one of these solutions is the mobile application with augmented reality which will be evaluated by experts and

those involved indicating the satisfaction of the project. The importance of technologies is very effective for education. It will greatly help specialists dedicated to Attention Deficit Hyperactivity Disorder, so it is intended to design a mobile application with augmented reality for children with ADHD to improve their attention in their daily activities or their studies.

This work will consist of the following, in section II, the literature review will be shown; in section III, the methodology to be developed will be shown; in section IV, the results will be shown; in section V with the discussion of the project and finally, section VI which is the conclusion and future work.

2. Literature Review

The best impact that technologies have is the mobile application because it generates a great novelty in the users according to their interests. The discipline project in children with attention deficit and hyperactivity will have a great impact because a mobile application will be made to facilitate the specialist's activities with the children and do it from the comfort of their homes. Also, this author points out the importance of mobile application that provides digital developments for learning in people with disabilities because nowadays, children are using a mobile device; these can be used as therapies to improve their quality of life and increase their motivation for their cognitive tasks, ensuring that the tool is essential for children with ADHD [12]. In the same way, the following author, who made a mobile application for diagnosing people with ADHD, gave 2 to 7 weeks of evaluation, giving good results through technology [13]. In such a way, this author assures that the mobile application is the best treatment for children with ADHD since the distancing by covid-19 has allowed us to work with technologies, and thanks to the mobile application, parents can treat their children without the need of a specialist [14], according to these authors comment that the importance of using the mobile application for education or for other types of problems is very important since the society is pending of these mobile devices.

The contribution of augmented reality is an effective innovation for the user, ensuring their attention on it; that is why this author shows us the development of augmented reality for children with ADHD speeding up the ability to read and write, stimulating the attention of students, improving their reading and spelling [15]. This next author indicates the development of augmented reality with Unity 3D to diagnose family problems with children with ADHD, for it must have the support of the psychologist for the result. This development tries to complete the cognitive game by being more efficient than the traditional diagnosis [16]. Augmented reality is an educational plan for ADHD with a variety of advantages and challenges, shown to be effective in education, fulfilling the goal of capturing the child's attention [17]. These authors show the impact that augmented reality has on children with ADHD, generating a great impact on their attention.

The development of the methodology is very important, and for this work, Design Thinking will be performed, providing a short-term innovation project is why it is highly recommended by specialists dedicated to innovation; this author performs a mobile design with augmented reality generating a great impact by users, ensuring their satisfaction for its development [18]. Mobile design is important for decision-making in companies dedicated to mobile development, allowing for evaluation and analysis of those involved, verifying the weak points of the application and seeking constant updates to modify the project [44]; also, the authors show the importance of this methodology that is responsible for the design and innovation that involves a joint analysis to understand the user's problems and generate impactful solutions.

Finally, the authors of the literature review show us the importance of the development of technology, design and analysis for society, providing a solution to the problems of users, which is why it motivates us to carry out this work of innovation dedicated to attention deficit disorder and hyperactivity using augmented reality technology that will allow us to achieve the goal of improving the discipline and attention of the child.

3. Methodology

This section explains the design thinking methodology that will be used to solve the project, which will consist of five phases (Empathize, Define, Ideate, Prototype and Test), and will also show the tools that will be used to carry out the mobile design and augmented reality.

3.1. Design Thinking Methodology

It is a methodology dedicated to design and innovation. It is highly recommended by companies dedicated to developing innovative products to satisfy their customers [20][21]. This methodology prioritizes finding the main problems of users to propose a variety of solutions to show them based on a design; its activities must be performed in a team for decision-making and updating the project [22][23]. To better understand this methodology should visualize it in Figure 1.

3.1.1. First Phase Empathize

Empathizing This is the first part of the design thinking methodology, in charge of contacting people to learn about their problems through surveys or interviews [24] [25].

3.1.2. Second Phase Define

It is the second part of the methodology, responsible for analyzing the problems of the first part with the objective of establishing a series of relevant solutions for the user [26][27].
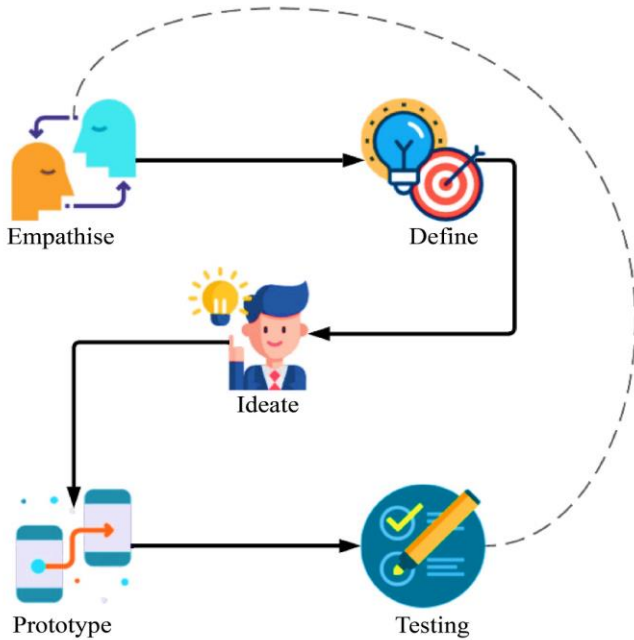
Fig. 1 Methodology design thinking

3.1.3. Third Phase Ideate

It is the third part of the methodology; it fulfills the objective of proposing innovative ideas based on the problems and deciding the most innovative idea put forward by the working group [28] [29].

3.1.4. Fourth Phase Prototype

The fourth part of the methodology is in charge of designing the chosen idea and satisfying the user by fulfilling his needs; for this task, the designer must constantly be conversing with the user to design step by step what has been requested [30] [31].

3.1.5. Fifth Phase Testing

It is the last part of the methodology, in charge of conducting surveys or interviews on the prototypes to update or modify some design functions for the user's comfort and approval of the prototype [32] [33].

3.2. Technologies for Mobile Application with Augmented Reality

This part shows the tools that will help us to achieve the objective (Figma, Tinkercad, Metaclass Studio); Figure 2 shows the functionality of the tools for mobile design with augmented reality.

3.2.1. Figma

It is an application responsible for interface design, is highly demanded and recommended by designers, and has various functions and tools for web and mobile prototyping [34] [35]. This application is hosted on the web and performs its work in groups and in real-time; at the end of each work can be exported in standard formats such as pdf, png jpg [36] [37].
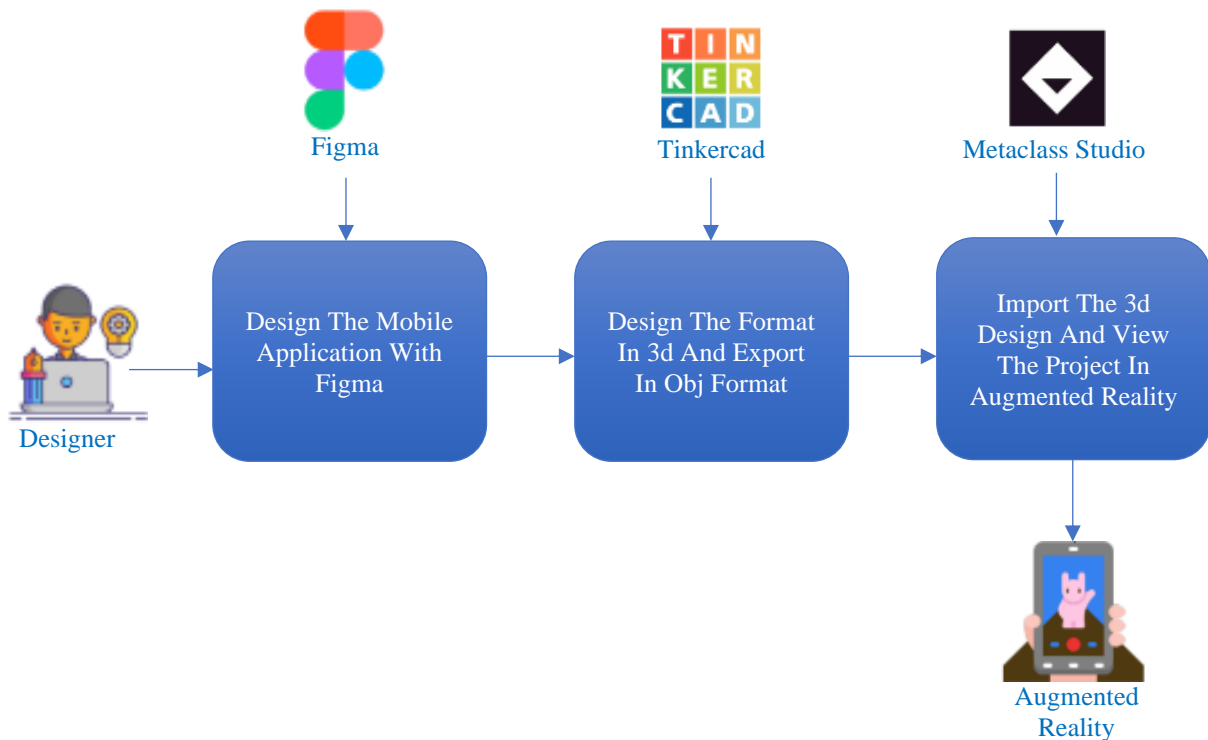

Fig. 2 Tools for mobile design and augmented reality

3.2.2. Tinkercad

It is a 3D design and modeling program with the facility to perform digital animation projects; it is used by beginners to experts and can be worked with from the computer [38] [39]. Tinkercad also has the usability of Arduino simulation and electronic circuits to create light and motion objects [40] [41].

3.2.3. MetaClass Studio

It is a free mobile application located in the play store dedicated to visualizing augmented reality projects and in charge of importing 3D designs; its use is simple and can be used from basic to advanced [42][43].

4. Methodology

In this section, we will show the results of the methodology showing the final product, which is the mobile design with augmented reality; we will also have the validation by experts to show satisfaction with the mobile application, and at the end, we will have the advantages and disadvantages of the methodology.

Table 1. Questions

ID	Questions
Q1	Gender
Q2	Does the child have communication difficulties?
Q3	Does the child have impulsive behaviors?
Q4	Does the child have sleep problems?
Q5	Does the child have difficulty paying attention?

4.1. Results of the First Phase of the Methodology: Empathize

The first results indicate the first survey to be made to parents in which there will be 5 questions (Q1 to Q5); these questions will be used to know the needs of people, as shown in Table 1.

4.2. Results of the Second Phase of the Methodology: Define

The second phase will show the results of the survey of the 120 parents, which will allow the innovation team to evaluate the results of the first phase and make decisions, as shown in Table 2.

Table 2. Survey response

ID	Answers
R1	Male 82%, Female 18%
R2	Yes 67%, No 33%
R3	Yes 72%, No 28%
R4	Yes 75%, No 15%
R5	Yes 90%, No 10%

In these results, it can be observed that in the first question of the survey, 82% are male and 18% are female; in the second question of the survey, it can be observed that 67% have communication problems and 33% do not. In the third answer, it can be observed that 72% have impulsive behaviour and 28% do not; in the fourth answer, it can be observed that 75% have sleep problems and 15% do not. In the fifth answer, it can be observed that 81% have difficulties paying attention to their activities, and 10% do not.

4.3. Results of the Third Phase of the Methodology: Prototyping

The third part of the results will show the most relevant solutions for the innovation team to make the decision and choose a solution for ADHD. To choose the solution, the three team members must score each solution, and the best-scored one will be selected as the best proposal for the user, as shown in Figure 3.
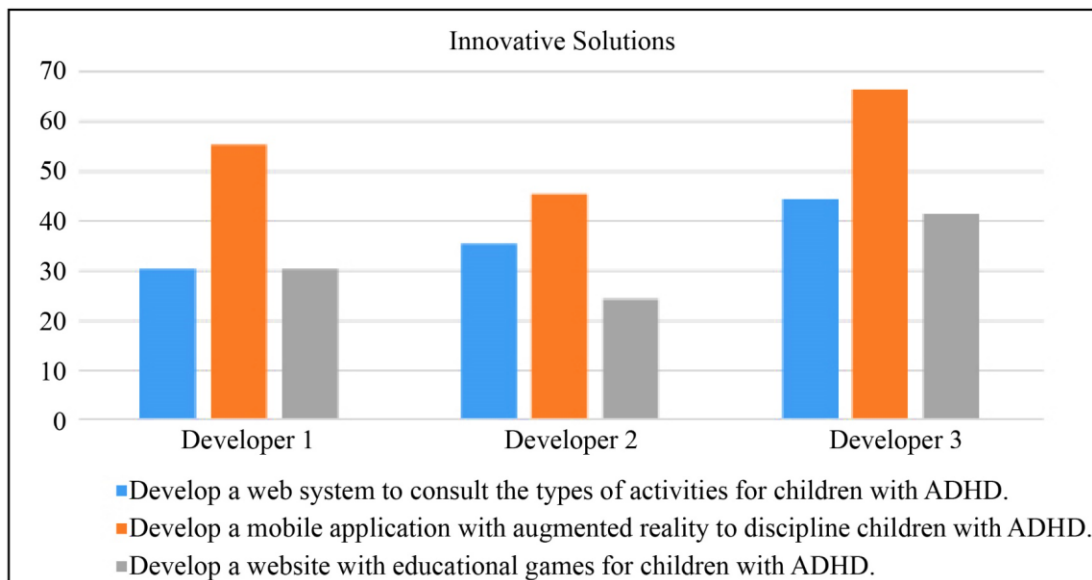

Fig. 3 Tools for mobile design and Augmented Reality

4.4. Results of the Fourth Phase of the Methodology: Prototyping

The fourth part of the results shows the prototype of the best solution proposed in the third phase, which consists of making a mobile application with augmented reality. Figure 4 shows the first part of the mobile application, indicating that the user must click on the screen to continue with the next process, which consists of entering their name and the child's age to provide them with treatment according to their age.

(a)   (b)
Fig. 4 Home: (a) Start Application (b) User data

The user must select his favorite treatment to start his activity, which includes putting the pieces together, selecting the matching shapes, and finally putting the words together, as shown in Figure 5.
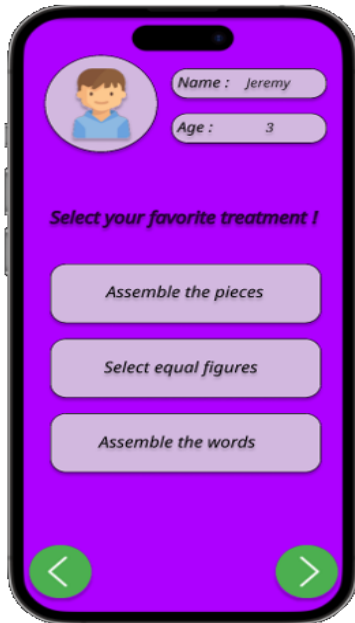

Fig. 5 Select the activity.

The first activity presents the design with augmented reality, which is responsible for assembling the pieces of the human body in such a way that the child with ADHD must have the help of a family member or specialist to solve the activity, as shown in Figure 6.
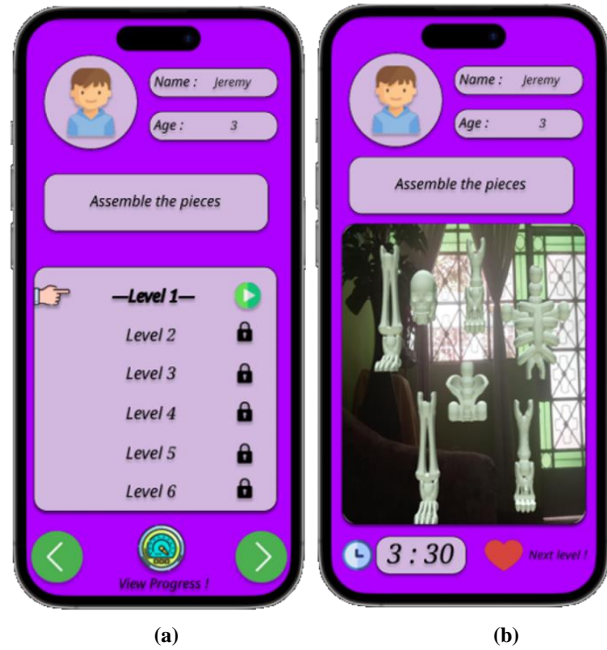

(a)   (b)
Fig. 6 Assemble the pieces: (a) Choose level (b) Treatment level 1

The second activity presents the design with augmented reality that is responsible for selecting the same figures in such a way that the child with ADHD must, with the help of a family member or specialist, solve the activity, as shown in Figure 7.

(a)   (b)
Fig. 7 Select equal figures: (a) Choose level (b) Treatment level 1

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The third activity presents the design with augmented reality that is responsible for assembling the words according to the figure shown in such a way that the child with ADHD must solve the activity with the help of a family member or specialist, as shown in Figure 8.

(a)   (b)
Fig. 8 Assemble the words: (a) Choose level (b) Treatment level 1

Figure 9 shows the ADHD child's activity report to visualize his progress and detail what needs improvement in each activity.
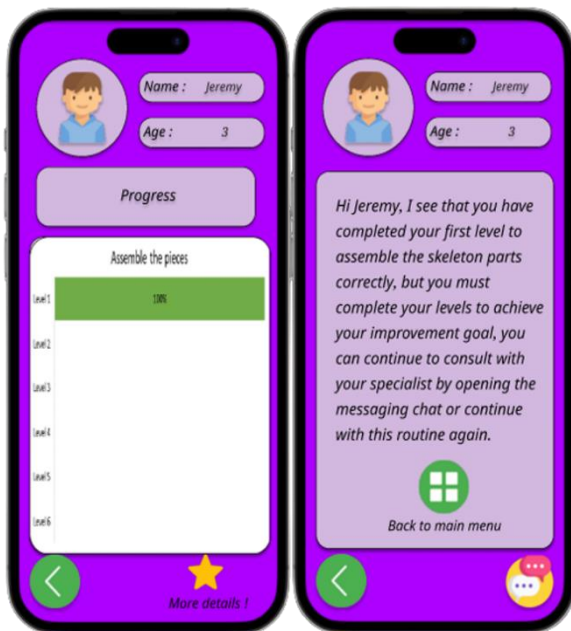

(a)   (b)
Fig. 9 Activity report: (a) Graphical report (b) Text report

Figure 10 shows the option for the user to launch a consultation with the specialist to solve the problem of activity and to be in constant communication with the patient.

Fig. 10 Chat

4.5. Results of the Fifth Phase of the Methodology: Testing

This last test result shows a survey based on the augmented reality prototype that was applied to the users, fulfilling the objective of finding possible improvements for the project or upgrading to a new design. So, five questions (Q1 to Q5) are asked, as shown in Table 3.

Table 3. Survey response

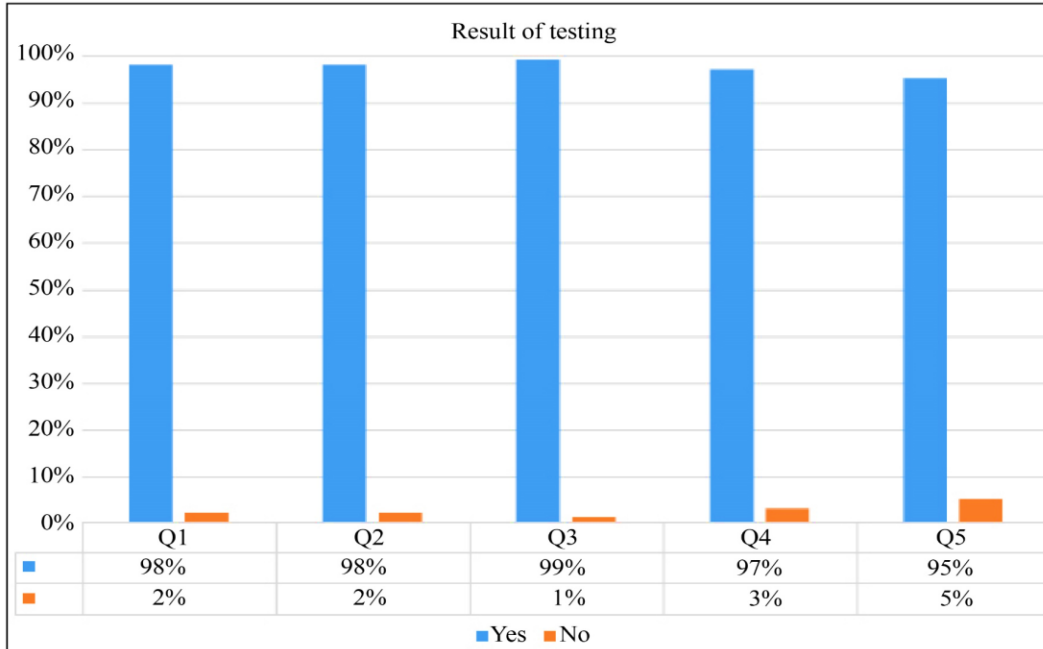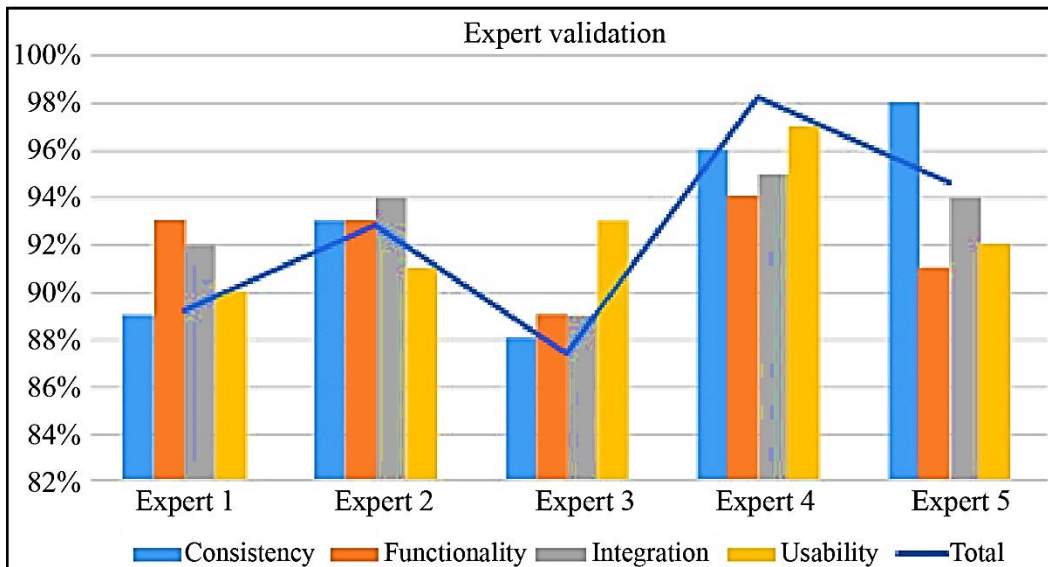| ID	Question
Q1	Will the mobile app improve the attention of children with ADHD?
Q2	Do you think it is better to work with a specialist?
Q3	Is the design of the mobile application very nice?
Q4	Do you think the mobile application should be applied in study and health centers?
Q5	Do you think the games mentioned in the mobile application will meet the project's objective?

Fig. 11 Result of the testing stage

Fig. 12 Expert validation

Figure 10 shows the survey results to validate the prototype's success and its recommendations; among them, 120 parents were surveyed, indicating in the first question that the children improve their attention, 98% of the respondents confirmed this, and 2% did not. In the second question, it was indicated that the work should be done in conjunction with the specialist, 98% of respondents confirmed this, and 2% did not. The third question indicated that the design is very attractive to the user, 99% of the respondents confirmed this, and 1% did not. The fourth question indicates that the mobile application should be applied in study and health centers; 97% of the respondents confirm this, and 3% say no. Finally, the last question indicates that the games meet the project's objective; 95% of the respondents confirm this, and 5% do not.

4.6. Expert Validation of the Prototype

In this part of the work, an expert validation would be performed to know the satisfaction of the prototype; for this, it must have the four acceptance criteria (Consistency, Functionality, Integration and Usability); these four levels will be scored with three levels, the low level 0% to 49% where the low impact is shown, the intermediate level that has a score of 50% to 79% indicating that the prototype should improve in its design and the last level that scores from 80% to 100%

indicating the correct acceptance by the experts. Table 4 shows the levels of acceptance, and to find the total level, it is necessary to add the four criteria and divide by the number of criteria.

Table 5 shows the results of the five experts indicating their correct acceptance of the augmented reality prototype.

The detailed validation of the experts in Figure 11 shows that the first expert accepts the program by 91%, the second by 97%, the third by 91%, the fourth by 96% and the fifth by 94%, giving a total satisfaction of 93%.

Table 4. Level of acceptance

Lower	Middle	High
0% - 49%	50% - 79%	80%- 100%

Table 5. Level of acceptance

Experts	Functionality	Usability	Consistency	Integration	Total	Level
Expert 1	93%	90%	89%	92%	91%	High
Expert 2	93%	91%	93%	94%	97%	High
Expert 3	89%	93%	88%	89%	90%	High
Expert 4	94%	97%	96%	95%	96%	High
Expert 5	91%	92%	98%	94%	94%	High

Table 6. User ratings

Involved	Ease of learning	Efficiency	Satisfaction	Total	Level
Hyperactive Child	99%	99%	99%	99%	High
Specialist	97%	97%	97%	97%	High
Parents	99%	97%	96%	99%	High

4.7. Usability Analysis

The usability analysis will serve to verify that the software or mobile application works correctly with those involved, affirming the ease of learning, effectiveness and satisfaction indicated by the child with hyperactivity, specialist and parents, so Table 6 shows the final result of this section.

Figure 13 indicates the final result in a graph to show the score of those involved in the usability of the mobile application; the child with hyperactivity indicates 99% acceptance of the 3 pillars of usability, which is the ease of learning, effectiveness and satisfaction, the specialist indicates 97% and the parents 97%, these results show a high level of acceptance concluding that the application is suitable to be used by those involved.

4.8. Inspection of Technology Results

Table 7 shows the comparison of the result on technology, indicating that augmented reality is one of the most recommended methods to solve problems in early stimulation as well as in education, also the stakeholders indicate which is the best practice with technology, so they rate the best technology that exists to provide the right solutions.

Table 7. Inspection of results on technology

Under	Mobile Application	Web system	Augmented Reality
Hyperactive Child	83%	5%	89%
Specialist	89%	13%	98%
Parents	85%	7%	94%

The experience that those involved show the best results in their practices with technology, ensuring a high level of use of augmented reality and mobile applications that streamline the process of helping children with ADHD or any other disease that can be treated with the help of technology why the web system is excluded from solving these problems.

4.9. About the Methodology
4.9.1. Advantages

The advantage of the design thinking methodology is that it has the ability to quickly find new solutions for users based on a long analysis observation to know the main needs of people.
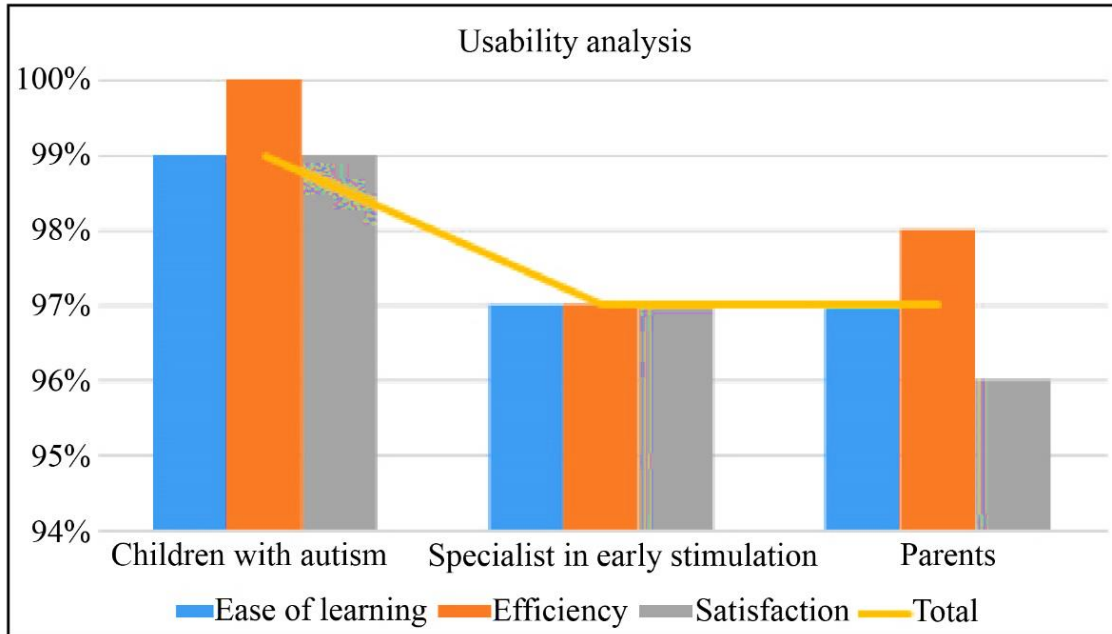
Fig. 13 Usability Analysis

4.9.2. Disadvantages

The disadvantage of the design thinking methodology is that not having good management can end up in a slow and unstructured process, in addition to not having the facility to carry out the project for software development and only focus on design and innovation.

4.9.3. Comparison

It is clear that the design thinking methodology is dedicated to the design and search for innovative solutions for people as opposed to other methodologies, such as scrum, that has an organized and structured management to present the project on time and just like the extreme programming methodology (XP) that is responsible for developing the system interactively with the customer to solve their problem.

5. Discussions

This work is aimed at children with ADHD to improve their attention and hyperactivity using an application with augmented reality, which is why there are solutions that are similar to the project presented, which is why this author [14] develops a mobile application for children with ADHD since in times of covid-19 they were forced to interact with technologies, I feel one of the entertainments for these children and gradually improve their attention. In the same way, this author [15] develops augmented reality as it generates a novelty for these children with ADHD in order to

speed up their literacy skills and attention, to complement the Design Thinking methodology, which is the heart of the project and that is why it is equal to this author [44] as it develops an innovation project with this methodology to solve problems in the short term and impact with its design to the user. These authors indicate the validity of these methods since the mobile application and augmented reality are a great complement to developing the project's objective.

6. Conclusion and Future Word

A mobile design is implemented to discipline children. A mobile design is implemented to discipline children with attention deficit and hyperactivity with augmented reality. This work is in conjunction with the design thinking methodology that is responsible for solving problems according to the needs of people, and that is why the objective is achieved and additionally validated by the five experts indicating their satisfaction with this project. The main limitation during the project was the mobile development decision since the methodology focuses on design rather than development. For future work, it is expected that this project will be developed by software engineers who are dedicated to programming and specialists in the field of Attention Deficit Hyperactivity Disorder (ADHD). This project is suggested to be implemented in educational institutions and medical centers and to show new ideas such as artificial intelligence.

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