Recommendations for the Development of Augmented Reality Video Games for Children with ADHD

Augusto Morante Castañeda[1], Omar Cahuana Rios[1] and Eduardo Díaz[1]

[1]Universidad Peruana de Ciencias Aplicadas, Prolongación Primavera 2390, Lima 15023 – Perú
U201912150@upc.edu.pe, U20161C887@upc.edu.pe, pcsijord@upc.edu.pe

Abstract. Currently, the percentage of children with Attention-Deficit / Hyperactivity Disorder (ADHD) is between 7% in Peru. This is a problem for their development at an early age, since they would demonstrate poor academic performance compared to neurotypical children. This paper aim is to propose 10 recommendations to develop a video game with Augmented Reality for children with ADHD. The recommendations have been extracted from 25 research works. Specifically, the proposal is based on the extraction of recommendations for development video games with Augmented Reality for children with ADHD. The recommendations were divided into 2 categories: (i) Video game development recommendations with augmented reality, (ii) Video game components recommendations. For a better understanding, an illustrative example was developed with the use of the proposed recommendations. This work may be of interest to video game developers focused on children with ADHD.

Keywords: ADHD, Recommendations, Augmented Reality, Video game.

1 Introduction

Currently one of the most common disorders in childhood is Attention Deficit / Hyperactivity Disorder (ADHD), it is characterized by symptoms of inattention, impulsivity and hyperactivity and in most cases, it is identified in the school environment. and family since children present multiple problems of cognitive, emotional and social development [1]. If not identified early or treated appropriately, it can lead to poor school performance and behavioral problems compared to their neurotypical study peers. This would have long-term consequences such as job failure, stress, low self-esteem, problems with relationships, depression or substance abuse [2].

In Peru, the accuracy of the percentage of infants who suffer from this disorder is unknown; however, it is estimated to be between 3% to 7% [2]. There are three types of ADHD [3]: (i) ADHD with a predominance of attention deficit, is more focused on lack of attention, continuous neglect, difficulty following instructions, and avoidance of tasks that require mental effort. (ii) ADHD with a predominance of hyperactivity, is more focused on nervous movements of the hands or legs, difficulty staying seated, running or climbing on things excessively, talking excessively, constantly interrupting

people, difficulty waiting or wait, (iii) combined ADHD, which presents the symptoms of both cases.

The contribution of this work is the proposal of 10 recommendations for the development of video game applications with augmented reality for children with ADHD, the proposed recommendations were extracted from the analysis of 25 research works related to the use of video games with the use of Augmented Reality. The recommendations are divided into 2 categories: (i) recommendations on the development of augmented reality in mobile application video games, where different types of tools for the development of video games are explained, as well as patterns and methods to improve the experience of children; (ii) recommendations on video game components for children with ADHD, which indicates the impact of using video games on the approaches of patients with ADHD and their cognitive consequences of learning. These recommendations for the development of video games for children with ADHD are aimed at children between the ages of 4 and 10, so it is a stage where children can have their ADHD treated.

The scope of the research is applied to an illustrative example, which has the purpose of showing the use of the development of a video game that has implemented the set of recommendations regarding its graphic components or design patterns.

The rest of the paper is structured as follows. Section 2 reviews the literature related to the development of video games with augmented reality divided into 2 subgroups. Section 3 defines the recommendations for the development of the video game. Section 4 defines the illustrative example of the project based on the recommendations extracted from the articles. Finally, Section 5 presents the conclusions of the work, the limitations, as well as future work.

2 Related works

In this section, we review works related to the development of video games with augmented reality for children with ADHD. This is achieved by performing a Targeted Literature Review (TLR), it is a non-systematic and informative literature review that aims to keep only the significant references to keep biases to a minimum.

The proposal of recommendations for the development of video games with augmented reality for children with ADHD is based on research work collected from the Scopus bibliographic repository (see https://www.scopus.com/home.uri).

The search string used in this work is the following: (“ADHD” AND “augmented reality” OR “rules” OR “mobile app” OR “design patterns”).

The inclusion criteria are: (1) topics related to the use of mobile applications with augmented reality, (2) development of applications for neurodivergent children, qualification received by patients with neurological disorders. The exclusion criteria are: (1) topics not related to the use of Augmented Reality, (2) topics not linked to children with ADHD. The first search shows 38 scientific articles, therefore, with the established criteria, 10 scientific articles have been selected. The research works were divided into two groups: (i) Use of augmented reality in mobile application video games, and (ii) video games for children with ADHD.

2.1 Use of augmented reality in mobile application video games

Brun et al. [4] developed CartonEd, a complete and open kit designed for children that allows them to build their own Augmented Reality (AR) device. The study examines the usability of the guide application and the construction process, shows the main components of the CartonEd kit and the results of an evaluation carried out with 57 children and adolescents (from 8 to 16 years old), which show a positive result regarding your built device (all functional), your feelings and desires in relation to augmented reality.

Liu et al. [5] presented a bibliometric analysis and literature review on the Geo AR mobile game, a new form of video game enabled by geolocation and augmented reality technology. Furthermore, they mention that Geo AR mobile games be built as "full games", that is, with sensors and augmented reality to achieve sustainable success.

Bhadra et al. [6] presented a new ABC3D game developed with augmented reality, which allows improving the knowledge of literacy based on writing in preschool children. This video game takes advantage of the motivating power of interest and the possibilities of augmented reality to involve children in the practice of writing-based literacy. ABC3D is bimodal, consisting of: (i) a "scan" mode that allows children to scan drawn letters and view three-dimensional images of content starting with the same letter and (ii) a "vehicle" mode that challenges Children collect objects that begin with certain letters as specified by the software or the instructor.

Saleem et al. [7] investigated the influence of augmented reality mobile applications on consumers' behavioral intention to use this technology, using the technology acceptance model. Partial least squares structural equation modeling was applied to verify path relationships. The findings of the study indicated that the augmented reality application directly influences perceived usefulness, perceived ease of use, perceived enjoyment, and indirectly influences attitude toward use and behavioral intention to use.

Saragih & Suyoto [8] propose an interactive mobile application and augmented reality for the tourist sites of Batam. The interactive mobile application uses marker-based augmented reality and provides information and a map of the city's tourist sites. The studio uses Android Studio to develop the prototype of the mobile application called “Kudan AR SDK” for augmented reality and Adobe XD to create the interface design.

To summarize related work considered in this group, we can stat that they different methods of using augmented reality in video games [5] [6] [7] [8] from the development of kits to biometric analysis evidencing a pattern of skill improvements in education including different methods such as usability evaluations, user testing, video game development and augmented reality acceptance models. Therefore, it’s important to use recommendations that allow you to approach video games with augmented reality.

2.2 Video games for children with ADHD

Rodrigo-Yanguas et al [9] analyzed the effectiveness of a virtual reality video game,

"The Secret Trail of Moon" (TSTM) for children with ADHD. Comparing with an online chess training group and a control group, the aim is to demonstrate that both TSTM and online chess are effective in children with ADHD clinically stable on medication, and highlighting the advantages of serious video games in virtual reality

Peñuelas-Calvo et al [10] reviewed systematically the evidence on the use of video games as assessment tools and interventions for children with ADHD. It is suggested that gamification and cognitive training are key mechanisms in these interventions for children with ADHD. The need to optimize the software and promote collaboration between developers and health professionals for future research is emphasized.

Anaeet al [11] presented two exploratory studies carried out in children with ADHD and children without the disorder to illustrate behavioral patterns: excessive use and positive use of video games. One study investigates video game use using questionnaires, while the other is based on observing children's performance on video games. Pathological video game use may be a risk factor for the subsequent development of other addictive behaviors. However, in a playful and motivating context, children with ADHD are capable of mobilizing their attention capacities and achieving a performance equivalent to that of children without ADHD.

Faraone et al. [12] compared the diagnostic accuracy of the Conners Brief Rating Scale, Parent Version, the Conners Continuous Performance Test II, and the interactive game "Groundskeeper" in discriminating psychiatric patients from children with and without ADHD. The diagnostic accuracy of the Groundskeeper was found to be similar to the Conners Inattention Scale and superior to the CPT II. The combination of the three tests improved diagnostic accuracy. These preliminary findings suggest that computer games may be useful in the ADHD diagnostic process.

Cardona-Reyes et al. [1] propose the use of virtual reality environments as an alternative to support the learning process in children with special educational needs, such as ADHD and other associated disorders that children present. These proposed virtual reality environments are designed under a user-centered approach and their contents are in line with expert therapeutic guidelines. They developed a case study in which the child's experience is evaluated through the use of an interactive environment to support the special educational needs of primary school children in an educational institution in Mexico.

As a conclusion on works considered in this group, we can state that there are works focused on the development of video games with augmented reality [10] [11] [12] and virtual reality [9] [1] for children with ADHD. Among them, the effectiveness of a video game is analyzed, exploring approaches and methodologies, comparing it with other video games, improving the cognitive process. They focus on the use of assessment, treatment and educational support tools in these students with ADHD using different patterns and methodologies identified to improve the therapeutic approach to ADHD. This shows that video games are important for children with ADHD.

3 Definition of recommendations for the development of the video game

This section defines a set of ten recommendations for the development of video game applications with augmented reality for children with ADHD. The recommendations were based on the analysis of 25 research works that develop augmented reality video games for children with ADHD, to extract generic recommendations, each recommendation allows indicating that it should be used in the development of a video game with certain contexts such as: (i) the use of augmented reality, (ii) the design of software patterns, (iii) the number of sessions, (iv) cooperative games, (v) gamification techniques and others. For each recommendation, a prefix "R" with a number was used sequentially, for example, we have recommendations R1, R2, and so on. Next, we describe the recommendations for the development of the video game, that were identified in the 25 research works:

3.1 Video game development recommendations:

R1: Works that link the development of Augmented Reality (AR) in applications were analyzed: (i) Schmalstieg and Höllerer et al [13] indicate that perception used by computers in the real world amplifies human perception and cognition in a notable way, and work in The field requires knowledge in different disciplines such as computer graphics or human-computer interaction. (ii) Liu et al. [14] developed The Go-Light, augmented reality is used for the safety and protection of children at home. The use of a friendly character such as an "elf" (creature from Norse mythology) stands out, which discourages children from approaching dangerous objects or areas through actions such as dancing or jumping. (iii) Blum et al. [15] developed TimeWarp, it is a game that takes place in the open air, set in a medieval context, in which the player must find elves within a stable area. In terms of scenarios, the player can experience a city in periods from times like the Roman era, or even contemporary Europe. In conclusion, the use of augmented reality in video games can provide an interactive and stimulating environment, mainly the use of fantasy characters and environments, being beneficial for children with ADHD.

R2: Works on design patterns for video game development was analyzed, the patterns analyzed are: (a) Model View Controller (MVC) design pattern, (b) Observer pattern. The Model View Controller design pattern is the most used according to: Gamma et al. [16] show the benefits of using this design pattern are determining multiple views towards a model to provide multiple presentations to the user. The architecture of this model is conceived by adopting three architectural principles; be thin client, be layered with MVC and be balanced between client side and server side. Notable works on mobile applications with this Controller View Model pattern are provided by (i) Zhang et al [17] discuss about the implementation of a mobile augmented reality application (MAR Observer) and a server (MAR Server). For this implementation, a clear structure is demonstrated; by implementing the pattern, developers can have a more organized structure. The MVC Model would handle the business logic and data manipulation, the View would handle the presentation of aug-

mented reality effects, and the Controller would be responsible for handling user input and coordinating the Model and View. (ii) Tenemaza et al. [18] presented the MVC pattern in their project Mobile Return, a mobile application that uses adaptive augmented reality to help people with mental disabilities in their daily route, it's architecture is composed of: (a) the model, which comprises the logic business and (b) the data model. Every time the application receives a new position from the user's GPS (Global Positioning System), it calculates the return route. If the user leaves the allowed radius, the application warns the caregivers and sends messages with the information necessary to locate them. The Observer pattern according to Gamma et al. [16] serves mainly for graphical interface tools and allows application data as well as presentations to be reused independently. Some works that use this pattern are: (i) Hamza et al. [19] present TCAIOSC, this is a solution that seeks to facilitate the development of cross-platform mobile applications, it is mentioned that the use of the Observer pattern within Android mobile applications allows responding to events by the user, such as clicking on a button. or in an image. (ii) Hornariu et al. [20] present ObDroid, it is an experimental application that uses the Observer pattern for events within the Android device itself, such as messages, calls and location. In this case, the established components act as observers, waiting for certain events or content changes to occur. When an event or change is detected, the observer receives a notification and a background service is started to collect the relevant data. This Observer pattern allows the application to be highly responsive to changes on the device, where data must be collected and sent to the server. In conclusion, the Model View Controller pattern is recommended, which facilitates modularity and separation of the responsibilities of the game logic, user interfaces, and data management. In addition, the Observer behavior pattern is recommended, it can be useful for handle events and actions in the game, which is relevant in an AR environment and even more so for detecting and receiving changes in data from ADHD patients.

R3: Works and applications were analyzed about the software development approaches that should be taken for the development of applications. (i) Young et al. [21] propose iterative design as one of the most relevant in their mHealth project, a mobile health application designed to perform cognitive evaluations on older adults. The authors consider it as an approach that allows constant improvement of the product or service to the long of the time. (ii) Hooglugt and Ludden [22] present MoveDaily, a mobile application that seeks to help people adopt healthier lifestyles and increase their physical activity and focuses on exploring how digital interventions can be designed to encourage change of behavior. (iii) The PuzzleWalk application, a mobile application designed to promote physical activity in adults with autism spectrum disorder. For the development of this application, the iterative development was divided into four phases, (a) defining the target user behavior, (b) conducting participatory sessions, (c) usability evaluation through test patients, and (d) evaluation of the effectiveness and viability of the system. In conclusion, it is recommended that video game development should focus on iterative development and continuous delivery to be able to adjust the game based on user feedback.

R4: Work on immediate feedback mechanisms was analyzed in the work of (i) Bång et al. [23] presented the Power Explorer project, a mobile video game that aims

to transform the home into a persuasive environment where users can learn about household appliances and electricity consumption. The video game provides practically instantaneous feedback on the consumption of household appliances. This sets the feedback into an activity framework that can facilitate understanding of the energy consumption of household appliances. They also suggest that immediate feedback and contextualization can be means to change people's energy consumption patterns at home. (ii) Muis et al. [24] examined two studies about children's perceptions of technology use in the classroom and the effects of receiving immediate feedback while using this technology in the context of developing literacy skills. (iii) Cho and Castañeda [25] determined whether there were changes in students' motivational and affective engagement after participating in video game activities with a grammar-focused mobile application in Spanish courses. With immediate feedback, students can instantly check whether their answers are correct or incorrect, allowing them to learn and improve at their own pace. In conclusion, immediate feedback is recommended allowing children with ADHD to make a direct connection between their actions and their results. This can help them develop a better understanding of the rules of the game and improve their ability to follow these rules. Additionally, providing this type of feedback in a fun and engaging format can help maintain the child's motivation and attention.

In summary, the recommendations extracted from this category result in using augmented reality, Model View Controller pattern, Observer pattern, iterative development and immediate feedback for the video game.

3.2 Video game component recommendations:

R5: Works related to gamification techniques that the video game must have were analyzed. (i) Ahmad et al. [26] designed a mobile video game based on existing literature on techniques used to retain attention and engage children with ADHD. They mention that rewards can be used to control the behavior of children with ADHD and how they can be used so that children can get involved in the video game. Rewards should be given frequently and should be withheld for tasks not completed or for not following instructions. (ii) Chen et al. [27] make it possible to help children with ADHD manage their medication, every time children report medication intake, parents are notified and the corresponding pending reward points appear for the approval of the parents. parents. Parents can then send a brief message of encouragement along with approved reward points to reinforce children's positive behaviors. (iii) Said et al. [28] developed a mobile video game for children with ADHD. Although the document does not provide specific details on how the game uses rewards, it mentions that rewards are an important factor in engaging children with ADHD. Children with ADHD are more sensitive to rewards and providing some type of reward for each successful achievement can help engage them during the learning process. In conclusion, it is recommended to use gamification techniques as rewards in the video game, this allows children with ADHD to be involved and motivated. Rewards play a crucial role in encouraging positive behaviors and adherence to routines and tasks.

R6: Works about the concept of video game sessions were analyzed. In the work

of (i) Morón et al. [29] focus on the use of a mobile application video game, which helps the rehabilitation of patients with acquired brain damage. The video game is part of an e-care and e-rehabilitation platform, and focuses on cognitive training. Short sessions are not explicitly detailed in the document, but it is mentioned that adjustments were made based on user feedback, which could mean shorter or longer game sessions. (ii) Choik and Paik [30] developed a virtual reality upper extremity rehabilitation program using video game applications. Patients in the intervention group received 30 minutes of conventional occupational therapy and 30 minutes of the virtual reality upper extremity rehabilitation program. Play sessions last 5 to 10 minutes and are carried out as part of a broader rehabilitation program that also includes conventional occupational therapy. (iii) Jung et al. [31] introduced Neuro-World, a set of six mobile video games designed to challenge visuospatial short-term memory and selective attention, allowing users to self-administer the assessment of their level of cognitive impairment. Patients played six video games on Neuro-World for a total of 30 minutes, or approximately five minutes per game. In addition, it is mentioned that patients can play up to 30 minutes a day, two days a week. In conclusion, the use of short sessions for the video game is recommended, with a maximum time of 30 minutes per game, which allows users to participate in therapy or evaluation in a way that adapts to their individual needs and abilities.

R7: Works about cooperative games were analyzed, in the work of. (i) Zheng et al. [32] focus on the use of serious video games (video games for educational or medical purposes) to help patients with ADHD. Cooperative video games promote communication with other users. Serious video games can improve the attention and suppress the impulse of ADHD patients, and also exercise the daily living skills and social skills of ADHD patients. (ii) De la Guía et al. [33], cooperative video games in this system involve the interaction of multiple users with distributed and tangible interfaces to improve their cognitive and communication skills. De la Guía et al. [34] present StiCap, an interactive system that uses games and RFID (Radio Frequency Identification) and WiFi (Wireless Network Technology) technology for the distribution of user interfaces. Cooperative video games in this system improve the participation and integration of users, also improving their communication skills, self-confidence, self-awareness and ability to work with others. In conclusion, it is recommended to use cooperative video games as a tool to improve the cognitive and social skills of children with ADHD. Through interaction and collaboration, children can improve their attention, impulsivity, daily living skills, and social skills.

R8: Works about the concept of the integration of motion sensors and eye tracking in the development of augmented reality video games for children with ADHD is a promising strategy, supported by various research. These studies suggest that the use of eye-tracking technology and motion sensors can significantly enrich children's play and learning experience. For example, a study by Lee-Cultura et al. [35] on touchless motion-based games for children, “Motion-Based Touchless Games” (MBTG), highlights how children's digital avatars can efficiently communicate their motion-based interactivity, which is crucial in experiential learning. Additionally, games' ability to collect multimodal data through sensor technology allows for a deeper understanding of children's cognitive and affective states during play. Another of Lee-Culture et al.

[36] studied, emphasizes the importance of varying degrees of avatar representation (ASR) and its impact on children's affective and behavioral processes, suggesting the need to adapt these elements in motion-based games to better support learning experiences. Together, these findings underscore the value of incorporating motion sensors and eye tracking into augmented reality video games for children with ADHD, offering a more personalized and effective approach to enhance their gaming experience and facilitate their learning and development.

R9: Works about the concept of the recommendation to use immersive and educational narratives in the development of augmented reality video games for children with ADHD is reinforced by recent research, which highlights the effectiveness of narratives in creating meaningful learning environments. In this work Pescarin et al. [37] and Fulmore et al [38] presented the importance of intrinsically integrating narratives with educational content and personalizing the player's experience. These narratives not only increase engagement and motivation, but also improve learning outcomes by providing meaningful and relatable contexts for students. Naul & Liu [39] reinforce these findings, demonstrating that narrative distribution, endogenous fantasy, empathetic characters and adaptive and responsive narratives are key components that improve immersion, engagement and motivation, which in turn sometimes leads to greater learning. These studies collectively suggest that immersive and educational narratives are not just a complement to educational games, but an integral element that can transform the learning experience, making it more engaging, relevant, and effective for children with ADHD.

R10: Incorporating elements of mindfulness (meditation) and relaxation in the development of video games for children with ADHD can greatly benefit from the integration of interactive technologies and games. Studies such as those conducted by Weekly et al [40] and Amon & Campbell [41] have shown that interactive electronic devices, such as mobile applications, can play a positive role in health by teaching relaxation techniques and physiologically monitoring the user's progress. Additionally, it has been found that regular practice of mindfulness techniques, such as yoga, mental work and biofeedbacks; which are effective in rebalancing the autonomic nervous system (ANS) in pediatric populations. Culbert's study [42] highlights that careful selection of technology can be useful for children to learn and practice mindfulness skills in more engaging and friendly ways. Furthermore, it is suggested that adapting these skills to children's interests and learning styles, and presenting them in a friendly manner, is effective for therapeutic interaction. This approach may include the use of biofeedback and relaxation-based techniques to treat a variety of conditions. Therefore, incorporating elements of mindfulness and relaxation into video games for children with ADHD using these technologies can offer a powerful and engaging method to improve their attention, concentration, and overall well-being.

In summary, the key recommendations for developing video games for children with ADHD include using gamification techniques, short gaming sessions, and cooperative play. Additionally, integrating motion sensors, eye tracking, and augmented reality enhances the learning experience. Immersive narratives within games improve engagement and educational outcomes. Finally, incorporating mindfulness and relaxa-

tion techniques, supported by interactive technologies, can significantly aid in the well-being and attention of children with ADHD.

4 Illustrative example with the proposed recommendations

This section shows an example of a video game that contains 5 proposed recommendations (R1, R2, R5, R6, R7) for the development of a video game for children with ADHD. Next, we describe how these recommendations would be implemented in the design and functionality of the video game called “EducAR”. It is an Augmented Reality video game that seeks to improve the participation and learning of children with ADHD through an interactive and motivating environment, which incorporates fantasy characters and environments in the educational processes. This video game will only have access to the rear camera of the mobile device and will generally consist of converting what is shown on the camera to a fantasy environment.

Figure 1 shows the use of the R1 recommendation with the use of a series of friendly characters in augmented reality, which vary according to the topic of study. These characters will guide children through educational content, helping them understand concepts in a fun and interactive way. Children will have the opportunity to learn in different fantasy environments. This can be especially useful for teaching history, geography and science, as children can “travel” to different times and places.

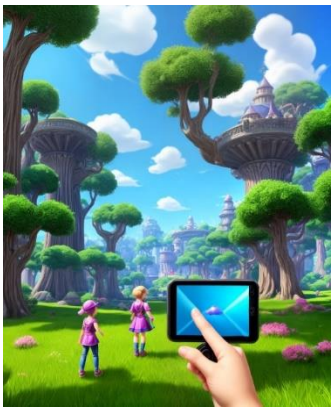

Fig. 1. Characters exploring the fantasy world with augmented reality.

Figure 2 shows that the video game contains recommendation R5 on gamification techniques that involves rewards, the video game is divided into modules, where each module has an interactive activity that reinforces the learned content and where children, when completing these modules, receive as gold score rewards, this will keep kids motivated. These activities may include treasure hunts, puzzles, and role-playing. To keep children motivated and engaged, the application will have a rewards system. Kids will earn points for completing tasks, which they can then redeem for virtual rewards. Children will receive instant feedback on their performance, which can help improve their self-esteem and motivation.

Fig. 2. Choice of modules where gold reward score is displayed

Figure 3 shows that the video game contains recommendation R6 where it is essential to take into account the duration of the game sessions to maintain the attention and interest of children with ADHD. For this reason, the application will be designed to allow play sessions of 5 to 20 minutes, and children will be able to play multiple sessions. This will provide enough time for interaction and learning, but will also limit overload and allow children to take regular breaks.

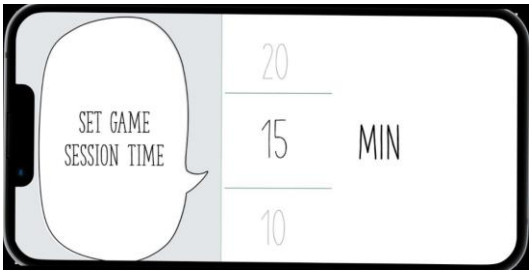

Fig. 3. Minute selection menu

Figure 4 shows that the video game contains recommendation R7 that mentions the cooperative video game. The video game will include cooperative video game features, allowing children to interact with their friends or family, encouraging collaboration and communication. These cooperative game elements could involve solving challenges together, competing in mini-games, or collaborating to achieve common goals. The video game will be compatible with most mobile devices and will comply with all privacy and safety regulations to protect children.

Fig. 4. Link with other video game users

Figure 5 shows the video game that contains recommendation R2, where it will be based on the MVC design pattern to provide a clear and organized structure. The Model component will handle the business logic and data manipulation. For example, the child's playing progress in the video game, information about rewards earned, and lessons to be presented based on previous performance. The View component will be responsible for the presentation of augmented reality effects. It will present visual information of the fantasy environment and characters, as well as the results of user interactions. The controller component will handle user input and coordinate the Model and View. It will translate user interactions, such as touching or moving virtual objects, into commands that the Model and View can understand and respond to.

Fig. 5. Child's progress, in this case how the fantasy town improves according to the user's progress.

5 Conclusions and future work

This paper summarizes a set of ten recommendations for the development of a video game with augmented reality for children with ADHD. We have analyzed 25 research works about of augmented reality of mobile application video games and design patterns to identify recommendations. The recommendations have been focused on the use development of a video game for children with ADHD. Recommendation R1 indicates the use of augmented reality in the video game, recommendation R2 emphasizes the use of design patterns such as the Model View Controller design and the Observer pattern. Recommendation R3 proposes using iterative design in the video game. Recommendation R4 considers using feedback immediately. Recommendation R5 considers gamification techniques such as the use of rewards for children in the video game. Recommendation R6 considers the use of short sessions in the video game. Recommendation R7 considers that the video game must contain cooperative games. Recommendation R8 integrates motion sensors and eye-tracking to enrich learning experiences. Recommendation R9 includes immersive and educational narratives to enhance engagement and learning. Recommendation R10 considers mindfulness and relaxation elements to improve attention and well-being.

As future work, the following have been considered: (i) develop experiments with children with ADHD using a video game with the proposed recommendations, (ii) deepen the understanding of the specific challenges faced by children with ADHD and explore new strategies to address their needs in the context of video games, (iii) analyze applications that provide emotional support, offering relaxation activities, breathing exercises, interactive games to manage stress and activities to promote self-esteem in children with ADHD; (iv) identify and incorporate new patterns, set goals, and measure progress over time with apps that help track symptoms and skills; (v) develop an experiment with the proposed recommendations with children with ADHD.

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