Development of a Pervasive Game for ADHD Children

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Abstract. The field of pervasive games is gaining importance in the last times. These games are characterized by exceeding the usual dimensions of time, space and social component that are present in traditional games. These games are usually played in an interactive space, in which several user interfaces following a multimodal approach work together to obtain the pervasive game experience. Pervasive games have proven to be useful in several fields, including the educational one. Here, we introduce *The Fantastic Journey*, a pervasive game directed towards children with Attention Deficit Hyperactivity Disorder. The game has been designed with the help of pedagogues so that it really matches some educational goals. The game is made up of some *missions* that integrate different kinds of interaction: gestural, tangible, etc. The game has been developed following a methodological approach developed as a previous work. In this paper, the main features of the game, focusing on its different missions and their educational goals, are explained.

Keywords: Pervasive game · Interactive space · ADHD

1 Introduction

Usually, games have been played out in the physical world, where they have made use of real-world objects and properties. However, human activities and relationships are migrating from the physical world to the virtual world. So, a new type of games has appeared. The term *pervasive game* is the usual way to refer to this new kind of games. Usually, the idea in pervasive games is that they overcome the limitations of traditional games in the spatial, temporal or social dimensions. In a previous work, we have defined pervasive games as "*a way to deliver a new gaming experience to the player through an evolution of the dynamics of the game, enriching the gaming space by means of the information provided by the context where it is played. This allows breaking the boundaries of the game, making reality part of it and that the elements in that reality have an influence during the game.*" [1].

Video games have proven to be useful to work with children and adolescents with special educational needs [2]. In this work we have focused on children with ADHD (Attention-Deficit Hyperactivity Disorder). Attention deficit hyperactivity disorder (ADHD) is a mental disorder whose symptoms include attention and concentration difficulties, lack of emotional auto-regulation, and a high level of impulsivity [3]. Interactive games are stimuli that can help to improve the attention and planning skills and could perform mediation functions encouraging children to explore, generate questions, and reflect. As far as we now, the game presented here is the first pervasive game aimed to ADHD children.

Pervasive games can be potentially played at any place. One possibility is to play them at an Interactive Space. Interactive Spaces are distributed user interfaces that support collaborative work in digitally augmented rooms or workplaces [4]. In our work we will work with pervasive games played in an interactive space.

This work is framed within a project for the development of multimodal pervasive games for children. In the scope of this project, we have developed a methodological proposal for the development of pervasive games [5]. One of the relevant elements in the proposal is the use of a Game Experience Design Document (GEDD) specific for pervasive games.

Taking all the aforementioned into account, in this paper we introduce a pervasive game named *The fantastic journey*. The game is intended to be played in an interactive space placed in the Cesar-Etopia labs in Zaragoza, Spain. The game is directed towards children with ADHD, and it has been developed with pedagogues that have helped us to establish the educational goals of the game.

This document is structured as follows: in Sect. 2, educational video games for ADHD are presented. Section 3 is about our previous work that has been used in the development of the game. In Sect. 4 we introduce the game with its main features. Finally, Sect. 5 is about conclusions and future work.

2 Related Work: Technologies and Applications for Children with ADHD

Several works that make use of technologies specifically developed for children with ADHD can be found in the literature. The applications can be classified considering different contexts: desktop applications, augmented reality applications and tangible interfaces. We are going to mention an example of each context.

In the context of desktop applications, ACTIVATE™ [6] is a program that combines cognitive brain training with physical exercise. It is composed by several neuroscience-based games specifically designed to increase and strengthen your child's ability to concentrate and focus, to work memory, to acquire speed in information processing, cognitive flexibility, etc. It has a real time data module that collect children results and interactions, generating reports, alerts and statistics available for parents and educators.

In the context of augmented reality, Rizzo et al. have developed a virtual classroom in order to work attention deficits [7]. They make use of a head mounted display and different tracking devices to immerse children in the classroom. Children interact with the system through a virtual teacher, who assigns them different tasks to work the

different types of attention (classified in: focused, sustained, selective, alternating and divided) while several distracters are taking place.

Lastly, in the context of tangible interfaces, TangiPlan [8] is a system composed of six tangible objects whose objective is to help children work their executive functions. Each object represents a task that the child has to carry out in the morning. The child situates the objects at the places where the tasks have to be performed and select the time that they have to devote to every task.

3 Gaming Space and Development Methodology

The interactive space where the game will be played is an indoor space of around 70 m^2. It includes a real-time localization system, Kinects, microphones, and projectors. One of the most remarkable user interfaces it includes is the set of four tangible tabletop devices which allows working with the approach of tangible user interfaces. These devices are tables capable of both displaying images and tracking objects placed on them. We have used the devices (NikVision tabletops) in previous works with children with very satisfactory results [9].

Regarding the development of the game, in a previous work we developed the GeoPGD methodological proposal for pervasive game development [5]. This proposal evolves from the classic approach of game development, adapting it to the features of these games. The four components of GeoPGD should be defined in order to specify a pervasive game. This is done in the Game Experience Design Document (GEDD). Those four components are (i) pervasive narrative, (ii) game world, (iii) rules and (iv) pervasive dynamics.

4 The Fantastic Journey

In this section, we are going to provide the details of the game making use of the most relevant information included in the GEDD of the game.

4.1 Justification and Goals

The game is directed towards children with ADHD, who have problems of attention and concentration. The game helps to work these aspects in a fun way by means of the combination of different goals, devices and technologies. The educational goals of the game are the following:

- The development of selective, focused and maintained attention.
- The development of abilities of creation, organization and selection of the best strategy depending on the task.
- The planning of paths and processes linking space and time with the efficacy of the task.
- Listening in an active way.
- Solving problems using both oral and written information.
- Collaborating in an active and respectful way to achieve a common goal.
- Self-regulation of behavior in order to achieve the tasks in an effective way.

4.2   Features, Gameplay and Story

The game is an adventure game, in which the protagonist has to progress over the story interacting with different characters and objects. It is multiplayer, as players will interact among them in a collaborative way to achieve a goal. The game is played between the real world and the virtual game. This implies that the game is pervasive mainly in the physical dimension, as players can freely move throughout the interactive space. It also could have some kind of social pervasiveness, as players can interact with other people in the space and ask them for help.

The story is about a girl called *Pipo*, who has a dream in which she puts on a magic hat. With the hat on, she flies into the space, where she meets the *Comet of laughs*, which delivers laughs all over the universe. During the encounter, Pipo gets lost with the *bag of laughs*. Then, she decides to travel through the space to find the comet and return the bag. This story is an evolution of the one defined in [10].

The game uses the technologies present in the interactive space explained in Sect. 3. The target players of the game are between 7 and 12 years. The children will be accompanied by one of more *mediators*, which will supervise them, help them if they need it, or manipulate the progress of the game if the children find any difficulty. Before the start of every mission, a video with instructions is projected on the walls. The mediator has the option to replay it if needed.

4.3   Elements of the Game

The main elements that are present in the game are the following: the *protagonist*, the *friends* that will interact with her, the *stars* where the *missions* (challenges) take place and the *sound*, made up by a main theme and sound effects.

The physiognomy and visual style of the protagonist have been designed by a product designer following the recommendations of the pedagogues related to which would work best with ADHD kids: smooth and round shapes, smooth and not loud colors, visually powerful but without adornment. The final appearance of the character is shown in Fig. 1.

4.4   Missions

Magic Words. Here, children have to pay attention to the lyrics of a song and then, order the words that make up the chorus. This is made in the tabletop devices.

The Sun and The Moon. In this mission, children have to make up the shapes of the sun and the moon (projected on a wall) by placing themselves (localization) in the interactive space.

The Search for the Suitcase. Here, players have to find a suitcase and a key. The suitcase is physically hidden, whereas the key can be obtained by playing Starloop [4], a game that we have developed to improve computational thinking in kids.
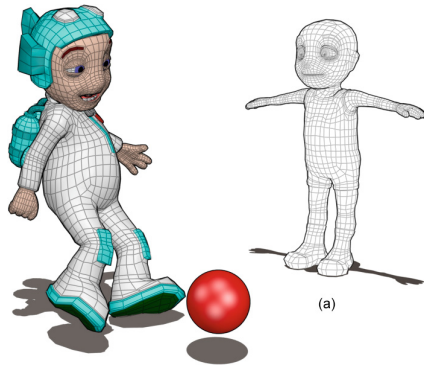
(a)

Fig. 1. Appearance of the protagonist of the game. In the right side of the figure, the main anatomy of the protagonist, made up of 5046 polygons.

Keyword. This mission allows working attention in both selective and global levels. Children will listen to a story in which a word is constantly repeated. Then, they will have to find the word in an alphabet soup that will appear on the tabletop devices.

Indians. Here, children have to follow patterns, so successive processing and selective attention are worked. Each tabletop device will represent a color and a shape (Fig. 2 left). First, players have to touch the table when it matches the element shown. Afterwards, they will have to touch the table repeatedly when it is required.

Fig. 2. Indians (left) and Butterflies (right) missions.

Freeing the Stars. Here, the goal is to free three stars that have been trapped in a spider web. Selective attention and simultaneous processing are the abilities developed. The player has to select the elements required by means of gestural interaction.

Meteorite Attack. This mission is about destroying a set of meteorites. It helps to work on selective attention and planning of time-space paths. The meteorites get destroyed by interacting with the tabletop devices.

Butterflies. In this game, players must stay quiet so that the butterflies that are projected on the walls are placed on the flowers (Fig. 2 right). The idea is to work on the inhibition of impulsive behaviors and on self-control. When the players have been quiet for two minutes, the mission finishes.

Encounter with the *Comet of Laughs*. The last phase of the game consists of a projection of the last scene, in which the protagonist meets the *Comet of laughs*, and of the playing of the song of the game, which will be sung and danced by the children.

5 Future Work

In this paper we have introduced *The fantastic journey,* a pervasive game for children with ADHD to be played in a multimodal interactive space. The game has been developed following a methodological approach which is specified in a Game Experience Design Document. The game is designed to achieve some educational goals. Thanks to the research project, we have been collaborating during the last two years with an association of children with ADHD and their families; in fact, they have help us to establish the educational goals of the game. Thanks to this collaboration, we will be able to evaluate the complete game, which will be our next step.

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