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Expanding the Magic Circle in Pervasive Casual Play

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Abstract

In this document we present proposals for merging the fictional game world with the real world taking into account the profile of casual players. To merge games with reality we resorted to the creation of games that explore diverse real world elements. We focused on sound, video, physiological data, accelerometer data, weather and location. We made the choice for these real world elements because data, about those elements, can be acquired making use of functionality already available, or foreseen in the near future, in devices like computers or mobile phones, thus fitting the profile of casual players who are usually not willing to invest in expensive or specialized hardware just for the sake of playing a game.

By resorting to real world elements, the screen is no longer the only focus of the player's attention because reality also influences the outcome of the game. Here, we describe how the insertion of real world elements affected the role of the screen as the primary focus of the player's attention.

Games happen inside a magic circle that spatially and temporally delimits the game from the ordinary world. J. Huizinga, the inventor of the magic circle concept, also leaves implicit a social demarcation, separating who is playing the game from who is not playing the game [1]. In this document, we show how the insertion of real world elements blurred the spatial, temporal and social limits, in our games. Through this fusion with the ordinary world, the fictional game world integrates with reality, instead of being isolated from it. We also present an analysis about integration with the real world and context data in casual entertainment.

Keywords: Casual games; Pervasive games; Sound; Video; Physiological data; Electrodermal activity; Accelerometer; Weather; Location.

Resumo

Neste documento são apresentadas propostas para fundir o mundo ficcional dos jogos com o mundo real tendo em conta o perfil dos jogadores casuais. Para unir jogos com realidade, procedemos à criação de jogos que exploram o uso de diversos elementos do mundo real. O nosso foco foi no som, vídeo, dados fisiológicos, acelerómetro, meteorologia e localização. Escolhemos estes elementos do mundo real porque é possível adquirir dados, relativamente aos elementos referidos, fazendo uso de funcionalidade já disponível, ou previsível num futuro próximo, em computadores e telemóveis, o que se adequa ao perfil dos jogadores casuais, jogadores esses que normalmente não estão disponíveis para investir em hardware dispendioso ou especializado, simplesmente para jogar.

Devido ao uso de elementos do mundo real, o ecrã deixa de ser o único foco de atenção do jogador, uma vez que a realidade também influencia o jogo. Neste documento, é descrita a forma como a inserção de elementos do mundo real afetou a posição do ecrã como o principal foco da atenção do jogador.

Os jogos acontecem dentro de um círculo mágico, que delimita espacialmente e temporalmente o jogo do mundo comum. J. Huizinga, o inventor do conceito do círculo mágico, também deixa implícita uma demarcação social entre quem está a jogar o jogo e quem é exterior ao jogo [1]. Nesta dissertação, mostramos como a inserção de elementos do mundo real tornou os limites espaciais, temporais e sociais mais difusos, nos nossos jogos. Graças a esta fusão com o mundo comum, o mundo fictício do jogo deixa de existir numa dimensão à parte da realidade para se integrar com a realidade. Também é apresentada uma análise sobre a integração de elementos do mundo real e dados de contexto no entretenimento casual.

Palavras-chave: Jogos casuais; Jogos pervasivos; Som; Vídeo; Dados fisiológicos; Atividade electrodermal, Acelerómetro; Meteorologia; Localização.

Contents

List of Figures

List of Tables

1. Introduction

It's a dangerous business, Frodo, going out of your door [...] You step onto the road, and if you don't keep your feet, there's no knowing where you might be swept off to.

J. R. R. Tolkien , The Lord of the Rings

Playing is an activity that has been around for a long time. According to J. Huizinga [1] play is free as people play because they enjoy it, not because they are forced to do it or because they are driven by some material interest. Play is also not real life but an escape from real life. Games happen inside a magic circle, a sacred isolated space that immerses the players [1].

For K. Salen and E. Zimmerman [2] a game is "*a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome*". Similarly to J. Huizinga, these authors think that games are artificial because they are separated from real life. There is conflict in games because games are a contest of powers that abide to certain rules. Games have a quantifiable outcome and at the end a player has either won or lost.

Digital games are games that use computers, mobiles phones or game consoles. Digital games have many advantages when compared with non digital games. In digital games the feedback can be immediate. Another advantage is the possibility of making use of large amounts of digital data like texts, images, video, audio, animations or 3D content and present it to the player when necessary. In digital games it is possible to automate complex procedures thus facilitating the gameplay. For example, in a digital chess game the computer can automatically move the pieces and ensure that the rules are not broken. If played on a device connected to the Internet, digital games allow networked communication with other people far away. In this way, people in different continents can play together. Non digital games may also share some or all of these qualities but in digital games these advantages are usually more robust [2].

However, even though all the advantages of digital games, they suffer, in our view, of the following limitation: the screen is the player's primary or even only focus of attention. Furthermore, interaction is narrow. Many games are still played only with keyboard input and screen and speakers output. With devices like Microsoft's Kinect, the Nintendo Wii Remote or the PlayStation Move Motion Controller the range of interaction widens. However, even with these devices, the screen is rarely deprived of its prime position. It would be interesting if, at least during a few moments, digital games could be played without looking at a screen. Pervasive games have already accomplished that objective with the inclusion of real world elements in games. That way, the player also has to pay attention to what is happening around her, because that will influence the outcome of the game. From here arises the motivation of our work.

1.1. Motivation

The motivation of our work is to merge casual games with the real world. While hardcore games have only the hardcore public in mind, a flexible casual game will be accessible enough for a game illiterate person but also difficult enough for the exquisite taste of hardcore players. By hardcore players it is meant here the select audience who invests long hours playing games and for whom games are more than simple fun. For true hardcore players, the game comes first, even in detriment of their real lives outside the game. Casual players, on the other hand, have a lighter view of the game world and use it, mainly, as a way to fill idle moments or to alleviate boredom. For a typical casual player life comes first and the game world follows, eventually, far beyond [3]. More information about the difference between casual and hardcore players can be found in Section 2.3.

Casual games assume the challenge of pleasing all audiences and bypass the luxury of focusing only in a restricted group of elite players. By fulfilling the requirements of a casual audience, hardcore players can still be attracted towards a game. However, when designing a game for hardcore players, casual players will be alienated [3,4]. By focusing on casual players' characteristics our motivation here is to provide pervasive gameplay for everyone. We intend to reach the casual players, who play games to pass the time of for stress relieve, but also the dedicated hardcore players who consider games to be a fundamental part of their lives.

Casual games are designed to attract the general public, but pleasing everybody is no easy task. Pleasing everybody, with a pervasive component in between, is even more difficult. Adding a pervasive component to casual games in such a way that these games do not cease being casual, is an ambitious and difficult objective [5]. However, we consider this is a worthwhile objective because, again, as casual games are games for everyone, consequently, research done in this area will benefit a large number of persons.

From an economic point of view, casual games are an interesting area with revenues that, in 2010, amounted to $6.00 billion [6]. Furthermore, according to the Newzoo report [7], online casual, social and mobile games take 49% of the time spent on games and account for 27% of the money spent on games. Finally, casual games accounted for 75% of the time spent in PC video games in the game titles tracked in the Nielsen report [8].

1.2. Research Goal

Our objective is to break the barrier between reality and games, by integrating real world elements in casual games, and thus decrease the focus of the player's attention on the screen and divert that attention to the environment around the player. We, therefore, intend to introduce a pervasive twist in casual games in a way that complies with the following conditions [9]:

- As casual games are easy and simple to play, the real world elements must thus be integrated in a way that the game remains easy and simple for the player.
- Casual players are usually not willing to invest in expensive or specialized hardware [10]. So the inclusion of real world elements will make use of functionality already available (or foreseen in the near future) in devices like computers, portable computers or mobile phones.

1.3. Research Questions

From our research goal emerges one main research question and several subordinated sub questions:

- How is it possible to break the barrier between games and reality?
  - How can real world elements be inserted in casual games?
  - How can the player's attention be diverted from the screen?
  - How can the magic circle be expanded?
  - What are the technological challenges on the player side?

How to break the barrier between games and reality is our main research question. To answer it will be necessary to devise strategies for inserting real world elements in casual games, which constitutes the first research sub question. After inserting the real world elements in games, we will evaluate how they succeeded in what concerns diverting the player's attention from the screen and in what concerns enlarging the magic circle. The forth sub question will address challenges when providing pervasive entertainment to a causal audience.

1.4. Overview of the Research

The context that frames our research is presented in Chapter 2. Chapter 3 includes our proposals for merging casual and pervasive, via the insertion of real world elements in games. Chapter 4 considers how the insertion of real world elements influenced the role of the screen. Chapter 5 discusses how the magic circle was expanded. Chapter 6 presents an analysis about integration with the real world and context data and the technological challenges associated with pervasive entertainment. Finally, the conclusions are in Chapter 7.

1.5. Contributions and Publications

This research work provides the following contributions:

- ✓ Merge of casual games with reality through the integration of real world elements in games (Chapter 3). The real world elements we worked with are sound, video, the player's physiological data, accelerometer data, the player's location and the weather.
- ✓ Development of four games that demonstrate the integration of real world elements in casual games: the Castle of Count Pat (Section 3.1), the Imaginary Friend (Section 3.2), Weather Wizards (Section 3.3) and the Enchanted Moor (Section 3.4).
- ✓ An evaluation on how the introduction of real world elements affected the role of the screen (Chapter 4) and the magic circle (Chapter 5).
- ✓ A global reflection about the challenges faced when integrating real world elements and context data for providing pervasive games to a casual audience (Chapter 6).

The research work described in this document included a three months stay at Telefónica Research, in Barcelona, and a presentation of the work at the 3rd International UBI Summer School 2012 in Oulu, Finland.

Aspects of the described work are included in the following publications:

- Journal
  - S. Reis, N. Correia, Casual Games with a Pervasive Twist, Submitted to Entertainment Computing, Springer-Verlag (Chapter 4 and Chapter 7).
- Full papers
  - S. Reis, N. Correia, Co-located Interaction in Casual Games for the Dissemination of Traditional Stories, in: Proceedings of the 5º Science and Videogames Conference - 2012, Lisbon, Portugal, Portuguese Society for Videogames Science, 2012 (Section 3.4, Chapter 4, Chapter 5, Chapter 6 and Chapter 7).
  - S. Reis, N. Correia, Playing with the Weather, in: Proceedings of the 11th International Conference on Entertainment Computing (ICEC'12), Bremen, Germany, Springer-Verlag, 2012, pp. 172-184 (Section 3.3, Chapter 4, Chapter 5, Chapter 6 and Chapter 7).
  - S. Reis, N. Correia, An Imaginary Friend that Connects with the User's Emotions, in: Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology (ACE'11), Lisbon, Portugal, ACM, 2011 (Section 3.2, Chapter 4, Chapter 5, Chapter 6 and Chapter 7).
  - S. Reis, N. Correia, The Perception of Sound and Its Influence in the Classroom, in: Proceedings of the 13th IFIP TC 13 International Conference on Human-Computer Interaction - Volume 6946 - Part I (INTERACT'11), Lisbon, Portugal, Springer-Verlag, 2011, pp. 609-626 (Section 3.1, Chapter 4, Chapter 5, Chapter 6 and Chapter 7).
- Short papers
  - S. Reis, N. Correia, Engaging the Players with the Use of Real-Time Weather Data, in: Proceedings of the 4º Science and Videogames Conference - 2011, Porto, Portugal, Portuguese Society for Videogames Science, 2011, pp. 173-179 (Section 3.3, Chapter 4, Chapter 5, Chapter 6 and Chapter 7).

- S. Reis, S. Cavaco, N. Correia, Educative Sound Game, in: Proceedings of the 3º Science and Videogames Conference - 2010, Lisbon, Portugal, Portuguese Society for Videogames Science, 2010, pp. 159-164 (Section 3.1, Chapter 4, Chapter 5, Chapter 6 and Chapter 7).

- Doctoral consortium
  - S. Reis, Expanding the Magic Circle in Pervasive Casual Play, in: Proceedings of the 11th International Conference on Entertainment Computing (ICEC'12), Bremen, Germany, Springer-Verlag, 2012, pp. 486-489 (Chapter 1 and Chapter 7).
- Work in Progress
  - S. Reis, K. Church, Insights into Co-located Shared Mobile Search, in: CHI '13 Extended Abstracts on Human Factors in Computing Systems (CHI EA'13), Paris, France, ACM, 2013, pp. 1401-1406 (Chapter 6 and Chapter 7).
- Poster
  - S. Reis, T. Romão, N. Correia, Pervasive Play for Everyone Using the Weather, in: Proceedings of the 7th International Conference on Advances in Computer Entertainment Technology (ACE'10), Taipei, Taiwan, ACM, 2010, pp. 104-105 (Chapter 1 and Section 3.3).
- Workshops
  - S. Reis, N. Correia, Encouraging Co-located Players Social Interaction, in: Designing and Evaluating Sociability in Online Video Games - A CHI 2013 Workshop, Paris, France, 2013 (Section 3.2).
  - S. Reis, K. Church, N. Oliver, Rethinking Mobile Search: Towards Casual, Shared, Social Mobile Search Experiences, in: Searching 4 Fun! 2012, Barcelona, Spain, CEUR-WS.org, 2012, pp. 1-4 (Chapter 6 and Chapter 7).

2. Related Work

Guybrush: At least I've learnt something from all of this.
Elaine: What's that?
Guybrush: Never pay more than 20 bucks for a computer game.
Elaine: A what?
Guybrush: I don't know. I'm not sure why I said that.

The Secret of Monkey Island, LucasArts

To merge casual games with pervasive games it is firstly necessary to know the previous work done in these two genres of games. This chapter begins by further describing the magic circle, the frontier that demarks the territory where games happen (Section 2.1). Section 2.2 describes pervasive games and Section 2.3 describes casual games. Previous attempts of merging casual and pervasive games are mentioned in Section 2.4.

2.1. Magic Circle

Back in 1938, the celebrated theorist and historian, Johan Huizinga, in his book *Homo Ludens: A Study of the Play-Element in Culture* [1], defined play as "*a free activity standing quite consciously outside 'ordinary' life as being 'not serious', but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own* *proper boundaries of time and space according to fixed rules and in an orderly manner. It promotes the formation of social groupings which tend to surround themselves with secrecy and to stress their difference from the common world by disguise or other means*". From this work, the following characteristics of play can be highlighted:

- **Play is free** – People play because they enjoy it, not because of a physical necessity, material interest of moral duty.
- **Play is not real life** – Play is, on the contrary, an escape from real life.
- **Play is limited in both time and space** – playing is an activity that begins and ends and that happens inside a demarked playground.
- **Play creates order and is order** – play brings a temporary and limited perfection to an imperfect word [1].

Play is spatially and temporally separated from real life. Besides the spatial and temporal demarcation, during a play activity, a social demarcation is also implicit, in the form of the promotion of social groupings and in the secrecy that separates the ones who are playing from the ones who are not playing.

In the book *Homo Ludens: A Study of the Play-Element in Culture* the magic circle concept is introduced: "*The arena, the card-table, the magic circle, the temple, the stage, the screen, the tennis court, the court of justice, etc., are all in form and function play-grounds, i.e. forbidden spots, isolated, hedged round, hallowed, within which special rules obtain. All are temporary worlds within the ordinary world, dedicated to the performance of an act apart. Inside the play-ground an absolute and peculiar order reigns*" [1].

Departing from J. Huizinga's work, other authors have delved into the concept of the magic circle. For K. Salen and E. Zimmerman [2] "*the magic circle of a game is where the game takes place. To play a game means entering into a magic circle, or perhaps creating one as a game begins. The magic circle of a game might have a physical component, like the board of a board game or the playing field of an athletic contest. But many games have no physical boundaries - arm wrestling, for example, doesn't require much in the way of special spaces or material. The game simply begins when one or more players decide to play*". So, these authors also locate the game inside the protective frame of the magic circle.

For J. Juul [11], the magic circle is "*a description of the salient differences between a game and its surrounding context. It does not imply that a game is completely distinguished from the context in which it is played*". To illustrate this definition J. Juul mentions one example where, at dinner table, person A wants to reach for the salt but sees person B already extending her hand for it. It will be considered inappropriate for A to snatch the salt from B. However if, latter in the evening, A and B are playing a game, and A sees the chance to capture a game piece from B, then A will not hesitate to do it. Polite conduct is therefore different in the context of the dinner and in the context of the game. J. Juul adds that the magic circle is "*clearly not a perfect separation of a game from the rest of the world, but an imperfect separation that players negotiate and uphold*", classifying the magic circle, as "*the boundary that players negotiate*".

T. L. Taylor [12] starts by claiming that "*Games are typically thought of as closed systems of play in which formal rules allow players to operate within a 'magic circle' outside the cares of everyday life and the world. This rhetoric often evokes a sense that the player steps through a kind of looking glass and enters a pure game space. From Monopoly to Final Fantasy, commercial games in particular are often seen as structures conceived by a designer and then used by players in accordance with given rules and guidelines*". However, even though games are typically seen as closed spaces, T. L. Taylor argues that this may end up not happening because "*Players, however, have a history of pushing against these boundaries*".

M. Nitsche [13] further adds to an idea of an expanding game playground by foreseeing that "*Game worlds will spread into private spaces such as living rooms as well as public spaces like restaurants, prisons or museums – not to offer a virtual window in some kind of 'otherworld' but to provide a new perspective on the existing one. Ultimately, this is what these games will aspire to: to create new realities*". Nevertheless these new realities, though they may be superimposed on the real world, still somehow stand apart, or they would not be a new reality, but part of the existing reality.

E. Castronova [14] defined the magic circle in what concerns the synthetic world of cyberspace: "*I use a metaphor that I've found quite helpful in thinking about synthetic worlds: the membrane. The synthetic world is an organism surrounded by a barrier. Within the barrier, life proceeds according to all kinds of fantasy rules involving space flight, fireballs, invisibility, and so on. Outside the barrier, life proceeds according* *to the ordinary rules. The membrane is the 'magic circle' within which the rules are different. The membrane can be considered a shield of sorts, protecting the fantasy world from the outside world. The inner world needs defining and protecting because it is necessary that everyone who goes there adhere to the different set of rules. In the case of synthetic worlds, however, this membrane is actually quite porous. Indeed it cannot be sealed completely; people are crossing it all the time in both directions, carrying their behavioral assumptions and attitudes with them*". E. Castronova proceeds to explain that the membrane can be permeated via markets, politics and law.

The membrane is permeated via markets because when a player invests countless hours to fabricate a magic sword in the synthetic world of cyberspace that sword acquires real value. If players sell the objects they manufactured to other players charging real money, then this transaction somehow leaked into reality. Eventually, manufacturing magic swords in the game could become such a profitable activity that people would quit their daytime jobs to become a permanent worker in the virtual world. One could argue that the sword does not exist, that its value is illusory. However, E. Castronova counters that diamonds' value is also illusory. What good is a shinny stone that people wear around their necks, on their fingers or on their ears? If they are stranded alone on a desert island that stone is good for nothing. Though its frivolous nature the diamond has real value because of the time people invest to mine and polish it. Similarly, the magic sword becomes a commodity with real value because of the hours invested in it.

The membrane is permeated via politics because players conspire, in the privacy of forums outside the game, to change the rules of the game. For example, a group of archers may protest that the wizards are too powerful. Wary of the influence of the archers, the owners of the game, the programmer dictators, may wield to the pressure, officially announcing in the game that "*We felt that wizards were becoming too overpowered with their use of the Staff of Stupidity, so we reduced its damage*" [14]. And, thus, the rules of the game were corrupted by what happened outside the magic circle.

The membrane can also be permeated via law if the objects diligently manufactured by the players, in the game, become real property, eventually even protected by law. The synthetic world can be seen as a piece of software, just like Microsoft Word. Bill Gates does not own the documents that users created with Microsoft Word, so why should the programmer dictators own the magic sword or the Staff of Stupidity that players created in the game [14]?

K. Huynh et al. [15] further elaborate on the concept of the magic circle claiming that what happens inside the magic circle does not always stay inside the magic circle. As proof they present the case of a massively multiplayer online role-playing game that allows players to practice engagement and marriage rituals. These amorous relationships do not always remain as simple make believe with several players meeting their virtual romantic partners offline in the real world. These virtual couples cross the border of the magic circle into reality thus showing that the magic circle is not an unassailable barrier.

Another author that worked on the concept of the magic circle is M. Copier [16]. She considers that the current use of the magic circle is problematic and proceeds to argue that "*The visualization and metaphorical way of speaking of the magic circle as a chalk, or even, rusty circle is misleading. It suggests we can easily separate play and non-play, in which the play space becomes a magical wonderland. However, I argue that the space of play is not a given space but is being constructed in negotiation between player(s) and the producer(s) of the game but also among players themselves*". According to this author, there is no magic wonderland created from a complete isolation of the act of play. Still, M. Copier [16] relents that there is still a separation, though this separation is negotiable.

M. Consalvo [17] goes further in what refers to the permeability of the magic circle to the point of defending that there is no magic circle. She defies J. Huizinga's proposal and does not consider games as places isolated from ordinary life: "*we cannot say that games are magic circles, where the ordinary rules of life do not apply. Of course they apply, but in addition to, in competition with, other rules and in relation to multiple contexts, across varying cultures, and into different groups, legal situations, and homes*".

Except for M. Consalvo's [17] more radical view, there seems to be a general consensus, among the mentioned authors, that the magic circle protects the game, though there may be some crisscrossing or discrete smuggling, with the real world, going on along this frontier. The magic circle could therefore be broadly defined as "*the idea that a boundary exists between a game and the world outside the game*" [18].

Authors differ on how the magic circle is porous: J. Juul and M. Copier say the border between game and reality is subject to negotiation [11,16]; T. L. Taylor reports that players push against the boundaries [12]; M. Nitsche sees the playground invading the real world [13]; E. Castronova permeates the border with markets, politics and law [14]; evidence is furthermore provided that the border can be crossed romantically [15]. Even J. Huizinga, though defending the playground is a territory of seclusion, mentions the case of play communities that function as a way for players to retain the magic after the individual game is over, and admitting "*how difficult it is to draw the line between, on the one hand, permanent social groupings […] and the sphere of play on the other*" [1].

Though these differences among the authors, for the sake of consistency, in this document, we will retreat to the source in the form of the coiner of the term, J. Huizinga, and consider that the magic circle is limited spatially, temporally and socially and that it can be breached along these three axes. This was the perspective already previously assumed by M. Montola et al. [5], who also considered that the magic circle can blur spatially, temporally and socially. A game expands spatially if the game appropriates the ordinary world, with the whole world eventually becoming a playground. A game expands temporally if it is no longer clear when one is playing or not playing the game. And, finally, a game expands socially if it is no longer clear who is and who is not involved in the game [5].

There is no material proof that considering the border between the game world and the real world in terms of space, time and social is the correct and ultimate way. Why not in terms of negotiation? Why not in terms of markets, politics and law? However, as E. Zimmerman [18] sagaciously mentioned, nobody has ever seen the magic circle, nobody has managed to proof its existence by technological means, invoke it paranormally and there is no magic circle prophet, or as E. Zimmerman more accurately put it, no "*magic circle jerk*". In his words, "*The magic circle jerk doesn't exist. […] I'm sick of the magic circle jerk. Let's bury the bastard*" [18]. So, if no one has seen this border, it is debatable what the border is and how it relates to reality.

To sum up, in face of the controversy, whenever we refer to the magic circle, latter on in this document, the following is meant:

- The magic circle is a border between the game and reality.
- The magic circle limits the game in terms of where the game is played, when the game is played and with whom the game is played.
- The border can be expanded spatially, temporally or socially.

However, it is out of our scope to decide on a final definition of the magic circle. The assumptions made here about the magic circle and the spatial, time and social limits are made mostly for the sake of clarity. What we, indeed, aim is to use the real world elements to promote further contact between the fictional game world and reality (Section 1.2), regardless of an exact definition of the magic circle.

2.2. Pervasive Games

Pervasive games are games that merge with real life. A pervasive game is a "*genre in which traditional, real-world games are augmented with computing functionality, or, depending on the perspective, purely virtual computer entertainment is brought back to the real world*" [19].

PacManhattan [20], InStory [21], the Beast [22] and KnightMage [23] are four good examples of pervasive games.

PacManhattan [20] recreates the Pacman game in the streets of New York. In this game a player, wearing a Pacman costume, runs around trying to collect all the virtual dots. Four other players, dressed in ghost costumes, try to catch the Pacman player before all the dots are collected. The Pacman and the Ghosts each have a controller with whom they contact via mobile phone. As the dots are virtual, Pacman cannot see them. Pacman's controller, who updates Pacman's position on a map, directs Pacman to the still not eaten dots. The Ghosts' controllers also update the Ghosts' position on a map. After eating a Power Pellet, Pacman can hunt down the Ghosts. Pacman's controller communicates this information to the Ghosts' controllers who will then relay it to the Ghosts.

In InStory [21] users discover Quinta da Regaleira. Quinta da Regaleira is a beautiful architectural complex, classified as World Heritage, that includes a twentieth century palace and a garden for initiation rites with labyrinthine galleries and subterranean grottoes. Quinta da Regaleira is connected with strong alchemical and sacred connotations. Users visit this mystical place with the help of a mobile device that provides them geo-referenced activities. The mobile device offers specific information about the place the user is visiting as well as stories and games [24]. Players interact with several virtual characters, who function as narrators, such as a Hunter, an Amazon, a White Lady, an EcoVegan animal protecting figure and a Greyhound. To gain points and advance levels players solve puzzles and enigmas where they have to retrieve in-situ information at the geographical location they are currently at [25]. Players can also upload photographs, videos, sound clips and texts to create their own personalized activities [24]. As InStory is a flexible platform, that supports mobile storytelling, gaming activities and information access [21], it can be adapted to the exploration of other cultural or historical spaces. The system provides two applications, InAuthor and InContent. InAuthor is a game editor for the creation of geo-referenced storytelling and gaming activities, which are represented as nodes. InContent allows the design of screen areas that function as content for the nodes [24].

The Beast [22] was designed to promote the Steven Spielberg film Artificial Intelligence. In the film's posters Jeanine Salla was credited as being the sentient machine therapist. Those who considered this strange and searched the Internet found out that Jeanine Salla had a web presence. The game never admitted that it was not a game. To support this illusion the organizers of the game uploaded, to the Internet, a collection of photos, movies, audio recordings, scripts, corporate material, logos, web sites and flash movies. Players even received faxes and packages full of game world props and artifacts via the postal system.

KnightMage [23] is another example of a pervasive game where players explore a dungeon filled with treasures, equipment and monsters. The game resorted to STARS, a hardware and software platform, that enhances traditional board games with computing functionality. The platform provides virtual game components and the players can interact with physical playing pieces.

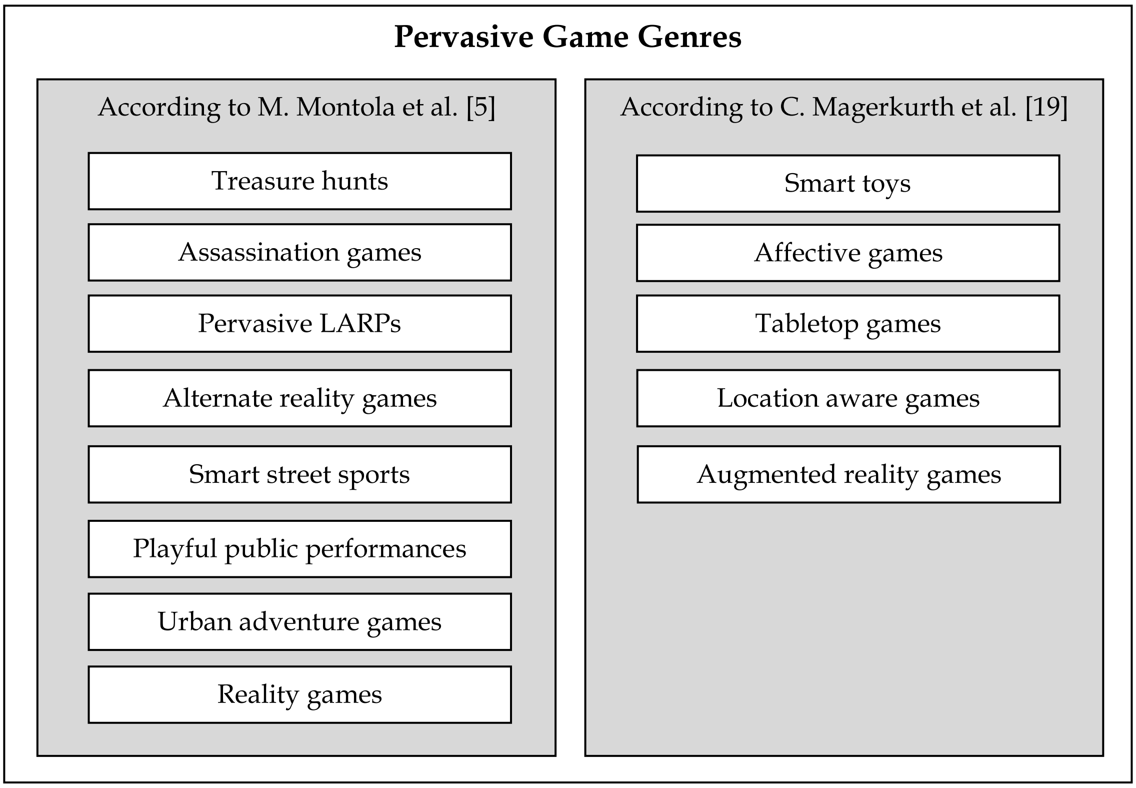


Figure 2.1: Pervasive game genres.

Pervasive games can fall into the following categories (Figure 2.1): treasure hunts, assassination games, pervasive live action role playing games (LARP), alternate reality games, smart street sports, playful public performances, urban adventure games and reality games [5].

Treasure hunts are about finding something. It may be, for example, a hidden object, a person or a location [5]. Geo cashing is a popular form of treasure hunt where players are given the GPS coordinates of a hidden object or place they have to find. In Story Mashup [26] players take pictures, with a camera phone, to illustrate stories. Nouns are extracted from the stories and players have to take a picture that matches that noun in a certain amount of time. The

Great Scavenger Hunt [27] is another game where players have to take pictures that match a list of items.

Assassination games were inspired by the film *The 10th Victim*. In this film people participate in a hunting game to satisfy their violent instincts. The hunting game has 10 rounds. In five of the rounds the player is the assassin and in the other five rounds is the victim. The player who survives receives a big reward [5]. BotFighters [28] is one example of an assassination game. The player's mission is to locate and destroy other players armed with a mobile phone that is turned into a weapon. Cruel 2 B Kind [29] is another game where players slain each other with serenades, compliments or an innocent group cheer.

Pervasive LARPs are dramatic and narrative game forms that occur in a physical environment. Players pretend they are someone else and pursue objectives while interacting with each other in character. Costumes and props are used to add more believability to the characters. Pervasive LARPs have diverse themes like vampires, crime, historical settings or futuristic eras. This type of game is usually created by a community and for that community only and has no external audience. The urban space may serve as a scenario for the pervasive LARP but outsiders are seldom included in the game. For example, in Masquerade, the vampires who reveal the supernatural world to outsiders are punished with death. Profit is rarely an objective and participation fees cover the expenses of setting up the game and little else [5,30]. Momentum [31] is another pervasive LARP where players pretend they are the ghosts of dead revolutionaries who were attacked by the forces of conformism and who have returned to the land of the living.

Alternate reality games present themselves not as games but as real life. This sort of games uses reality to build a fictional narrative where players usually cooperate, rather than compete, to solve puzzles and enigmas. Alternate reality games resort to multiple communication channels like web pages, email messages, phone calls or print based mails to progressively reveal clues to the players [5,32]. The Beast, that was already described before, in this document, is an alternate reality game. In I Love Bees [33], which is also an alternate reality game, the objective was promoting Microsoft's videogame Halo 2. It all started with a URL that appeared in a Halo 2 trailer. This was the URL to Margaret's site who was an amateur beekeeper. Margaret was a fictional character but nothing in the site indicated this. Several clues were hidden in Margaret's site that had been hacked. After a few months players finally discovered that the hacker was a damaged program that was leaking memories and code.

In smart street sports, another type of pervasive games, there are two kinds of players. One kind of players moves around in a city or in a more restricted space, like a university campus. These players are equipped with mobile phones or handheld computers. The other kind of players are sitting at their computers and play the game through the Internet. This second kind of players can communicate with the players that are moving around to give them instructions or information [5].

The previously mentioned PacManhattan [20] falls into the smart street sports genre. Human Pacman [34] is another smart street sport inspired in the Pacman videogame. In this game there is also a Pacman player that runs around in the real world and Ghost players that hunt down the Pacman player. Each of these physical players is helped by another player who is an Internet online player. However, in Human Pacman, contrary to what happens in PacManhattan, the helping players do not have to manually update the physical players' position on a map. Pacman and the Ghosts are equipped with wearable computers that do that task automatically. Furthermore, here, contrarily to what happens in PacManhattan, Pacman sees the dots in AR mode via the HMD display that is part of the wearable computer. Nevertheless, helpers are still necessary. Helpers inform their physical players' of the location of enemy players as they are not visible in a map that appears in AR mode.

Can You See Me Now [35] also belongs to the smart street sports category. In this game, runners chase online players in a city. Runners really have to run. Online players use the arrow keys on the computer keyboard to escape the runners in a virtual model of the real city accessible through the Internet. Runners, who are located via GPS, can see the positions of online players on a handheld map and can communicate with each other using walkie-talkies.

Capture the Flag [36] is another smart street sports where the players that move around are knights and the ones that sit at their computers and play through the Internet are guides. The knights' position is tracked via GPS. At the beginning of the game knights choose the location of their castle by placing a physical flag on the ground. The flag is a Bluetooth embedded device. After that a virtual castle and a flag appear in the guides' 3D map and in the knights' mobile phone screen. The knights' objective it to reach the opponent's castle and capture their flag. Guides place virtual magic potions and traps in the ground. As these items are invisible to knights it is up to the guides to orient knights towards rewards and away from danger.

Like smart street sports, playful public performances are also played in public spaces. However, smart street sports focus on competition and playful public performances are aimed at creating a spectacle [5]. The Big Urban Game [37] is an example of a playful public performance. It was a game designed for Minneapolis and Saint Paul with the objective of changing people's perspective about the cities they live in. In the game, three teams competed to move a 25 foot high inflatable chess piece through a series of checkpoints. The pieces' position was shown on the game's website and on local newspapers. Players voted on the route they thought the chess piece should follow. The chess piece was transported by volunteers along the selected route and the time spent in that operation was added to the team’s total time. At the final checkpoint the team with the lower total time was declared the winner. The previously mentioned Momentum [31], that was included in the pervasive LARP category, also includes some playful public performances. One of the public events was a demonstration to honor the dead. The second event was a party where the spirits bade farewell.

Urban adventure games are played in areas with historical or cultural significance. Their objective is communicating information about the place to the player. The previously described InStory [21,25], a platform dedicated to the exploration of cultural and historical physical spaces through gaming activities falls in the genre of urban adventure games. REXplorer [38], another urban adventure game, is a mobile spell casting game for tourists. In this game, players encounter spirits that are historical figures. The players' proximity to the spirits is detected via a GPS enabled mobile phone. Players gain points as they discover spirits and complete quests.

Reality Games encourage people to view the place they live in a different way and are usually organized for unaware participants. In Vem Grater [5], a game that was played in a university campus, the organizers pilled chairs in a tower, scribbled strange words on a wall and spilled something red on the floor. The game also included an actor who roamed the corridors of the university asking people if they had encountered ghosts. This was supposed to be a poltergeist mystery, but the game ended up attracting the wrong kind of attention because the university staff thought they were dealing with acts of vandalism. The staff called the police and at this point the game organizers finally had to step out, apologize and explain it was just a game.

Other authors propose the following genres for grouping pervasive games (Figure 2.1): smart toys, affective games, tabletop games, location aware games and augmented reality games [19].

Smart toys are toys augmented with pervasive technology. In Headbang Hero [39] the player wears a wireless motion sensing wig that evaluates the player's choreography when dancing to the sound of heavy metal music. Gauntlet [40,41], an arm piece enhanced with computer functionality, allows the player to manipulate real objects that act as game play elements. StoryToy [42] is a smart toy where the user interface is a farm, made of cloth, that is inhabited by stuffed animals that are equipped with motion sensors. The farm animals talk and react to each others' actions. In another work [43], a robot interacts with two users playing a chess game. The robot shows an empathic behavior towards one of the players and behaves in a neutral way towards the other. The robot shows empathy via facial expressions, by looking at the player and via verbal responses.

Affective gaming is about using emotions. To detect emotions this type of games may resort to thermal cameras, voice analysis or facial expression analysis and to sensors that measure the galvanic skin response or the activity in the cardiovascular, respiratory, or muscular system. In the affective game Brainball [44] players wear a headband with electrodes that reads brain wave activity using an electroencephalogram. Two players sit across a table with a ball between them. The ball rolls away from the player who is more relaxed. Mindflex [45] is another affective game. Here, the player wears a headset that reads brainwave activity to influence the trajectory of a ball in an obstacle course.

In tabletop games players sit together around a game. Chess is an example of a tabletop game. Tabletop games can be enhanced with technology. Such is the case of the already previously mentioned KnightMage [23] game. False Prophets [46] is another tabletop game where players use physical pieces to move around on a game board that is a projected map. The Build-a-Tree [47] tabletop game was designed to help visitors of a natural history museum learn about evolution. Other authors [48] coupled interactive tabletops with mobile phones to create the game Copoly which is an adaptation of Monopoly. Players interact with the world map on the interactive tabletop. The mobile phones show each player the amount of money and the list of owned properties.

Location aware games are games that use the player's physical position in the gameplay. That is the case of Pirates [49] where each player is the captain of a ship. The game's interface is visible through a handheld computer. To move the ship the player moves in the physical space. The location of the player is determined via proximity sensors. Viking Ghost Hunt [50], another location aware game, uses sound to more effectively immerse the player and stimulate emotional engagement. In iFitQuest [51] players run away from a ghost or collect coins. In either case their game’s characters movement is controlled by their movement in the real world.

Augmented reality games place virtual objects in a real world environment. This can be done using a head mounted display, projectors or handheld devices with cameras to combine images from the camera with virtual content. In the augmented reality ARquake [52] players fight monsters that are visible with an HMD helmet. Other authors propose a snake game with a maze that is built by the player via photos from the real world [53]. In UBI, The Guardian Dragon [54], a dragon, which acts as the user’s sidekick, guides the player through a real world space. EyePet [55] is another augmented reality game where the player takes care of a virtual pet and plays games with it. Augmented reality has also already been used in a game to treat cockroach phobia [56].

2.3. Casual Games

Casual games are currently an interesting area that can offer a happy escape and distraction to the necessary, but sometimes dull and tedious chores of everyday life. Windows Solitaire, Tetris and Pacman are three good examples of well known classic casual games. Casual games amounted to a $6.00 billion revenue in 2010 [6]. Card and puzzle are among the most popular casual games genres [8].

Like all other games, casual games are fun. However, to fall into the casual segment, a game must be easy. Casual games are easy in the sense that they have simple rules and natural interfaces that make use of images and symbols, in detriment of long and fastidious text descriptions [3,57]. In casual games the gameplay should be as obvious as possible so that even novice users without game literacy can quickly learn how to play.

It is not advisable, in a casual game, to require the player to have a perfect performance. In case the player commits an error the punishment is desirably light and even fun [57].

As casual games usually run in parallel with the player's other everyday activities the game should be easily interrupted if the door bell rings or if the player has to talk to a friend or if some other important event to the player occurs [57].

Casual games may offer long term rewards, but short term gratification is essential [10].

Being fast is another characteristic that goes hand in hand with casual games. Nowadays, work demands increasingly more and more hours of people's time. This means that player sessions should not be long. Usually, casual players enjoy playing the game in small time increments instead of playing during a long session of several hours [3,10].

In casual games, being politically correct is a plus. Casual games are designed for the general public. Thus, addressing controversial thematic or using sexually explicit language is probably going to offend certain players and turn them away from the game. Violence should preferably be avoided. However, some violence may be included as long as that violence is not explicit. Showing a cartoon character hitting another character is tolerable. Showing a 3D realistic character hitting another character with a club along with a realistic simulation of blood spattering is probably too much [10]. However, there are game developers who, nevertheless opted for bloody gameplay. Such is, for example, the case of Fangz, a mobile game where the player violently slays vampires [58–60].

It is better, for a casual game, to offer a gameplay that triggers positive emotions and leave out a survival of the fittest scenario where the player is forced to kill and destroy in order to succeed. As much as possible, the game should not defy the norms of the player's social context [57]. As social norms vary from place to place, to be on the safe side, it is better to show players abstract content like, for example, puzzles. Tetris and Pong both rely on abstract concepts and were successful. If one steps outside abstract content, then it is better opting for completely innocuous subjects like, for example, running a farm. FarmVille [61] is one example of this option.

In casual games it is better to favor style over realism. Including 3D graphics in the game is OK, but it is more important to resort to stylish graphics with bright saturated colors. Sound can be used to create the mood, but the players should be able to turn it off, in case they are playing at the office or in the classroom [10].

Casual players are often described as the antithesis of hardcore players. 51% percent of casual players are female and 49% are male. 62% of casual players are over 35 years old and 38% are under 35 years old. Usually, casual players do not perceive themselves as gamers [4]. People play casual games at home, at work, while they are waiting for the bus or while they are traveling. The reasons for playing are diverse: fun, relaxation, socializing, or escaping from reality for, at least, a few moments. Casual players play more often from 7 pm to 9 pm and from 11 am to 2 pm [4]. In contrast, hardcore players are typically 18-35 year old males [4] who like difficult, challenging games [3] and who play mostly at home [4]. Casual players favor escapism. For hardcore players the game is more than mere escapism. It is an integral part of their lives [10].

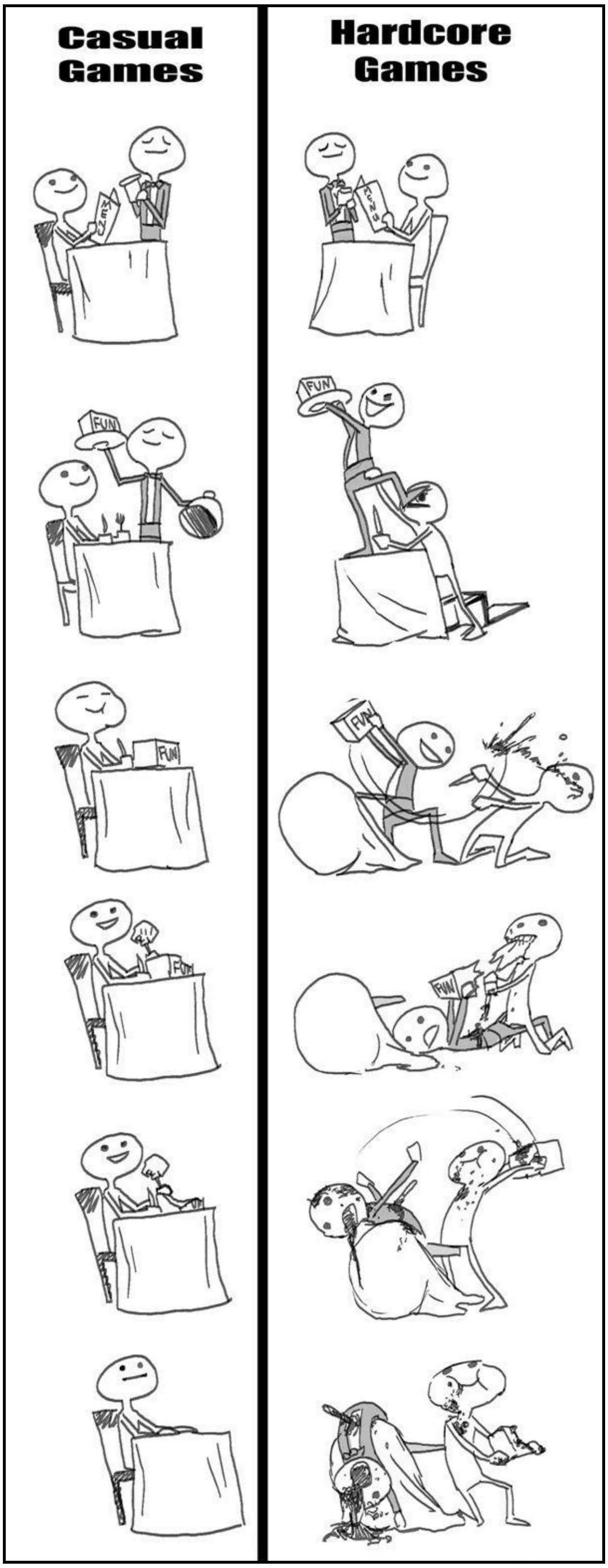


Figure 2.2: Casual games versus hardcore games representation by an unknown author.

According to Jesper Jull [3], casual games may be played for long hours and therefore in a way that is not casual at all. If the casual game is flexible it will allow the player to have a meaningful experience within a short time frame but does not prevent players from investing more time in the game. Usually, hardcore games are inflexible for they do not allow players who are only interested in a short term commitment. A flexible casual game can be played in both a light and a hardcore way, therefore eventually attracting hardcore players.

In Figure 2.2 another distinction between casual and hardcore games is presented. We found this image in several sites and could not determine who the original author was. We leave the interpretation open to the reader. However, it seems to us, the image alludes to the more challenging aspect of hardcore games.

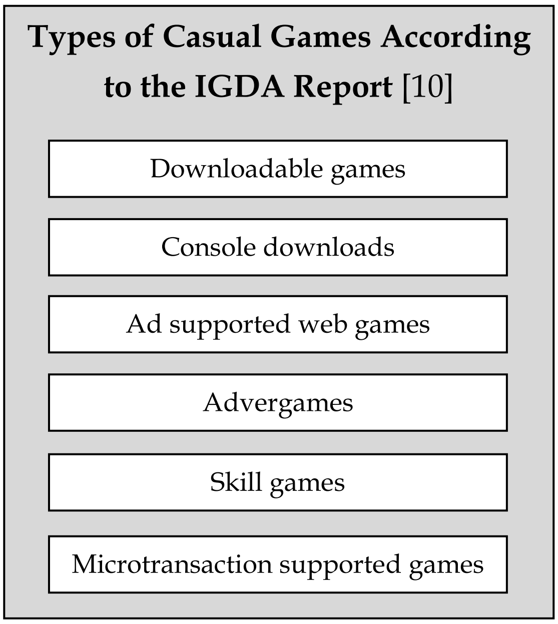


Figure 2.3: Types of casual games.

The IGDA report [10], groups casual games in the following types (Figure 2.3): downloadable games, console downloads, ad supported web games, advergames, skill games and microtransaction supported games.

Downloadable games are typically available through portals or in the developers' pages. In this genre of games the player downloads a file, then usually a short installation follows and after that the casual game is ready to be played. Normally, the player can use the game during a trial period for a certain amount of time. After that, to continue playing it is necessary to pay a fee. Today, with faster Internet connections, the file size tends to increase in order to accommodate more features for players' enjoyment.

Console downloads are games that are downloaded to a game console, instead of a PC. Nowadays, players can download games, for their consoles, through the Internet.

Ad supported web games are other sort of casual games. These games are usually played in a browser. Sometimes the ad appears before the game starts, other times the player is confronted with ads when changing levels or at the end of the game. The ads can be integrated inside the game, as in game ad-related content, or be placed around the game, as a banner. In the browser, these banners may be placed above, bellow, to the left or to the right of the game. Sometimes, the game is completely surrounded by banners and becomes an island in the middle of the publicity.

Other type of casual games are the advergames. Advergames are developed with the primary intent of promoting a brand or a product. Advergames go beyond just showing some in-game ads. The whole concept of the game revolves around the sponsor of the game. Typically, advergames are distributed for free and their success is measured by the number of players the game reaches and by the time they spend playing the game [4]. An advergame has to be fun and it also has to be a good advertisement for the brand or product being promoted. If the product or brand is not promoted or if the client perceives the product erroneously, then the game is a failure. However, a sole focus on publicity is not convenient because if an advergame does not entertain the players that advergame is also a failure. For an advergame to be successful both the entertainment and the publicity objectives have to be fulfilled.

Casual games can also be skill games. In this type of games, players have to pay a certain amount of money to be allowed to play. After that, they enter a tournament with other players. The players with the highest score win a cash prize or some other sort of material reward. Skill games bear therefore some resemblance to a casino or to a lottery, as in both casinos and lotteries people risk a certain amount of money in hopes that they might gain the big prize. However, skill games are not only related to luck. They are called skill games because it is assumed that the player needs to develop her game skills in order to maximize the chance of winning. Innovation is seldom welcome in skill games as players are generally more inclined to pay the entry fee if they feel the gameplay is familiar.

In microtransaction supported games players have free access to the game's basic features. This type of games usually has a virtual economy with a virtual currency. The player can then pay to have certain advantages in the game [4,10]. Payments in microtransaction supported games are usually small.

Mobile phones, though not directly included in the categories suggested by the IGDA report (Figure 2.3), are becoming an increasingly more popular platform for casual games [4,62] with revenues that in 2011 amounted to $2.72 billion worldwide [62]. Strategy Analytics [63] estimates that 1 in 7 of the world's population owns a smartphone in the third quarter of 2012 with 1.038 billion units in use worldwide [63]. According to mobiThinking the global smartphone penetration is 16.7% [64]. Significant time on smartphones is spent on games. Flurry [65] monitored time spent across app categories and concluded that 39% of the time is spent on games. In tablets this percentage raises to 67%.

Furthermore, nowadays, with the advent of application stores such as the App Store for iPhones, Google Play, for Android devices, BlackBerry World or the Windows Phone Store the possibilities for mobile games have widened. However, this fragmentation also poses challenges for developers who want to develop a game for all these different application stores. There are already some solutions for coding only once for different types of end devices. For example, PhoneGap [66] allows developers to work with a single codebase for iOS, Android, Windows Phone, Blackberry, webOS and Symbian [67]. Still, a wide diversity of smartphones results in variable processing power, internal storage or different screen sizes [62]. According to the Visionmobile Report [68,69], HTML5 may become a common ground across different platforms as it is supported by 371 million mobile devices. However the levels of compatibility vary. The Visionmobile Report [68,69] also predicts that there will be no single winner in the smartphone race with Android and iOS sharing the leadership, and Windows Phone eventually challenging BlackBerry for the third place. S. Bicheno from Strategy Analytics predicts Android and iOS will maintain leadership as far as 2017 [70]. So, variability in mobile devices will likely remain a constant, at least in the near future.

2.4. Casual Pervasive Games

Some games have already managed to fit both the requirements of casual and pervasive games. In Insectopia [71], a pervasive casual game, players use their mobile phones to hunt for rare bugs. Bluetooth devices around the player, detected by the phone, are the sources of the bugs. Blowtooth [72] also explores the detection of other Bluetooth devices to smuggle drugs. Flying Cake [73] resorts to a mobile device's camera to throw a virtual cake at an opponent. The game uses a face detection technique to superimpose a virtual character on the face of the opponent. Another game also resorts to a mobile device's camera and to marker tracking to superimpose a virtual chess board on reality [74]. In the mobile game Cubodo [75] players cooperate with each other to transport a virtual package around the world. The package is displaced by the players' real physical movement. In another game players slay imaginary opponents, at certain locations, with stab and slash movements of their mobile phones [76]. It is also possible to create casual games that interface with the real world using only a mere PC or portable computer. Social Heroes [77] is a game where players trade points by tagging each other using Twitter. The technological requirements are very low. Players just have to be able to connect to Twitter through their PCs.

A survey to 168 persons in Norway found out that 57% of the respondents believed that pervasiveness adds value to a game and 38% were neutral. Only 5% of the respondents believe that pervasiveness will make the game worse [78]. These results seem to support the existence of casual games with pervasive components which were released by companies. Undercover [79,80] is a game for mobile phones where players can locate other players as well as opponents via GPS. The game is set in an apocalyptic scenario where one's mission is to fight against the increasingly powerful terrorist cells. In Foursquare [81] and SCVNGR [82] players progress in the game by visiting certain places. In GEwar [83], a web browser game that resorts to Google Earth, players recruit and train armies to capture cities. Turf Wars [84] is a mobile game that also revolves around conquering real world places. In the GeoGuessr [85] browser game the player is taken on a journey around the world and has to guess the location of the place shown via Google's Street View. In Shadow Cities [86] the player becomes a mage and takes over the streets by making runes on the mobile phone screen. Ingress [87] is about discovering sources of mysterious energy, with the help of the mobile phone, while fighting for the Enlightened or the Resistance side. In Zombies, Run! [88] players run around trying to escape and horde of zombies while receiving instructions via their headphones. Sharkrunners [89] resorts to the movement of real sharks.

Even though the mentioned games suggest interesting possibilities for merging games and reality, still none of those references discuss how the introduction of real world elements affects the magic circle or the position of the screen as the main focus of attention or presents a general reflection about the challenges for inserting real world elements in games. Branton et al. [90] argue that the lack of interoperability standards may hamper the growth of pervasive games. However, the authors do not focus in the requirements of casual players and their paper does not inform developers and researchers about possible pitfalls along the way. Y. Chang et al. [91] propose a conceptual design framework for games but they focus only on the specific case of handheld augmented reality games. Casual players' requirements were also not taken into account by these authors. In Mythical the Mobile Awakening [92] the authors discuss how environment, spatio-temporal, proximity, and social contexts can contribute to player enjoyment, but the constraints about using these contexts were not presented. M. Montola [93] states that, in pervasive games, people may feel embarrassed when they are required to do obvious gestures, role-play, use equipment or behave in a ridiculous manner. M. Montola [93] also mentions potential problems such as the un-intuitiveness of wireless technologies, battery life or lack of accuracy when determining the players' location. However, the author does not describe specific problems when working with real world elements such as the weather, physiological signs, accelerometer data or sound. Casual players' requirements were also not considered. B. H. Thomas [94] compiled a survey that focuses specifically on visual, mixed, and augmented reality games on academic and commercial contexts. The author proposes an augmented reality gaming taxonomy based in the display technology. Games are grouped in the head-mounted display, handheld display, and spatial immersive display categories. These were considered as the three major display technologies. The lack of affordable sensors with the required precision is pointed as an issue and smartphones are recommended as a stable platform for the development of commercial games.

3. Merging Games with Reality

Theoretical results about black holes suggest that the universe could be like a gigantic hologram.

Jacob D. Bekenstein, Scientific American

As described in the Introduction (Chapter 1), the objective of the work proposed here is to develop ways of integrating real world elements in casual games. To include real world elements in casual entertainment we resorted to the creation of several games that may address one or several real world elements.

Figure 3.1: Real world elements that were integrated in casual games.

The Castle of Count Pat (Section 3.1) deals with sound. The Imaginary Friend resorts to the player's emotions, activities and location (Section 3.2). The Imaginary Friend is more of a toy than a game, for the main objective here was to keep the player company. Weather Wizards uses real time weather data and the player's location (Section 3.3). The Enchanted Moor Game resorts to video input and particularly to face recognition (Section 3.4).

We made the choice for sound, video, weather, the player's location, the player's activities and the player's emotions (Figure 3.1) because these real world elements can be acquired via functionality already commonly available, or expected to soon become commonly available, in computers, portable computers, mobile phones or tablets.

If our research was targeted only for the narrow fringe of dedicated hard core players (Section 2.3), resorting to equipment that would be used only for the specific purpose of the game would likely not represent a problem. For example, a true hard core player would not turn away from investing in a graphics card that supports the exigent frame rate of the latest videogame but which is a complete overkill for running a word processor, word processor being the only software that this player needs for work in her real life. A true casual player would stick to the games that run in the low end computer which, sometimes, struggles even to run the simple word processor software. When working for all audiences, casual and hardcore alike, it is necessary to be flexible enough so that the game runs in a wide range of end devices [3,10].

3.1. The Castle of Count Pat

The Castle of Count Pat [95,96] is a casual game that resorts to sound capture and that merges seamlessly with the players' natural environment. The game motivates students to make less noise in the classroom.

Students can develop several different types of work in the classroom. Sometimes, the teacher may expose something to the students and need the whole class to keep quiet and listen to what is being explained. Other times, students engage in tasks where they have to talk to each other. Nevertheless, whatever the activity is, if the sound level is too high it will be difficult for people to listen to each other. Furthermore, excessive noise can disturb students in other classrooms. Even though classroom noise may have different sources, some internal and others external to the classroom, here the focus is on the noise caused by the students talking to each other.

Noisy classrooms have an adverse effect on students' learning and the strain on teachers' voices can result in illness, as is described in Section 3.1.1. Other persuasive games are described in Section 3.1.2. Our game, which is further described in Section 3.1.3, is populated by characters that are only happy in the silence. If students are quiet they will gain more points. The game is, therefore, an incentive for students to change their behavior via an increased awareness of how much noise they are causing. Implementation and architecture details are in Section 3.1.4. The game was tested in an elementary and secondary school. Before the game was tested we assessed the school's initial situation to determine the teachers' and students' views about noise in the classroom (Section 3.1.5). The game's test results are presented in Section 3.1.6 and a final discussion is addressed in Section 3.1.7.

3.1.1. Effects of Classroom Noise on Students and Teachers

Classroom noise is detrimental to students' learning and can result in several adverse consequences. Noise decreases word recognition performance [97]. According to another source noise negatively affects performance in verbal tasks, like reading and spelling, and performance on speed tasks [98]. Noise is also prone to cause fatigue and headaches [99]. Noise is still related to the annoyance of both students and teachers. Chatter in the classroom is considered an annoying sound source. Teachers are more sensitive to noise than students and experience a higher level of stress. Females felt that noise caused them more stress than males [100].

It, therefore, seems to be beneficial if the noise level is low. To control the noise produced by students, inside the classroom, the teacher can resort to several classroom management strategies. The teacher can establish rules so that students know when they can talk and when they are supposed to be quiet and then reward students for adequate behavior by giving them a better grade, stars, points or smiley faces or showing their names in an honor board. A student's inappropriate behavior can be punished by asking that student to leave the classroom or by giving her or him extra tasks to do or by keeping the student inside the classroom during recess [101]. However, none of this clearly shows to the students how much their behavior is disruptive. If students could perceive, in a quantitative way, how much their behavior is disruptive, then perhaps they would be more inclined to be quiet or to lower their voices. Our game was designed to test this hypothesis, as is further explained in Section 3.1.3.

Students are not the only ones negatively affected by a noisy classroom. Teachers, in consequence of the strain to their voices, may suffer health problems. Voice is one of the most important tools for a teacher because they have to talk for a long length of time and may also have to make themselves heard over a loud background noise. 62.7% of teachers are affected by voice problems [102]. Voice problems are more frequent in teachers than in other professions [103].

Voice problems can significantly affect a teacher. Teachers with frequent voice problems have decreased control and influence at work, low social support, poor job compensations, poor health and vitality perceptions and deficient job satisfaction [102]. Voice problems are also the cause behind lost days of work due to sick leave [104].

Voice problems are associated with the personality of the individual [105]. Teachers with voice problems tend to have a higher reactivity to stress. Still, if reactivity to stress is indeed a cause of voice problems, this personal characteristic may be difficult to change.

To ease or prevent voice problems the teacher can use a microphone for voice amplification. Adequate voice training, better acoustic conditions in the classroom and the absence of environmental irritants like dust or smoke are helpful. A fewer number of lessons will reduce the strain to the voice. Another solution is to reduce the number of children in the classroom as fewer children will produce less noise.

Usually, the teacher cannot change the work schedule and also cannot decide how many children are in the classroom. However if all children are quiet, while the teacher is explaining something, the teacher will not have to talk so loud, thus reducing the strain on the vocal cords. Our game motivates children to keep quiet or lower their voices. In the next section some examples of persuasive technology are presented.

3.1.2. Changing Behavior with Games

Persuasive technology has already been successfully used to change people's behavior. A few diverse examples include: help children deal with bullying situations [106]; motivate people to recycle waste materials [107,108]; encourage decrease of energy consumption at home [109–112]; encourage healthy dietary behaviors in kindergarten children [113]; raise teenagers' oral health and dental hygiene awareness [114]; stimulate physical play [115]; help people quit smoking [116]; help elders take their medication on time [117]; improve engagement in science controversies and develop skills in evaluating evidence and forming arguments [118]; improve awareness of drugs abuse effects [119];

raise awareness about water scarcity [120]; improve workers' mental engagement in routine activities [121]; treat cockroach phobia [56]; incentive people to throw rubbish in a bin, instead of on the floor [122]; incentive people to obey the speed limit [123].

These examples show that there is great potential to alter people's behavior, not only in the classroom, but in many other situations.

In what particularly refers to influencing the amount of sound produced by the students while talking to each other, G. Schmidt and R. Ulrich [124] used a sound level meter to monitor a free study period. An observer recorded the data from a position in the rear center of the room and wrote it on sheets of paper attached to a clipboard. If the students kept the sound level low, for ten minutes, they would receive two extra minutes for the gym period and a two minutes break to do whatever they wanted, before the beginning of the next ten minutes period. However, if the students became too noisy, during the ten minutes silent period, a whistle would be blown and the timer would be reset back. H. Strang and J. George [125] resorted to an automated clown to show the children if the sound level was too high. The clown had five lights that simulated the jacket buttons, two lights that simulated the eyes, one light that simulated the nose and five lights that simulated the mouth. If the children kept the sound level low the clown's lights would turn on. J. Groff [126] patented an alarm that emits a sound when the classroom is too noisy.

3.1.3. The Game

Our game shows students, in real time, quantitatively and graphically, the amount of sound in the classroom. The game runs in a computer that is connected to a video projector or to an interactive whiteboard so that all students can see the output of the game. Sound is captured through a microphone connected to the computer where the game is running. The game is populated by characters that enjoy the silence. If the amount of sound the microphone is detecting is low the score increases. If the amount of sound the microphone is detecting is too high the score decreases and may even become negative.

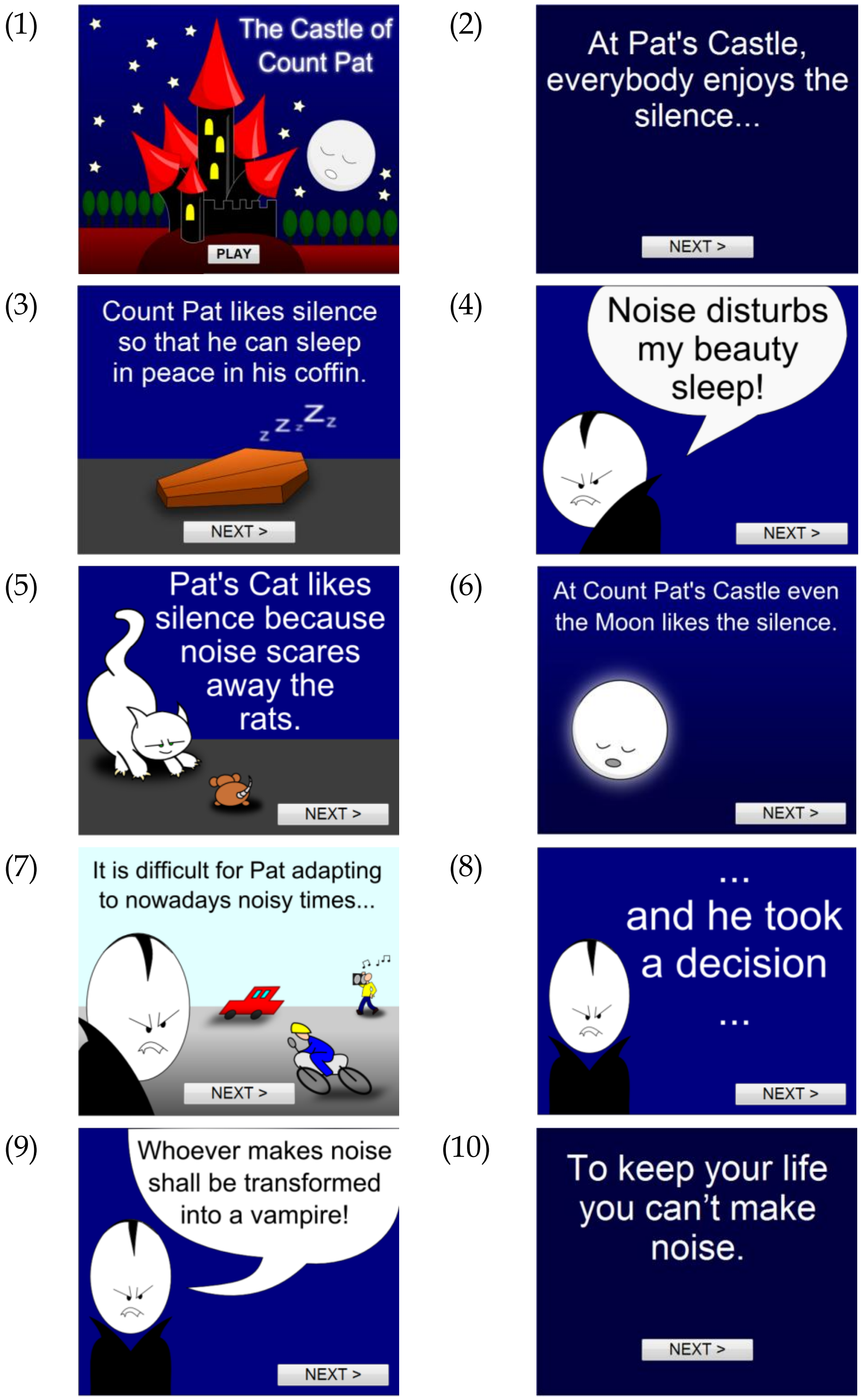
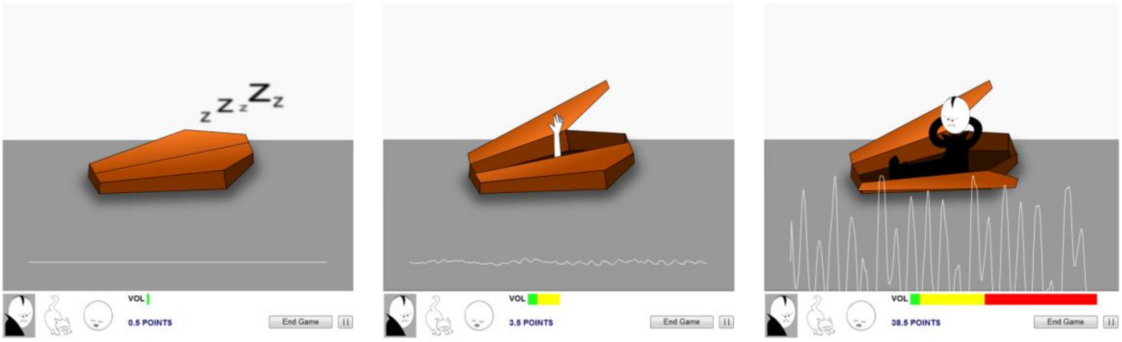


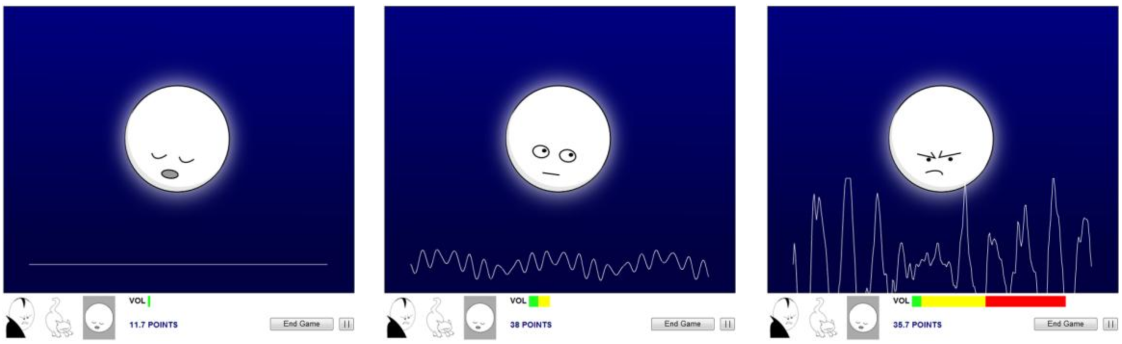
Figure 3.2: The game begins with a story that explains why silence is necessary at Count Pat's castle.

State 1	State 2	State 3
Low noise	**Medium noise**	**High noise**



(a) Count Pat

(b) Pat's Cat



(c) Moon

Figure 3.3: The different states of the three characters in the game.

The game's name is "The Castle of Count Pat". The characters of the game are Pat, a centuries old vampire, Pat's Cat and the Moon. The game begins with a story that explains the necessity of peace and quiet at Count Pat's Castle (Figure 3.2). Count Pat does not like noise because he wants to sleep peacefully in his coffin. Count Pat's Cat likes silence because noise scares away the rats. It is difficult for Pat to adapt to nowadays noisy times so he took a decision: everyone who is making noise shall be turned into a vampire. If students want to keep their lives, they will have to keep quiet or at least lower their voices. The story is presented as a sequence of images. The teacher reads the story aloud to the students. To advance, the teacher presses the next button at the bottom of each image of the story. We chose this sort of interface because, this way, the teacher can present the story to the students at her or his desired speed. A video would make it more difficult to slow the pace of the story if some of the students had not understood it.

After the story in Figure 3.2, the game starts. The teacher, together with the students, can choose a character to interact with: Count Pat (Figure 3.3 (a)), Count Pat's Cat (Figure 3.3 (b)) or the Moon (Figure 3.3 (c)).

The sound wave is below Count Pat (Figure 3.3 (a)) and the Moon (Figure 3.3 (c)). The frequency spectrum, after a Fourier transform is performed on the sound data, is integrated in the Cat's fur (Figure 3.3 (b)). At the bottom left corner of the game's interface the three available characters are presented. The teacher, or one of the students, can change the character by clicking on one of them. The other elements of the interface are: a volume bar that shows the amount of sound the microphone is detecting; the score; a button to end the game; and a button to pause the game.

Each character has three states. In state 1 all the characters are sleeping (Figure 3.3). This is the best possible state. While in state 1 the score increases 0.2 points a second. The character remains in state 1 while the volume bar shows only its green section. The volume bar is divided in three sections. The leftmost section is green. The middle section is yellow. The rightmost section is red. If the volume bar shows the green and yellow sections, the character changes to state 2. Here, the score increases 0.1 points a second. In state 2 Pat opens the coffin, the Cat stands up and the Moon awakes (Figure 3.3). If the volume bar is showing the green, yellow and red sections the character changes to state 3. This means the students are making too much noise. While the character is in state 3 the score decreases 0.1 points a second. If the students do not become quieter the score can turn negative. In state 3, the characters are wide awake and angry. Pat puts his hands over is hears, the Cat's fur stands on end and the Moon shows a displeased face (Figure 3.3).

Previous tests were conducted, in a classroom, with the students and their teachers, to decide when the amount of sound detected by the microphone is too high in order to determine the green, yellow and red sections of the volume bar. We were told, by the teacher, when the noise was considered excessive.

To determine the state of the character we calculated the average of the last 10 activity level values of the microphone. The activity level is the amount of sound the microphone is detecting. Values range from 0, where no sound is detected, to 100, where very loud sound is detected. Each second the game collects 24 values of the microphone's activity level. We calculated the average of the last 10 activity level values because, if individual values were considered, the character would change between states too fast. At each second, the last computed average value is evaluated to determine how much to increase the score.

While the game is paused the score does not change. After the game ends the final score is displayed.

3.1.4. Implementation and Architecture

The game was implemented in HTML5 and in ActionScript 3.0. In Figure 3.4 the game's architecture is visible. The HTML5 game layer presents the initial story to the players (Figure 3.2), shows the game controls, the score and the volume bar. The ActionScript 3.0 game layer implements sound input and animates the characters.

We resorted to the ExternalInterface ActionScript class [127] to allow communication between the ActionScript 3.0 game layer and the HTML5 game layer.

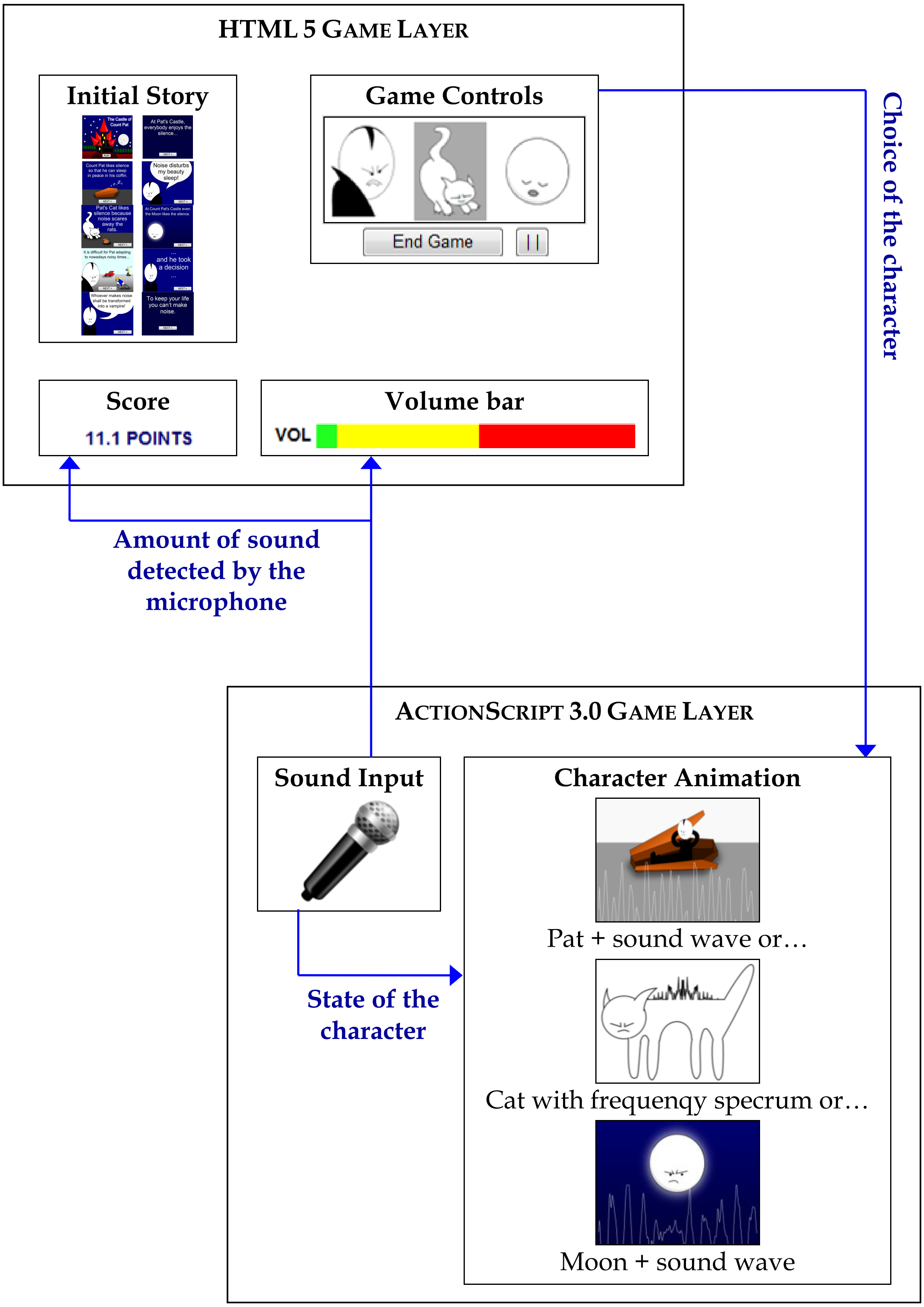


Figure 3.4: The Castle of Count Pat game architecture.

In the HTML5 game layer it is possible to choose between Pat, the Cat or the Moon. This choice is communicated to the ActionScript 3.0 game layer so that the chosen character is animated, with the sound wave, in the case of Pat and the Moon, or the frequency spectrum, in the case of the Cat.

The ActionScript 3.0 game layer performs sound input. The amount of sound detected by the microphone is sent to the HTML5 game layer that computes the score and shows the volume bar. The amount of sound detected by the microphone is also used by the ActionScript 3.0 game layer to choose the state of the character (Figure 3.3).

3.1.5. Assessment of the School where the Game Was Tested

The game's tests were conducted in a school that is both an elementary and a secondary school. To evaluate the school's initial situation we conducted a survey to 60 of the school's 150 teachers.

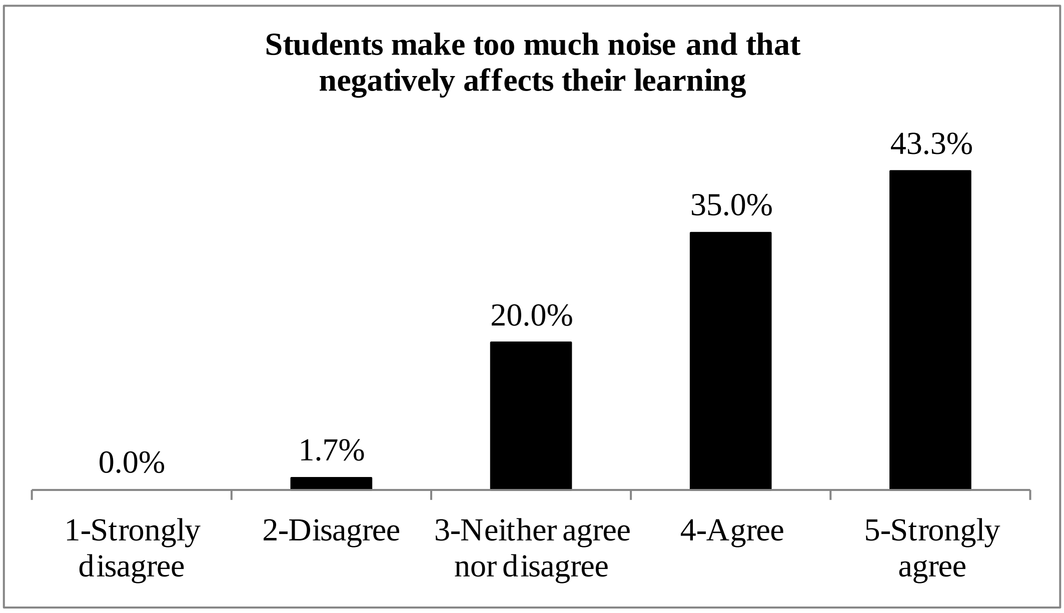


Figure 3.5: Do teachers think that students make too much noise?

The teachers were questioned, with a paper survey, at the staff room, a place where teachers can rest. The survey was previously tested and was anonymous, but we were present at the staff room in case teachers had any doubt about the survey.

Through the survey we tried to determine if noise, caused by the students, was a problem. 78.3% of the inquired teachers agreed or strongly agreed that students make too much noise and that negatively influences their learning (Figure 3.5).

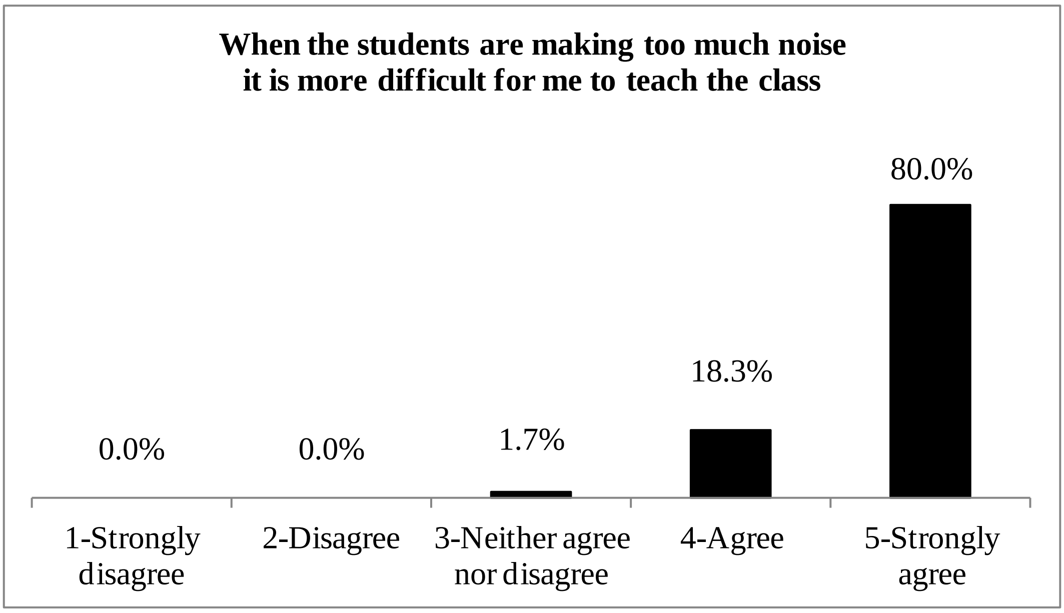


Figure 3.6: Do teachers find it more difficult to teach the class when the students are making too much noise?

Almost all teachers agreed, or strongly agreed that when the students are making too much noise it is more difficult for them to teach the class (Figure 3.6).

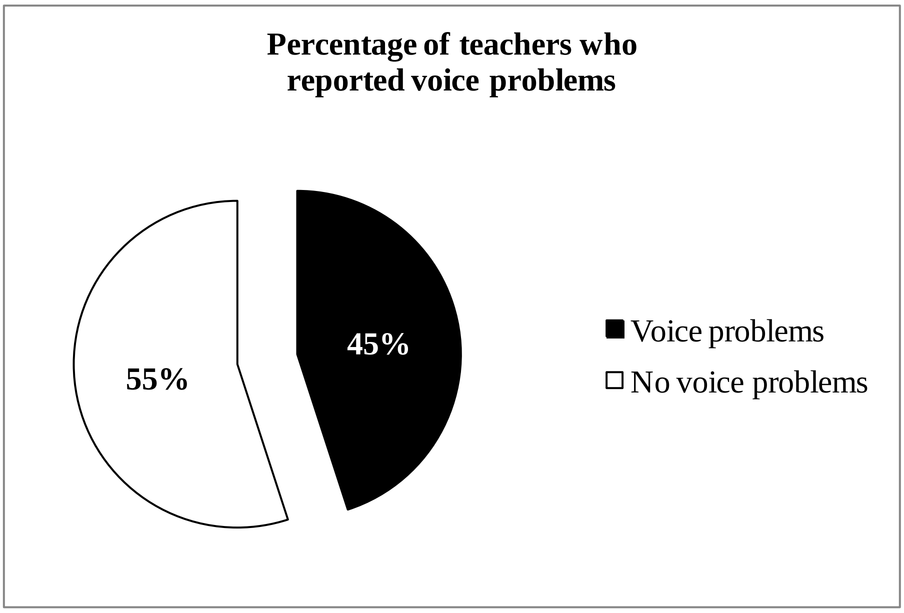


Figure 3.7: Teachers who reported voice problems in consequence of their professional activity as teachers.

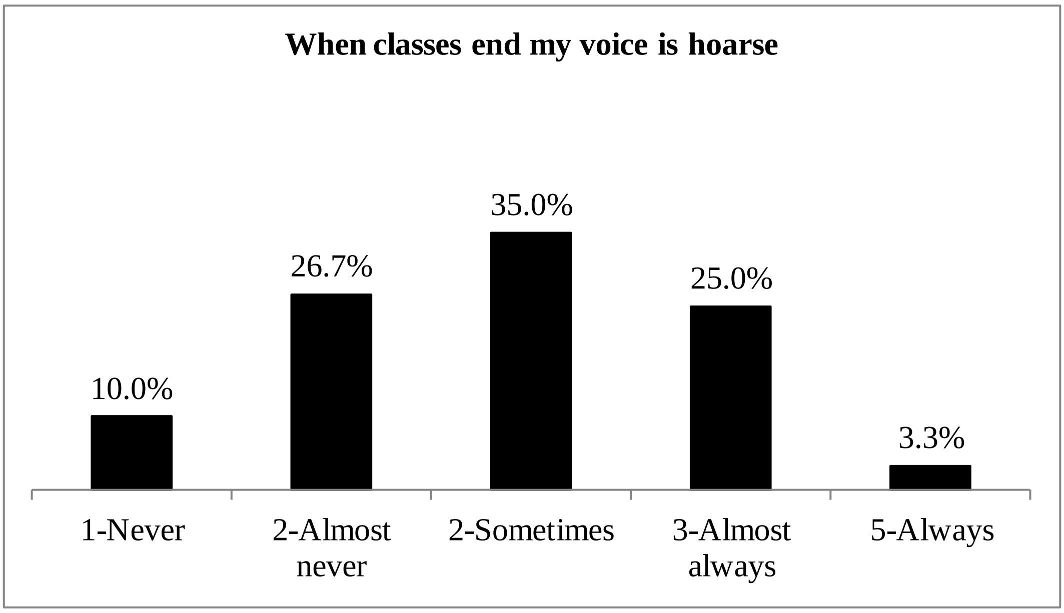


Figure 3.8: Teachers who feel that by the time their classes end their voices are hoarse.

45% of the teachers reported voice problems (Figure 3.7) like a hoarse voice, pains, vocal cord nodules or polyps or even being completely aphonic. Two of the enquired teachers underwent surgery because of their voice problems. One teacher afflicted by voice problems mentioned that those voice problems resulted in a depression and another reported feeling extremely tired. Even though almost half of the enquired teachers have voice problems, 45% is not a percentage as high as the one found by R. Alvear et. al [102].

In what specifically refers to a hoarse voice, only 10% of the teachers are never afflicted by this problem, at the end of a day's work (Figure 3.8).

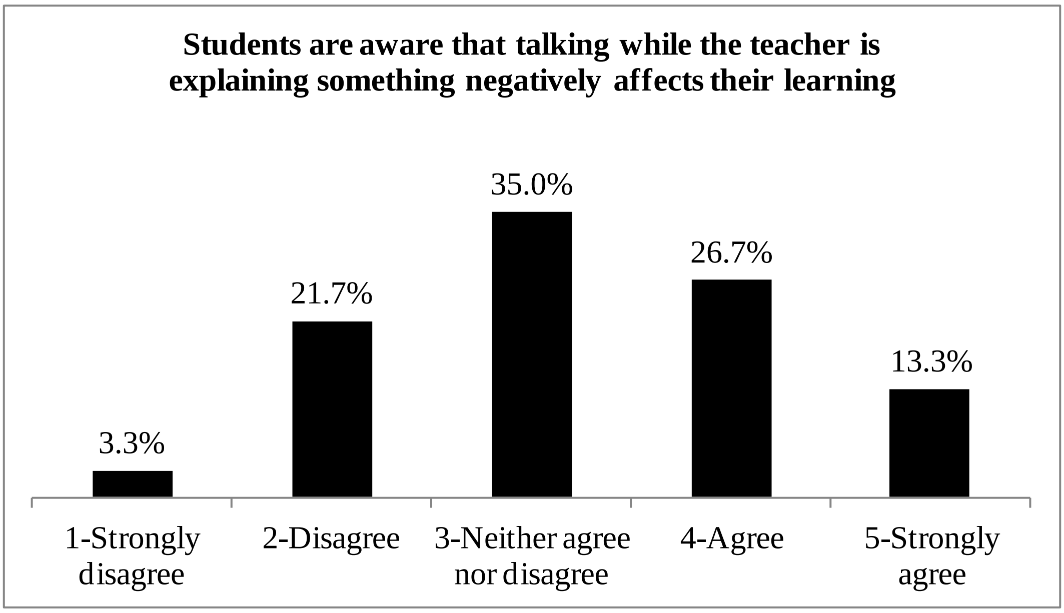


Figure 3.9: Do teachers think that students are aware that talking while the teacher is explaining something negatively affects their learning?

We asked teachers if they thought that students were aware that talking while the teacher is explaining something negatively affects their learning (Figure 3.9). 25% of the enquired teachers strongly disagree or simply disagree that students are aware of it. 35% neither agree nor disagree. 40% agree, or strongly agree, that students are conscious that their behavior is negatively affecting their learning.

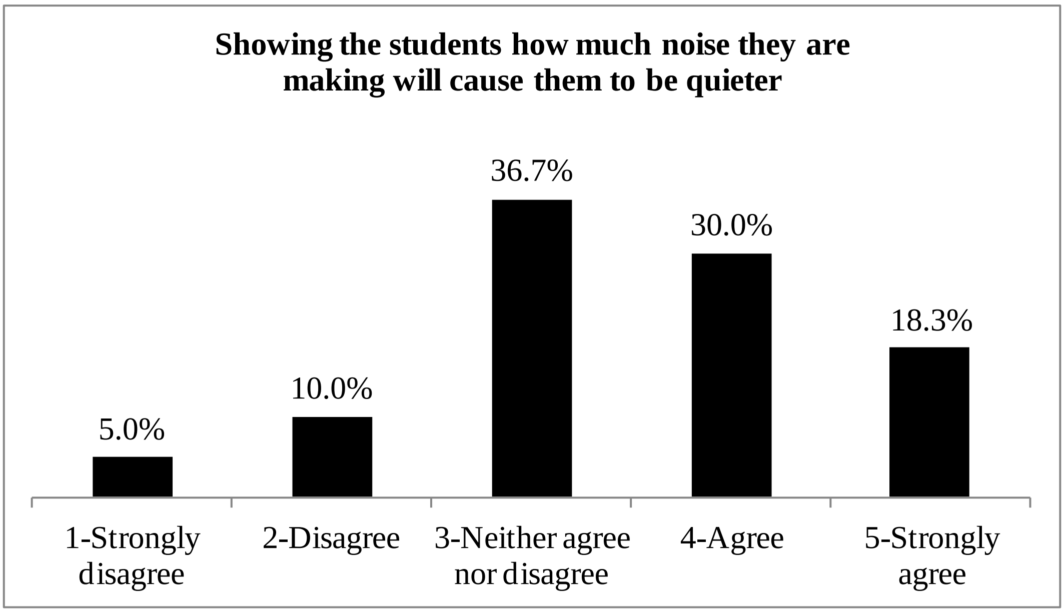


Figure 3.10: Do teachers think that showing the students how much noise they are making will cause them to be quieter?

When we asked the teachers if they thought that showing the students how much noise they are making would cause them to be quieter, 48.3% of the teachers agreed or strongly agreed this would work (Figure 3.10). 36.7% of the teachers think that showing the students how much noise they are making would have no effect and 15% think that students would make even more noise.

So, even though 40% of the enquired teachers believe that students are aware that they make too much noise in the classroom (Figure 3.9), 48.3% of the teachers believe that showing the students how much noise they are making is an extra reinforcement that might have some positive effect (Figure 3.10).

We tried to determine if the teachers' views about noise in the classroom were similar to the students' views. To this effect we enquired 81 students from 4 classes. These classes are the same classes where the game was tested. The survey was anonymous and previously tested.

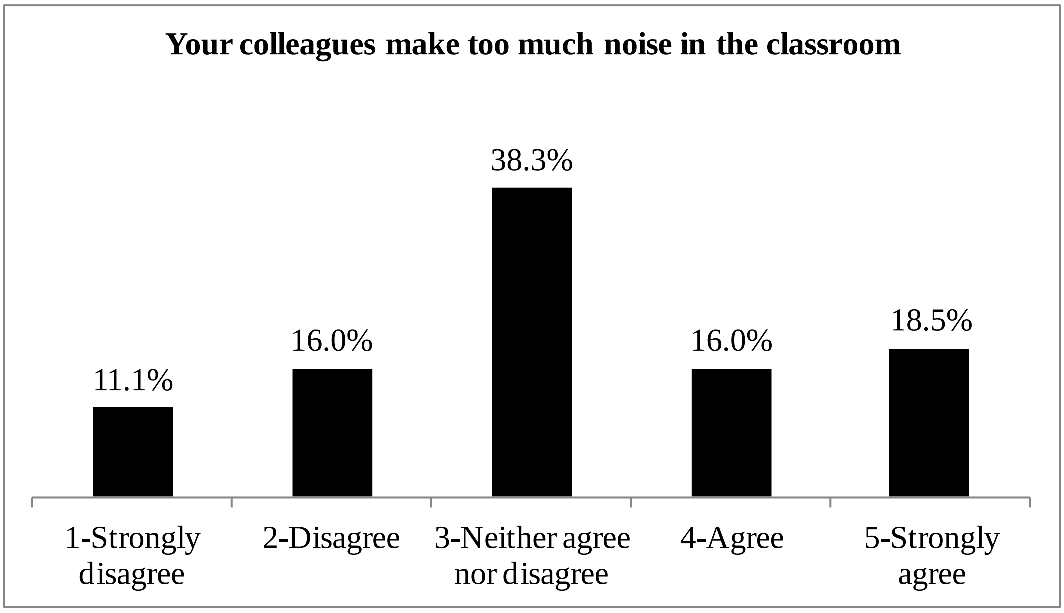


Figure 3.11: Do students think their colleagues make too much noise in the classroom?

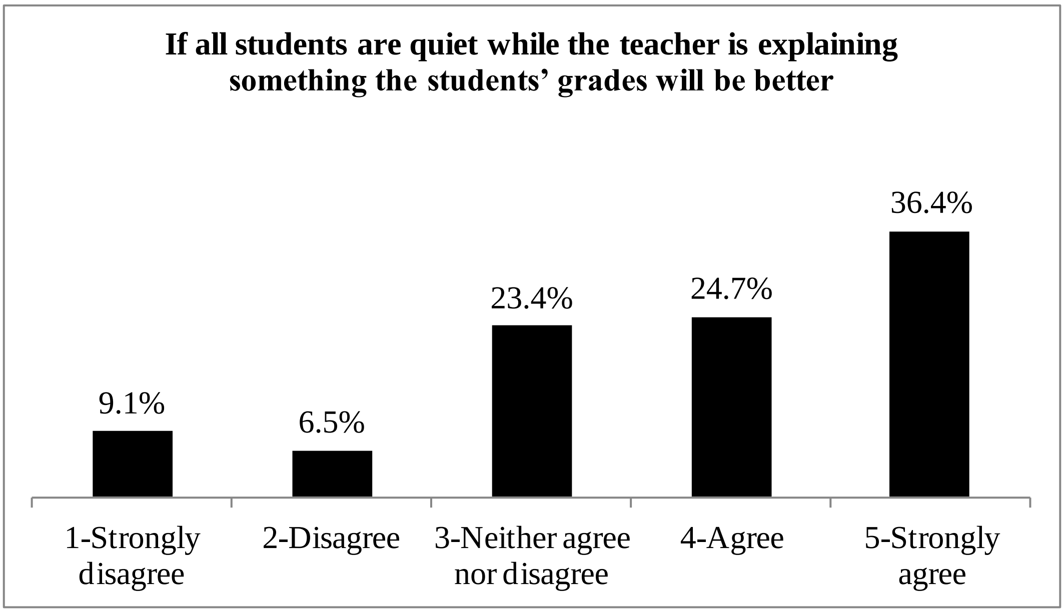


Figure 3.12: Do students think that if they are quiet the grades will improve?

Only 34.5% of the inquired students think that their colleagues make too much noise in the classroom (Figure 3.11). In contrast, 78.3% of the inquired teachers consider the noise caused by the students' excessive (Figure 3.5). So, the inquired students and teachers have different views and perhaps students do not completely realize that, according to the teachers, they are too noisy.

However, 61.1% of the students agree or strongly agree that if students are quiet, the grades will be better (Figure 3.12). Therefore, most students and teachers agree that a quieter class will result in better grades.

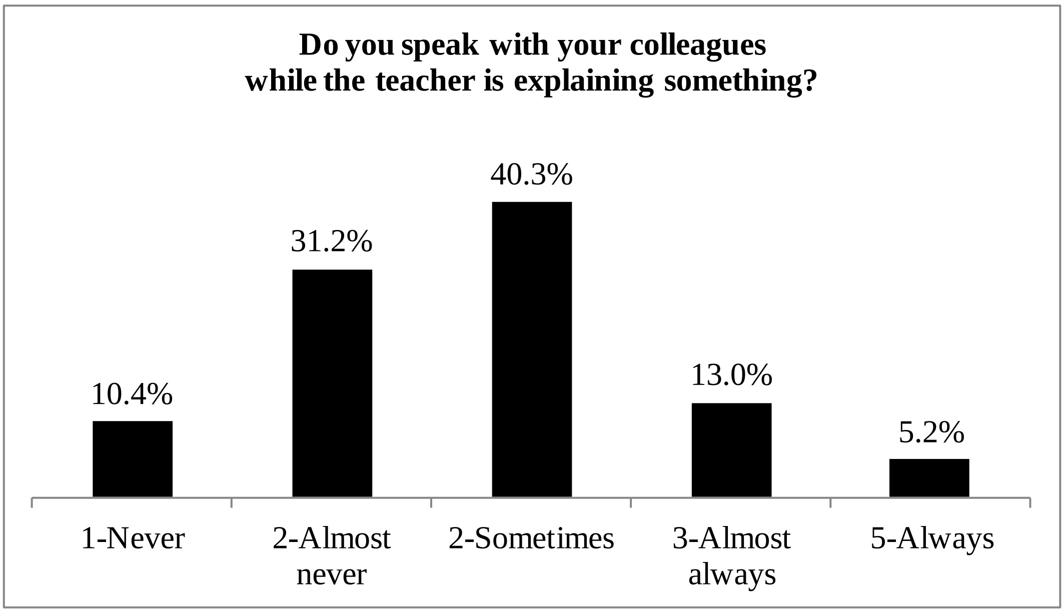


Figure 3.13: Do students speak with their colleagues while the teacher is explaining something?

Students were asked if they speak with their colleagues while the teacher is explaining something (Figure 3.13). 40.3% admitted to doing it sometimes, 13% almost always and 5.2% always. So, according to these responses, whenever teachers are trying to explain something, there is likely some background noise produced by students talking to each other.

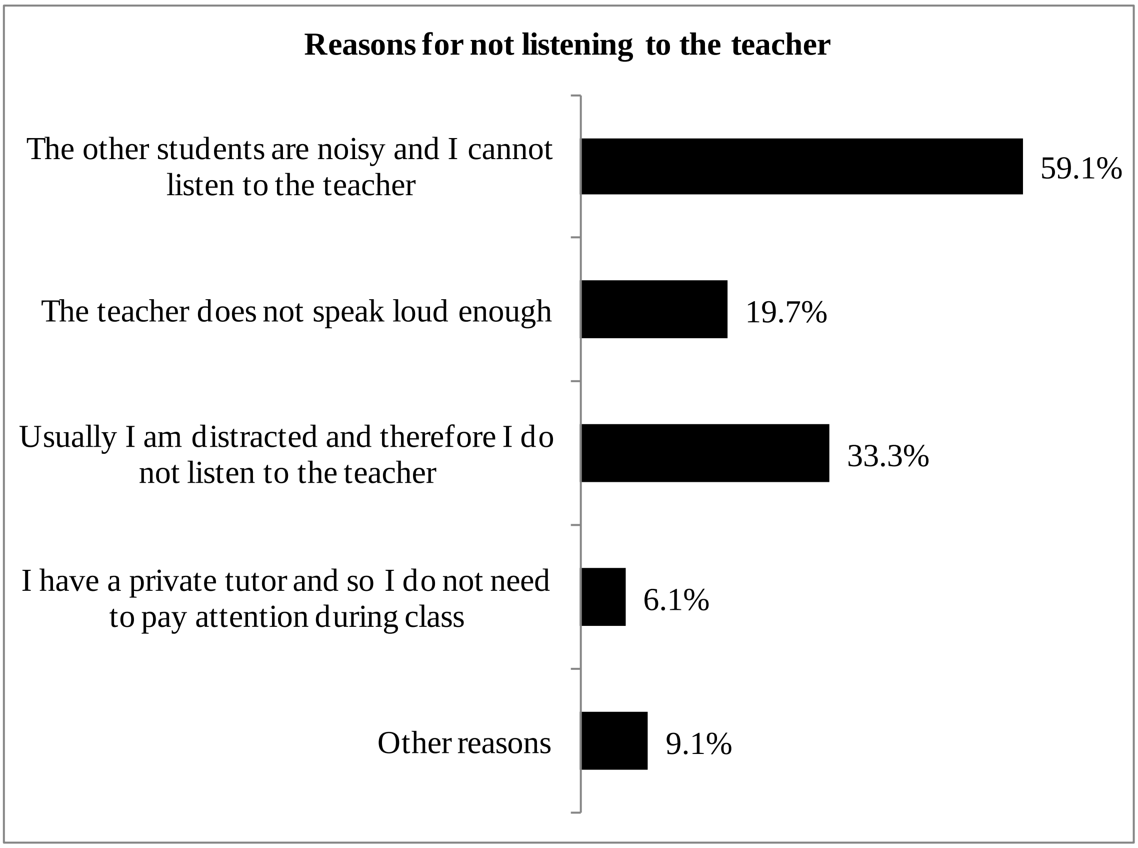


Figure 3.14: Reasons for not listening to the teacher.

We also asked students what were the main reasons that caused them not to listen to the teacher. Students could mention more than one reason. Figure 3.14 shows that the main reason, chosen by 59.1% of the respondents, is the noise caused by other students. Our game therefore addresses the problem mentioned by most students.

19.7% of the students suggest the teacher could speak louder. However, some teachers may find it is impossible to further raise their voices. We consider this reason is also directly related to the problem addressed by our game, because if the class is quieter there will be no need for the teacher to speak louder.

33.3% of the students admit they are usually distracted and because of that they do not listen to what the teacher is saying. This reason is not directly related to our game. However, perhaps a quieter classroom will make it easier for students to concentrate on what the teacher is saying. A noisy classroom may act as a source of further distractions that will turn the students' attention away from learning.

6.1% of the students revealed that they have a private tutor that teaches then the contents they should supposedly learn during class and, for that reason, it is not necessary for them to pay attention at class. According to this students' perspective the classroom seems to be, mainly, a place for social gathering. However, not all students get to have a private tutor and, for those who do not have a private tutor, the class is their only opportunity to have access to a professional who can teach them and clarify their doubts.

Finally, 9.1% of the students mentioned other reasons.

3.1.6. Evaluation

Our game was tested in four classes of an elementary and secondary school. We shall refer to the classes as classes A, B, C and D. All of them were practical classes of Informatics. The classes' duration was 90 minutes.

Class	Teacher	Number of students	Grade	Age average	Age standard deviation	Age range
A	X	18	8	14.6	1	12-16
B	Y	27	9	14	0.9	13-17
C	X	21	9	15.5	0.6	15-17
D	X	15	12	17	0.4	16-18

Table 3.1: Composition of the classes where the game was tested.

The number of students, grade, age average, age standard deviation and age range of each class can be observed in Table 3.1.

Before any tests were conducted we interviewed the teachers of the classes to determine what they thought about them. Among teacher X's classes, class D was expected to be the quieter one. Class D's students were described by the teacher as being mature and hard working. Class A and class C's students were younger and the teacher expected them to be noisier. Class A was considered problematic because, even though it had only 18 students, many of them were repeating that grade. The teacher told us she left that class often feeling tired and with a hoarse voice.

Teacher Y expected class B to be noisy because this was the class with the greatest number of students and also because the students were still very immature.

Both teachers told us that students often loose conscience of how loud they are talking when they are engaged in group work.

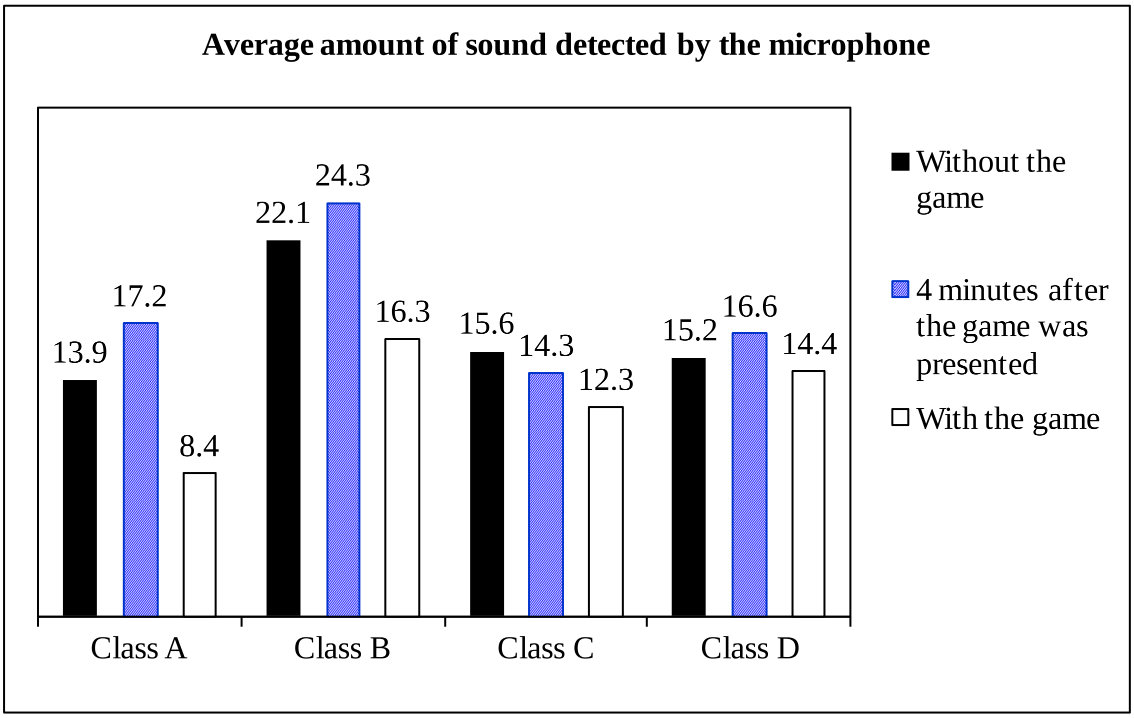


Figure 3.15: Average amount of sound detected by the microphone with and without the game.

First, we computed the average amount of sound detected by the microphone in all the classes without the game (Figure 3.15). Teacher X told us she was surprised that class A was the least noisy of her classes. The teacher attributed the greater fatigue, felt in class A, to the extra effort she had to make to motivate the students.

Figure 3.16: Class while the game is being tested.

Class	Average amount of sound detected by the microphone		Decrease
	Without the game	**With the game**	
A	13.9	8.4	39.6%
B	22.1	16.3	26.2%
C	15.6	12.3	21.2%
D	15.2	14.4	5.3%

Table 3.2: Average amount of sound detected by the microphone during a first lesson without the game and during a second lesson with the game.

In the second lesson the game was tested. A video projector was used to show the game to all students (Figure 3.16). The classroom had two whiteboards. We projected the game on the rightmost whiteboard. The teacher used the leftmost whiteboard when necessary. During the test of the game none of the teachers needed to show slides to the students. If this was the case, then a second video projector would be necessary. At the beginning of the class the game was explained to the students. The students were told that the game would be tested is several classes and that the quieter class would receive a mystery gift. The three characters were shown to the students and they chose one of them. Afterwards, the lesson continued as usual.

In all of the classes the amount of sound detected by the microphone decreased (Table 3.2). In class A there was a 39.6% decrease. This was the highest reduction across all classes. Class D was the class where the use of the game resulted in the smallest decrease. The average amount of sound detected by the microphone decreased only 5.3%. In classes B and C there was a decrease of 26.2% and 21.2% respectively.

Also, in all of the classes, except in class C, the average amount of sound detected by the microphone, during the 4 minutes after the game was explained to the students, was higher than in the first lesson without the game (Figure 3.15). This happened because, at first, the game captivated the students' curiosity and they tried to test it. Some students would raise their voices or whistle to see how the game reacted. They asked how much the score would increase, when they were quiet, and commented on the changes in the sound wave or in the frequency spectrum according to the different types of sounds produced.

Gradually, students turned their attention to their tasks. However, the game was not forgotten. Throughout the class, students would often look at the projection to check the score. If one of the students was talking too loud, another one would usually ask her or him to lower her or his voice. Some students asked us what the score in the other classes was. For these students, competition with the other classes seems to be a motivation. Other students tried to set goals. Those students would turn to the rest of the class and say that they had to increase a certain number of points till the end of the lesson and urged the others to be quiet. This type of peer pressure was more frequent in classes A and B than in classes C and D.

At the end of the lesson, where the game was tested, the students filled an anonymous survey that was previously tested.

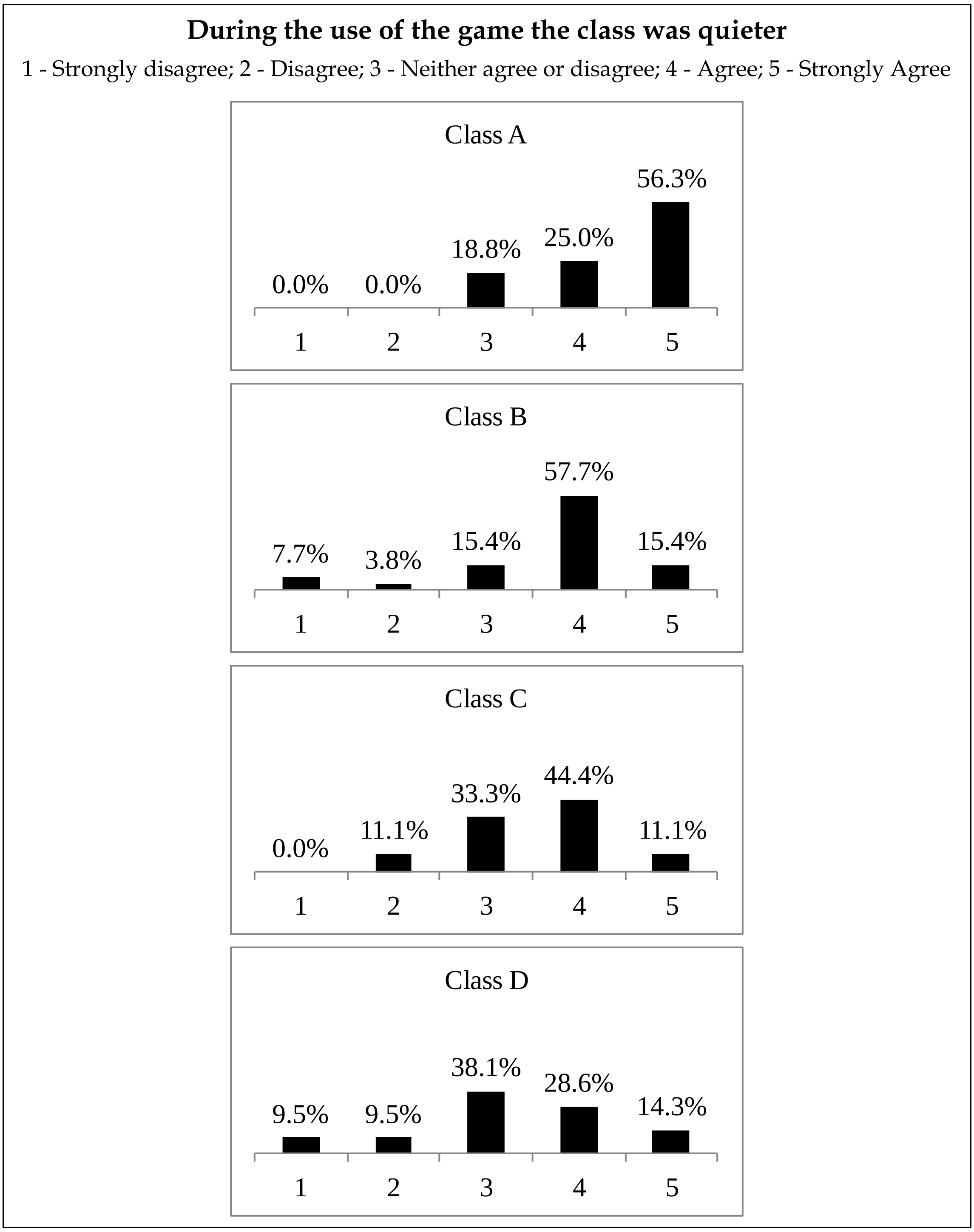


Figure 3.17: Was the class quieter during the use of the game?

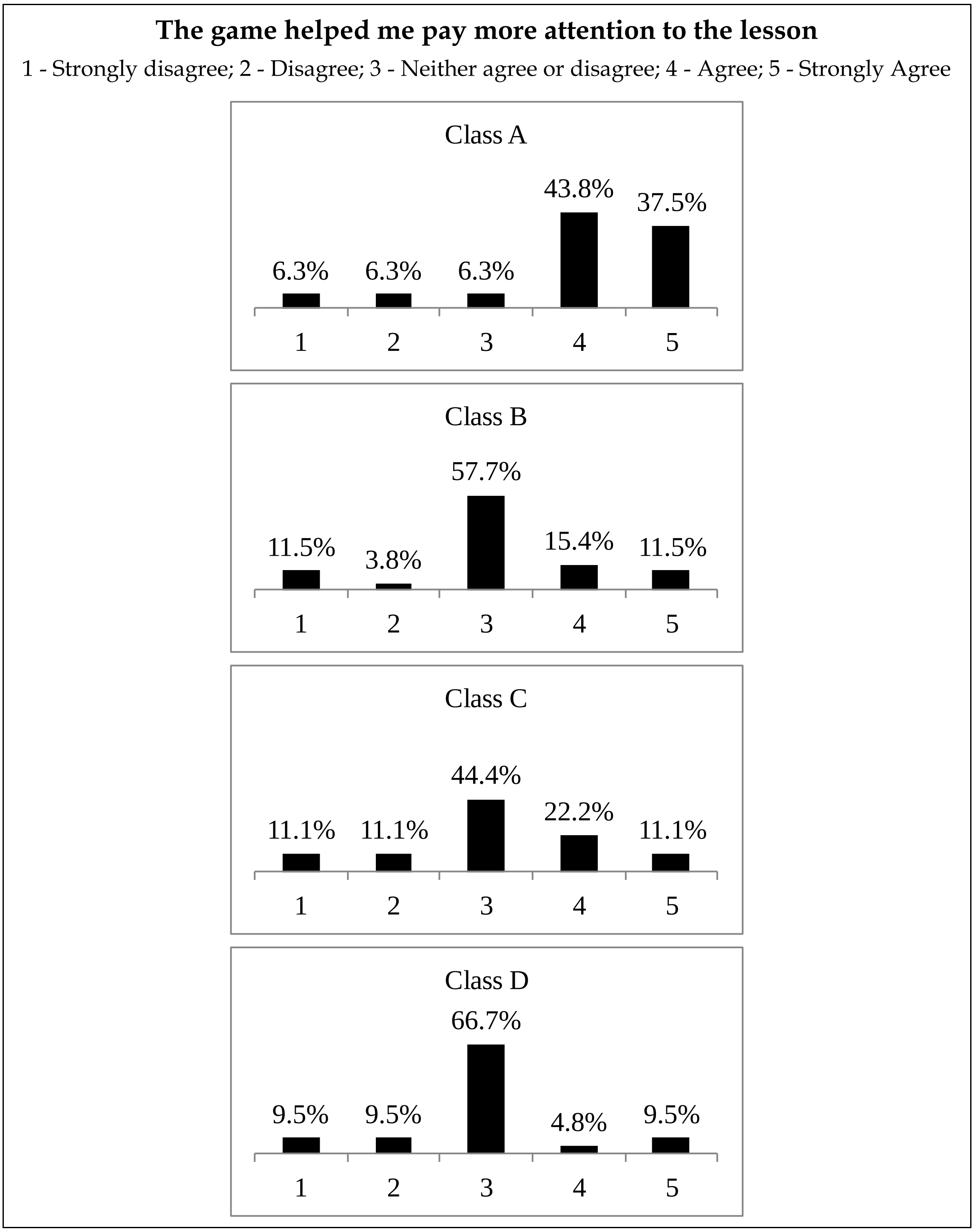


Figure 3.18: Did the game help the students pay more attention to the lesson?

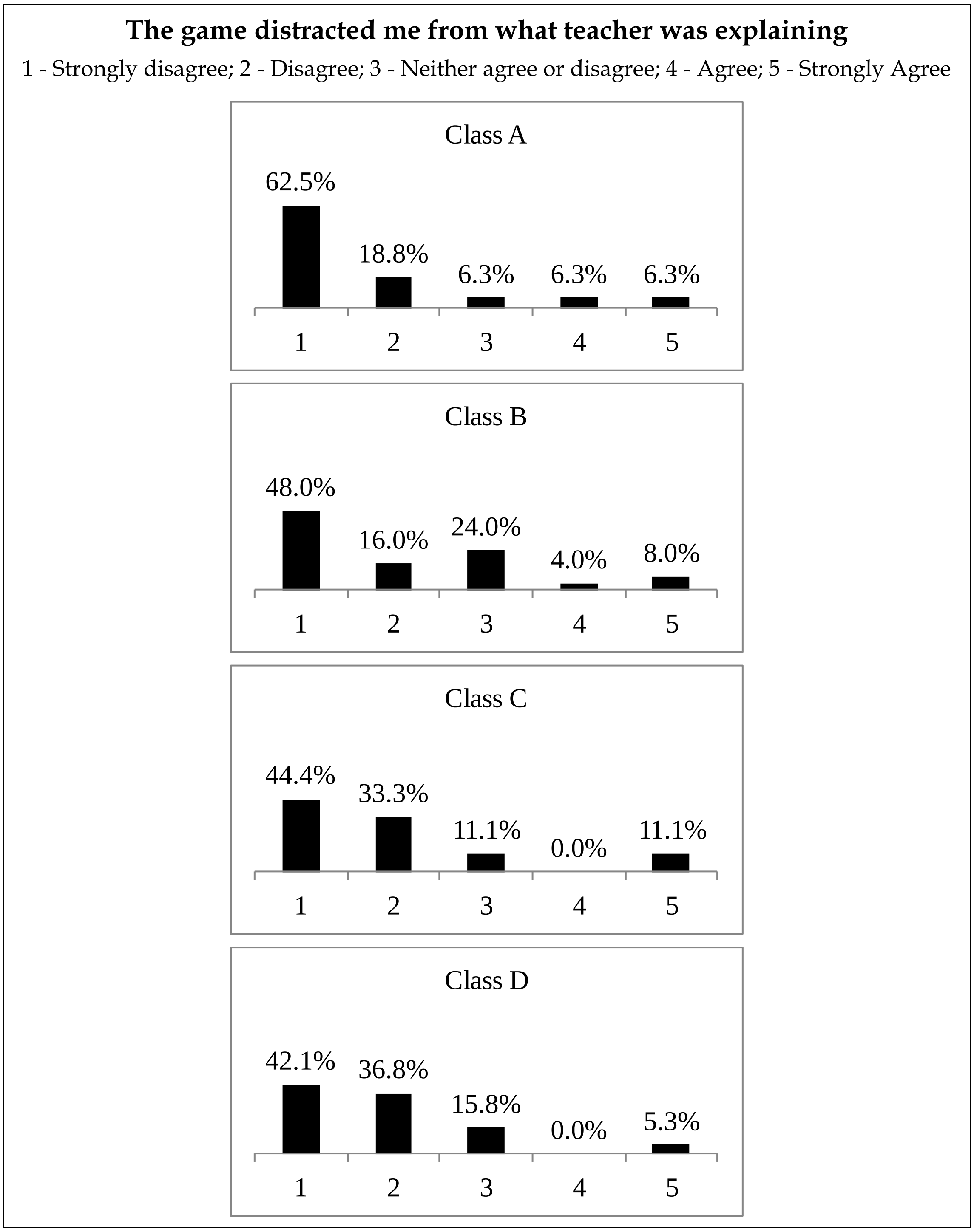


Figure 3.19: Did the game distract the students from what the teacher was explaining?

In the survey, we asked the students if the class was quieter, during the use of the game (Figure 3.17). In classes A, B and C most of the students agreed or strongly agreed that the classroom was quieter during the use of the game. These results are consistent with the results presented in Figure 3.15. Class A is the class where more students agreed or strongly agreed that the class was quieter during the use of the game. The average amount of sound detected by the microphone decreased 39.6% in this class and this was perhaps easily noticed by most of the students. In class D, only 42.9% of the students agreed or strongly agreed that the class was quieter during the use of the game. This happened, probably, because the average amount of sound detected by the microphone decreased only 5.3% and this was hardly noticed by the students.

We wondered if the game would cause the students to pay more attention to the class. The game could also have the opposite effect. If the students spent a lot of time looking at the game that could reduce the time they spent listening to the teacher or working in their tasks. So, we asked the students if the game helped them pay more attention to the lesson (Figure 3.18).

Only in class A did most of the students agreed or strongly agreed that the game helped them pay more attention to the class. In classes B, C and D the answer "Neither agree or disagree" was the most chosen one.

We interviewed the teachers of classes A, B, C and D and they noticed no visible change in the students' attention to the lesson, even in class A. This seems to indicate that the game did not significantly influence the attention of the students to the lesson.

To make clear if the game decreased the students' attention to the teacher we included another question in the survey. We asked the students if the game distracted them from what the teacher was explaining (Figure 3.19).

In all the classes, the attention to what the teacher was explaining of most students was not negatively affected by the game. The percentage of students that agreed or strongly agreed that the game distracted them is quite small in all the classes. This indicates that even though the game did not cause the students to pay more attention it also did not cause the opposite effect. As the game does not measure the attention of the students to the lesson we consider that these results are not surprising.

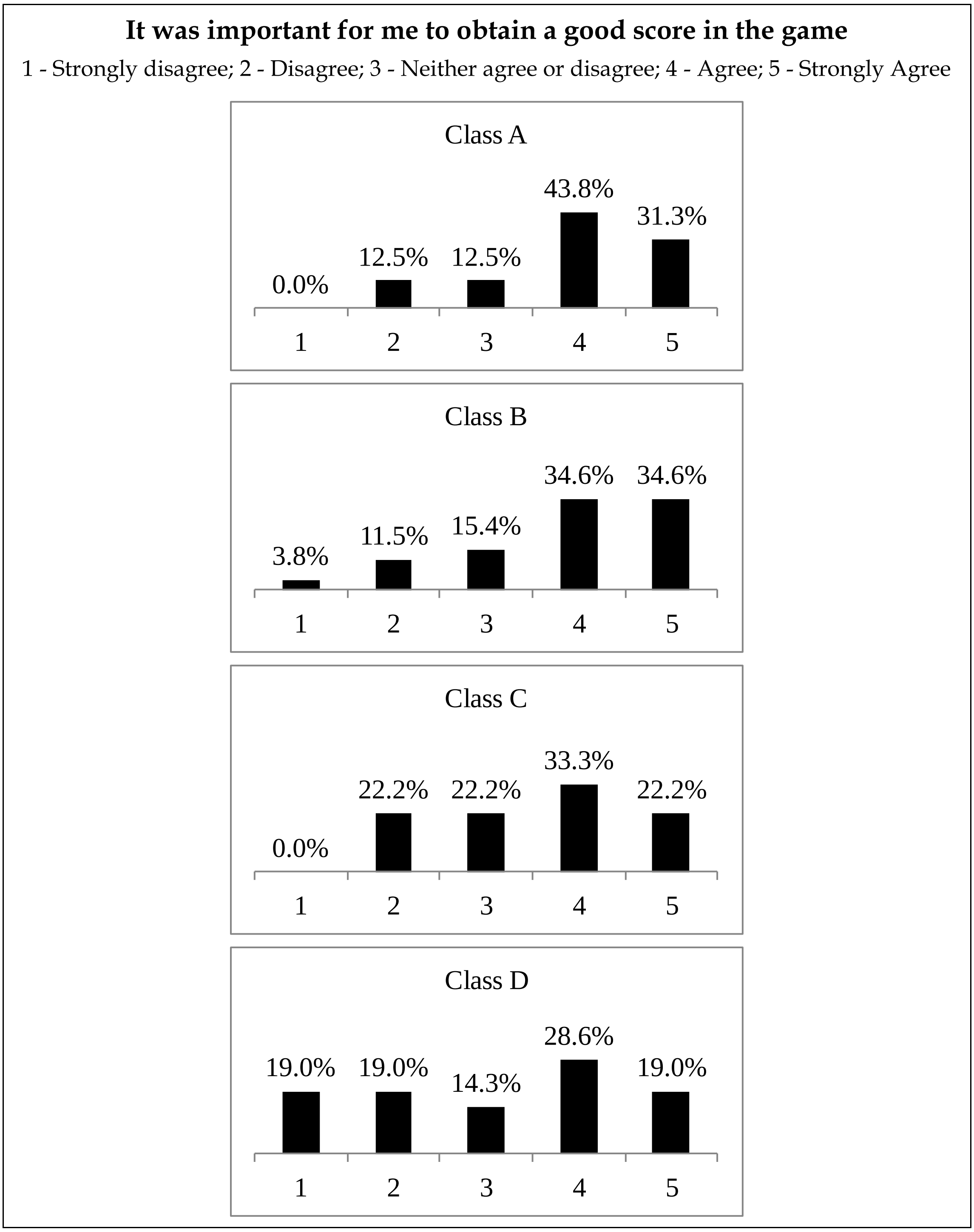


Figure 3.20: Was it important for the students to obtain a good score in the game?

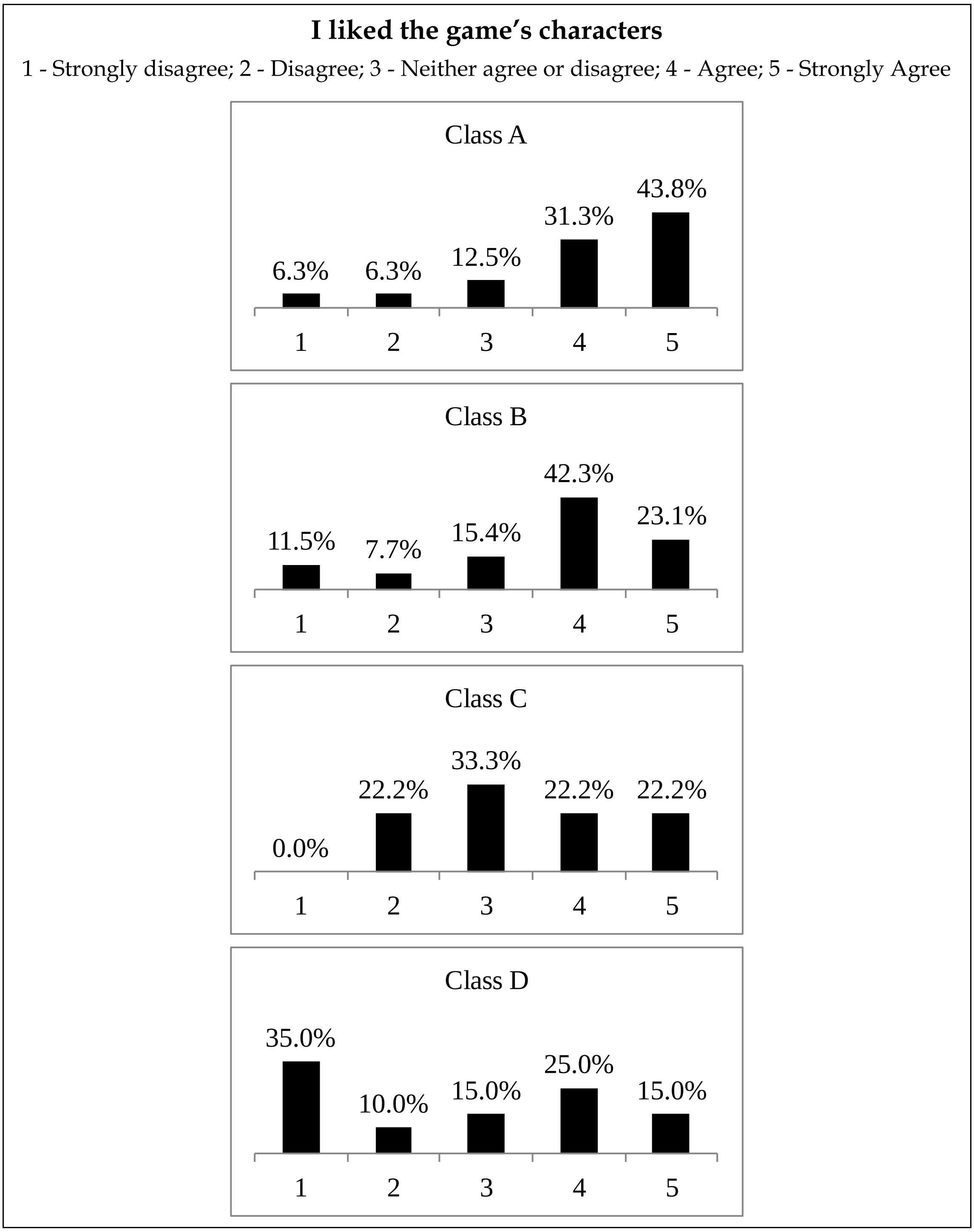


Figure 3.21: Did students like the game's characters?

In the survey we asked the students if it was important for them to obtain a good score in the game (Figure 3.20).

75.1% of the students in class A and 69.2% of the students in class B considered it was important for them to obtain a good score in the game. This means a high percentage of the students were trying to stay quiet or, at least, lower their voices. That is perhaps one of the reasons why the average amount of sound detected by the microphone greatly decreased in both these classes.

In class C more than half the students were interested in a good score and that seems to have contributed to a decrease of the average amount of sound detected by the microphone during the use of the game.

Class D is the class with the lowest percentage of students interested in a good score. If there was a way to increase class D's interest in a good score, perhaps the average amount of sound detected by the microphone would have decreased more.

We were also interested in knowing if the students liked the game's characters (Figure 3.21).

If the students liked the game's characters then maybe they could create some sort of empathy with the characters and that would motivate the students to please the character by staying quiet or lowering their voice level.

In classes A and B most of the students agree or strongly agree that they liked the game's characters. In class A, the percentage of students that strongly liked the game's characters is higher than in class B, though.

In class C, 44.4% of the students agreed or strongly agreed that they liked the game's characters.

The worst results were obtained in class D. 35% of the students strongly disliked the game's characters and 10% did not like them. Many of these students complained, in the survey, that the characters were too childish and, therefore, not appropriate for their age. Indeed, class D is the class where the age average is higher. This seems to indicate that a different approach should have been used with these older students. Perhaps, if the students liked the characters they would feel more inclined to please them and stay quiet.

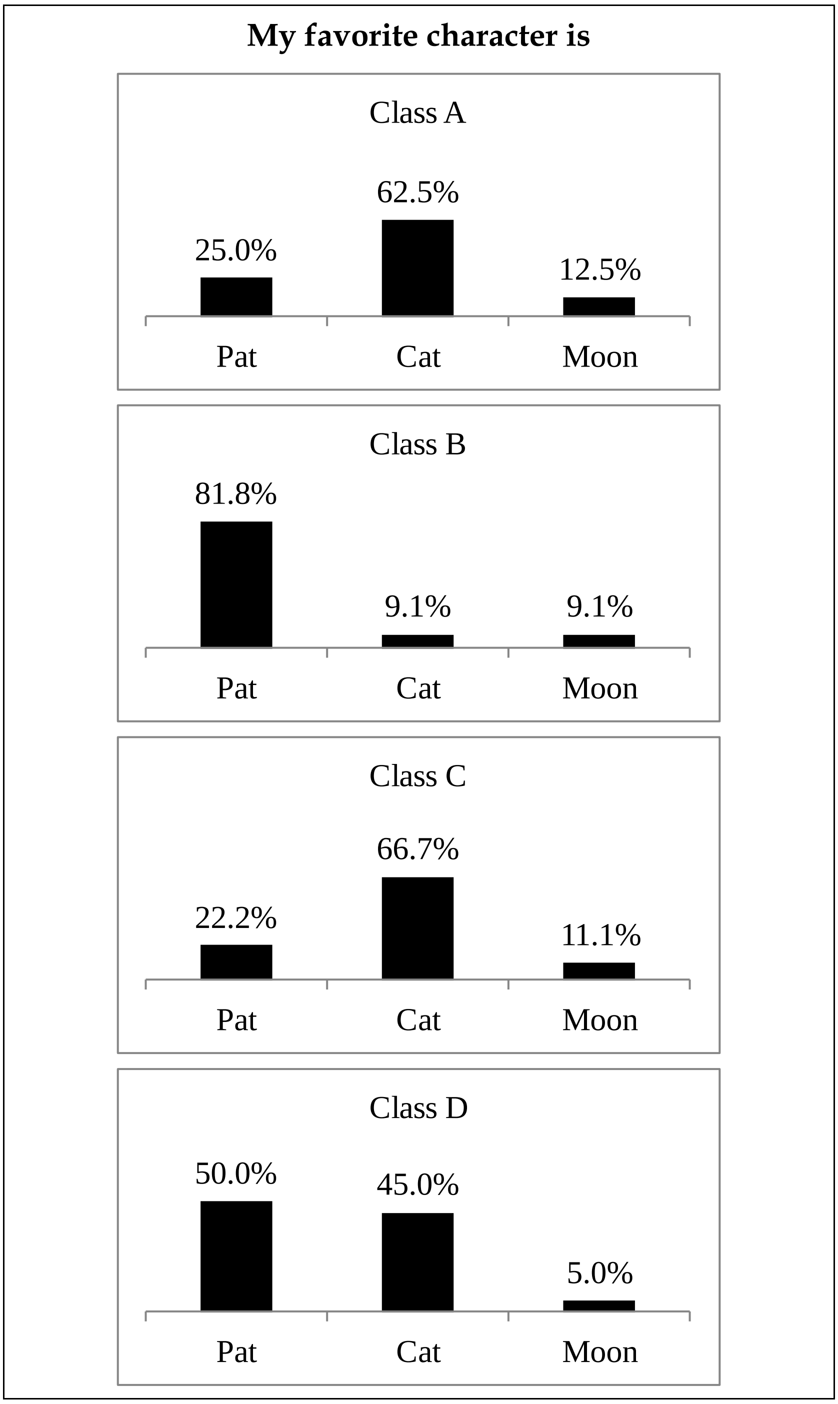


Figure 3.22: Students' favorite characters.

In classes A and C the favorite character was the Cat (Figure 3.22). Some students told us that they found funny how the sound spectrum was integrated in the Cat's fur and how the Cat stood up when he was angry. In this way, the sound real world element is represented in an expressive and dynamic way. In classes B and D the favorite character was Count Pat. The Moon was the least liked character in all the classes. Some students found the Moon too dark and dull. Others said that with Pat and with the Cat it was easier to perceive when the character was happy or angry.

3.1.7. Discussion

We investigated if the quantitative and graphical perception of sound, by students, in a classroom, can affect how noisy these students are. A survey was conducted to 60 teachers, of an elementary and secondary school, to find out if they considered that noise, caused by the students talking to each other in the classroom, was a problem. 78.3% of the inquired teachers agreed or strongly agreed that students make too much noise and that negatively affects their learning. Besides, 98.3% of the inquired teachers thought that when the students are making too much noise it is more difficult to teach the class. Only 34.5% of the inquired 81 students agreed or strongly agreed that their colleagues make too much noise in the classroom.

The teacher can tell the students that they are speaking too loud, but this does not show then, in a quantitative way, how much noise they are making. Our hypothesis was that, if students are more aware of how much noise they are making this would cause them to be quieter. To test this hypothesis we developed a game that shows students, in real time, the amount of sound a microphone is detecting in the classroom. The lower the amount of sound the microphone is detecting, the more points the students accumulate. The game shows the sound wave or the frequency spectrum, after a Fourier transform is performed on the sound data. The game's interface also integrates a character and a volume bar. The character changes state and the volume bar changes size according to the microphone's activity level.

Students had a choice of three characters. The Cat was the preferred character in classes A and C and Count Pat was the preferred character in classes B and D. The Moon was the least preferred character in all the classes. The Cat integrated the representation of the real world element sound in his fur. This could be a guideline to show information about other real world elements. Not via separate graphic representations, but in a seamless integrated manner, like in Pat's Cat.

The game was tested in classes A, B, C and D. A video projector was used so that all students could see the output of the game. The average amount of sound detected by the microphone was computed during a first lesson, for each class, without the game. Afterwards, during a second lesson, the average amount of sound detected by the microphone was computed again while using the game. The average amount of sound detected by the microphone decreased 39.6%, 26.2%, 21.2% and 5.3% in, respectively, classes A, B, C and D. The age average of classes A, B, C and D is 14.6 years old, 14 years old, 15.5 years old and 17 years old respectively. Therefore, the game performed better, in the reduction of the average amount of sound detected by the microphone, with the younger students. Future work will have to be conducted to test if showing the students the amount of sound detected by the microphone in the classroom is a strategy that works better with younger students. Several students in class D complained that the game's characters were too childish. If the game's characters had been more adequate to these students then perhaps they would have felt more inclined to be quieter or to lower their voices. Nevertheless, even in class D, the average amount of sound detected by the microphone decreased 5.3%.

The influence of the game in the students' attention to what the teacher was explaining was also tested. We interviewed the teachers of the classes and conducted an anonymous survey to the students. The answers show that the game did not negatively influence the attention of the students in class.

3.2. Imaginary Friend

Sometimes, one wants a friendly shoulder to lean on or someone with whom to share the good and the bad times. We propose a metaphor of an imaginary friend who accompanies the user and to whom the user can confide her emotions.

Imaginary friends, though nonexistent, provide many advantages to their human companions. Imaginary friends can help one get through difficult or stressful times [128] and children with imaginary friends are significantly more creative [129]. Imaginary friends are common among children. Approximately 50% of children aged between 5 and 12 years old have experiences with imaginary friends [130]. Perhaps many adults also have imaginary friends but lack the courage to assume it because they feel it is too childish a thing for their age. That is not the case of adult fiction writers, as 92% of them experience the illusion that their characters have independent thoughts, words or actions, as if they were real persons [131].

Countless people write to an imaginary friend that exists only in the pages of a diary. One of the most famous of these imaginary friends is Kitty, who accompanied Anne Frank through the difficult times in the attic during the Second World War. Another well know imaginary friend is Hobbes from the Calvin and Hobbes cartoon books by Bill Watterson. Hobbes is a tiger that accompanies Calvin and discusses everyday matters with him. Hobbes is really just a stuffed tiger but, for Calvin, Hobbes is much more than a mere toy. He is alive and has feelings, just like a real person.

Previous work in detecting and using emotion is presented in Section 3.2.1. The Imaginary Friend [132,133] proposed here walks by the side of the user. The user can confide the emotions she is feeling to the Imaginary Friend. This concept is further detailed in Section 3.2.2. Section 3.2.3 focuses on the walking activity. Section 3.2.4 details how the Imaginary friend connected with the user's emotions. Section 3.2.5 presents details about the implementation and about the game's architecture. The evaluation of the game can be found in Section 3.2.6. In Section 3.2.7 a proposal to expand the Imaginary Friend to a multiplayer game via emotion castles is presented. Section 3.2.8 proposes another expansion where several Imaginary Friends recommend social connections among people who share similar interests. Finally, a discussion is included in Section 3.2.9.

3.2.1. Detecting and Using Emotions

In what concerns the detection of emotions, S. D'Mello and A. Graesser [134] present a multimodal affect detector that combines conversational cues, body language, and facial features. G. Rigas et al. [135] propose a method for the recognition of happiness, disgust and fear using input signals such as facial electromyograms, electrocardiogram, the respiration and the electrodermal skin response. K. Kim et al. [136] propose yet another emotion recognition system that resorts to electrocardiogram, skin temperature variation and electrodermal activity as input signals. Finally, the iCalm [137] is a wristband that measures electrodermal activity which does not need sticky gel.

According to R. Picard [138] a device that monitors the emotions of the person who is using it will open possibilities for new and imaginative interactions in games. Some even foresee that, someday, we shall use devices that interpret our emotions and inform us of everything we need to do to be happy [139].

The Imaginary Friend is an application that is in touch with the user's emotions. Several other forms to interact with the user's emotions have already been proposed. I. Leite et al. [140] developed a scenario in which a robot recognizes the user's affective state and displays empathic behaviors. B. Kort et al. [141] propose a computer based model that recognizes the students' affective state and reacts in such a way that learning proceeds at optimal pace. In another work a robot mirrors the emotions happiness, fear and neutral of a human being [142]. The How Was Your Day Companion [143] establishes a conversation with the user about work related topics. In the game Emotional Flowers [144] the player's facial expression controls the growth of a plant. The objective of the game is to grow the plant as fast as possible resorting to positive emotions like happiness or surprise.

The Imaginary Friend is projected on the floor via a pico projector connected to a mobile phone (Section 3.2.3). Projectors have already been used for interacting with smart objects [145], to overcome the limitations of the small displays of mobile phones [146], to share the feelings of the user [147] or even to provide a sixth sense [148].

One of the functionalities of the Imaginary Friend is to record and display past emotions (Section 3.2.4). The Mappiness [149] application asks users if they feel happy, relaxed or awake to discover how people's happiness is affected by their local environment. The Glow mobile app [150] shows where people are feeling good. MobiMood [151] is another mobile application that enables groups of friends to share their moods with each other. In the Twitter mood project [152] the happiness of users was inferred from the analysis of their tweets. However, neither the Twitter mood project nor any of the mobile applications mentioned relate the user's emotions to the electrodermal activity.

3.2.2. The Toy

Our objective was to create an Imaginary Friend that accompanies the user and keeps her company (Figure 3.23 (a)). This Imaginary Friend has a special bond with the user and can feel what the user is feeling (Figure 3.23 (b)). As the user walks around, in her everyday life, she leaves behind emotion cookies (Figure 3.23 (c)). These cookies are invisible to creatures from the real world. However, the Imaginary Friend, who lives in the border between the real world and the imagination world, can see those emotion cookies and will store them all in a jar. To know the emotion that corresponds to each cookie the Imaginary Friend will need the user's help. Each time a cookie is collected, the Imaginary Friend will question the user to discover to what sort of emotion that cookie corresponds (Figure 3.23 (d)).

Figure 3.23: The Imaginary Friend's concept.

3.2.3. Walking Along with the User

Our Imaginary Friend accompanies the user. When the user looks down the friend is there. The Imaginary Friend is projected on the floor using a pico projector attached to the user's backpack shoulder strap (Figure 3.24). The projector is connected to a mobile phone that runs the interactive application. The user also wears a bracelet with an electrodermal activity sensor. This sensor is used to measure the arousal of the user, as is further explained in Section 3.2.4. In Figure 3.25 a close up of the Imaginary Friend is presented.

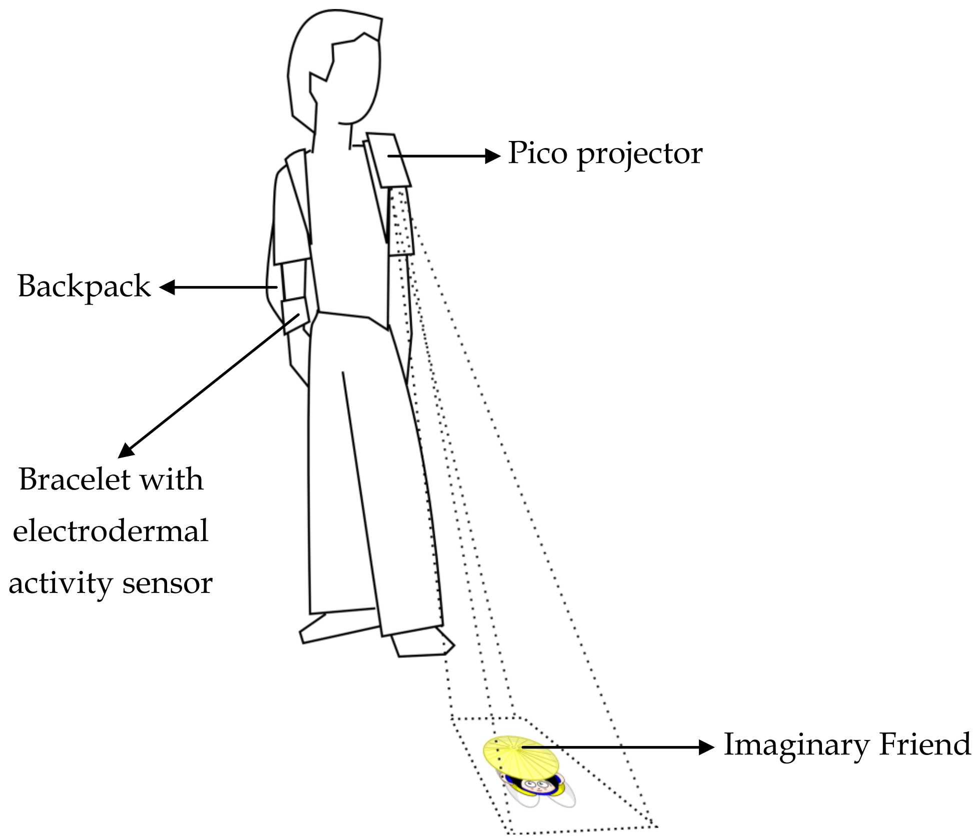


Figure 3.24: Illustration of the user with the Imaginary Friend.

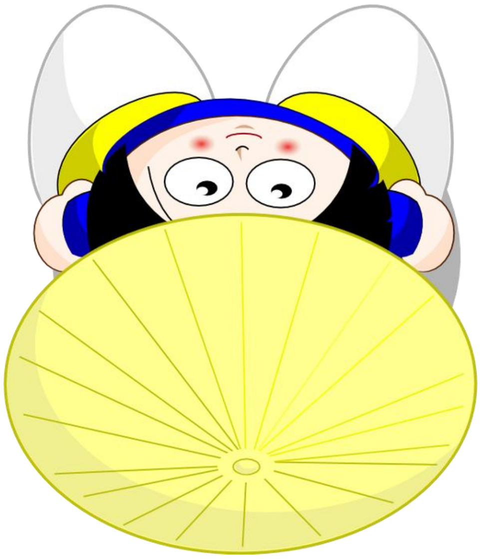


Figure 3.25: Close up of the Imaginary Friend.

Figure 3.26: Two users with the Imaginary Friend. The Imaginary Friend can be seen, projected on the floor, by the side of each user.

Figure 3.26 shows two photographs of two users with the Imaginary Friend. These users have a pico projector attached to their backpack shoulder strap, as represented in Figure 3.24. The users are also wearing the bracelet, with the electrodermal activity sensor, on their right wrist.

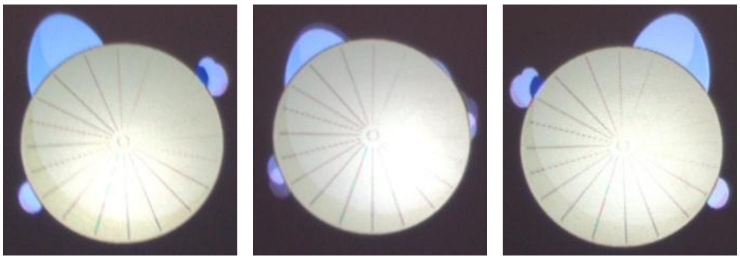


Figure 3.27: Projected image of the Imaginary Friend while the user is walking. Hands and feet move back and forth.

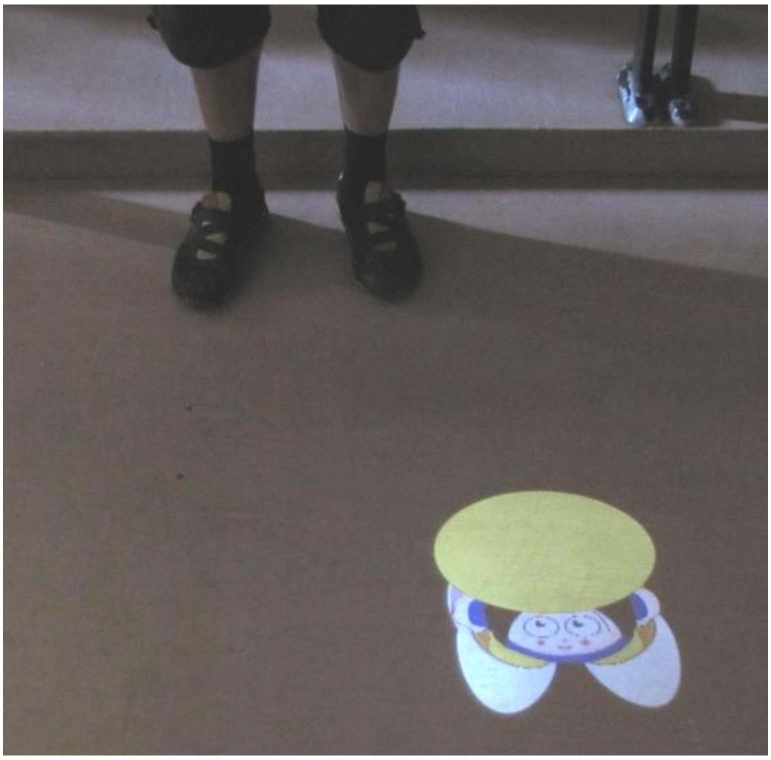


Figure 3.28: Projected image of the Imaginary Friend while the user is standing still.

When the user is walking, the Imaginary Friend is also walking besides the user. In the animation of the imaginary friend, the hands and feet move back and forth to convey the impression of a human being walking (Figure 3.27).

The Imaginary Friend is seen from a top view as if he is someone shorter than the user. The background is black, so that in that area no colors are projected. This way, we tried to create the illusion that the Imaginary Friend is really standing on the floor. We considered including a grass background but the grass would not feel like part of a real floor. A black background was therefore considered the best choice. The Imaginary Friend has very light colors because darker colors were harder to see in the projection.

When the user is walking, the Imaginary Friend assumes she is too busy and just walks besides the human companion keeping company.

When the user stops walking, the Imaginary Friend also stops and looks up to convey that he is paying attention to what the user is doing (Figure 3.28). We detect if the user is standing or walking by analyzing the accelerometer data on the mobile phone.

3.2.4. Connecting with the User's Emotions

The Imaginary Friend automatically detects changes in the arousal of the user. Arousal corresponds to a change in conductance at the surface of the skin due to an external or internal stimuli experienced by the user [153]. The user wears a bracelet with the electrodermal activity sensor on her wrist (Figure 3.29). The electrodermal activity sensor is attached to the user's wrist. The bracelet is used to prevent the sensor from falling or from displacing due to the user's movement.

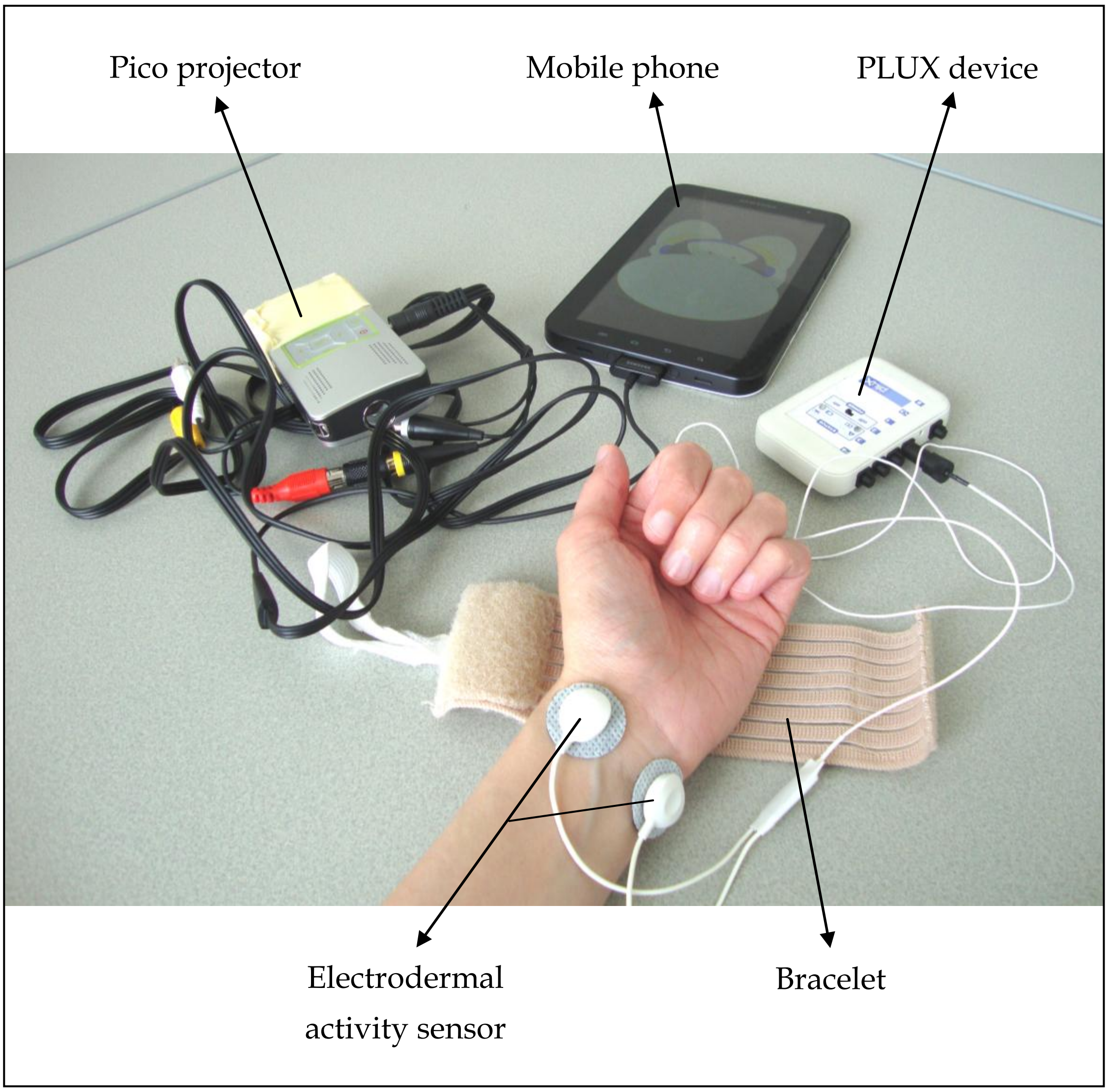


Figure 3.29: All the devices used in the Imaginary Friend.

In Figure 3.29, the bracelet is not strapped and the sensor can be seen on the user's wrist. In Figure 3.30, the bracelet is strapped. The sensor is connected, with wires, to a PLUX device [154] that transmits the data, via Bluetooth, to the mobile phone (Figure 3.29). The PLUX device can be attached to a belt, placed inside a pocket or inside the backpack. The mobile phone is connected to the pico projector, in order to project the Imaginary Friend on the floor. We attached the pico projector to the backpack shoulder strap with tape. Some of that yellow tape can still be seen in Figure 3.29.

Figure 3.30: The bracelet, with the sensors underneath, on the left, connected to the PLUX device, on the right.

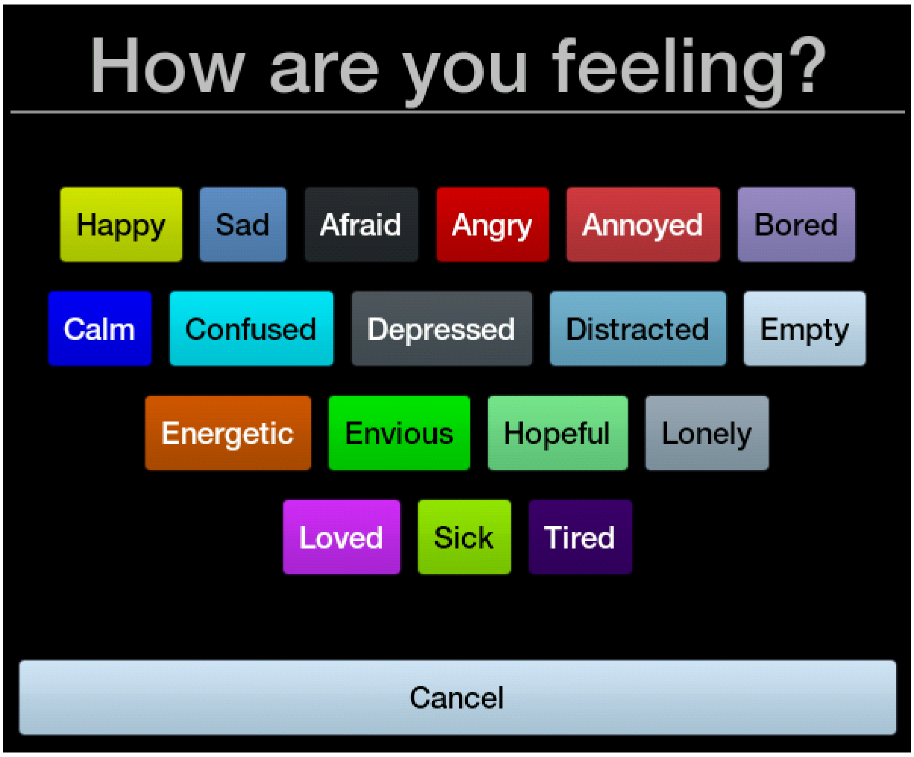


Figure 3.31: Emotion tags.

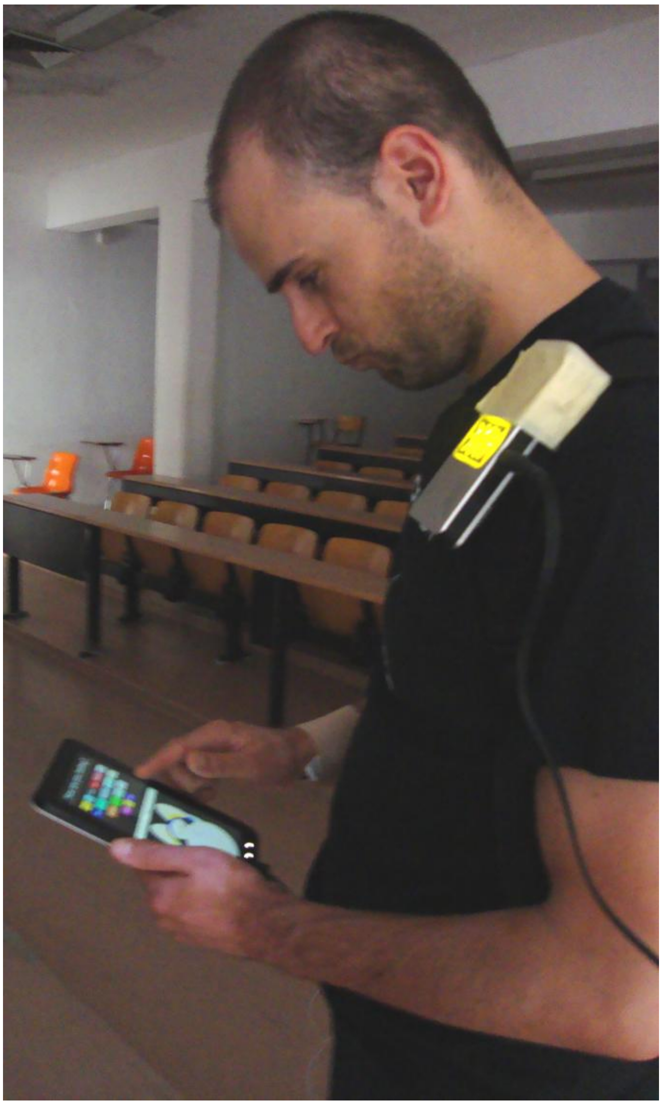
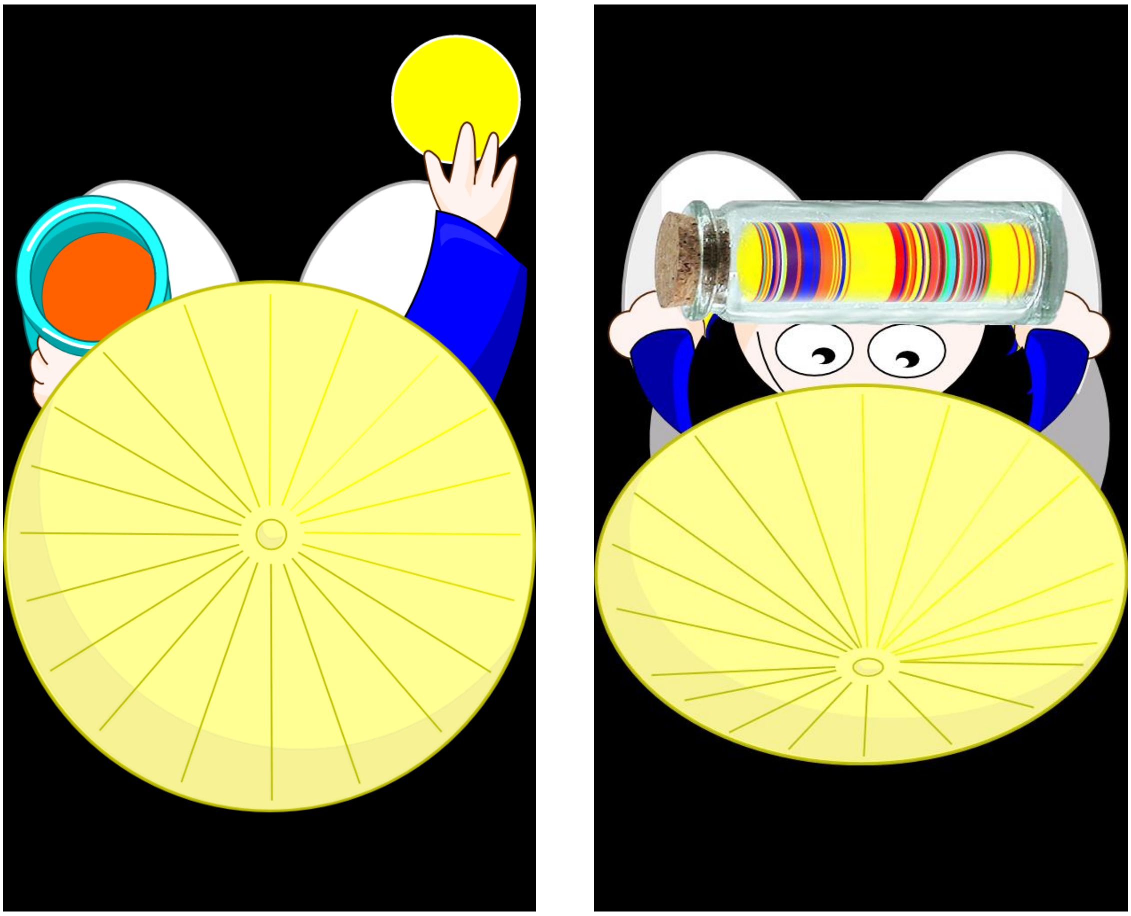


Figure 3.32: User selecting an emotion tag.

When there is a significant increase or decrease in the arousal, the external or internal stimuli behind that change might have caused an alteration in the emotion the user is feeling. To discover what emotion the user is feeling, the Imaginary Friend will pose a question and present several emotion tags (Figure 3.31). The phone beeps and vibrates to warn the user that the Imaginary Friend is posing a question. The available emotion tags are Happy, Sad, Afraid, Angry, Annoyed, Bored, Calm, Confused, Depressed, Distracted, Empty, Energetic, Envious, Hopeful, Lonely, Loved, Sick and Tired.



(a) Retrieving the emotion cookie left behind by the user

(b) Jar with the stored emotion cookies

Figure 3.33: Collecting and storing the emotion cookies.

To attribute a color to each emotion tag we used an adaptation of the colors proposed in other projects [155–157]. Happy and Sad are emotions easy to interpret, so we placed them near the top left corner of the screen (Figure 3.31). The rest of the emotions are organized in alphabetical order.

Deciding which emotions to include in our emotion tags (Figure 3.31) was difficult for there is no consensus about a list of emotions associated with colors, that can describe all emotional states [155–157].

We could have included all the emotions we consulted on previous works, but then the list would become too extensive. Plutchik's model [155] alone includes 32 different emotions. Showing 32 emotion tags to the user seemed to us like too much information, especially for the small screen of a mobile phone. We wanted the choice of an emotion tag to be a quick decision because the Imaginary Friend is supposed to integrate with the user's daily life. Reading through and choosing among 32 emotion tags while running to catch the tram looks like a complicated task.

On the other hand, if the choice of emotion tags is too limited then the user may feel the emotion she is feeling is not there.

In the end we decided to substitute emotions, that were mentioned in the consulted references [155–157], and that were somehow overlapping, for a single emotion. For example, serenity, joy and ecstasy, were considered, by R. Plutchik, as similar emotions that were associated with different tonalities of yellow. We therefore decided to group these emotions in the emotion tag Happy.

We also aimed for grammatical consistency in the Imaginary Friend question and in the chosen emotion tag. The Imaginary Friend asks "How are you feeling" (Figure 3.31). If a human being asks this question and another human being wants to indicate a certain emotion a possible answer would be "I feel X", where X would be replaced by one of the emotion tags.

After the user selects an emotion tag (Figure 3.32), an emotion cookie is left on the ground. The cookie and the selected emotion tag have the same color. In the case represented in Figure 3.33 (a) the cookie is yellow because the user selected the emotion tag Happy. The emotion cookie already inside the jar has the color of the previously selected emotion tag. In this specific case it was the Energetic emotion tag. The Imaginary Friend picks up the emotion cookie and stores it inside a jar (Figure 3.33 (b)). The most recent emotions are near the opening of the jar, on the left side of the picture. The most ancient emotions are at the bottom of the jar on the right side of the picture. The animation associated with the process of storing the emotion cookie is projected on the floor.

By looking at the most frequent colors inside the jar (Figure 3.33 (b)) the user can have an idea of what emotions have dominated her recent life.

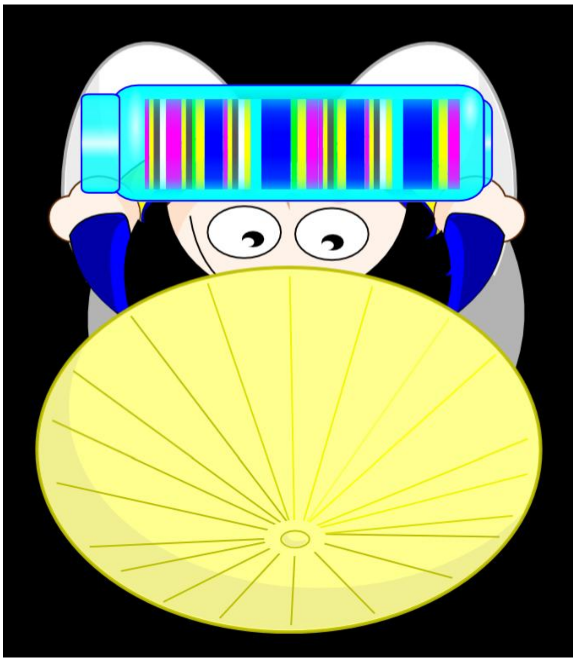


Figure 3.34: An initial version of the Imaginary Friend holding a cartoon jar.

Figure 3.35: List of past emotions experienced by the user.

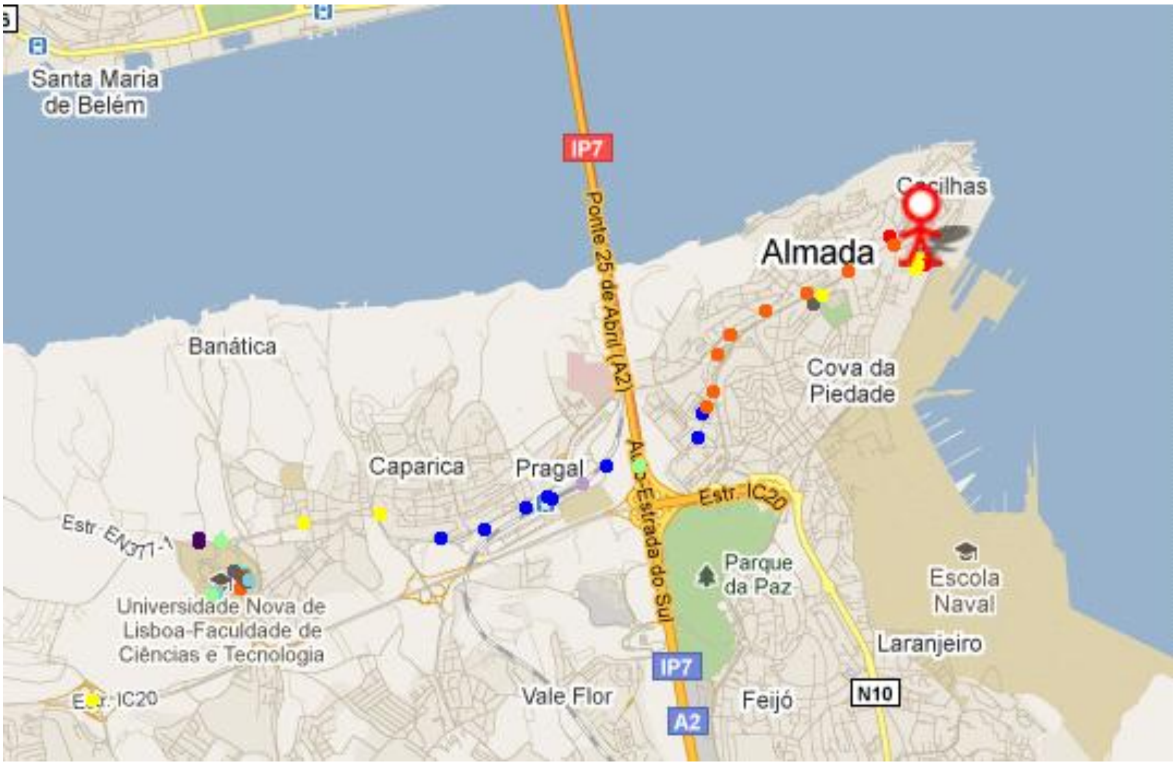


Figure 3.36: Places where the emotion cookies were collected by the Imaginary Friend. The current position of the user is represented by a red figure.

We initially considered a version where the Imaginary Friend would hold a cartoon jar (Figure 3.34), however, we opted for the version presented in Figure 3.33 (b). The jar in Figure 3.33 (b) is an edited photo of a real jar. This is meant to cause a contrast with the cartoon style of the Imaginary Friend as the jar symbolizes a connection with reality. The user's emotions are real and so they are stored inside a real jar by the Imaginary Friend.

Besides the jar, there are other ways of consulting past emotions. The user can consult a list with all the past emotions ordered by descending chronological order (Figure 3.35). Each line shows the color and the name of the emotion tag selected by the user, when answering to the Imaginary Friend. Each line also indicates when and where the emotion cookie was collected.

The user can also visualize, in a map, the places where each emotion cookie was collected by the Imaginary Friend (Figure 3.36). Each circle, in this map, represents an emotion cookie. The current position of the user is represented by a red figure.

When the user clicks a line, in Figure 3.35, the list will disappear and the map will appear, centered at the point where that emotion cookie was collected.

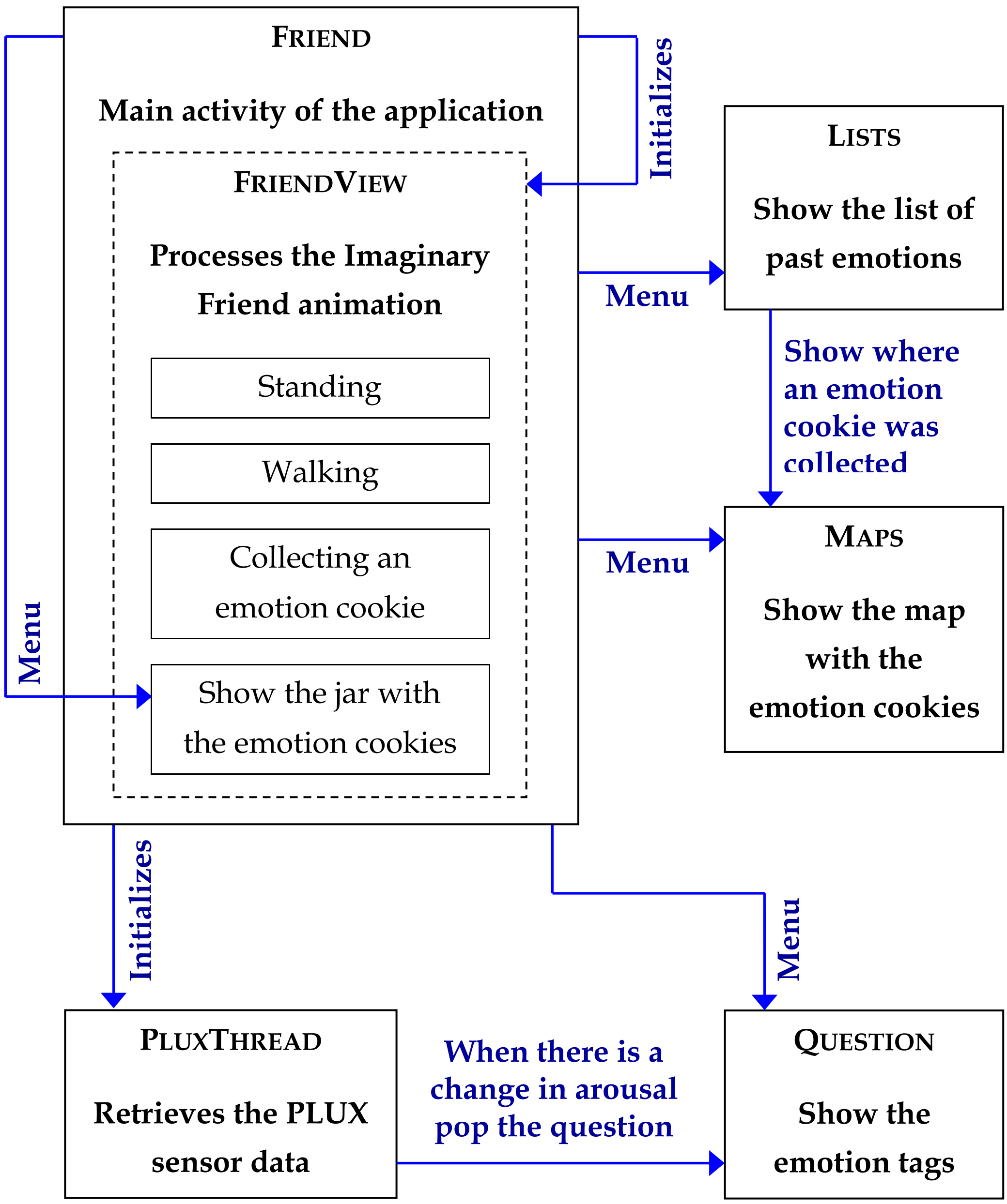


Figure 3.37: Imaginary Friend architecture.

3.2.5. Implementation and Architecture

The Imaginary Friend was implemented as an Android application for mobile phones. In Figure 3.37 the application's architecture, combined with the activity of the interface, is schematized.

Android applications typically integrate several activities. Activities generally interact with the user and they are a single focused thing that the user can do [158].

The activity Friend is the application's main activity and is responsible for initializing the FriendView class and the PluxThread thread. The FriendView class is integrated as part of the Friend activity's layout. Through the activity Friend the user can access a menu that allows her to: show the Imaginary Friend holding the jar with the collected emotion cookies (Figure 3.33 (b)); access a map that displays where each emotion cookie was collected (Figure 3.36); show a list with the collected emotion cookies (Figure 3.35); indicate how she is feeling (Figure 3.31). The emotion tags, with the "How are you feeling?" question are automatically displayed when there is a sudden change on arousal. However the user can herself report how she is feeling by her own initiative.

The FriendView processes the Imaginary Friend animation so that the Imaginary Friend looks up, when the user is standing, walks when the user is walking and collects an emotion cookie after the "How are you feeling?" question. The class FriendView extends the SurfaceView class, thus providing a dedicated drawing surface [159,160].

The Lists activity shows the list of past emotions cookies (Figure 3.35). When clicking on a past emotion the user can see, on a map, the place where the emotion cookie was collected (Figure 3.36). The Maps activity shows the map with the emotion cookies (Figure 3.36). The PluxThread interacts with the PLUX device via Bluetooth and starts the Question activity when a sudden change on arousal is detected.

Finally, the Question activity shows the emotion tags (Figure 3.31). Information about the emotion cookies and the place where they were collected is stored, on the phone, on an Android SQLiteDatabase.

3.2.6. Evaluation

The Imaginary Friend was tested with eleven users. The youngest user is 15 years old and the oldest user is 58 years old. The average user age is 36.5 years old with a standard deviation of 14.4 years. Five of the users are females and the remaining six users are males. The users were questioned, with a paper survey, after they used the Imaginary Friend application. The survey was previously tested.

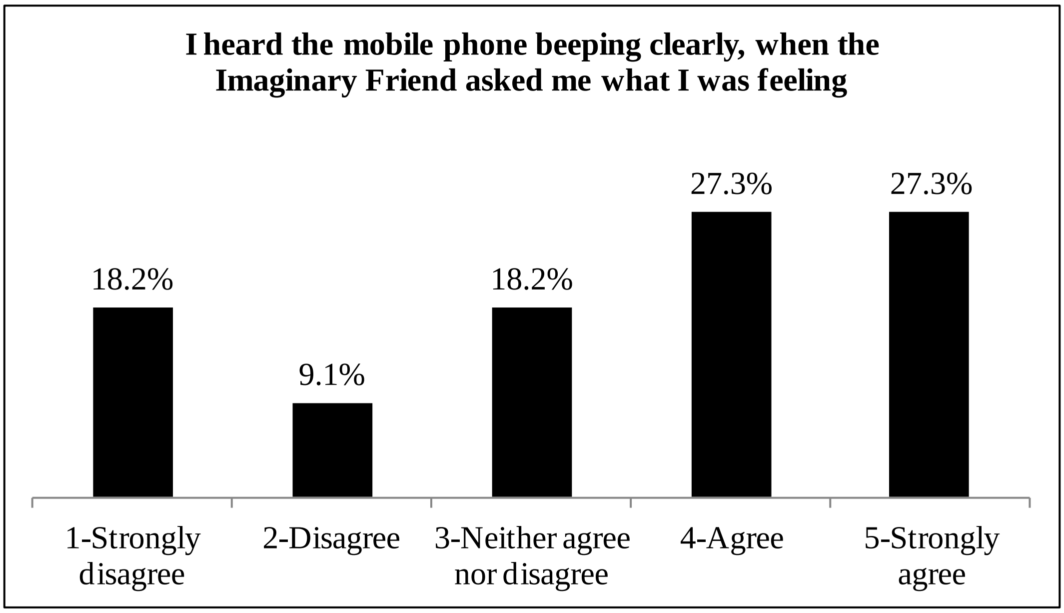


Figure 3.38: Did the users hear the mobile phone beeping clearly when the Imaginary Friend asked them what they were feeling?

When the Imaginary Friend asks the user what emotion she is feeling (Figure 3.31) the mobile phone vibrates and beeps. We wondered if this was enough to captivate the user's attention. 54.6% of the users agreed or strongly agreed that they could clearly hear the beep. 27.3% of the users were completely unable to hear the beep or were hardly able to hear it (Figure 3.38). Some users complained that it was difficult to hear the beep when they were talking with other people or immersed in a noisy environment.

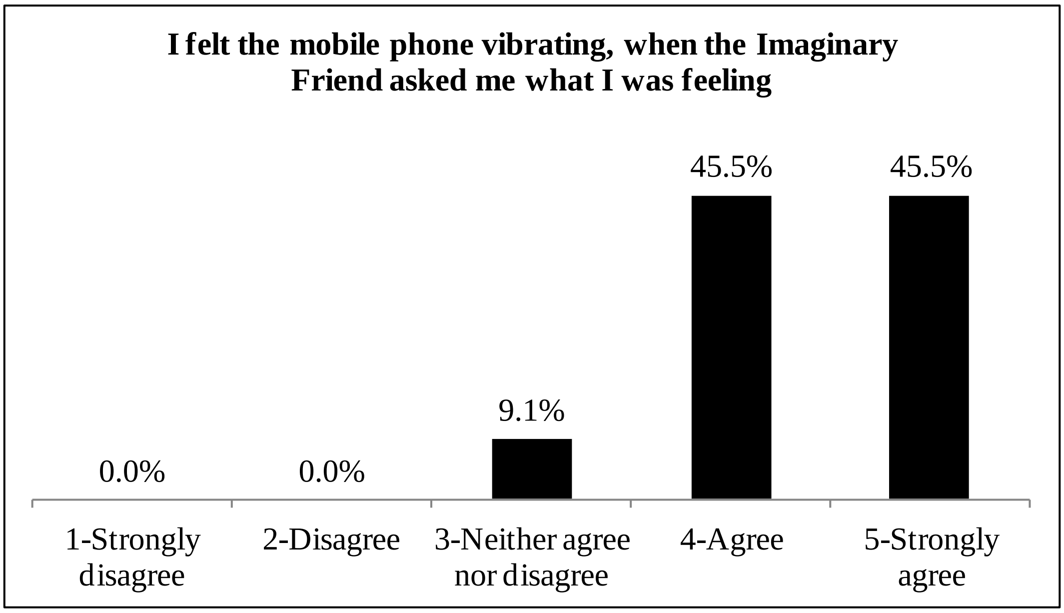


Figure 3.39: Did the users feel the mobile phone vibrating when the Imaginary Friend asked them what they were feeling?

However, almost all users were able to feel the phone vibrating when the Imaginary Friend posed a question (Figure 3.39).

During the time that the users tested the application, the Imaginary Friend asked them what emotion they were feeling a total of 270 times. 237 answers were collected. Users were, therefore, able to answer 87.8% of the Imaginary Friend's questions. This seems to indicate that the beep combined with the vibration of the mobile phone was an efficient way to captivate these users' attention. Still, one user suggested the use of a flashing light, similar to a siren of a police car, to more effectively warn the user that the Imaginary Friend is posing a question. Another user suggested that instead of beeping the mobile phone could play a recording asking the user how she felt. The user argued that would be quite more personal than a simple electronic beep.

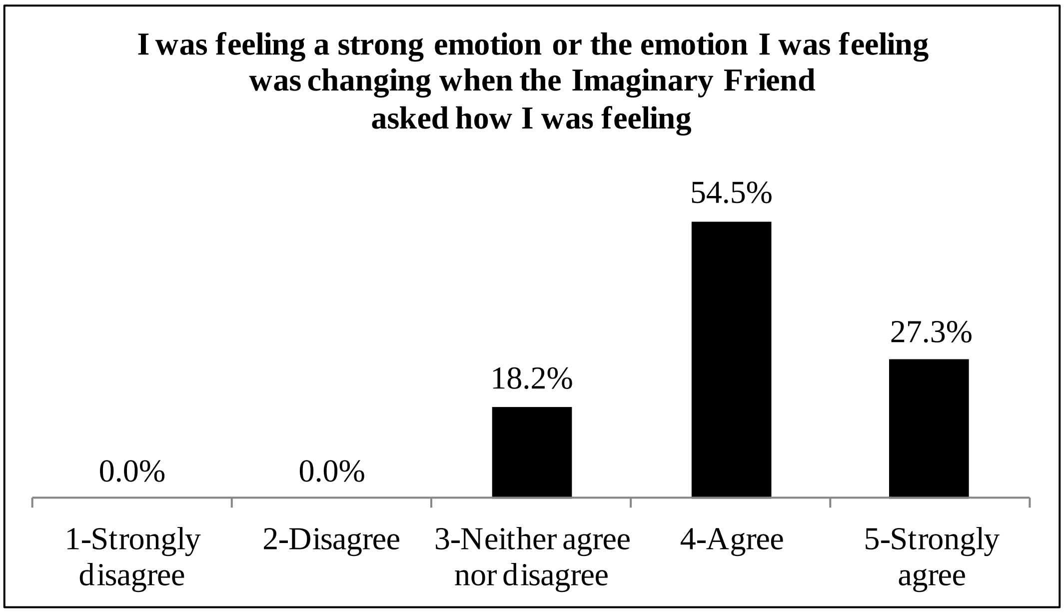


Figure 3.40: Were the users feeling a strong emotion or was the emotion they were feeling changing when the Imaginary Friend asked them how they were feeling?

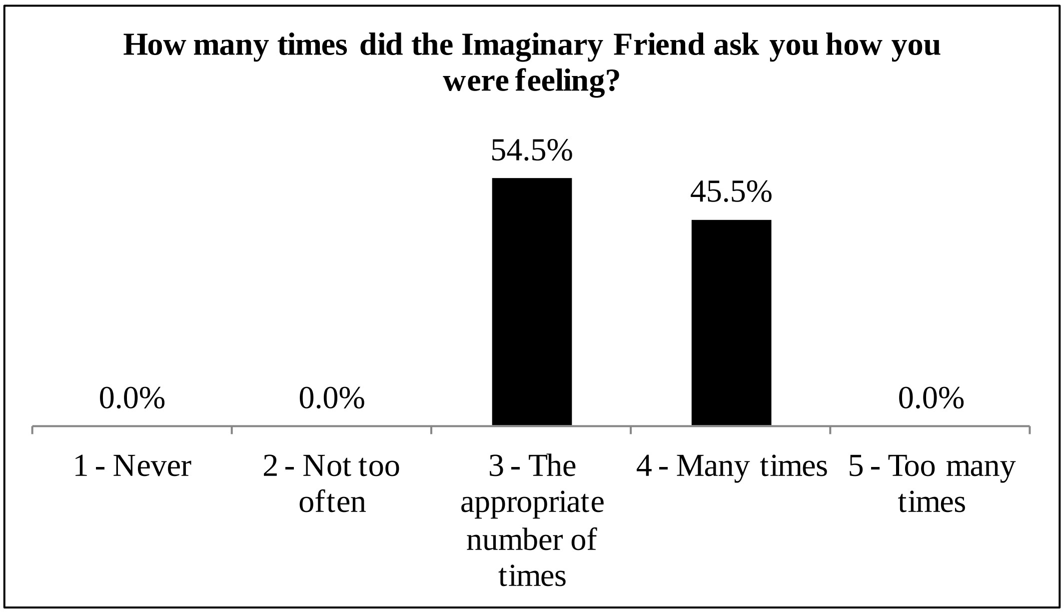


Figure 3.41: Were the users questioned about how they were feeling the appropriate number of times?

81.8% of the users agreed or strongly agreed that they were feeling a strong emotion or that the emotion they were feeling was changing when the Imaginary Friend asked them how they were feeling (Figure 3.40).

54.5% of the users also thought the Imaginary Friend questioned them the appropriate number of times. The remaining 45.5% think the Imaginary Friend asked them how they were feeling many times (Figure 3.41). We consider this an important result because if the Imaginary Friend never or hardly poses questions the users may perceive the application as being unresponsive. If the questions pop up too often, the application may be perceived as annoying or as an unwelcome disruption in the users' activities.

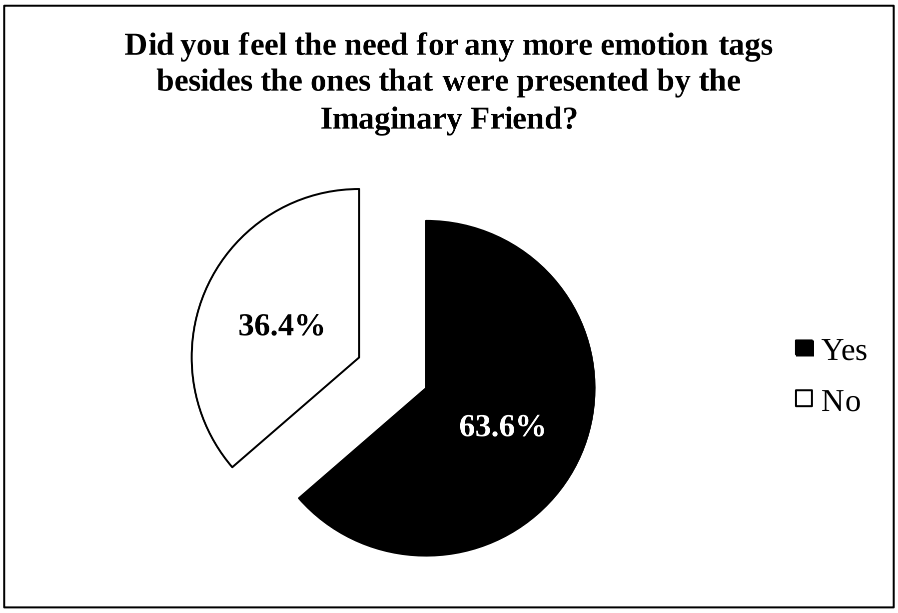


Figure 3.42: Did users feel the need for any more emotion tags besides the ones that the Imaginary Friend presented?

To inform the Imaginary Friend how she is feeling the user presses a button with an emotion tag on the mobile phone. 63.6% of the users considered that some extra emotion tags were needed (Figure 3.42). 36.4% of the users complained that a button with the emotion tag Nervous or Anxious was missing. 18.2% wanted a button with the emotion tag Focused and another 18.2% wanted a button with the emotion tag Hungry.

One user asked for a better way of organizing the emotions and suggested ordering them by levels of intensity. This is an interesting suggestion but we found it hard to implement because the same emotion may have different levels of intensity. For example, a person may be a bit distracted or completely distracted. So it is difficult to know where distracted should be placed in that gradient. Adding emotion tags to the ones presented in Figure 3.31 also presents some additional problems. The greater the number of emotion tags available, the harder it will be for the user to find the one she wants. Besides, the greater the number of emotion tags, the harder it will be to choose a unique color for them all.

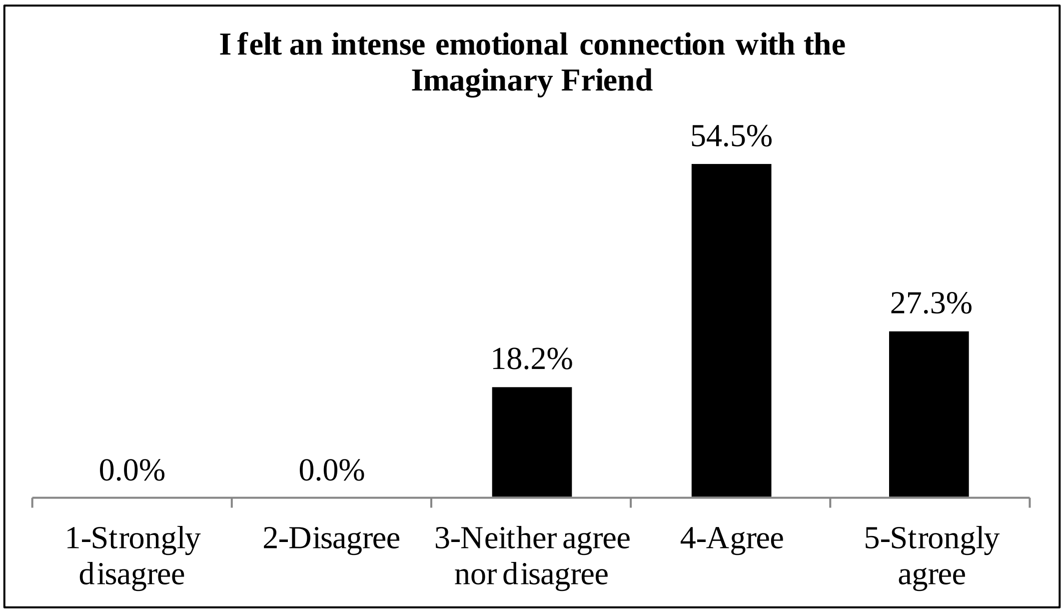


Figure 3.43: Did users feel an intense emotional connection with the Imaginary Friend?

Another aspect we were concerned with was the emotional connection users develop with the Imaginary Friend. If the users feel an emotional connection with the Imaginary Friend then perhaps those users will be more inclined to answer how they are feeling. 54.5% of the users felt an emotional connection with the Imaginary Friend and 27.3% of them felt an intense emotional connection with the Imaginary Friend. None of them strongly disagreed or disagreed feeling an emotional connection with the Imaginary Friend (Figure 3.43). This suggests that none of the users felt antipathy for the Imaginary Friend.

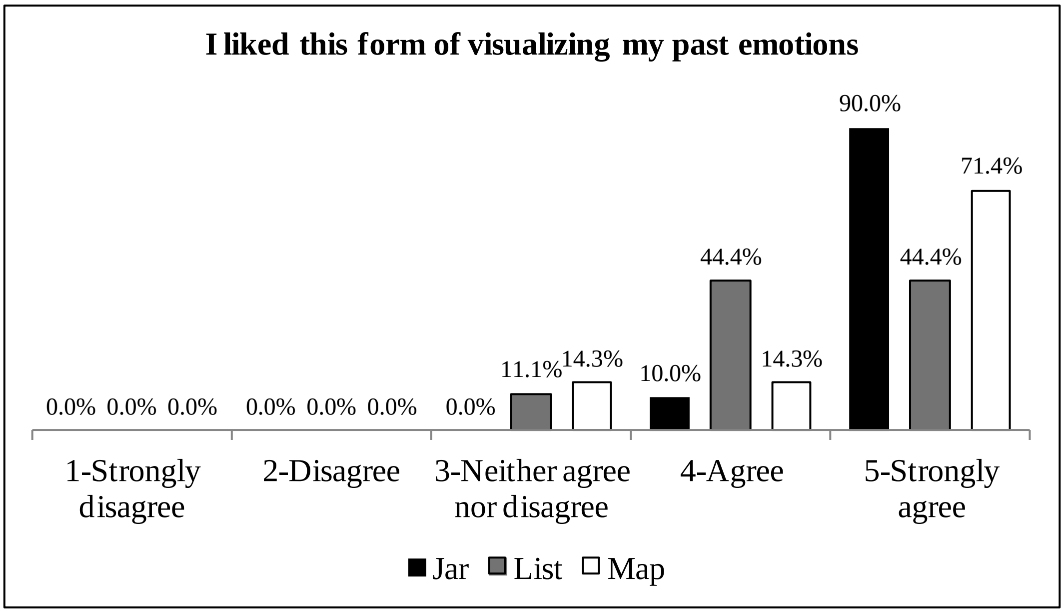


Figure 3.44: Comparison on how the users liked different forms of visualizing past emotions.

The users could visualize their past emotions in three different ways: inside a jar (Figure 3.33 (b)), in a list (Figure 3.35) or in a map (Figure 3.36). 90% of the users strongly agreed that they liked visualizing the past emotions as emotion cookies inside the jar, 71.4% strongly liked the map and 44.4% strongly liked the list (Figure 3.34). The jar was therefore the most favored form of visualization by the users. This form of visualization was the only one that was directly linked to the Imaginary Friend as the character held up the jar for the user to see. Both the list and the map occupied the whole screen of the mobile phone and the Imaginary Friend was not visible. This might have influenced the results.

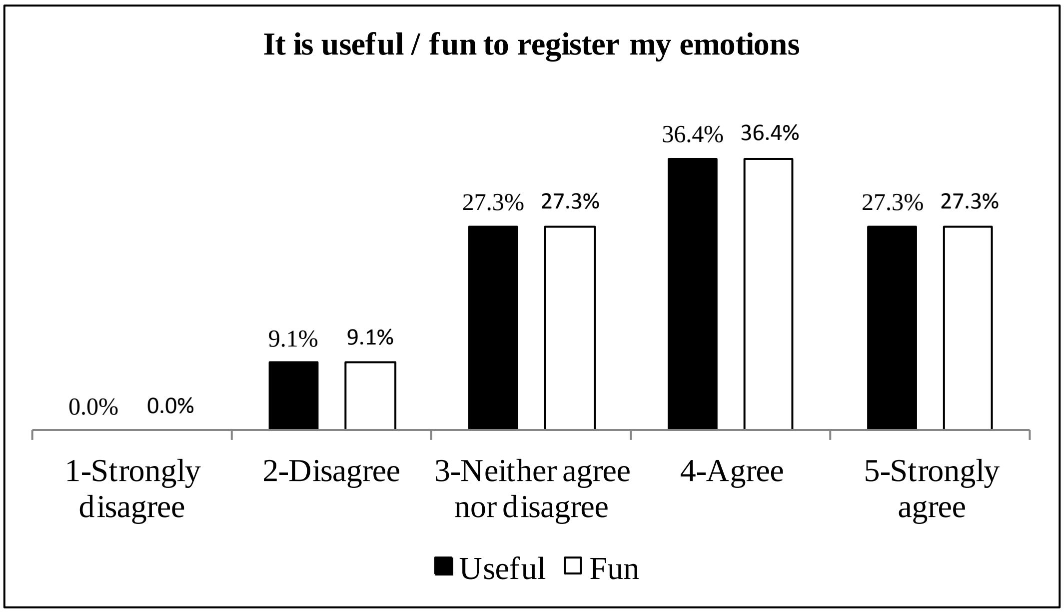


Figure 3.45: Did the users find it useful / fun to register their emotions?

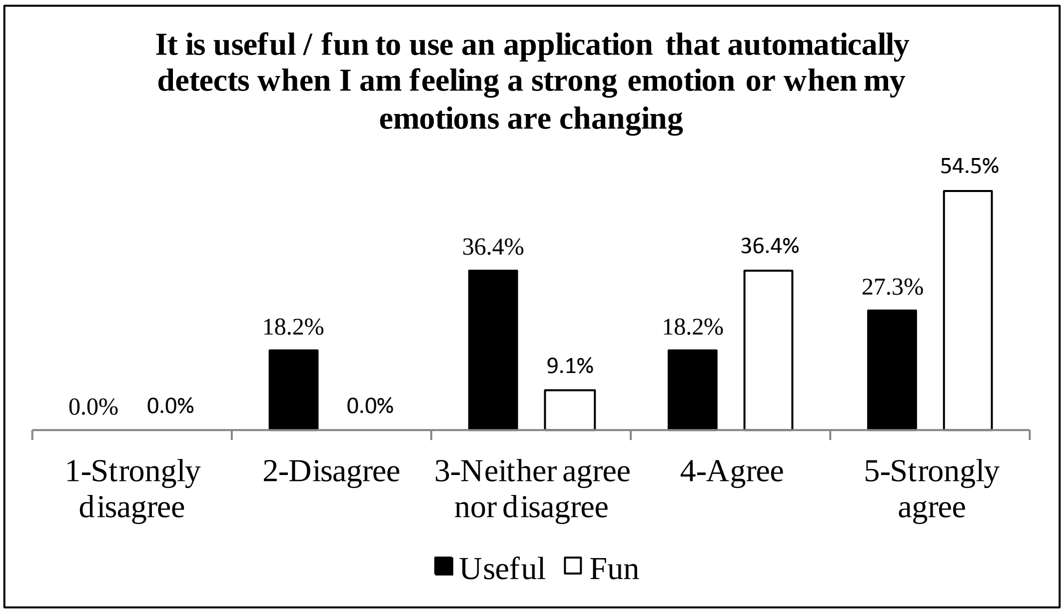


Figure 3.46: Did the users find it useful / fun to use an application that automatically detects when they are feeling a strong emotions or when their emotions are changing?

Most of the users found it both useful and fun to register their emotions (Figure 3.45). In what refers to using an application that can automatically detect strong emotions or changes in the emotional state, the inquired users found it more fun than useful (Figure 3.46). 90.9% of the users think it is fun to use such an application but only 45.5% believe it is useful.

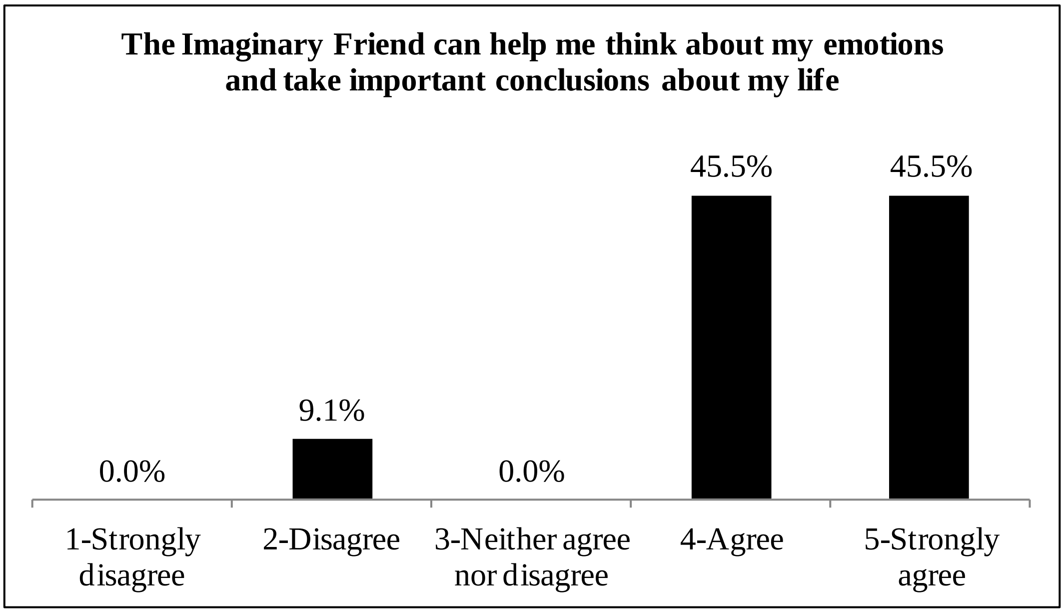


Figure 3.47: Did the Imaginary Friend help users to think about their emotions and take important conclusions about their lives?

91% of the users agree or strongly agree that the Imaginary Friend can help them think about their emotions and take important conclusions about their lives (Figure 3.47). So, when the users were asked, simply, if it was useful to register their emotions, 63.7% of them agreed or strongly agreed (Figure 3.45) and when we asked them if it was useful to use an application that automatically detects strong emotions or when the emotions are changing the percentage of users who agreed or strongly agreed lowered to 45.5% (Figure 3.46). However, when a specific advantage was mentioned, thinking about their past emotions, some users seemed to reconsider and the percentage that agreed or strongly agreed increased to 91%.

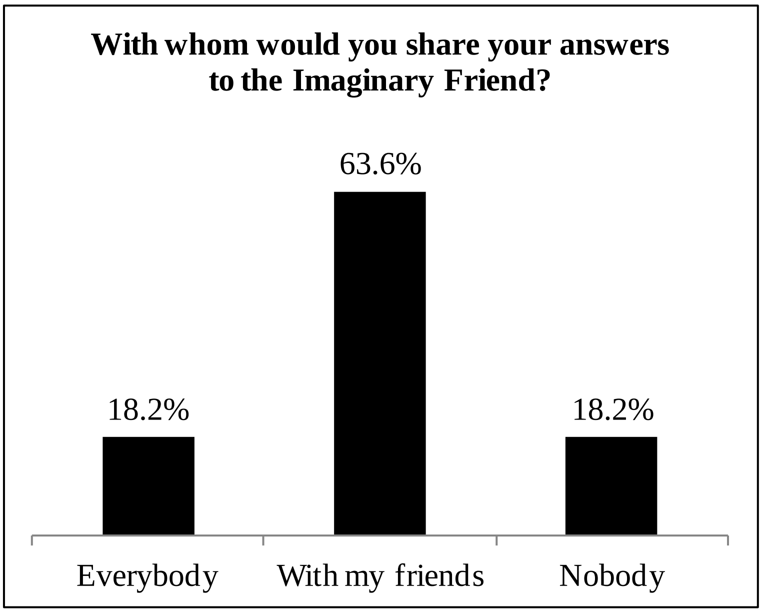


Figure 3.48: With whom would the users share their answers to the Imaginary Friend.

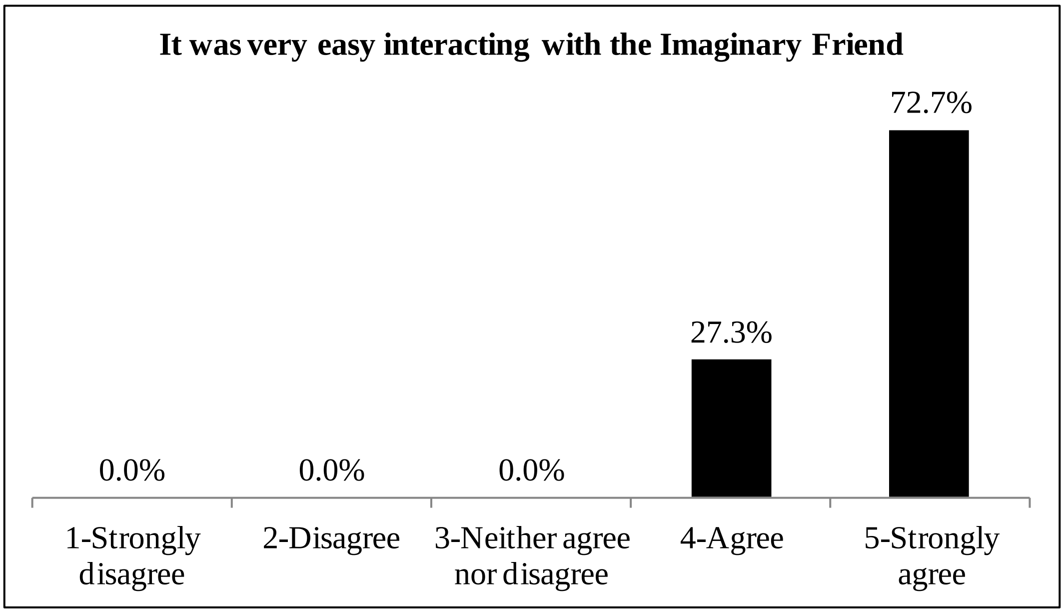


Figure 3.49: How easy the users considered it was to interact with the Imaginary Friend.

If they could share their answers to the Imaginary Friend, 18.2% of the users would share those answers with everybody, 63.6% would share their answers with friends only and 18.2% would not share their answers (Figure 3.48).

As for the area where to place the electrodermal activity sensors, 66.7% of the users favored the wrist while the remaining 33.3% preferred the fingers via some device that looked like a ring. One of the users added that she would like the device to be as discrete as possible.

All of the users agreed or strongly agreed it was very easy interacting with the Imaginary Friend (Figure 3.49). All of them would recommend the Imaginary Friend to their friends.

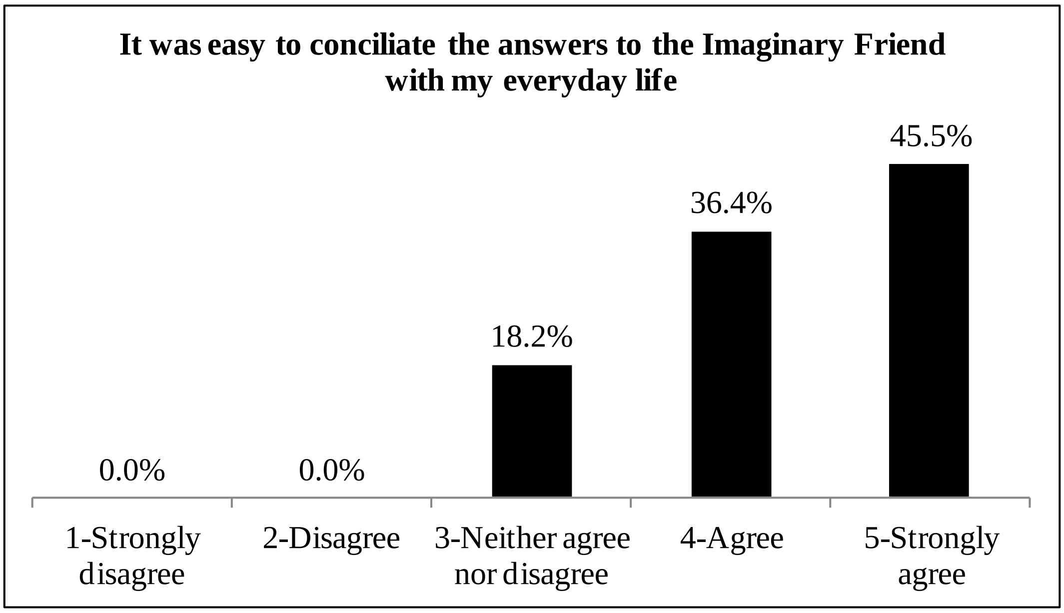


Figure 3.50: How easy the users considered it was to conciliate the answers to the Imaginary Friend with their everyday lives.

When the users were asked specifically if it was easy to answer to the Imaginary Friend in their everyday lives, 81.9% of them agreed or strongly agreed it was very easy to do so (Figure 3.50). Even though the Imaginary Friend is projected on the floor, via the pico projector, to choose an emotion tag it is necessary to press a button in the mobile phone and that operation may be disruptive as it draws the attention away from the projection. Perhaps, using voice would make it even simpler to express the emotions without looking at the screen.

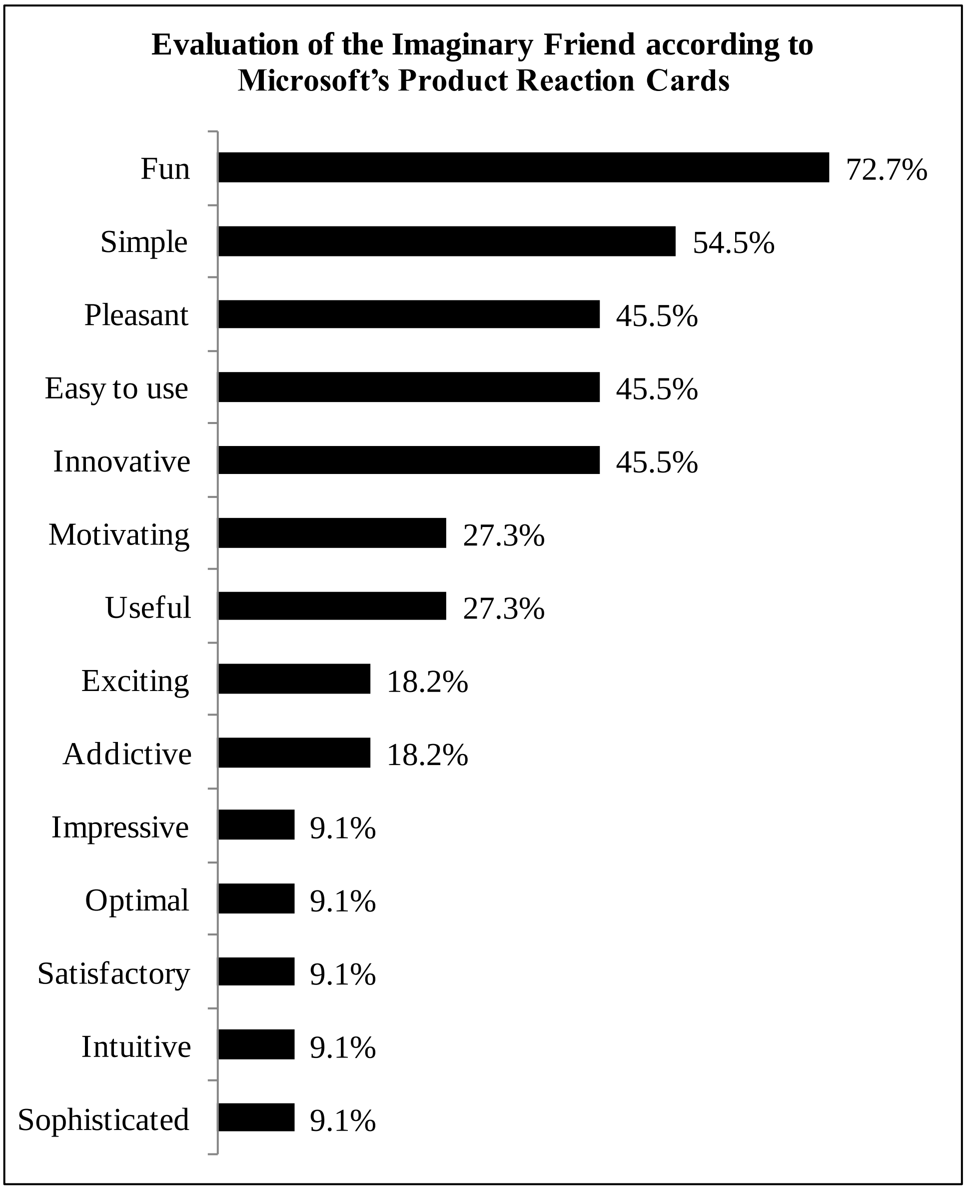


Figure 3.51: Evaluation of the Imaginary Friend according to Microsoft's Product Reaction Cards.

The users were asked to choose an expression that best describes their experience with the Imaginary Friend. 72.7% thought it was fun. 54.5% considered it simple. For 45.5% of them it was a pleasant, easy to use or innovative experience. 27.3% considered it motivating or useful. The rest of the expressions, chosen by the users, to evaluate the Imaginary Friend, can be consulted in Figure 3.51. The expressions are an adaptation of the Microsoft Product Reaction Cards [161]. The users could choose as many expressions as they wanted.

3.2.7. Emotion Castles

For now the Imaginary Friend is a toy that keeps the user company. The user can establish objectives and compete against herself. For example, after a period were many Angry and Annoyed emotion cookies were collected (Figure 3.31), the user may establish the objective to lead a calmer life, and the Imaginary Friend will serve as a way of monitoring if the emotion calm has become more prevalent in the user's life via the number of Calm emotion cookies retrieved. However, there is still no way for the users to compete against one another.

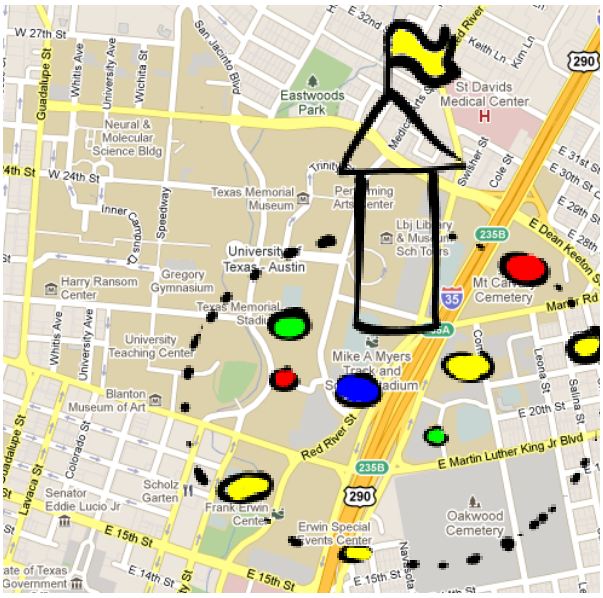


Figure 3.52: Emotion castle.

Our proposal is to populate the map in Figure 3.36 with emotion castles. When a large number of emotion cookies are close together a castle will rise. The castle flag is the same color as the most frequent emotion in that area (Figure 3.52). A castle belongs to all players who contributed with emotion cookies to its construction. Castles evolve and grow as more emotion cookies are added to its construction, and are ruled by the players who supplied more emotion cookies to the virtual building. This way, players can fight each other for the rule of the castles and to become the most successful landowner.

The Imaginary Friend resorts to both a pico projector and to an electrodermal activity sensor. Pico projectors are already available for sale in many places. As far as we know, there are no mobile phones with electrodermal activity sensors. However, there are already a few commercial versions available. We used a PLUX device [154]. The Q Sensor [162] is another example of a commercially available device that monitors arousal. In a not so distant future, devices that measure electrodermal activity may become more common and the Imaginary Friend proposed here may thus become a viable commercial proposal for the general public. If several people use devices that measure the electrodermal activity it will be possible to resort to competition, via the emotion castles, to better motivate users to tell the Imaginary Friend how they are feeling.

3.2.8. Sociability Framework for Imaginary Friends

The Imaginary Friend may serve as a social trigger for shy people [133] because other people, who are looking at the projection, may feel the impulse to talk with the user.

Eventually, in social events, the projected Imaginary Friends may pull together their human companions based on the human companions' similar interests or personal characteristics. The Imaginary Friend may even assist by suggesting the initial conversation topics.

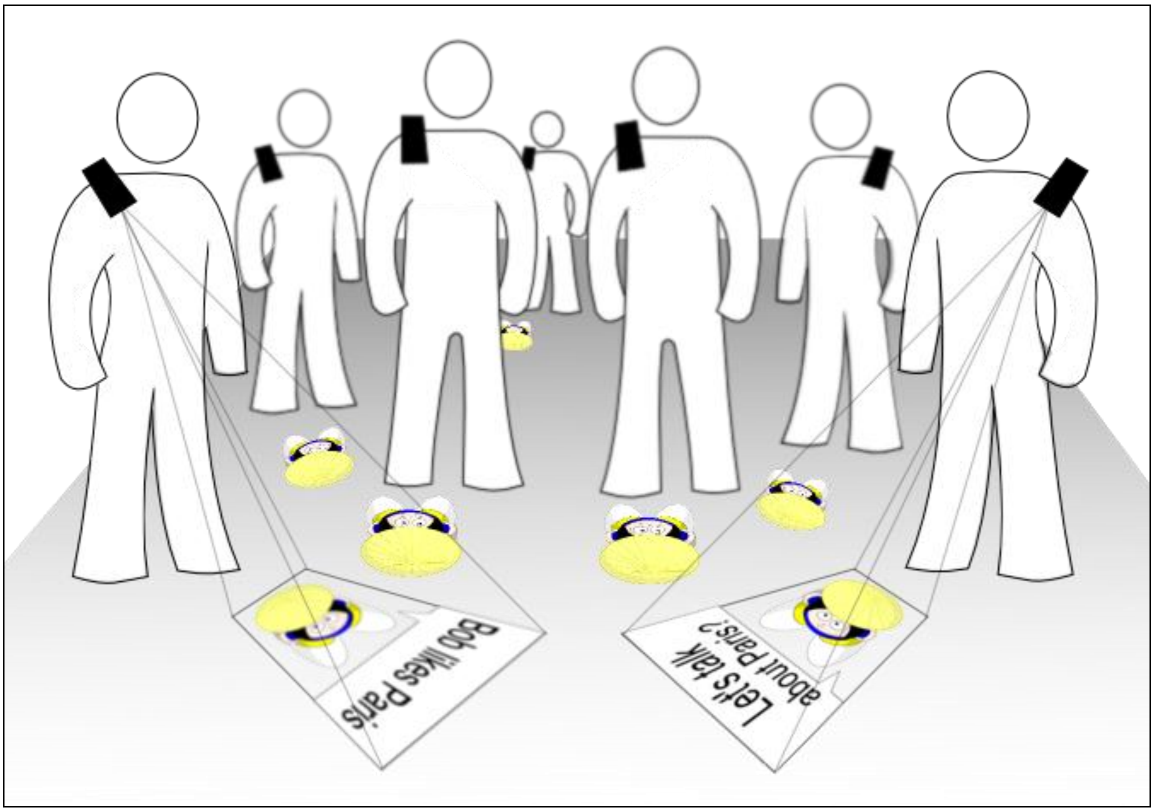


Figure 3.53: Imaginary Friends suggesting possible social connections.

In Figure 3.53 a party where the users each have an Imaginary Friend is represented. Eventually, in parties, people may tend to talk only with the people they already know. However, in the situation depicted in Figure 3.53 one of the Imaginary Friends discovers that another person at the party also enjoys the city of Paris. The Imaginary Friend then tries to pull the human companion for a conversation with this still unknown person about the city of Paris. Besides parties, the virtual companion can also be helpful for example, with children, at the beginning of the school year, so that students may more easily know others based on similar hobbies of preferred activities. In professional events, such as conferences, Imaginary Friends could pull together people who work on similar areas.

For this strategy to work, it is necessary that people, gathered at an event, have pico projectors. There are already several commercially available pico projectors, as standalone devices or embedded in mobile phones, so pico projectors may become quite common in the near future. If people have no pico projectors, then perhaps other forms of interaction could be devised, resorting only to the mobile phone.

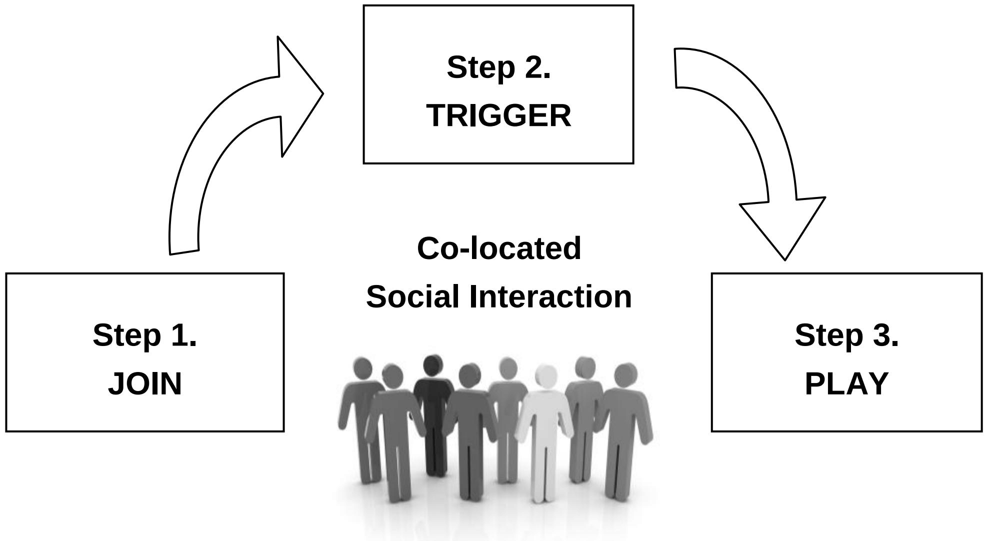


Figure 3.54: Outline of a sociability framework for co-located interaction in games.

We intend to expand our efforts and to create a sociability framework (Figure 3.54) that can be applied to encourage social contacts resorting to games.

This framework will, firstly, focus on joining the players. To assure a common place it is possible to appoint a latitude and a longitude. Currently, smartphones are usually equipped with GPS and location can also be determined via the Geolocation API Specification, thus enabling their owners to head themselves towards a determined position.

After assembling the players, step 2 is to trigger social interaction for the game. It is not enough for players to simply be at the same place, but unaware of each other and to bypass the chances for social connection. GPS suffers inaccuracies and location via the Internet is even less accurate so players may be several meters apart. It is possible to resort to face detection to assure that players are effectively side by side and looking at the camera. We resorted to this strategy in the Enchanted Moor game that will be further explained in Section 3.4. However, in the Enchanted Moor game, interaction was mostly with people familiar to the player. We intend to stimulate engagement even among strangers or people who scarcely know each other. Flash mobs have already demonstrated that it is possible to join crowds just for the sake of entertainment. Projected multimedia via pico projectors may also function as a way for players to spot one another.

After the initial inertia is overcome, players enter the magic circle [1,5] and actual gameplay begins. In step 3 it will be important to evaluate how immersed the players were in the game, how engaging and fun was the social interaction and how the game affected social relationships between people. Our objective here is that the game functions not only as a way to join people and pass the time but also to check how an entertaining activity can influence how close people feel to one another and even help forge new social links.

3.2.9. Discussion

A metaphor of an Imaginary Friend and the implementation of that metaphor were presented. The Imaginary Friend walks along the user and collects the emotion cookies that user leaves behind. The user can later visualize those cookies inside a jar where the Imaginary Friend stored them (Figure 3.33). It is also possible to consult a list with the past emotions (Figure 3.35) or the places where the emotion cookies were collected (Figure 3.36). The Imaginary Friend resorts to variations in the electrodermal activity to know when to ask the user how she is feeling. The data obtained with the electrodermal activity sensor is transmitted via Bluetooth to the mobile phone where the Imaginary Friend's application is running. The mobile phone is connected to a pico projector that is attached to the user's backpack should strap (Figure 3.24 and Figure 3.26) and projects the Imaginary Friend on the floor. The Imaginary Friend mimics the user, walking when she is walking and standing still when the user is standing still. This behavior was implemented resorting to the accelerometer of the mobile phone.

The interaction of the Imaginary Friend with users was tested. Results indicate that 81.8% felt an emotional connection with the Imaginary Friend. 63.7% thought it was fun to register their emotions. Fun was, furthermore, the most frequent expression, chosen by the users, to describe the Imaginary Friend. 91% of the users also considered that the Imaginary Friend could help them reflect about their emotions and take import conclusions about their lives.

The electrodermal activity was an adequate indicator to know when to question the users as 54.5% of them thought the Imaginary Friend questioned them the appropriate number of times. 45.5% thought the Imaginary Friend questioned them many times, but no user responded that the Imaginary Friend questioned her too many times.

However, 63.6% of the users felt that certain emotion tags were missing among the ones presented by the Imaginary Friend. We could simply add extra emotions to the ones presented in Figure 3.31, but if there are too many emotion tags it will be more difficult for the user to find the one she wants. As emotion tags are differentiated by color, it will also be more difficult to find a unique color for every emotion tag. Future work will still have to be done in what concerns the emotion tags. One possibility to better organize the emotion tags is to take into consideration the arousal and valence of each emotion. The CAAT tool [163] may be a good option to graphically arrange the emotions presented to the user. According to CAAT's authors, this tool provides a reliable and quick way to assess affective states.

Assuming that devices capable of monitoring the electrodermal activity may, one day, become as common as mobile phones equipped with GPS and accelerometer functionality, a proposal for a multiplayer game, where users resort to their emotions to compete for the rule of emotion castles, is presented.

In another proposal, several projected Imaginary Friends act as facilitators for social engagement, suggesting possible new connections among people and conversations about common interests.

3.3. Weather Wizards

According to Bo Walther, adaptronic games "*are games consisting of applications and information systems that simulate life processes observed in nature. These games are embedded, flexible, and usually made up of 'tangible bits' that oscillate between virtual and real space*". To be adaptronic a game should react to changes in the environment in real time [164]. Sharkrunners [165] is an example of an adaptronic game. In Sharkrunners the game uses the position and movement of real sharks out in the ocean to influence the gameplay. Another example is Boktai [166], a game where sunlight charges the player's weapon.

Other way for a game to be adaptronic is to resort to the real weather. According to Stenros [167] this may be too conceptual and not enough to give players the feeling that the game is merging with real life. Peter Molyneux, who included real weather patterns in a game so that it matched the real weather outside the player's window, goes further on this argument and looking back on the experience considers that is was "*a dumb, stupid idea*" [168]. So, is this argument final and true? Is using the real weather really a lost bet? We decided to give it one more try and address this question in more detail. Perhaps the way the weather is included in the game may make a difference. Just mimicking the weather outside the player's house may not be much fun or contribute to the gameplay. But, if the weather is closely bound to the gameplay, instead of being a mere background feature, then perhaps that may cause a difference. The key contribution here is to shed further light on how real time weather data can contribute to the gameplay as an example of integrating real world elements in games.

Some other researchers have already made interesting work in using weather information in games. This work is addressed in Section 3.3.1. In Section 3.3.2 we propose a game that revolves entirely around the weather with implementation details in Section 3.3.3. The game's evaluation is in Section 3.3.4 and finally the discussion is in Section 3.3.5.

3.3.1. Weather in Entertainment

Several games have already resorted to the weather to influence the gameplay. In the game Free All Monsters [169], monsters can be freed according to the weather conditions. With this game the authors considered how location based games should be redesigned to accommodate the increase of scale and addressed the participation inequality of players. However, specific results about the influence of the weather in the players' interaction are not presented.

In Weatherlings [170] each player has a deck of cards with weather dependent creatures. The players battle each other in arenas that correspond to real locations. The choice of arenas is limited to U.S. cities. Even though the game makes use of real weather conditions the weather data is not real time, so this game cannot show how the use of real time weather data influences a game.

Mythical the Mobile Awakening [92] is another adaptronic game where players perform magic rituals to enhance their magic skills. The authors show an interesting comparison of several types of contexts (environment, spatio-temporal, proximity, and social) in the gameplay. However the weather is not analyzed in detail.

Heroes of Koskenniska [171] is about raising environmental awareness among visitors of a Biosphere Reserve in Finland. The game resorts to temperature, humidity and illumination sensor data, however this is not the focal point of the game but an accessory to the game's storyline. Furthermore, contrary to the game we are proposing (Section 3.3.2) this game cannot be played everywhere.

In Epidemic Menace [172] virus motion is influenced by the wind direction and strength. Similarly to what happens in Heroes of Koskenniska, this game can only be played in a specific place.

In Samurai Romanesque [173], if it rains in Tokyo players cannot use their muskets and their mobility in the game becomes limited. Weather conditions were supplied by the Japanese Weather Bureau. Flightgear [174], Realistic 3-D Golf and the Driving Game [175] are all games that resort to real weather conditions to achieve more realism. In Black & White [168] the weather in the game matches the weather outside the player's house. AgriVillage [176] also resorts to the weather to influence crops, but the weather is simulated by the game. Levee Patroller [177] is another game where the weather is simulated. When it rains the player's sight becomes limited and playing the game is therefore more difficult.

Figure 3.55: Multicolor weather rooster.

Weather has even been used for aesthetic purposes in tangible objects such as in the in multicolor rooster (Figure 3.55). The wings and the tail of the rooster change color according to the weather, from blue, in dryer environments, progressively to pink, in environments where the humidity is higher.

So, even though several games have already somehow resorted to the weather, none of the mentioned previous work provides an analysis specifically focused on the influence of the weather in the gameplay and in player enjoyment. To find out how the weather contributes to the gameplay we propose a game [178–180] that is presented in the next section.

3.3.2. The Game

In our game [178,181], the player assumes the role of a wizard and duels other players. During the duels, the player's chances of winning are directly related to the weather at the duel location.

Figure 3.56: Weather Wizards game running in two different mobile devices.

Weather Wizards was implemented as an application for mobile phones (Figure 3.56). The game can be downloaded from Google Play [179]. Our game is, as far as we know, the first Android native application that resorts to real time weather data.

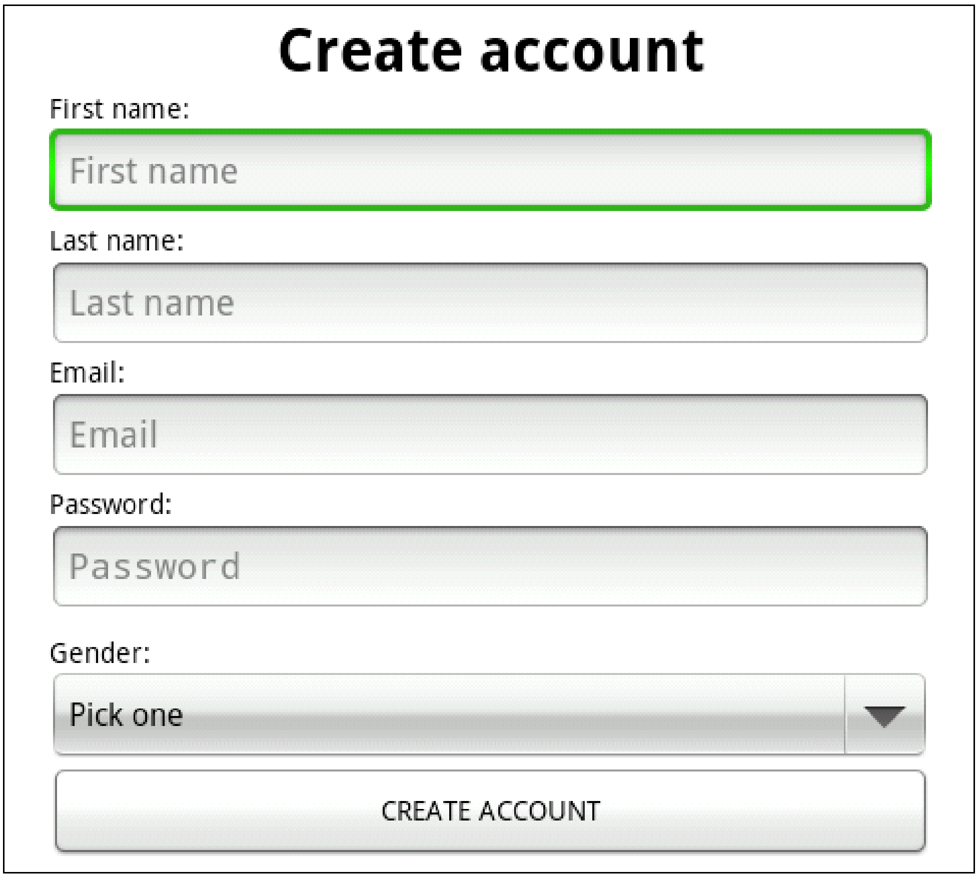


Figure 3.57: Creating a user account in Weather Wizards.

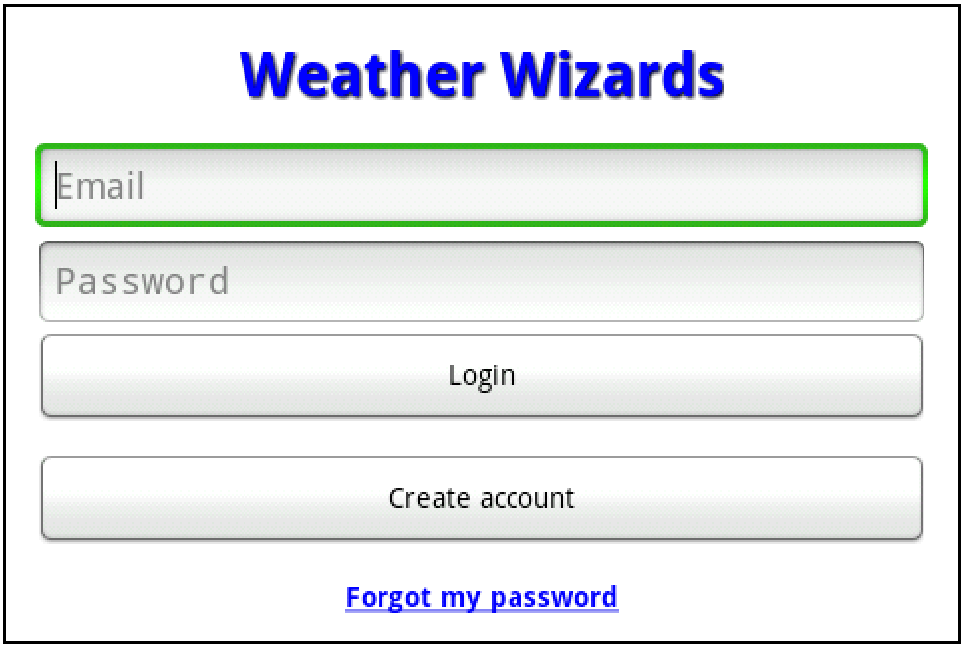


Figure 3.58: Login in Weather Wizards.

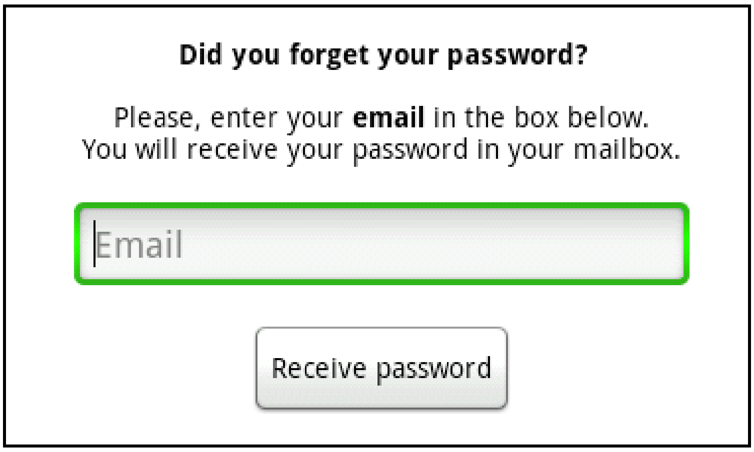


Figure 3.59: How to retrieve the password in Weather Wizards.

Figure 3.60: Player's profile in Weather Wizards.

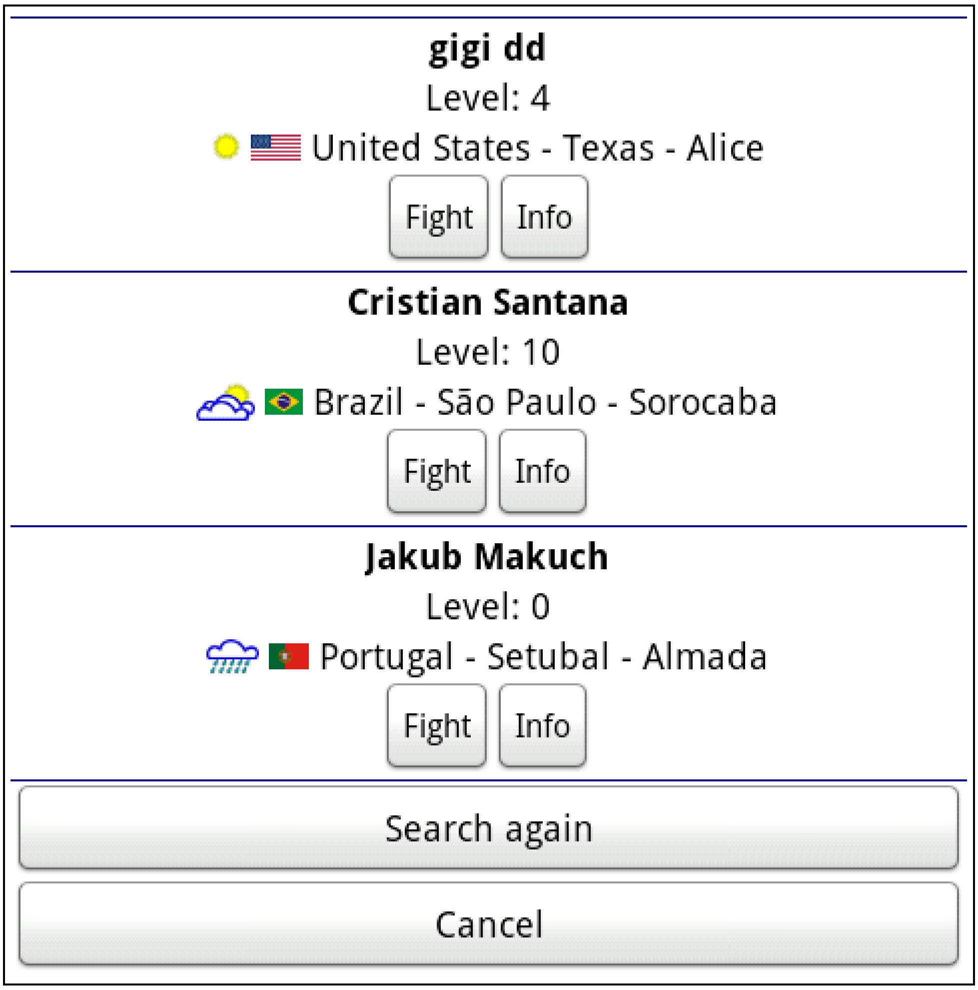


Figure 3.61: Duel list with possible rivals.

Weather Wizards is a multiplayer game. All the players' data is stored on a server. For that reason, a connection to the Internet is required to play the game. The mobile phones send the player's data to the server where the fate of the duels is decided. Real time weather data is retrieved via Weather Underground's API [182] and the name of the place corresponding to the latitude and longitude of the player's current location was obtained with Google's Geocoding API [183]. Weather Underground's API and Google's Geocoding API are contacted by the server.

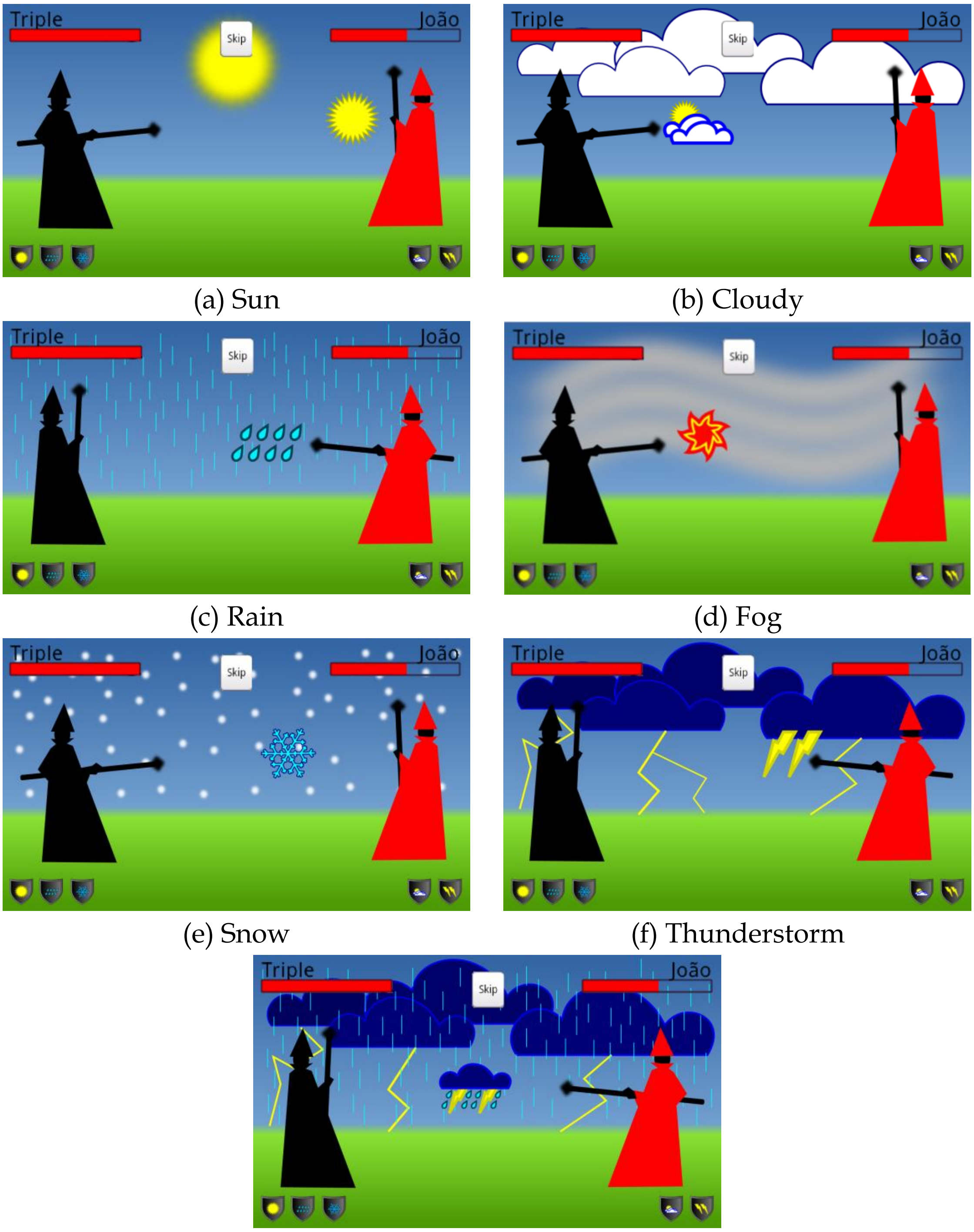
When playing the game for the first time, in a mobile phone, users are required to create a user account (Figure 3.57). If they already have a user account they can login (Figure 3.58) or send their password to their email (Figure 3.59), in case they forgot it. The login persists across game sessions. The user is only required to login again after explicitly logging out.

In Figure 3.60 the player's profile is presented. Here, the player can check her level, experience, life, coins, location and the weather at her location. In front of the experience points there is a green bar that provides a graphical representation of how many points are left to reach the next level.

If the user presses one of the Fight buttons (Figure 3.60) a list of possible rivals is presented (Figure 3.61). There are two Fight buttons (Figure 3.60) because some mobile phones' screens are very small. So, if the user scrolls down to see the rest of the options and the first Fight button is no longer visible in the screen it will not be necessary to scroll up again in order to start a duel. All the game revolves around duels that are affected by the weather so we wanted the buttons that allow a duel to start to be as available as possible.

For each wizard in the list (Figure 3.61), the name, level, location and weather at the player's location are presented. It is possible to find out more information about a wizard by pressing the Info button.

Figure 3.62: Rival's profile



(a) Sun (b) Cloudy (c) Rain (d) Fog (e) Snow (f) Thunderstorm (g) Thunderstorm with rain

Figure 3.63: Wizards dueling in different types of weather.

After pressing the Info button (Figure 3.61) the profile of the possible rival appears (Figure 3.62). The first wizard in the list (Figure 3.61) is chosen randomly from among all the wizards whose level is inferior or equal to the player's level. The second wizard is chosen randomly from among all the wizards whose level is superior to the player's level. The third wizard in the list is chosen randomly from among the ones who are nearby the player. So, even though the wizards in the list are randomly chosen, diversity was forced. There will always be a wizard who is equal to the player or weaker than the player, a wizard stronger than the player and finally another wizard who is close by. If the player is not happy with the presented possible rivals it is possible to ask the game to search again and other wizards will be presented.

To start a duel the player presses the Fight button, in the duel list, corresponding to the wizard she wants to fight with (Figure 3.61). Optionally it is also possible to press the Duel this Wizard button in the rival's profile (Figure 3.62).

After pressing the Fight button the player's wizard teleports to the rival's real location. The duel's background shows the weather at the rival's location. In Figure 3.63 several different weather conditions, during a duel, are presented. The sun may be shinning (Figure 3.63 (a)), it may be a cloudy day (Figure 3.63 (b)), it may be raining (Figure 3.63 (c)), it may be a foggy day (Figure 3.63 (d)), it may be snowing (Figure 3.63 (e)) or there may be a thunderstorm (Figure 3.63 (f)) or a thunderstorm with rain (Figure 3.63 (g)) at the rival's location. The player is the black colored figure on the left and the rival is the red colored figure on the right.

During the duel each wizard will take turns to attack the opponent casting spells. The health bar of each wizard, represented at the top of the screen (Figure 3.63), will gradually decrease for each successful attack. Eventually, the health of one of the opponents will decrease to zero and the duel ends. The victorious wizard is the player whose health is above zero. The wizard whose health is equal to zero loses.

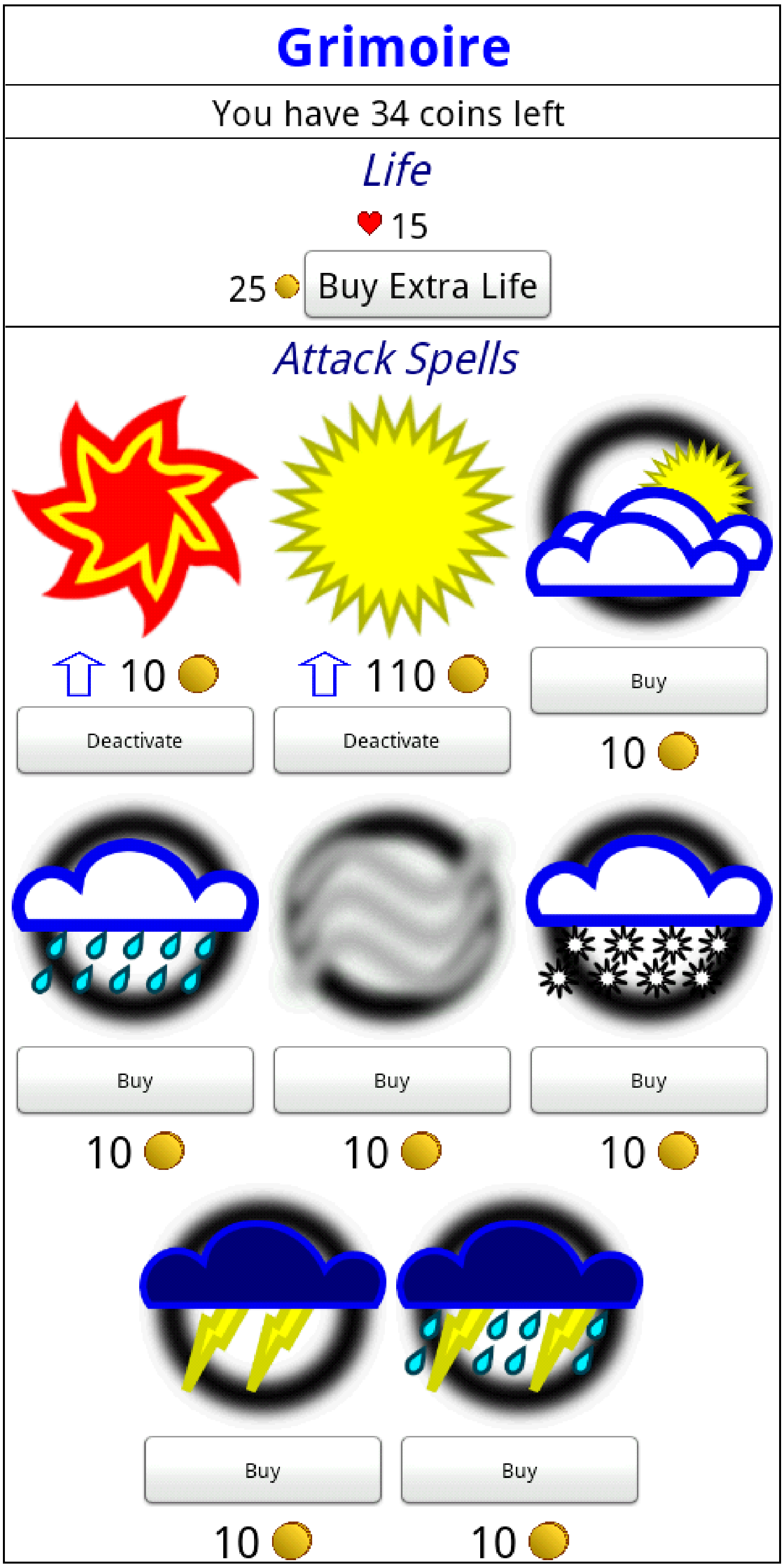


Figure 3.64: Player's grimoire with options to buy lives and buy, upgrade and activate and deactivate spells.

Each wizard can cast different types of spells. There is one basic attack spell that is available to all wizards but which is not very powerful. The really powerful spells are the weather spells. The available weather spells are: clear sky, cloud, rain, fog, snow, thunderstorms and thunderstorms and rain. Each of those spells becomes stronger if the weather element it corresponds to is present during the duel. So, if it is raining at the rival's location and the player casts a rain spell, that spell will become stronger.

The spell to cast, in each turn, is chosen randomly from among all active spells in the wizard's grimoire. Spells are stored in the wizard's grimoire (Figure 3.64). In the Grimoire a wizard can buy, upgrade and activate or deactivate spells. If a spell is deactivated that spell will not be cast during a duel. So, if the wizard has a strong rain spell and the rival to duel is at a rainy location it will be convenient to deactivate all the spells, except for the rain one, in order to maximize the chances of success.

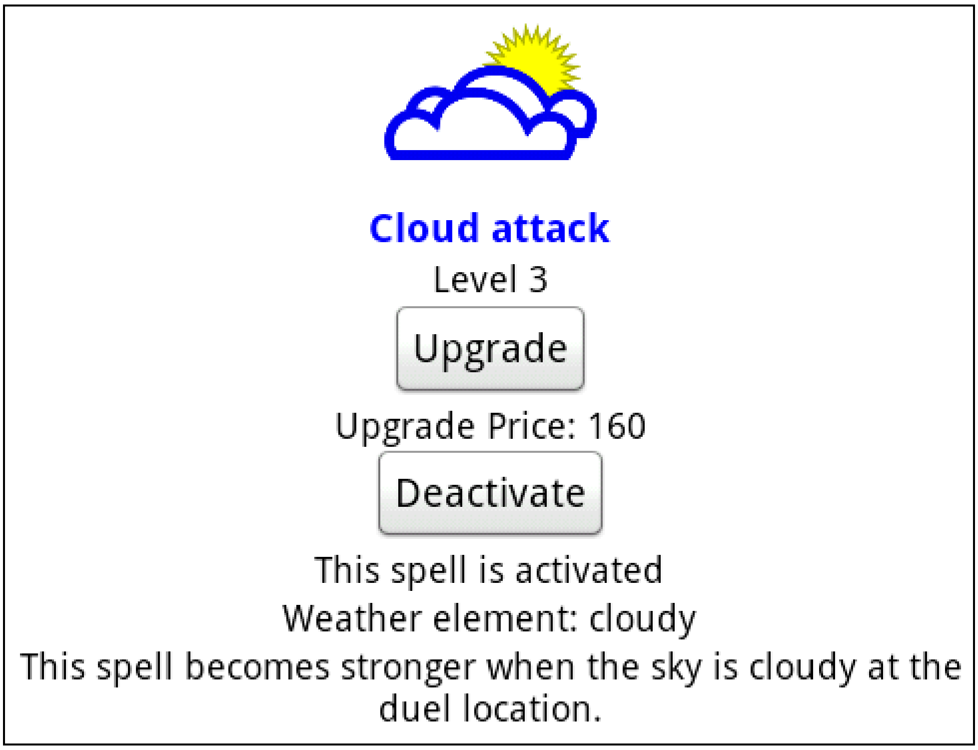


Figure 3.65: Spell detail.

Figure 3.66: A locked spell.

To better protect herself, a player can also buy defense spells. Similarly to what happens in the attack spells there are also clear sky, cloud, rain, fog, snow, thunderstorms and thunderstorms and rain defense spells. A defense spell will decrease the health damage received by the wizard when attacked with the corresponding attack spell. Defense spells are represented bellow each wizard during the duel (Figure 3.63).

When the player presses a spell in the grimoire more information about that spell can be visualized (Figure 3.65). Initially, some of the spells are locked (Figure 3.66). However, as the player gains more experience those locked spells will progressively become available.

Figure 3.67: A player's master.

Figure 3.68: The Master grants a scholarship to the lackey.

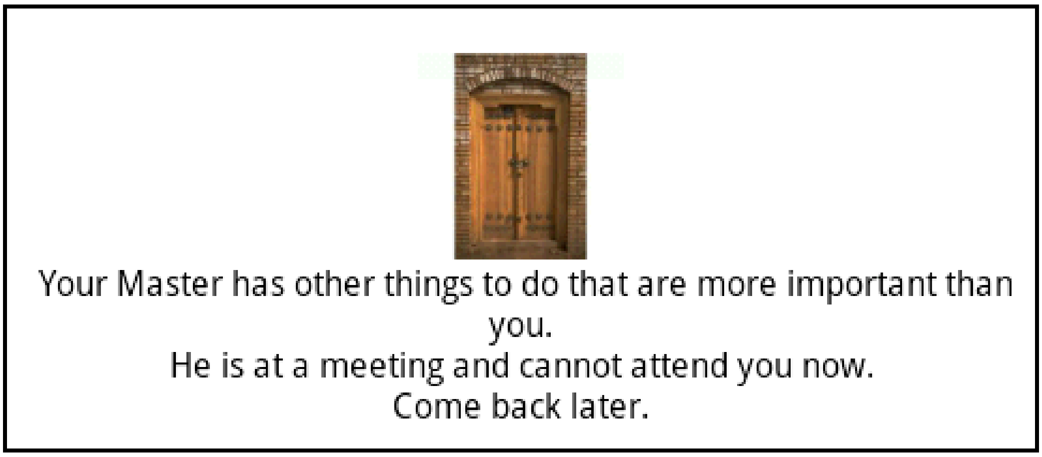


Figure 3.69: The Master is too busy and cannot grant the scholarship at the present moment.

After a player acquired enough experience that player can become master of the wizards defeated during the duels, who turn into lackeys. Figure 3.67 shows a player's master.

Having a master is not entirely devoid of advantages as the master concedes a daily scholarship to the lackeys (Figure 3.68). However, persistence may be necessary until the master is finally available to grant the scholarship (Figure 3.69). The higher the level of the master the higher is the value of the scholarship. With the scholarship's coins the wizard can buy more spells for the grimoire or upgrade spells that are already in the grimoire. Another way of wining coins is through duels. When a duel ends the player always receives coins, whether she wins or loses. However, more coins are awarded when defeating higher level wizards.

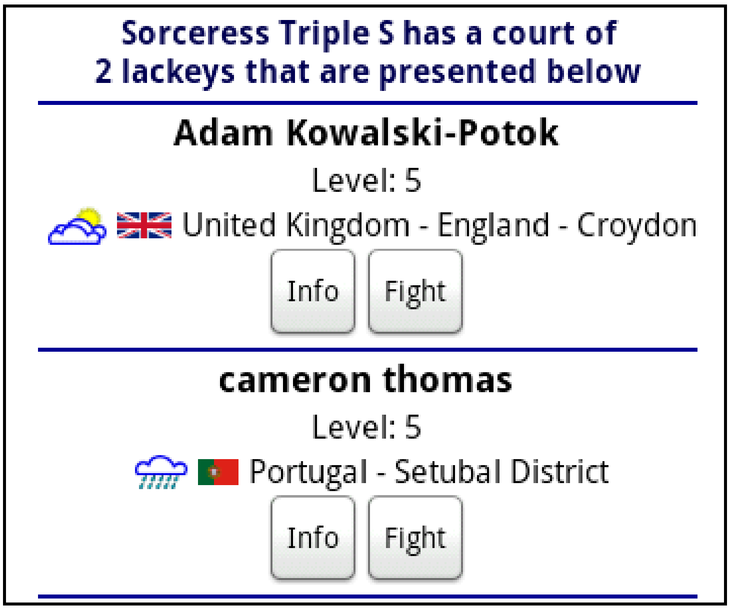


Figure 3.70: A player's lackeys.

A wizard can find out who is her master (Figure 3.67) and check on her lackeys (Figure 3.70) by pressing, respectively, the Master button and the Lackeys button in the Profile (Figure 3.60).

Some wizards may not have a master. For example, the player whose profile is presented in Figure 3.62 was, at the time of writing, the most experienced wizard in the game and had no master. That is why there is no Master button is his profile. Similarly, in a wizard without lackeys, the Lackeys button will not appear.

Figure 3.71: Power Rank.

Figure 3.72: Lackeys Rank.

Figure 3.73: Menu in the Weather Wizards game.

To motivate and provide visibility to the most successful players, Weather Wizards has two types of ranks: the Power Rank (Figure 3.71) and the Lackeys Ranks (Figure 3.72). In the Power Rank wizards are ordered by experience and in the Lackeys Ranks they are ordered by the number of lackeys. The ranks are accessible through the menu button (Figure 3.73) of the Android phone.

3.3.3. Implementation and Architecture

Weather Wizards architecture integrates a client and a server side. The client side is an Android application for mobile phones. Weather Wizards client includes several activities [158]. Figure 3.74 shows Weather Wizards client architecture. Figure 3.75 shows Weather Wizards server architecture and the interactions with the client architecture (Figure 3.74) and with the external providers.

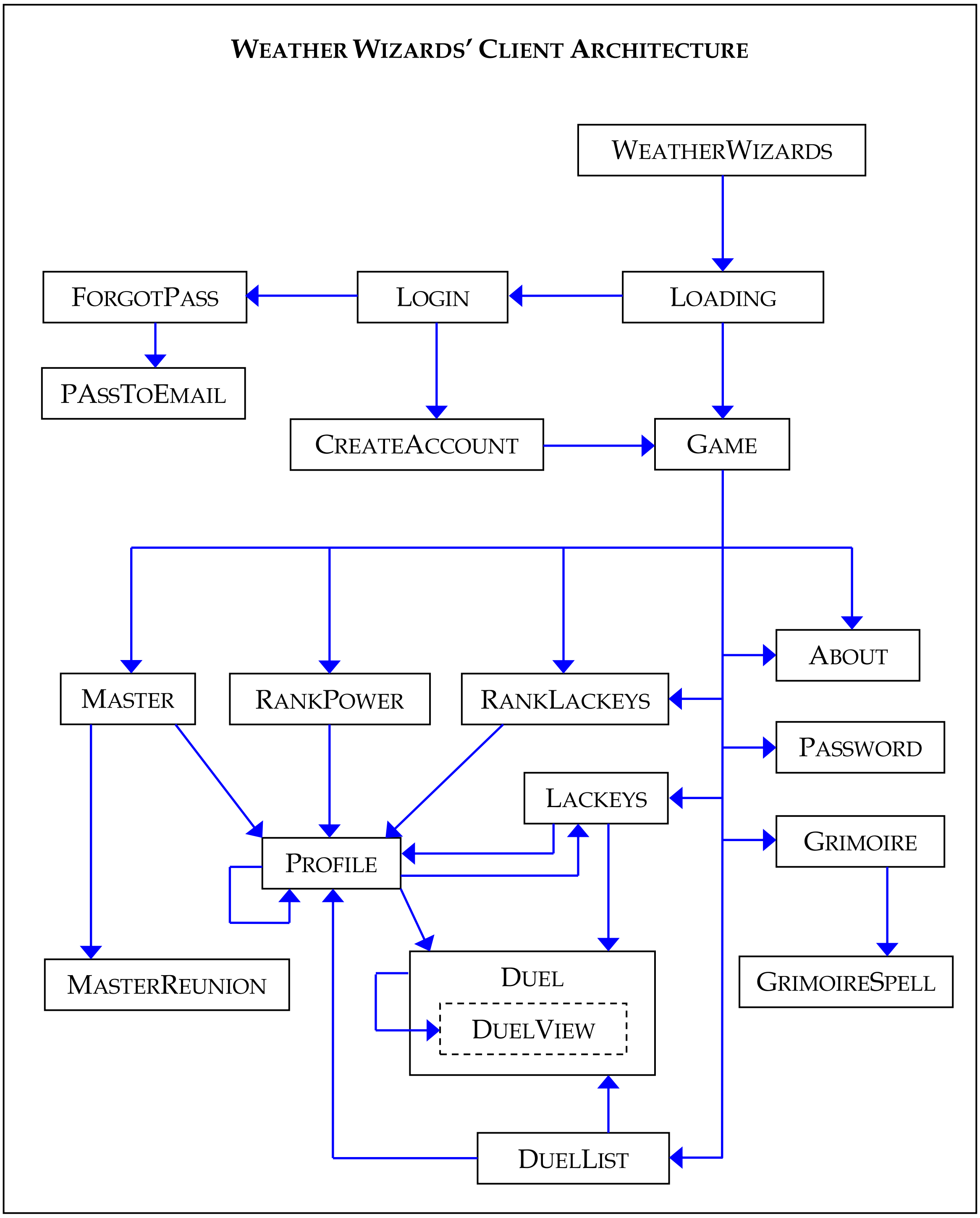


Figure 3.74: Weather Wizards client architecture.

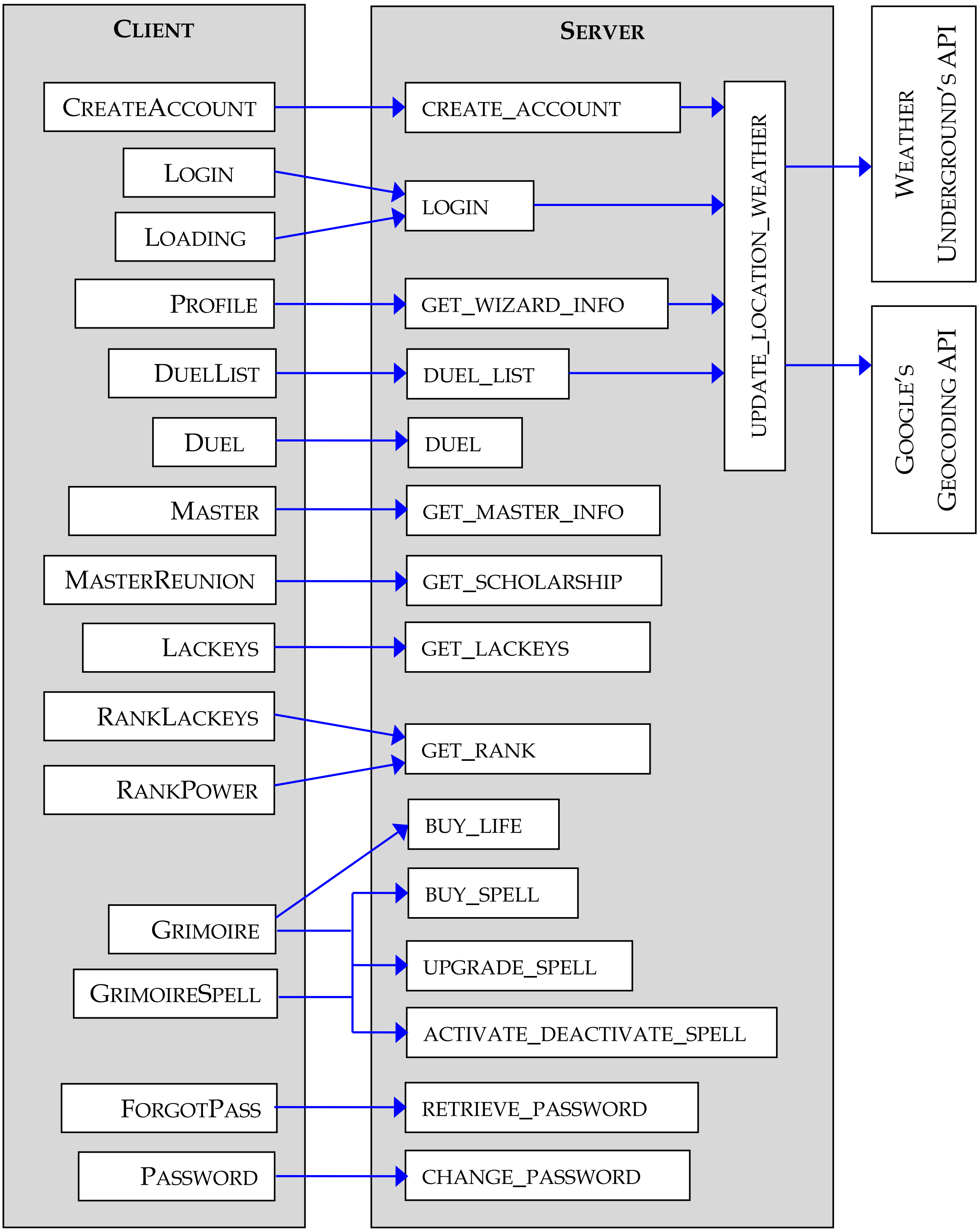


Figure 3.75: Weather Wizards' server functions interacting with the client and with the external providers.

Communication between the server and the Android clients is done via JSON. The player's information is stored in a MySQL database in the server. Locally, the clients also store player information in the Shared Preferences [184]. Among other information, the user's email and password are stored in the Shared Preferences so that they persist across several game sessions thus not requiring the player to enter them at the beginning of each game session. The server side was coded with PHP code.

Weather Wizards is the application's main activity (Figure 3.74) and launches the Loading Activity. The Loading activity retrieves the player's email and password, stored in the Shared Preferences [184], and authenticates the player in the server, via the login function (Figure 3.75). If the player is correctly authenticated the Loading activity starts the Game activity (Figure 3.60). However, if this is the first time the user is playing Weather Wizards, or if the authentication fails, then the Loading activity starts the Login activity (Figure 3.58).

In the Login activity (Figure 3.58) the player can either enter her email and password, if she is already a registered user, or click a button that starts the CreateAccount activity (Figure 3.57).

The CreateAccount activity (Figure 3.57) allows the player to create a new user account. The first name, last name, email, password and gender entered by the player are sent to the server and, if all information is correct, the create_account function (Figure 3.75) creates a new user on the server. After the new account is created the CreateAccount activity, on the mobile phone, starts the Game activity.

In the Login activity the user can also press a link and start the ForgotPass activity (Figure 3.59) to retrieve her password. The retrieve_password function (Figure 3.75), on the server, retrieves the password corresponding to the email, entered by the player, and the PassToEmail activity (Figure 3.74) then sends the password to the player's email.

The Game activity (Figure 3.74) shows the player's profile (Figure 3.60). In the Game activity the player can:

- Start the DuelList activity (Figure 3.61), by pressing the Fight button.
- Start the Master activity (Figure 3.67), by pressing the Master button.

- Start the Lackeys activity (Figure 3.70), by pressing the Lackeys button.
- Start the Grimoire activity (Figure 3.64), by pressing the Grimoire button.
- Press the menu button (Figure 3.73) and access the following options:
    - Start the RankPower activity (Figure 3.71).
    - Start the RankLackeys activity (Figure 3.72).
    - Change the password via the Password activity.
    - Logout.
    - Exit the game.
    - Start the About activity that shows information about the game's authors.

The Profile activity (Figure 3.62), that shows information about a possible rival, can be started via the Master (Figure 3.67), RankPower (Figure 3.71), RankLakeys (Figure 3.72), Lackeys (Figure 3.70) and DuelList (Figure 3.61) activities. Via the Profile activity (Figure 3.62) it is possible to start another Profile activity, by pressing the Master button, thus checking that rival's master. In the Profile activity it is also possible to start the Lackeys activity, thus discovering who are the rival's lackeys. If the Master or the Lackeys button do not appear (Figure 3.62) that is because the wizard in display has no master or no lackeys in her court.

The Duel activity (Figure 3.63) can be started by choosing a rival in the DuelList activity (Figure 3.61), by pressing the Duel this Wizard button in a wizard's profile (Figure 3.62) or by choosing a wizard in the Lackeys activity (Figure 3.70). The Duel activity contacts the server to decide the fate of the duel. The DuelView, which in part of the Duel activity's layout, processes and presents the duel animation (Figure 3.63).

In the Master activity (Figure 3.67) there is a Collect Scholarship button that starts the MasterReunion activity. The master may be unavailable (Figure 3.69). If the master is available (Figure 3.68) the server is contacted and the get_scholarship function (Figure 3.75) increases the player's number of coins in the MySQL database. The information about the Master, in the Master activity, is retrieved via the get_master_info function on the server side.

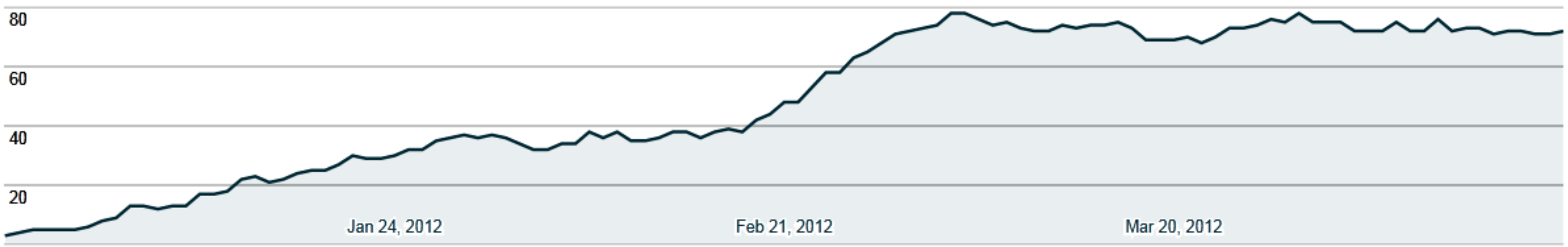


Figure 3.76: Evolution of active device installs in Weather Wizards.

As can be seen on Figure 3.75, almost every activity on the client side (Figure 3.74) is supported by a function that retrieves or updates information on the server side. Some activities are supported by the same function. For example, the Login and Loading activities are both supported by the login function, on the server side. This function receives an email and a password and checks it against the MySQL database. However, in the Login activity (Figure 3.58) the email and the password are entered by the user. The Loading activity retrieves the email and password from the Shared Preferences. The Grimoire (Figure 3.64) and GrimoireSpell (Figure 3.65) activities also share functions on the server side. This happens because both these activities allow players to buy, upgrade and activate or deactivate spells. However, the Grimoire activity presents all the spells at the same time, while the GrimoireSpell activity shows additional details about a spell.

Weather Underground's API [182] and Google's Geocoding API [183] are contacted by the update_location_weather function (Figure 3.75) on the server side. Communication with Weather Underground's API is done via XML and communication with Google's Geocoding API is done via JSON. The location and the weather at a player's current location are checked when creating a new account (Figure 3.57), when the player logins (Figure 3.58), during the Loading activity, during the Profile activity (Figure 3.62) and for all the players presented in the DuelList (Figure 3.61) activity.

3.3.4. Evaluation

To test how the use of the weather affects player enjoyment, a user study was conducted. The application was deployed on Google Play [179]. We could have sent the application's APK file to a few selected users and ask them to install it in their phones. However, we thought that deploying the game on Google Play would provide us with the more realistic scenario possible, rather than merely having the players sitting at the lab to experiment the game [185]. In order to create a realistic scenario, and so that our game would be subjected to all the same constraints that other games are subjected to when they are deployed in the wild, no rewards were offered to players for installing and playing the game. The game was advertised on the research group's web page, on social networks and on mailing lists.

The application was deployed on Google Play in 27 December 2011 and during a period of 3 months there were 306 user installs. The evolution of the active device installs is presented in Figure 3.76.

When the game is installed players are asked what their gender is. 70% of our users are male, 20% are female and 10% preferred not to answer that question.

To evaluate the game and influence of the weather in player enjoyment we resorted to both the logs of the player data stored in the server and to a survey that the players filled via the web. We sent an email to players asking them to fill the survey. 21 players responded to our survey. 81% of those players are male and 19% are female. Their average age is 28.6 years old with a standard deviation of 5.6 years. 85.7% of the players use their phone to play games. The remaining 14.3% do not use their phones to play games (so probably, ours was the first they installed). 9 of the players were students, 6 worked in areas related to informatics and finance, 5 were researchers and 1 did part time jobs.

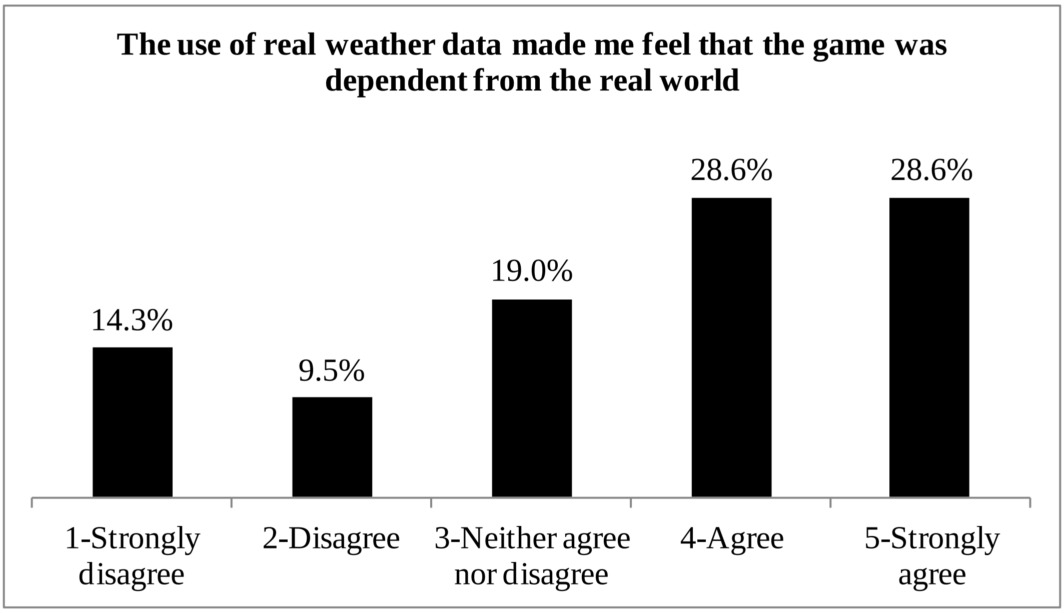


Figure 3.77: Did the use of real weather data made the players feel that the game was dependent from the real world?

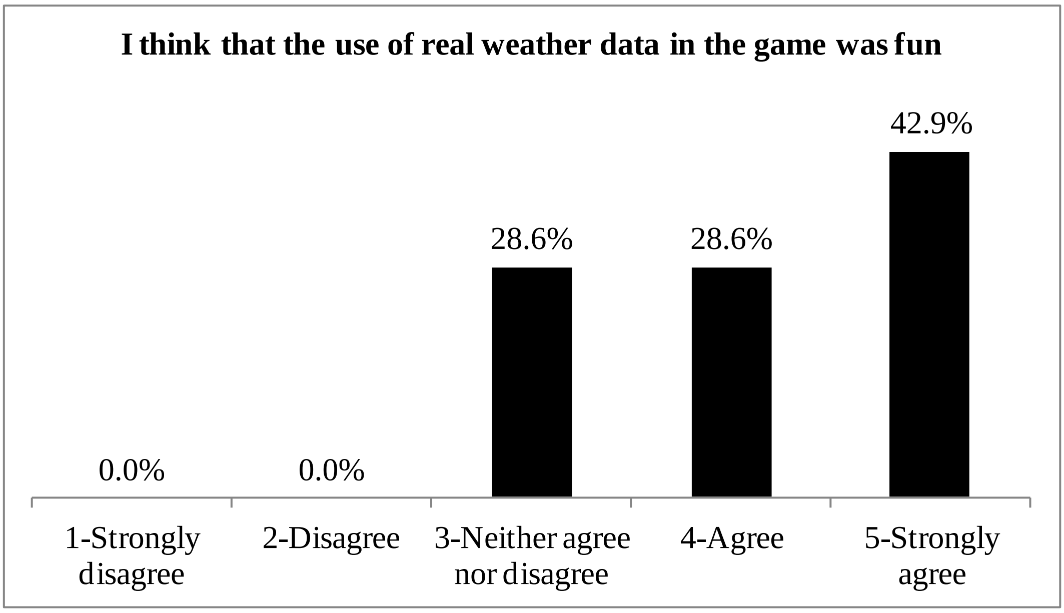


Figure 3.78: Did the players think that the use of real weather data in the game was fun?

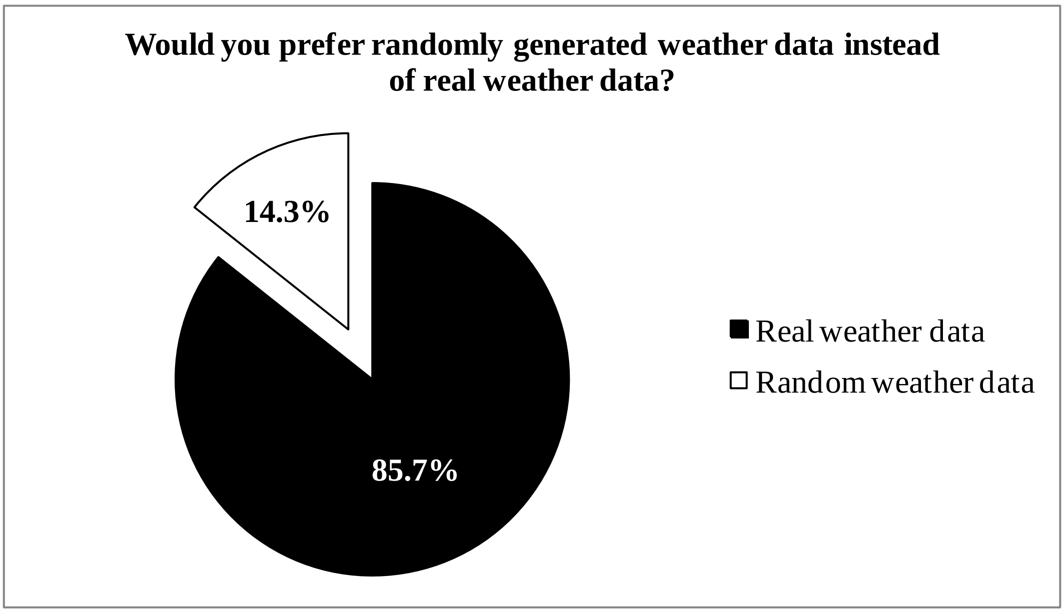


Figure 3.79: Do the players prefer randomly generated weather data or real weather data?

57.2% of the players agree or strongly agree that the weather made them feel that the game was dependent from the real world (Figure 3.77).

71.5% of the players agree or strongly agree that using real weather data was fun (Figure 3.78). None of the players thought that using real weather data was not fun. 28.6% of the players neither agree nor disagree. So, there were players who even though didn't feel that the game was dependent from the real world, nevertheless found the use of weather data fun.

We asked players if they would prefer randomly generated weather data instead of real weather data. 85.7% of the users prefer real weather data. 14.3% would rather have randomly generated weather data (Figure 3.79).

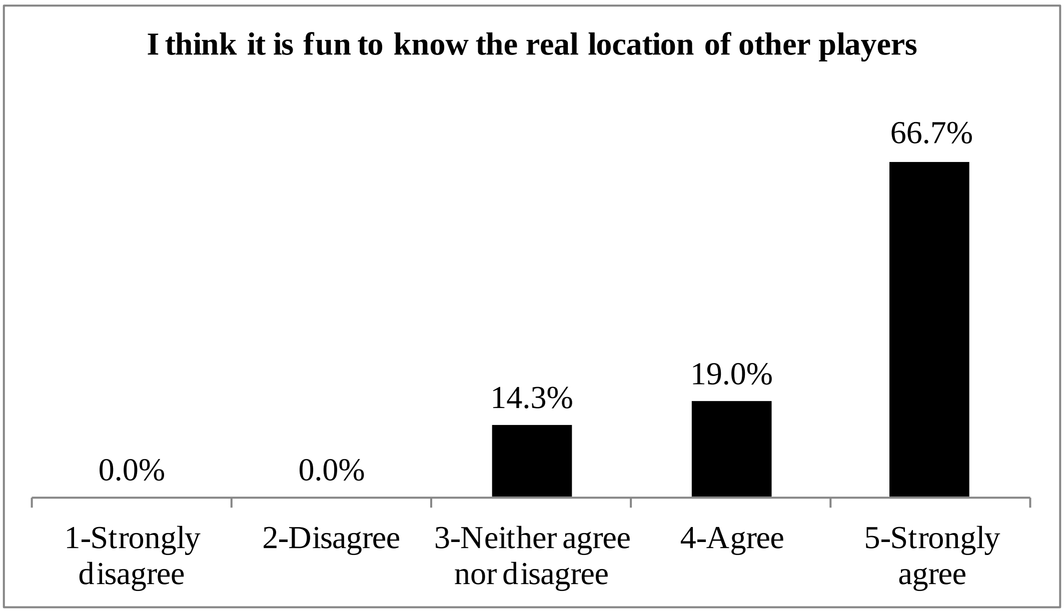


Figure 3.80: Do players think it is fun to know the real location of other players?

As Weather Wizards depends of the user's location, we asked users if they thought it was fun to know the real location of the other players (Figure 3.80). It is possible to know the real location of another player through that player's profile (Figure 3.60) and through the duel list (Figure 3.61). In the ranks (Figure

3.71 and Figure 3.72) there is also a flag that indicates the country where the player is. 85.7% of the players agree or strongly agree that it is fun to know the real location of the other players. This percentage was higher than the one that refers to the use of the weather (Figure 3.78).

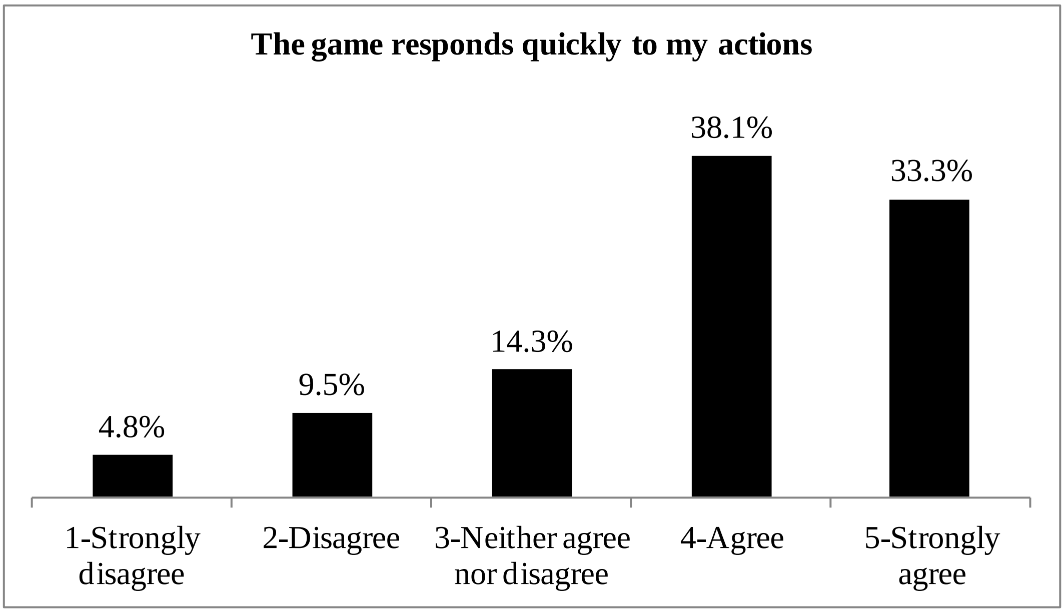


Figure 3.81: Does the game respond quickly to the player's actions?

Since the game was made available on Google Play, until the time of writing, players have fought 10335 duels. These duels were initiated by 125 distinct users. In 66.9% of those duels the spell that corresponded to the weather at the rival's location was activated.

We also asked players if the game responds quickly to their actions. To obtain the real time weather data the phone needs to contact the server and the server needs, in turn, to contact the Weather Underground API. Those two steps could cause some delay. Surprisingly, 71.4% of the players agree or strongly agree that the game responds quickly to their actions (Figure 3.81).

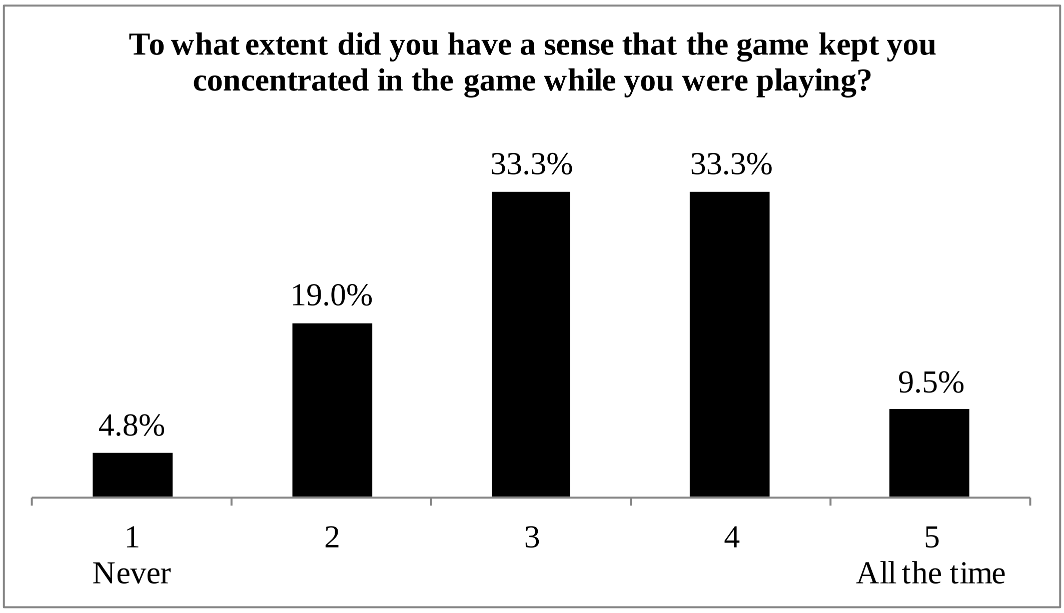


Figure 3.82: Did the game kept the players concentrated while they were playing?

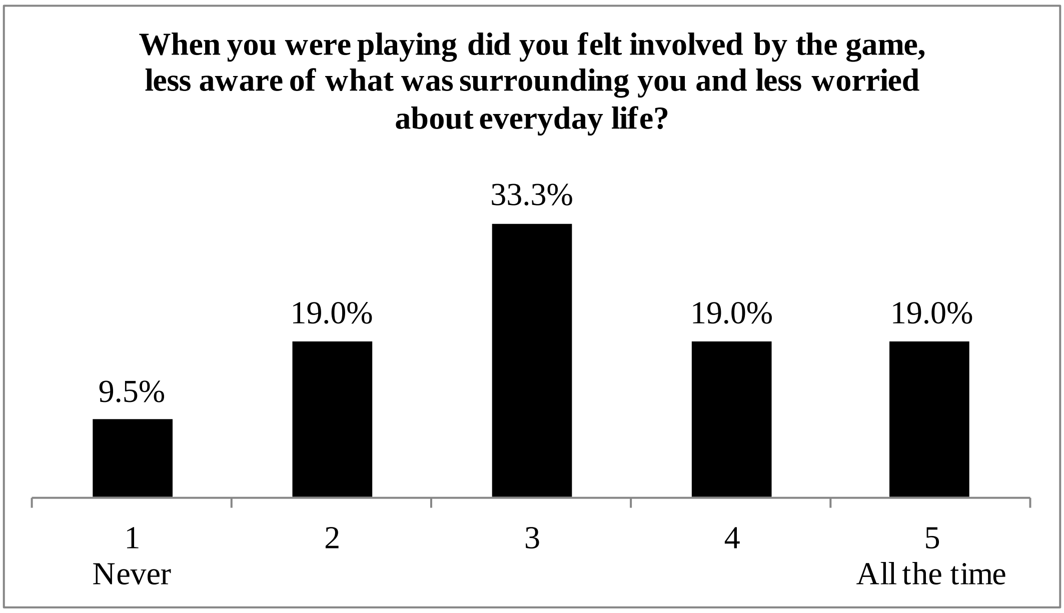


Figure 3.83: Did the players feel involved by the game, less aware of what was surrounding them and less worried about everyday life?

In the survey, players were asked a series of questions based on the Game Flow. People experience flow when they do an activity for the sole sake of the activity, for enjoying themselves and not to receive material rewards [186,187]. In one of the questions we asked players to what extent did they have a sense that the game kept them concentrated while they were playing. This question was related to the concentration element of the Game Flow. Providing a lot of stimuli from different sources is a criteria that contributes to the concentration element and that in turn contributes to the flow. As the weather is another stimuli we wondered if this element might favor concentration. Another of the elements of the Game Flow is immersion. In what refers to this element players were asked if they felt involved by the game, less aware of what was surrounding them and less worried about everyday life. As the weather surrounds the player, constantly immersing her, eventually this might favor immersion. However, our results regarding concentration (Figure 3.82) and immersion (Figure 3.83) were quite neutral. The average value for concentration is 3.2 and the average value for immersion is again 3.2. This may be due to the fact that Weather Wizards is a casual game designed to be played during short bursts of time and meant to be easily interrupted in case the player has something else to do [10]. So perhaps Weather Wizards' casual nature didn't inherently favor concentration or immersion.

In the survey players were asked how the game could be better, what they liked and what they didn't like. 28.6% of the players wanted better graphics. Conversely, 14.3% of the players liked the game's graphics and praised its simplicity. 23.8% of the players wanted more interactive combats and demanded features such as friends' lists, so that they could track their progress and challenge them, exchange of messages between wizards or different privileges based on the player's real location. 42.9% of the players praised the innovation, originality or idea behind the game. 9.5% of the players mentioned the masters and lackeys functionality (Figure 3.67) as good way for new players to more easily attain visibility and rise in the game's hierarchy (Figure 3.72). Experience is cumulative over time, so it is more difficult for a new player to surpass players that have been in the game for a longer time. Lackeys, in contrast, are relatively easier to steal.

Our results indicate that real time weather data has potential to contribute positively to player enjoyment in a game, but there are risks associated with it [188]. Weather data providers may crash or may not scale appropriately if the number of players increases. Furthermore, if one opts for a paid solution weather data will become an extra cost. Inaccuracy problems may also surface as the weather data supplied by the provider may be wrong. However, there may be one way to avoid this external dependency. The application Weddar [189] may have found the solution. Weddar is a weather report service powered by its own users. It is not a game, but the strategy that they used may be the way out for games not to become dependent from an external, possibly paid, solution. Of course, there can be some inaccuracy in this sort of approach, but weather data providers may also suffer from some form of inaccuracy. So this may well be a possibility worth considering.

3.3.5. Discussion

With Weather Wizards, a game where the weather is central to the gameplay, the contribution of real time weather data to player enjoyment was analyzed. A survey was conducted to the players. 71.5% of the players considered that using real weather data was fun and 57.2% of them thought that the use of real weather made them feel that the game was dependent from the real world. When asked if they would prefer using real weather data or randomly generated weather data 85.7% of the users preferred real weather data and only 14.3% would opt for randomly generated weather data. Our results therefore indicate that real time weather data can contribute positively to player enjoyment.

In what refers to the concentration and immersion elements of the Game Flow, our results were only slightly positive, possibly because Weather Wizards is a casual game, built to be played for short amounts of time. In a short amount of time it is difficult for a player to feel completely immersed and detached from the real world.

Our survey was conducted in a limited population, and the respondent rate might eventually have affected the outcome, but the user results about the use of real weather data are encouraging so we believe there are still many opportunities to explore in what refers to the combination of weather and games.

As future work we plan to port this application to other devices in order to augment the number of potential players and run more user tests. We also plan to offer the choice of different skins for the game because even though several users complimented the aesthetics and simplicity of the game, others would prefer a more elaborate design.

3.4. Enchanted Moor

Digital games have often been accused of leading to social isolation [190,191]. Here, a strategy is presented where players have to socialize in order to win, so that the game becomes a trigger, and not a deterrent, for social engagement. In multiplayer games players often have to collaborate, but that collaboration may be remote. Here, the players need to be co-located so that face to face contact is achieved. Besides stimulating co-located interaction among players, our game [192,193] pursues the additional objective of raising awareness about Enchanted Moors for these mythical characters are an important part of Iberian traditional tales [194–197].

Previous work about games that are targeted at the preservation of cultural heritage and that occur in social settings is discussed in the next section. Section 3.4.2 presents our proposal and Section 3.4.3 goes deeper into the implementation and architecture details. Section 3.4.4 describes the user study and presents the results. Finally, a discussion and possible future work is addressed in Section 3.4.5.

3.4.1. Disseminating Cultural Heritage through Games

Other researchers have already addressed the dissemination of traditional tales or of a country's history. In the InStory [25] project the authors resorted to a PDA to explore the gardens and palace of Quinta da Regaleira, in Sintra. In iLand [198] the oral culture and traditions of the Island of Madeira are exposed to foreigners and tourists. In another work the authors promote a prehistoric heritage site, the Gargas caves, to an audience of general public and particularly to children [199]. In the Skins [200] workshop students were encouraged to reflect on their traditional stories and to develop interactive environments based on them. The Archeoguide [201] project provides augmented reality reconstructions of ancient ruins of the archeological site of Olympia in Greece. Decho [202] is a framework for the digital exploration of cultural heritage objects. REXplorer [38] is a mobile game that explores the history and culture of Regensburg. In the next section our proposal of a casual game aimed at the preservation of cultural heritage making use of co-located social interactions is presented. We address the still scarcely explored thematic of Enchanted Moors.

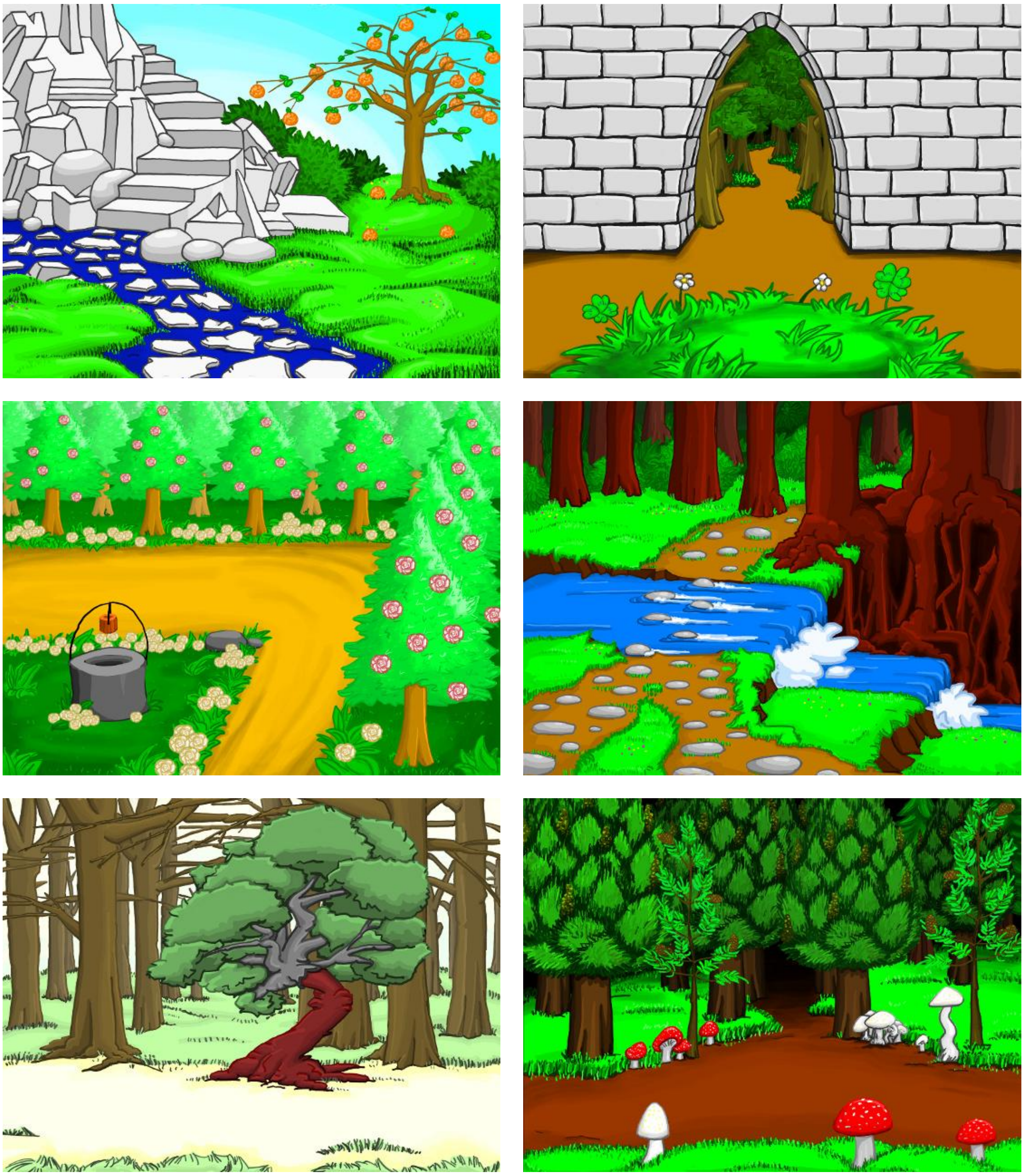
3.4.2. The Game

Our game [192,193] stimulates curiosity about Enchanted Moors' legends while encouraging social engagement among players. More than 800 years of history has provided Portugal with a vast collection of legends where the divine and the supernatural walk hand in hand with mortal humans. Enchanted Moors are an intriguing and popular part of Portuguese mythology. They are mythical beings who possess vast wealth and magic powers [194,195].

Figure 3.84: Lisbon under siege by Alfredo Roque Gameiro.

Screenshots of several parts of the labyrinthic forest

Screenshots of several parts of the labyrinthic forest



Screenshots of several parts of the labyrinthic forest

Figure 3.85: Screenshots of several parts of the labyrinthic forest.

Figure 3.86: Princess Laila waiting for the player by a waterfall.

Figure 3.87: The Moor Princesses, from left to right and from top to bottom: Fátima, Jasmina, Tadmor, Sara, Karima and Doniazade.

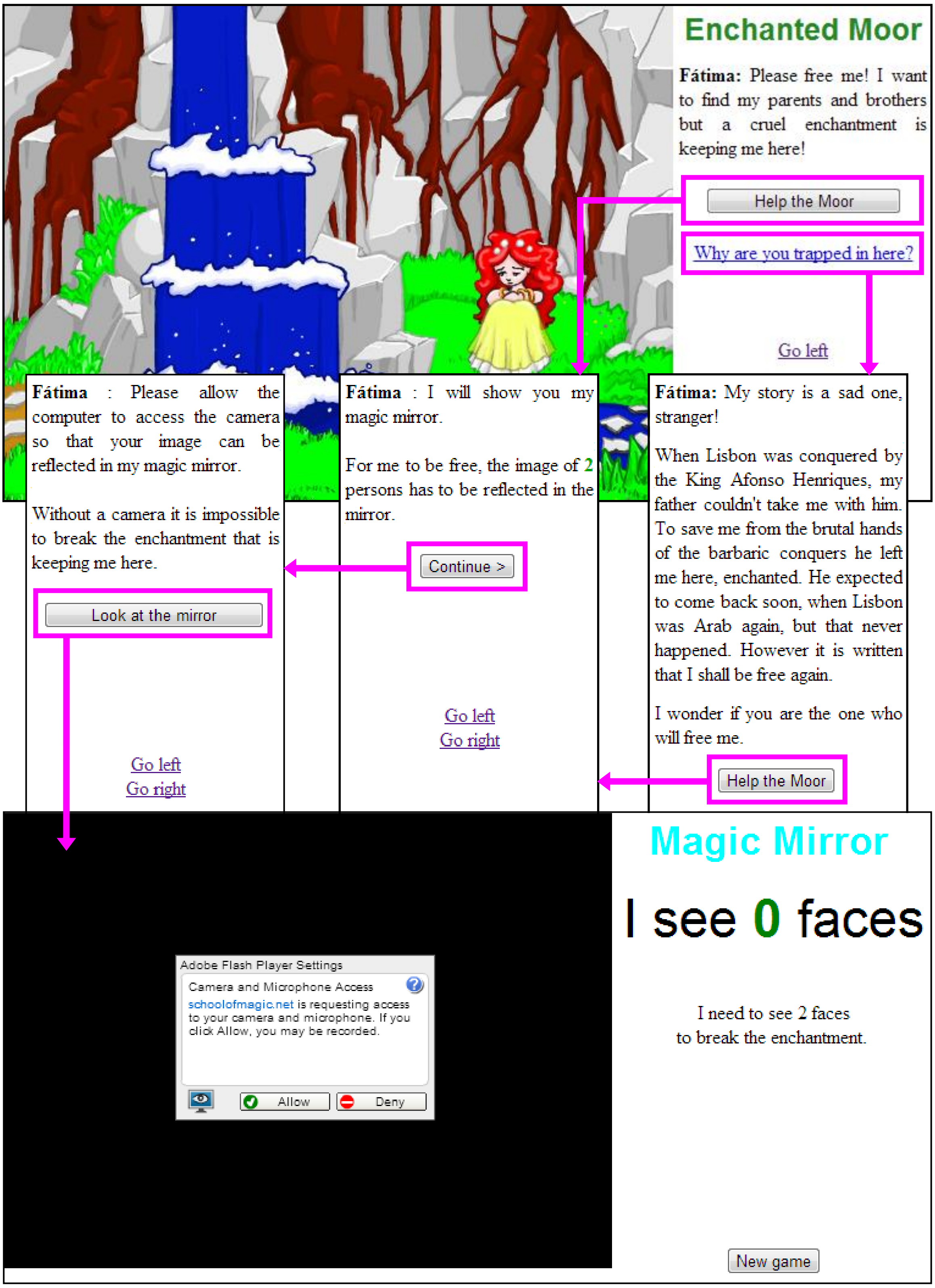


Figure 3.88: Saving the Enchanted Moor Princess.

Enchanted Moors' stories are varied, but there is a common thread to most of them. As the Portuguese conquered the territory under Moorish domain (Figure 3.84), some Moors, amidst the confusion of battle, where left behind. However, to assure their protection from the invaders, they were enchanted [194–196]. This enchantment would assure their safety until eventually the Moors returned to Portugal and had the opportunity to set them free. For example, a Moor who could not reach his daughter during the conquest of the Castle of Salir enchanted her so that she became invisible to the conquers' eyes [196]. The Moor's enchantment can be broken if a trustworthy savior appears and completes a mission. For example, in Lagos, an Enchanted Moor required a woman to build a house without doors and windows. The woman became the village's ridicule for building such a nonsense building. However, when the construction was over the enchantment was broken and he rewarded her with an immense fortune. According to legend, many Enchanted Moors are still trapped in Portugal and throughout Iberia [197], patiently waiting for someone to break their enchantment and set them free [196].

Our objective is to motivate curiosity about Enchanted Moors' folk tales through a game that relies on a collaborative activity. In our browser game, players wander through a labyrinthic forest (Figure 3.85). Players have to find their way through this labyrinth till finally they meet the princess. We chose a forest because, in legends, Moors are reported to be sighted in such places [196].

The Enchanted Moor waits for the player by a cascade. In Figure 3.86, Princess Laila waits while she contemplates her jewelry. Besides Princess Laila, there are other six sister Moor Princesses in the forest: Fátima, Jasmina, Tadmor, Sara, Karima and Doniazade (Figure 3.87). The princess that presents herself to the player is randomly chosen.

After finding the princess (Figure 3.88), the player can either progress directly to save the Enchanted Moor by pressing the Help the Moor button or know why she is trapped in there by pressing the "Why are you trapped in here?" link. If the player presses the "Why are you trapped in here?" link, the right side of the interface changes to show the princess's story. In the case of Figure 3.88, Fátima progresses to explain that she is trapped since Lisbon was conquered by King Afonso Henriques. Her father could not take her with him, so to protect her from the brutal hands of the invaders he cast a spell and left her enchanted. Fátima’s father expected this to be a temporary solution and to come back to Lisbon soon and rescue his daughter. However, as this did not happen, Fátima’s only hope is to wait for a brave hero. She keeps her spirits up because it is written that she will be free once again. After reading the princess’s sad story, the player can press the Help the Moor button, bellow the story. Fátima will then say that, for her to be rescued, she needs two people to look at her Magic Mirror. After pressing the Continue button, bellow this message, Fátima asks the player to allow the game access to the camera. After pressing the Look at the mirror button an Adobe Flash application starts.

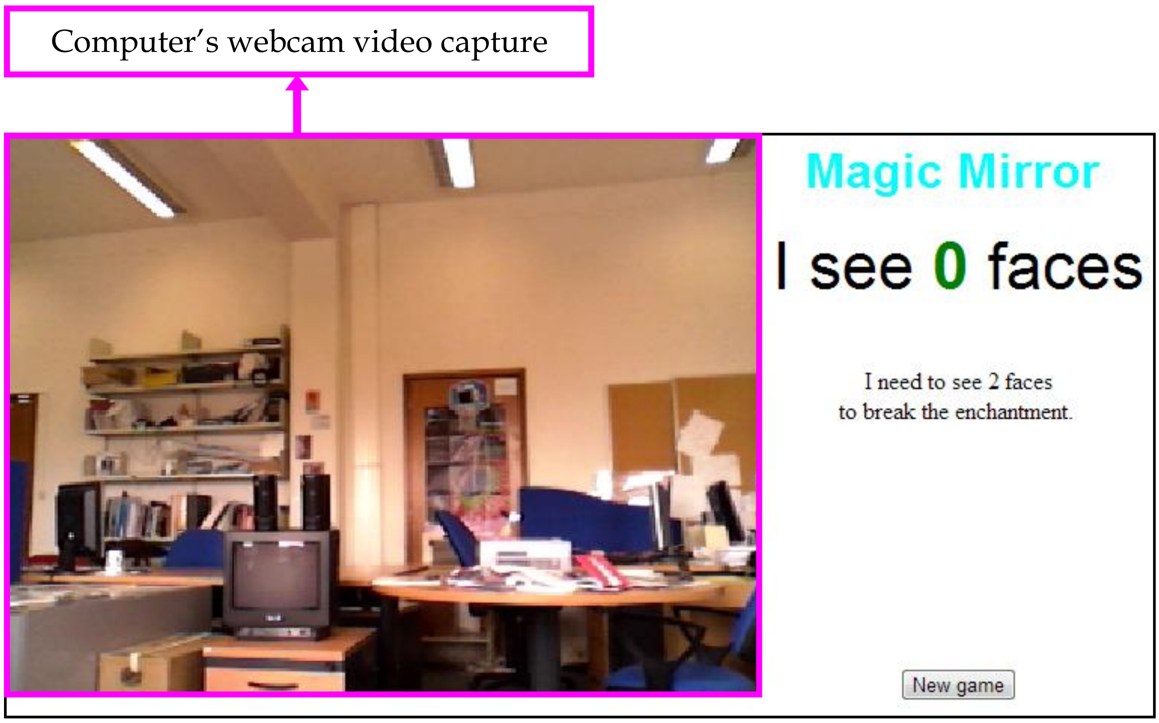


Figure 3.89: Magic Mirror with zero people looking at it.

Through a face detection algorithm that resorts to the Haar Cascade Classifier we know how many players are looking at the mirror. For the face detection we resorted to code from the Marilena project [203] and to code by Quasimondo [204]. In Figure 3.89, the left side of the interface shows a video capture by the computer's webcam. The player has moved away to find someone to help her free the Enchanted Moor and so zero people are looking at the Magic Mirror.

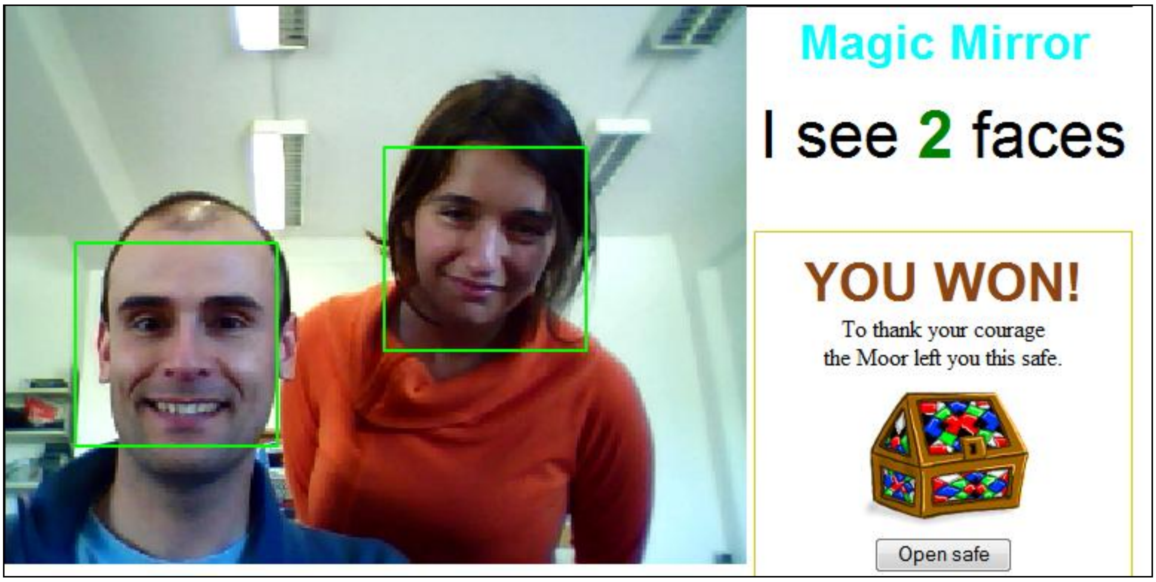


Figure 3.90: Magic Mirror with face detection via the computer's webcam video capture. The player's faces are highlighted by the green outline of rectangles.

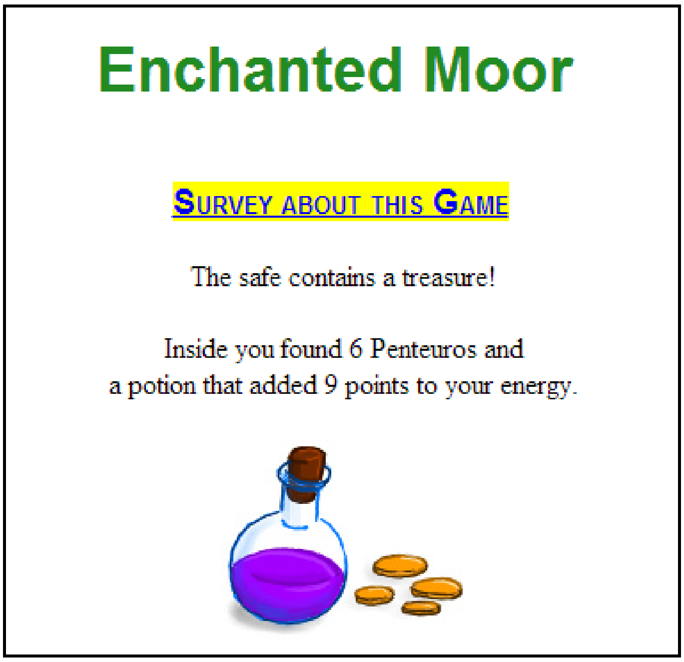


Figure 3.91: The player's reward for saving the Enchanted Moor.

Figure 3.90 shows 2 players looking at the Magic Mirror. The faces of the players are highlighted by the green outline of a rectangle. After the required number of players has been attained, the spell is broken and the princess is set free. As a way of thanking the player for his or her courage the Enchanted Moor offers a safe (Figure 3.90) filled with virtual gold coins and a potion (Figure 3.91). In Figure 3.91 the link to the user survey, with a yellow highlight, is visible over the reward.

Our proposal can be applied or adapted to other mythical elusive creatures. For example, similarly to Enchanted Moors, leprechauns also hide treasures. If captured by a human the leprechaun may give the captor a pot of gold [205].

3.4.3. Implementation and Architecture

The Enchanted Moor is a browser game coded in HTML5, ActionScript 3.0 and VBScript. Figure 3.92 shows the game's architecture.

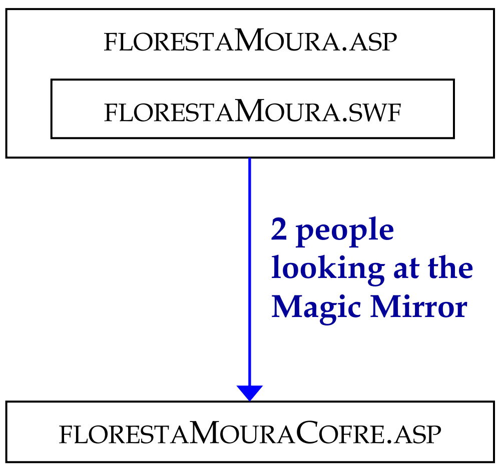


Figure 3.92: Enchanted Moor game architecture.

The florestaMoura.asp webpage processes the Moor Princess dialogs with the player (Figure 3.88). Embedded in the florestaMoura.asp, the florestaMoura.swf file deals with the video capture and outlines the faces of the players (Figure 3.90). Via the ExternalInterface ActionScript class [127] the florestaMoura.swf file communicates to the florestaMoura.asp webpage how many people are looking at the Magic Mirror. When two people are looking at the mirror, florestaMoura.asp offers the player a safe (Figure 3.90). After opening the safe, florestaMouraCofre.asp shows the gold coins and the energy potion inside the safe (Figure 3.91).

3.4.4. Evaluation

To test our strategy we made our game available through the Internet and advertised it in mailing lists and on social networks. In the game there is a link to an anonymous survey that was previously tested (Figure 3.91). Players were asked to fill the survey after they played the game. No material rewards were offered for filling the survey. We considered that an online game would provide us with a more realistic test scenario [185]. We monitored accesses to the game and collected answers from players to the survey during one week. During that time period our game was accessed 898 times. The game was completed 130 times, which means that the Moor Princesses were successfully rescued 130 times. Those 130 rescues do not forcibly correspond to 130 different users as the same player can rescue Moor Princesses several times.

49 players answered our survey. From those 49 answers, 6 answers were discarded because we found out, through those players' answers to the open ended questions, that they did not allow the game to access their camera and the camera is vital to this game experience. The camera access issue seems, furthermore, to have caused some controversy. We received mails from people where they stated that they would never allow a webpage to access their cameras and others complained about the same problem in social networks. So, even though portable computers and smartphones usually have an embedded camera we wonder how reluctant people will be to let an entertainment application make use of it.

As 6 people refused to grant access to the camera that left us with 43 questions to analyze. 34.9% of those players are male, 62.8% are female and 2.3% did not answer what their gender was. The average age is 20 years old with a standard deviation of 6.9. The younger player is 10 years old and the older player is 35 years old. 46.5% of the players live in Brazil, 41.9% live in Portugal, 9.2% live in other countries and 2.3% did not answer where they live.

Our objective was to disseminate knowledge about Enchanted Moors so we asked players if they had already heard or read something about this kind of mythological being before the game. 46.5% of the players responded affirmatively. The remaining 53.5% of the players had never heard about Enchanted Moors before. So even though Enchanted Moors are not completely unknown to everyone, still more than half the players had never heard about them before.

Figure 3.93: Tag cloud with the names of all the mythological beings mentioned by the players. Font size is proportional to the number of times the creature was mentioned. The words corresponding to the top ten mentioned beings are marked with a green font color and yellow background.

However, even if 46.5% of the players had already heard about Enchanted Moors before the game, still, that does not give us an indication of the popularity of these mythical beings. So, before asking if they had heard about Enchanted

Moors, we asked players to mention all the mythological beings that they know of. Elves were mentioned by 46.5% of the players and were the most popular mythological being. Only 11.6% of the players included the Enchanted Moors among their known mythological beings (Figure 3.93). So, even though 46.5% of the players are aware of the existence of Enchanted Moors, only 11.6% of them spontaneously included them in their list of known mythological creatures.

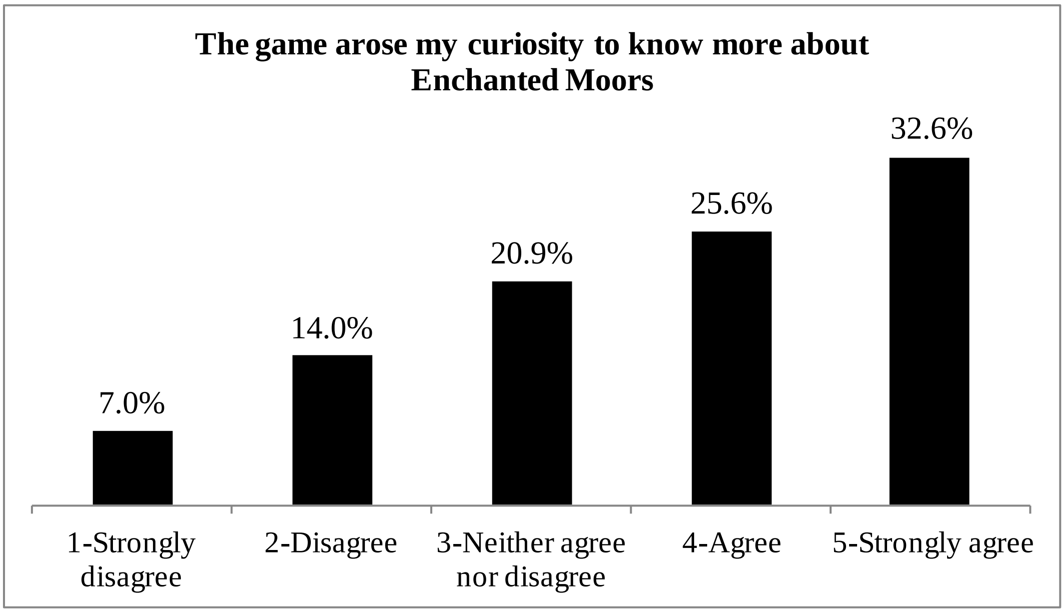


Figure 3.94: Did the game arise the players' curiosity to know more about Enchanted Moors?

After playing the game 58.2% of the players became curious to know more about Enchanted Moors (Figure 3.94). To disseminate the knowledge about Enchanted Moors, among the general public, players suggested resorting to games, online materials like photos, texts and videos, films, theater plays, books and even interacting with local communities via projects.

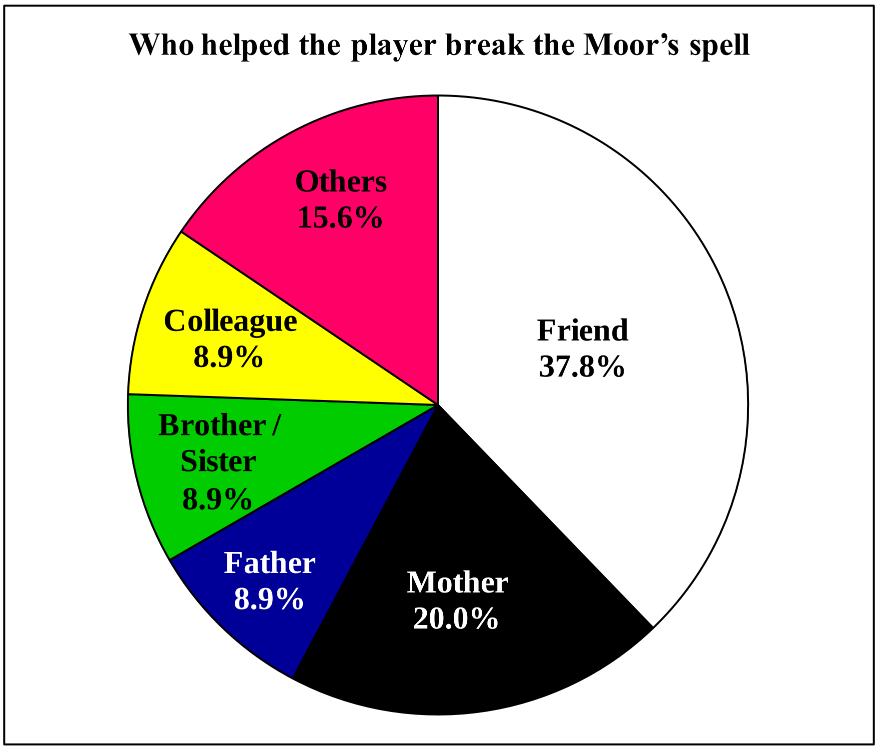


Figure 3.95: Who helped the player break the Moor's spell?

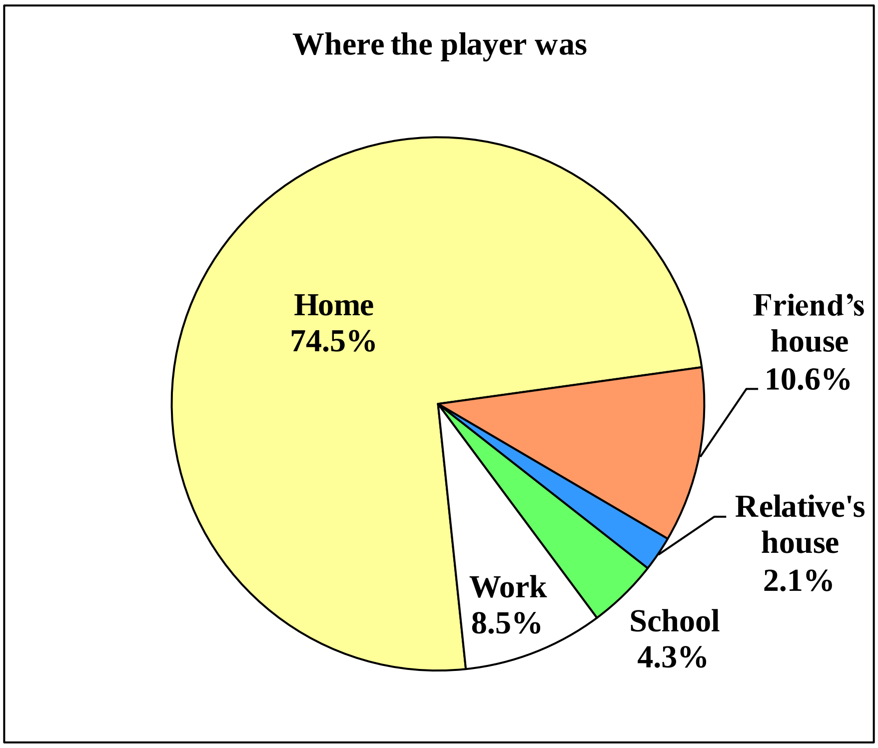


Figure 3.96: Location of the player when breaking the Moor's spell.

Another of our objectives was to promote social contact among people so several questions were made to understand the context where the game was played. To break the Moor's spell it was necessary for two people to look at the Magic Mirror. This was done in order to encourage social contact among the player and another person in his or her vicinity. After the Moor's spell was broken 43% of the players would keep chatting for some time with the person that helped them in the game. So, not only is social contact necessary to win the game as for 43% of the players that contact continued for a while, by chatting to each other, after the game ended. As for the person that helped the player rescue the Moor, most of them resorted to friends and family (Figure 3.95) and most players were at home when playing the game (Figure 3.96).

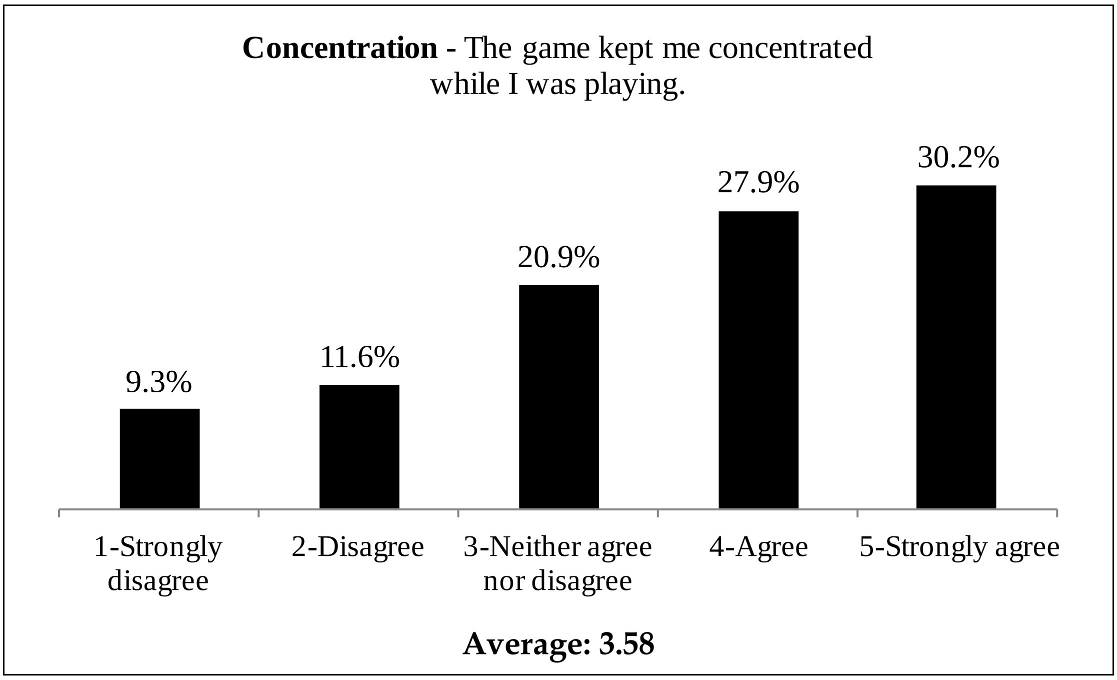


Figure 3.97: Enchanted Moor evaluation according to the Concentration criteria.

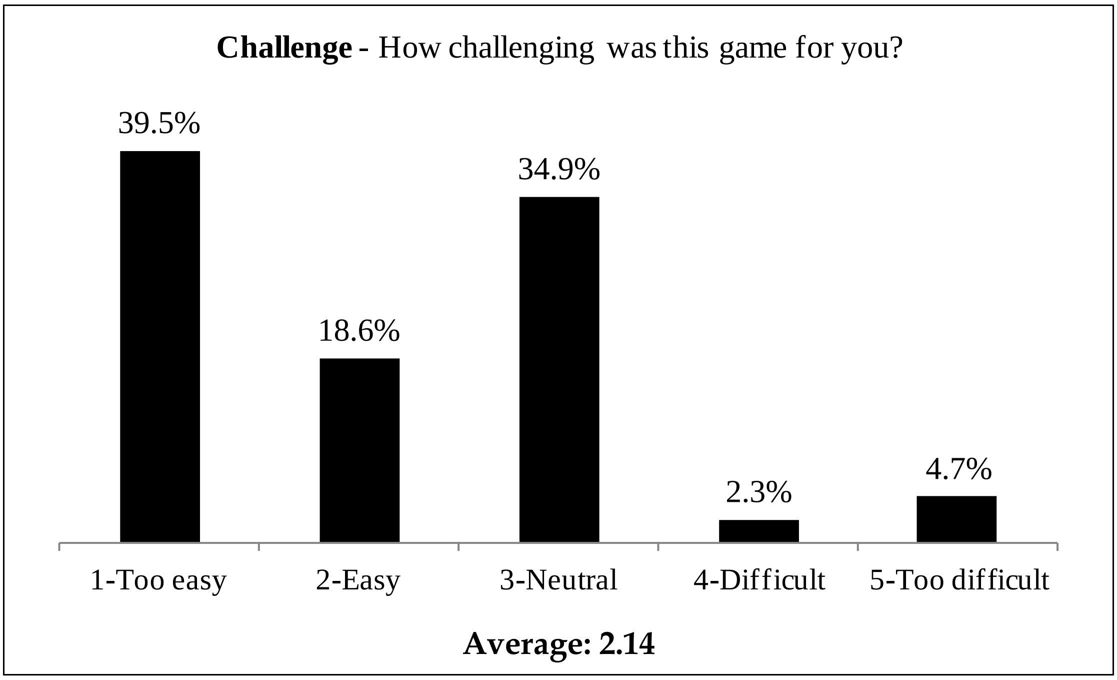


Figure 3.98: Enchanted Moor evaluation according to the Challenge criteria.

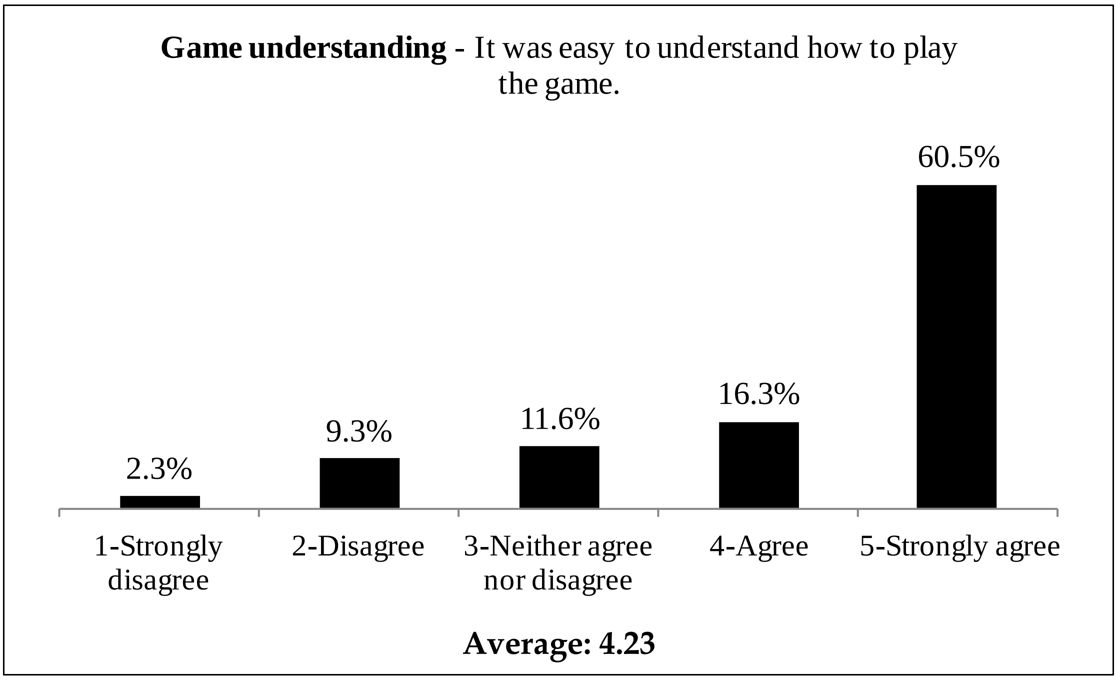


Figure 3.99: Enchanted Moor evaluation according to the Game Understanding criteria.

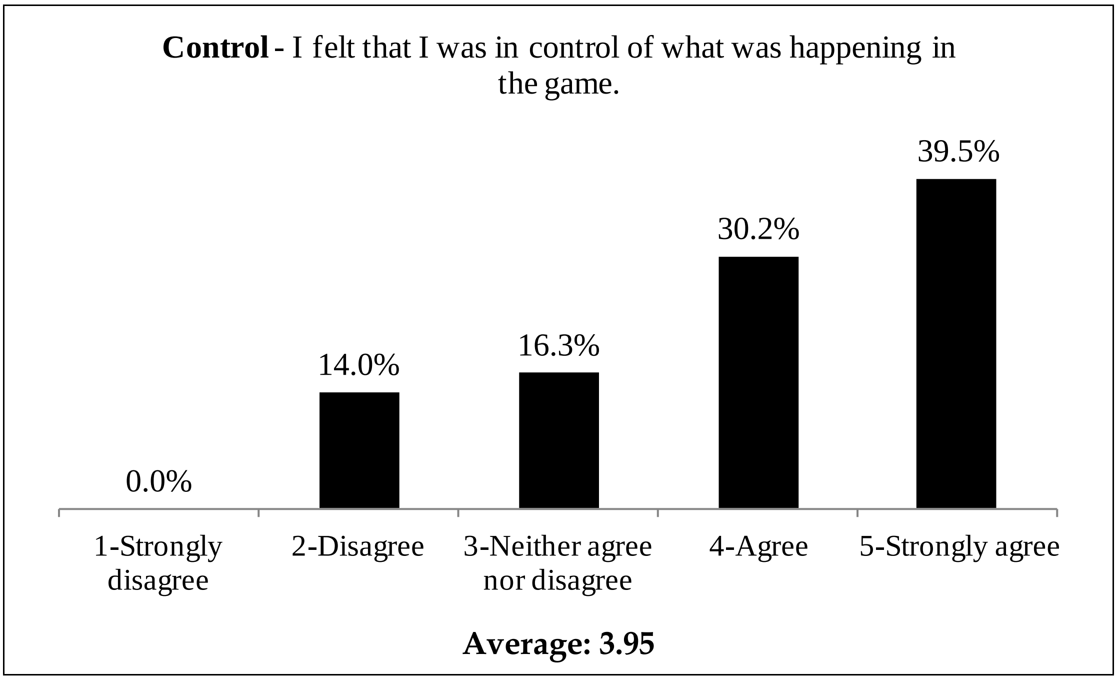


Figure 3.100: Enchanted Moor evaluation according to the Control criteria.

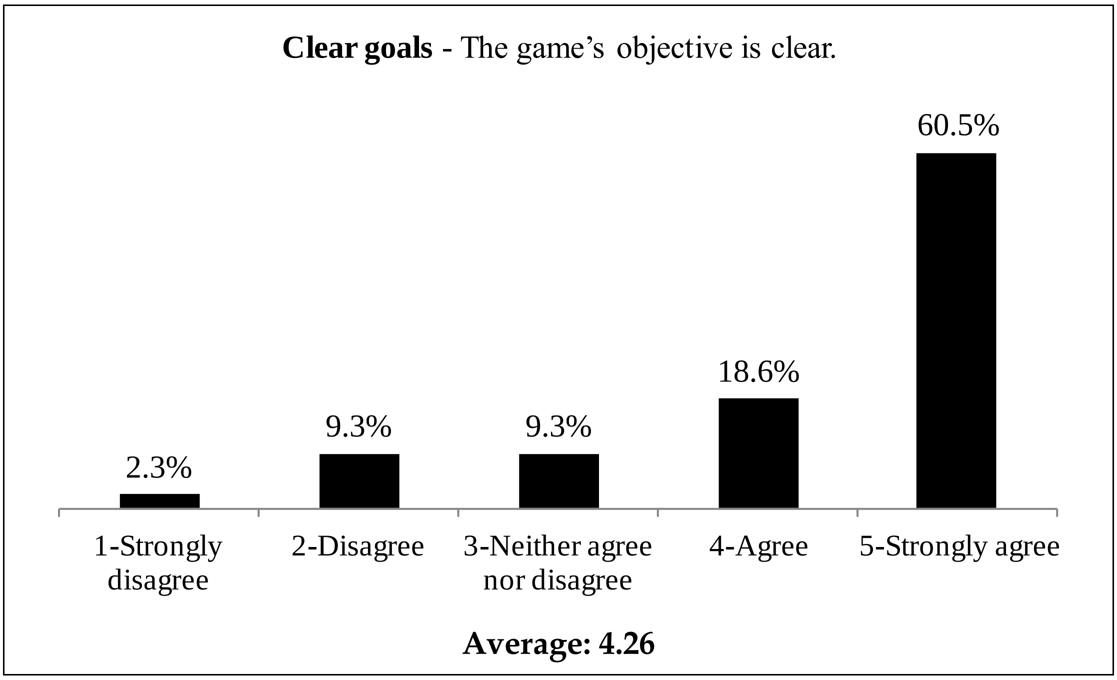


Figure 3.101: Enchanted Moor evaluation according to the Clear Goals criteria.

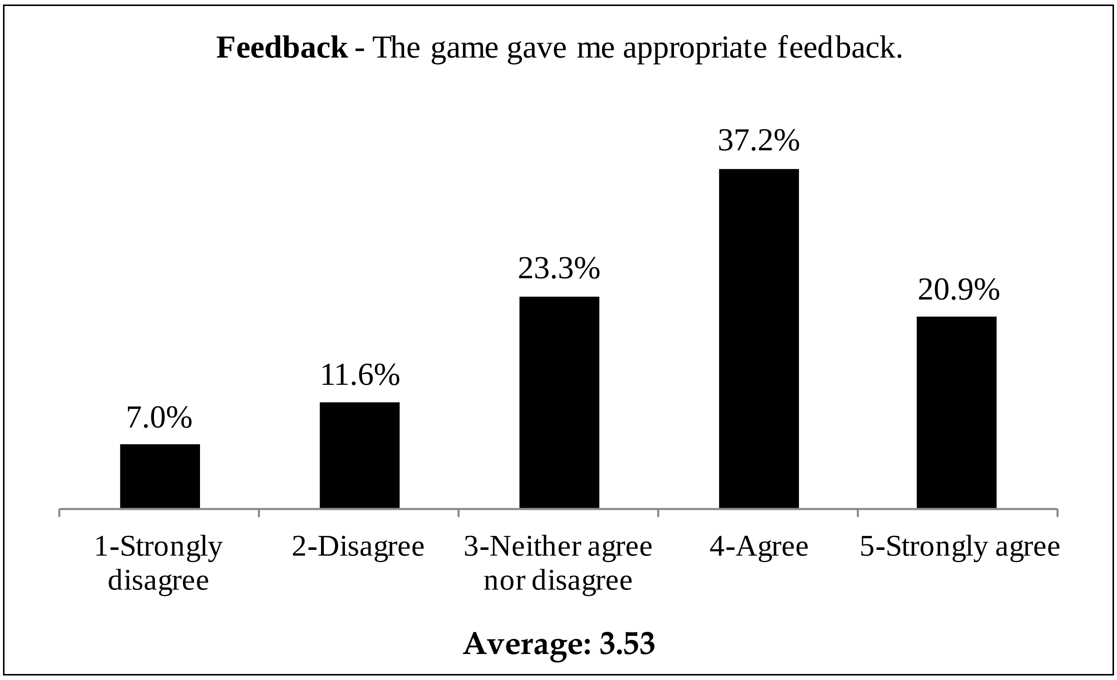


Figure 3.102: Enchanted Moor evaluation according to the Feedback criteria.

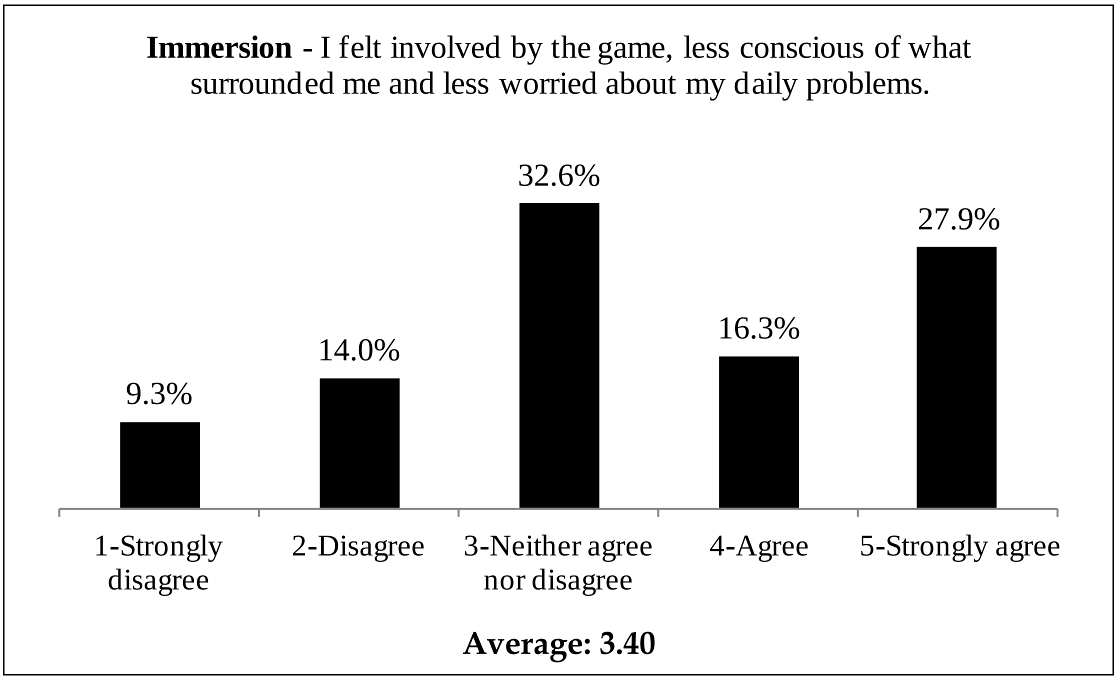


Figure 3.103: Enchanted Moor evaluation according to the Immersion criteria.

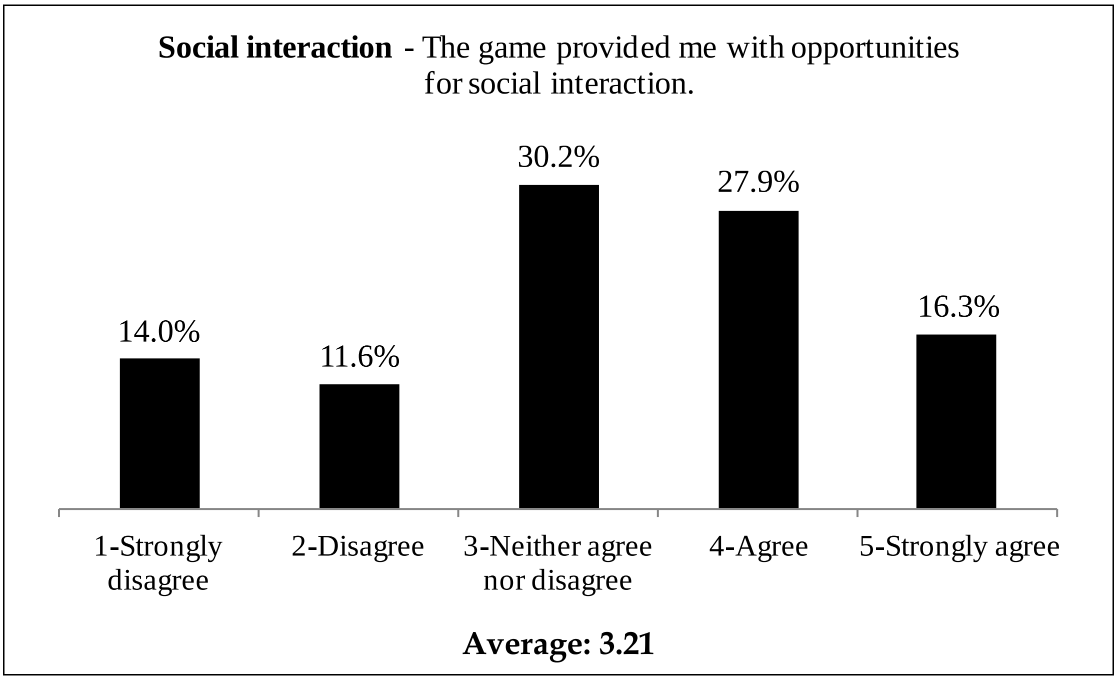


Figure 3.104: Enchanted Moor evaluation according to the Social Interaction criteria.

To evaluate how much the game pleased the players we resorted to the Game Flow Criteria. These criteria define how to achieve player enjoyment in games [176,186]. For each criterion, in the survey, the player indicates, in a scale of 1 to 5, how much he or she disagrees with a statement and the higher the score is the better, with the exception of the level of challenge where players indicate if the challenge is too easy or too difficult. A too difficult challenge might cause players to shy away but a too simple challenge may be boring [186]. For each criterion, the average score of the players' answers is presented below the corresponding graph (Figure 3.97 to Figure 3.104).

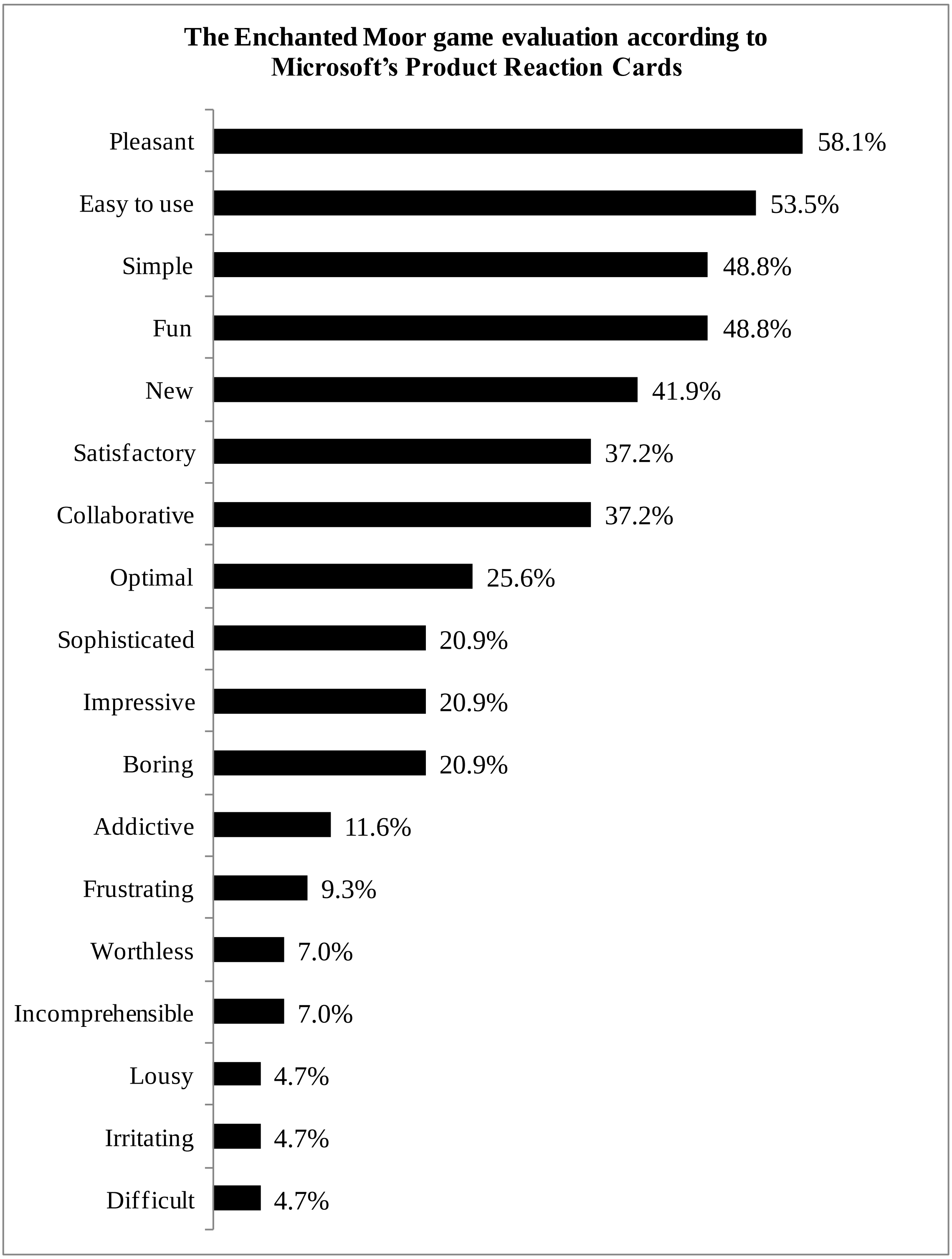


Figure 3.105: Evaluation of the Enchanted Moor game according to Microsoft's Product Reaction Cards.

The game managed to keep 58.1% of the players concentrated and the average score is 3.58 (Figure 3.97). As for the level of challenge, 58.1% of the players considered the game presented a low level of challenge. Only 4.7% of the players considered the level of the challenge too high (Figure 3.98). Perhaps other modes of play should have been provided for the ones who wished for more demanding entertainment. Also, most players (76.8%) found it easy to understand how to play the game (Figure 3.99). This game was designed to be a casual game and results seem to reinforce the game is indeed casual because having a shallow learning curve is one of the key characteristics of casual games [10]. The game provided a sense of control to 69.7% of the players (Figure 3.100). The goals were clear to 79.1% of the players (Figure 3.101) and in, what concerns this criterion, there seems to be little room for improvement. Furthermore, this criterion obtained the highest average (4.26) in comparison with all the others, though the level of challenge is excluded from this comparison as an extremely challenging game would not necessarily be better. As for the game's feedback, 58.1% of the players consider it was appropriate with an average score of 3.53 (Figure 3.102). The immersion received an average score of 3.40 with 44.2% of the players feeling immersed by the game (Figure 3.103). Finally 44.2% of the players encountered new opportunities for social interaction due to the game with an average score of 3.21 (Figure 3.104).

The game was also evaluated resorting to Microsoft's Product Reaction Cards [161]. Players were asked to choose the expressions they felt better described the game. The five most chosen expressions were pleasant, easy to use, simple, fun and new (Figure 3.105). Players could choose as many expressions as they wanted.

3.4.5. Discussion

A proposal to disseminate knowledge about folk tales via co-located interaction was presented. We focused on Enchanted Moors. When the Moors retreated from Iberia, during the Reconquista period [206], some were left behind and to protect them from the invaders enchantments were cast. The enchantment can be broken if a mission is completed by a savior [194–196]. Our proposal relies on a collaborative activity, as the magic energy of two saviors is required to break the spell that is trapping a Moor Princess. After playing our game 58.2% of the players became curious to know more about Enchanted Moors.

Playing digital games is often a solitary activity. However, in our game, players not only have to cooperate as they also have to be in each other's physical presence. One of our objectives was to stimulate social interaction and this objective was attained with 43% of the players as they kept talking for some while with the person that helped them break the Moor's spell. Interaction was mostly with friends and family and at home.

We are currently building a database of several Portuguese legends so that, in addition to the gold coins, the player is also offered a digital book with a legend. As future work we also plan to increase the complexity of the process necessary to save the Enchanted Moor. Players will be required to search and find magic symbols that are hidden in the forest. To win, the player will have to print these symbols that will afterwards be recognized when presenting them to the camera.

4. Role of the Screen

Anonymous author

By inserting real world elements into casual games one of our objectives was to influence the role of the screen as the principal focus of the player's attention. Here we will evaluate how the insertion of each real world element affected the role of the screen, in our games.

Real World Element	**Game**	**Used for**	**Role of the Screen**
Sound	The Castle of Count Pat	Monitor the amount of sound produced by the players	Secondary
EDA	Imaginary Friend	Monitor arousal	Secondary
Player's activities detected with the accelerometer	Imaginary Friend	Distinguish if the user is standing or walking	Secondary
Weather	Weather Wizards	Affect the player's powers	Primary
Video	Enchanted Moor	Detect the number of faces looking at the camera	Primary
Location	Imaginary Friend	Show the place where an emotion cookie was collected	Primary
	Weather Wizards	Show the place where the player is	

Table 4.1: Role of the screen, in consequence of the use of the real world elements.

Table 4.1 shows the role of the screen in consequence of the use of the real world elements in each of the games presented in Chapter 3.

In the case of the Castle of Count Pat (Section 3.1), we resorted to a video projector to show the game's output to players. This projection was the center of the players' attention only during the first moments of the game, while the teacher explained the game to the students and students tried to perceive how the amount of sound they produced influenced the game's character and their score. However, after that, the students mainly focused on their behavior, by telling each other to lower their voices or to keep quiet, with only occasional glances at the projection. The screen, or in this case, the projection, became secondary.

In the Imaginary Friend (Section 3.2), most of the game is influenced by changes in arousal. The screen assumes a secondary role, except when it is necessary to choose an emotion tag on the screen.

The accelerometer is also used in the Imaginary Friend to detect when the player is walking or standing. In games where the accelerometer controls movement in the game the connection to the screen is not broken. It is a form of input different from the keyboard or from buttons displayed on the screen, but still the screen remains the principal focus of attention. In games where the accelerometer is used to detect the player's activities it is possible to influence the game without forcibly looking at the screen.

In the case of Weather Wizards (Section 3.3) the player may decide to play the game according to the weather at the current moment, but after deciding to play, interaction is done looking at the screen. However, the weather did manage to contribute to the fusion between the real world and the imaginary game world, with 57.2% of the players responding that using real weather gave them the feeling that Weather Wizards was influenced by reality (Figure 3.77).

With video, in the Enchanted Moor game (Section 3.4), the screen maintained its prime position as both players have to look at the screen to break the princess's spell. After freeing the enchanted moor a conversation between the player and the person who helped her could ensue, however this socialization was a consequence of the way the game was structured and not part of the gameplay.

As for the player's location, in our games, we used it as an extra to proportionate more realism. In the Imaginary Friend, players can consult the places where the emotion cookies were collected and in Weather Wizards players can consult the names of the places where other players are. However, in other games, location has already proven to be a way to remove attention from the screen such as, for example, in the Capture the Flag game [36], were players move around, with their mobile phones, trying to capture virtual flags.

One can argue here that the real world elements were used mainly as a way to provide input to the games. Can real world elements also be used as a form of output? When real world elements are used as a form of input, changes in the real world element influence the game. Reversely, can changes in the game influence the real world elements? Can real world elements change in consequence of the game? Eventually, if the real world elements provide all the output necessary to play the game, then perhaps the player may avoid the screen totally.

It is possible to play a game without looking at a screen at all. For example, L. Valente et al. [207] created an interesting treasure hunt mobile game for blind users. The game displays nothing on the screen. Output is done by playing audio and by vibrating the phone. The screen was effectively avoided, however, playing a sound or vibrating the phone constitute forms of output that are generated by the phone. This game does not merge with the real world elements that exist, independently, on the player's daily life.

In the Castle of Count Pat we consider that sound produced in the classroom was simultaneously a form of input and output. Sound was a form of output because, in consequence of the game, the students lowered their voices. So the real world element sound, an element that existed in that classroom independently of the game, was changed due to the game (Figure 3.15). And by perceiving, through their hearing sense, that the classroom is more silent students can even bypass looking at the game's projection for they know, according to the game's rules that their score is increasing faster.

Let us now advance to physiological signs, and emotions, two elements of the Imaginary Friend. Can the player's emotions and physiological signs be changed because of what happens in the game? We consider this has been happening since games ever existed. In the thrill of a traditional game of hide and seek the heart races and joy overflows the players when they are winning. In a computer game, when facing a boss fight, aggressiveness and fear peak.

Standing, walking, running, jumping or sitting down are player's activities that can contribute to a game. We resorted to standing and walking in the Imaginary Friend. Besides functioning as input, these activities can also be influenced by the game. For example, if a mobile game is monitoring the number of steps as a way to gauge the player's physical activity then that player may be motivated to further engage in jogging in order to attain a better score in the game. Thus, the player's physical activities, as a real world element, were changed because of the game.

In what concerns the weather, for it to serve as output, weather would have to change according to what happened in the game. For the sake of mentioning a hypothetical situation, if a player obtained a good score, that player would be rewarded with sunshine and a rainbow. Bad performances could result in a thunderstorm above the player's head. None of this seems viable.

With a camera it is possible to capture videos or images from the real world. Following the same line of thinking as the one used for the other real world elements, if a game manages to change what is being acquired by the camera, then that game will have affected the real world element. It thus can be implied that the Enchanted Moor affected the real world by forcing the player not to be alone, which would conduce to a change in what was being acquired by the camera. However, if the player is looking back at the acquired video or image displayed on a screen, then the screen was not defeated. In the event the acquired video or images are not to be shown back to the player, then they have to be communicated, in some other way. For example, by telling the player, via the headphones, who is standing in front of her or by telling her if an object was detected.

As for location, it can be used as output, again following the same line of reasoning, if the player's location or the location of some game related object changes in consequence of the game. This is possible and has already been done. In geocashing players have to search for a hidden object, therefore altering their location. In the Big Urban Game [37] 25 foot game pieces were dislocated, according to the players' votes, through Minneapolis and Saint Paul. Players could even accompany the dislocation of the pieces in person, thus not using a screen.

The games presented in this document are not entirely played without looking at a screen. However, such a complete defeat of the screen was not our objective. We intended to challenge the screen's role as the center of the player's attention. Totally exiling the screen from the game was not the desired outcome.

5. Magic Circle Expansion

Reality is broken, and we need to start making games to fix it.
Jane McGonigal, Reality is Broken

This chapter elaborates on how our pervasive casual games affected the magic circle. However, in the ensuing analysis it is necessary to take into account that the magic circle is a concept hard to define and subject to controversy (Section 2.1), with different authors providing different definitions. Given the diversity of opinions about what exactly the magic circle is, the following discussion is focused on where (Section 5.1), when (Section 5.2) and with whom (Section 5.3) our games are played, for these were the play limits initially proposed by J. Huizinga [1], the inventor of the magic circle concept.

5.1. Space

When J. Huizinga [1] presented the concept of the magic circle, he indicated that games are delimited spatially. For example, in a game of cards the playground is the card table or the surface where the game is being played. So, this card table delimits the game spatially. In the case of hopscotch, the course laid on the ground is a way to separate that space from the ordinary world (Figure 5.1).

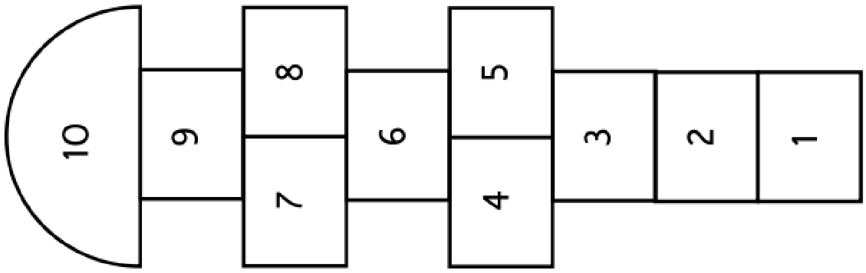


Figure 5.1: Course for a game of hopscotch [208].

Back in the time when J. Huizinga wrote his book, *Homo Ludens* [1], it was still assumed that people had to be in each other's physical presence to play a game. They would gather at the same place and the place where the game occurred would constitute the playground. With the advent of computers and of the Internet, determining the location where a game is played has become more complex because people no longer need to be in each others' physical presence to play together. In a massively multiplayer online role-playing game people of different countries and of different continents can play together. This massively multiplayer online role-playing game occurs on the realm of cyberspace. The playground now becomes a fictional place on the Internet, with no explicit physical boundaries.

In what refers to the spatial limitations of our games we will take into account what are the limits of the playground. It is important here to make a distinction between portable games and the limits of the playground. A game that is being played on a desktop is hardly portable. It is possible to carry the desktop from place to place but it is not practical. A Tetris game played on a mobile phone is portable. Portable games do not even forcibly require digital technology. A deck of cards is portable. A chessboard is portable. Just because the player can easily carry the game around that does not mean that the magic circle has no spatial bounds. Eventually, the magic circle may move around with the player, but have very tight spatial limits. Taking the mobile Tetris example, when the player is interacting with the game, the play activity happens in front of the mobile phone's screen. Let us suppose the player is waiting at the train station and playing a Tetris mobile game to fill the idle time. As the game happens in front of the mobile phone's screen, therefore the magic circle is the close vicinity of the mobile phone. When the train arrives, the player enters it and after sitting down resumes her Tetris game. The magic circle did not stay behind at the train station. It moved with the player and will keep moving around with her as the train advances along the rails. However, this magic circle never changes size and is, in fact, pretty small. A game that utilizes portable devices may or may not have a spatially large magic circle. It depends on the game. In the Tetris mobile game the magic circle is always the little space in front of the mobile phone's screen. A non portable game can do a much better job at enlarging the spatial limits of the playground. That is the case of the Castle of Count Pat.

Games	Where
The Castle of Count Pat	Classroom
Imaginary Friend	Whole world
Weather Wizards	Whole world
Enchanted Moor	Vicinity of the device where the game is played

Table 5.1: Spatial limits.

The Castle of Count Pat ran in a computer in a classroom. It was not designed to be a portable game. The playground is the whole classroom (Table 5.1). This is a much larger space than the confined magic circle in front of the mobile phone in the Tetris mobile game example. In the Castle of Count Pat, everything that happens in the classroom, and more particularly, everything that is prone to make noise becomes part of the game. The magic circle space is not limited to staring at a screen, or in this case, the game's projection. In several cases, the students were not even looking at the projection (Section 3.1) because just by listening they could gauge if they were being excessively noisy.

So, in the Castle of Count Pat the classroom marks the frontier of the magic circle. Eventually, noise produced outside the classroom can also influence the game's score, thus enlarging the magic circle a bit further. However, students may not be able to influence noisy events outside the classroom.

As for the Imaginary Friend, one could argue that it is a portable toy, for it runs in tablet, and consequently the magic circle's spatial limits is the vicinity of the mobile device, but that is not entirely true or even not true at all. The Imaginary Friend is not simply a toy that is carried around. In the Imaginary Friend, when the player collects an emotion cookie that emotion cookie is collected at a certain latitude and longitude and that physical location becomes part of the playground. The Imaginary Friend does not exist independently of the real world, in a separate small bubble, like the Tetris running in a mobile device. The place where the emotion cookie is collected can potentially affect the player's interaction with the toy, with, for example, the player eventually discovering a relation between her emotions and a location. With the emotion castles this connection with the physical space becomes even stronger for to conquer an emotion castle the player has to forcibly collect emotions at the castle's location. Due to this, the Imaginary Friend is more than a portable toy. The Imaginary Friend is a toy where the whole world becomes a playground (Table 5.1).

Weather Wizards is also a game that resorts to mobile phones. How large, spatially, is the magic circle, in this case? Similarly to the Imaginary Friend, Weather Wizards does not exist independently from its surroundings because, in Weather Wizards, the weather at the players' locations influences the outcome of the duels. The weather is part of the playground. Similarly to the Imaginary Friend, Weather Wizards is a game where the whole world is a playground (Table 5.1).

In the Enchanted Moor the spatial limits of the playground are very strict. The game, like typical computer games, is played by looking at a screen. When the player moves away from the screen to search for a helper to free the princess she is still playing the game. However, it is not foreseeable that the player will go very far away from the screen in this search. Therefore, in the Enchanted Moor game the magic circle is spatially limited to the vicinity of the device where the game is being played (Table 5.1).

According to M. Montola et al. [5], spatially expanded games are not limited to a certain physical area and they appropriate the space making it part of the game. How well did our games do according to this definition provided by M. Montola et al. [5]?

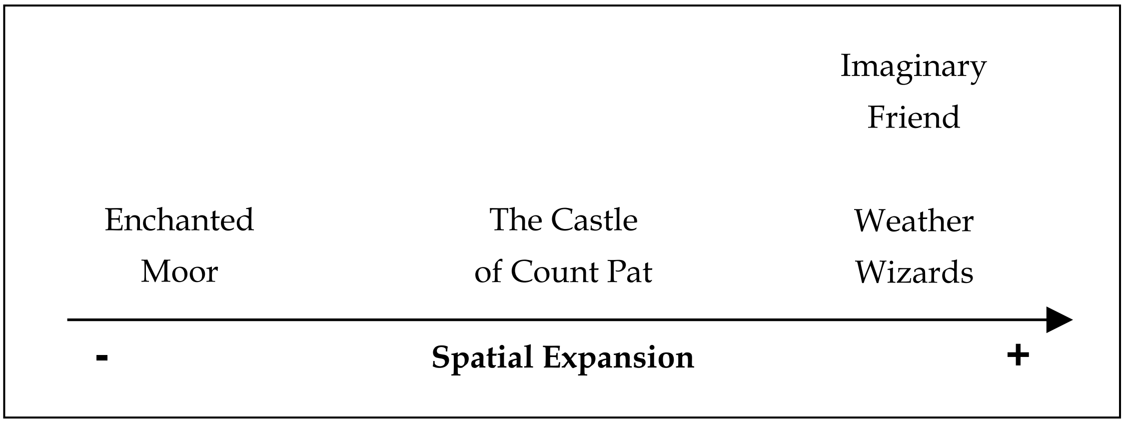


Figure 5.2: Spatial expansion in the proposed games.

The Enchanted Moor provides a very limited spatial expansion (Figure 5.2). The player may step away from the computer screen to find someone to help her save the princess, thus resulting in a slightly spatially enlarged magic circle than the one in a typical videogame where the player sits alone in front of a computer. However, this is very far from being an unlimited playground. In the Enchanted Moor there is also no appropriation of the physical space by the game, except for the modest detail of having to locate a helper.

The Castle of Count Pat does a better job, in comparison with the Enchanted Moor, at expanding the magic circle (Figure 5.2) by the appropriation of the classroom space and of noisy events happening inside it. The acoustical properties of the classroom, the size of the classroom, the way sound propagates in it also influence the outcome of the game. The way the microphone is placed and the way the sound sources are captured have consequences on the score. However, the game is restricted to a physical area. Everything happens inside the confines of a closed space.

In the Imaginary Friend and in Weather Wizards the magic circle is spatially expanded both by the appropriation of the space and by an unlimited playground. In the Imaginary Friend this appropriation is done via the emotion cookies and in Weather Wizards via the weather. Thus, the Imaginary Friend and Weather Wizards are the ones who did better at spatially expanding the magic circle, among the presented games (Figure 5.2).

5.2. Time

According to J. Huizinga [1] play happens inside a time frame. Play starts and then it ends. Games are, according to this viewpoint, ephemeral fantasy worlds. Here we will discuss how our games affected the start and the end of the play activity.

Games	When
The Castle of Count Pat	Lesson
Imaginary Friend	Merges with the player's real life
Weather Wizards	Active gameplay activity interlaced with awareness of the game running in the background
Enchanted Moor	Starts when the player decides to save the princess and ends when the player stops saving princesses

Table 5.2: Temporal limits.

In the Castle of Count Pat the game session lasted for the duration of the lesson (Table 5.2). The game started at the beginning of the lesson, when the teachers explained it to the students and ended at the end of the lesson.

In the Imaginary Friend there is not a defined start and end. This application was designed to merge with the ordinary world with most users finding it easy to conciliate the answers to the Imaginary Friend with their everyday lives (Figure 3.50). Eventually, the virtual companion may stay by the side of the player all the time, with the play activity lasting all the time (Table 5.2). The most active times, in the interaction with this toy, are when collecting emotion cookies, when consulting past emotion cookies and, in case of the implementation of the emotion castles, when fighting for the dominion of a castle. However, even when the player is more actively focused on her daily life, the Imaginary Friend keeps pace by her side, continuously monitoring and aware for possible changes in the electrodermal activity.

In Weather Wizards, there are periods of active play during the duels, or when interacting with the grimoire. The periods of active play can last mere minutes, if the player enters only one duel, or prolong for a long time with the player entering duel after duel. However, changes in the weather provide a stimulus for players to return to the game in order to better adapt their grimoires. So, even when not actively playing, it pays to keep an eye on weather conditions to more effectively choose which spells are active in the grimoire. Keeping an eye on weather conditions constitutes a less active form of gameplay that is, nevertheless, still part of the game (Table 5.2).

The Enchanted Moor is similar to traditional videogames. The game has a well defined start, when the player decides to save the princess, and a well defined end, when the player stops saving princesses (Table 5.2). Even if the player decides to save all the seven princesses, due to the repetitive nature of the process, in principle, gameplay will not go on for several hours.

M. Montola et al. [5], in what regards the time borders of the magic circle, consider, not only, how long play lasts but also how much the player controls whether she is playing or not playing. In a temporally expanded game it is more difficult for the player to choose not to play. The play sessions become so blurred that it is difficult to distinguish when one is playing from when one is not playing, with players rapidly shifting their attention from the game to the real world and vice versa. Even when the player is not interacting actively with the game, still the awareness of the game running in the background remains [5].

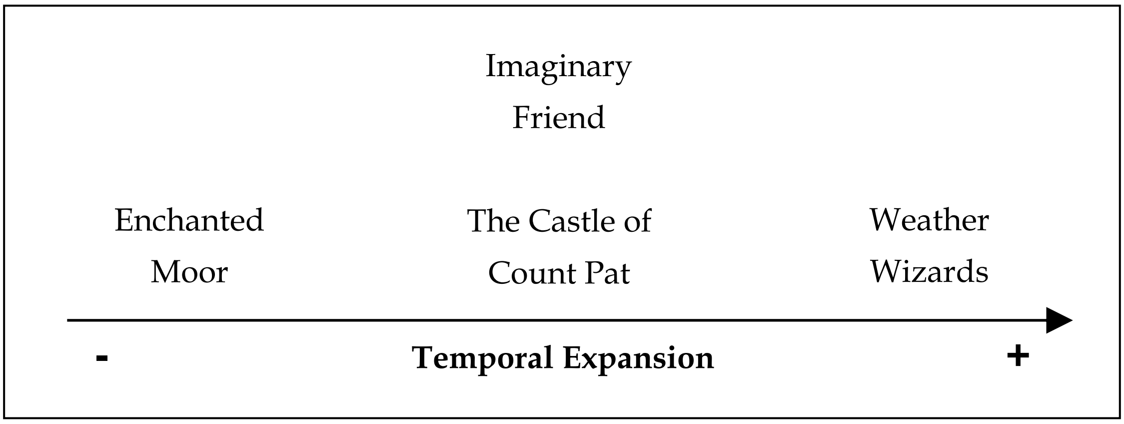


Figure 5.3: Temporal expansion in the proposed games.

According to the criteria proposed by M. Montola et al. [5], the Enchanted Moor is the less temporally expanded of our games (Figure 5.3). Gameplay is temporally limited and the player faces no adverse consequences for choosing not to play.

We consider that the Castle of Count Pat and the Imaginary Friend both equally expanded the temporal limits of the magic circle (Figure 5.3), though in different manners. Both of these games did better, at the temporal expansion of the magic circle, than the Enchanted Moor.

In the Castle of Count Pat it is more difficult for the players to choose not to play. For example, when playing Tetris, even when playing for several hours in a row, the player can pause the game (supposing that the game has a control to pause it) and interrupt the gameplay. The player suffers no adverse consequences for choosing not to play and can resume when she feels like it. In the Castle of Count Pat, if students forget the objective of the game and become too noisy their score lowers. So, even when working on their classroom activities, the awareness of the game remains. It is true that the Castle of Count Pat has a pause button, but this pause button is subject to the authority of the teacher.

The game will run for how long the teacher deems fit and students, the main participants of the game, could not choose to interrupt gameplay of their own accord. Even in the eventuality of the teacher pausing the game, still this results in adverse consequences for the players because, the longer the game is running, the more the score increases, provided that the students lower their voices. When the game is paused, the score does not increase. However, even though students could not decide to interrupt the game, the game lasted only for the duration of the lesson. The moment the students left the classroom clearly demarcated the temporal border of the game.

In the Imaginary Friend the play activity has potential to last longer than in the Castle of Count Pat, with the Imaginary Friend always standing faithfully by the side of the human companion. So, in terms of duration of the play activity, the Imaginary Friend can last for longer than a school lesson. However, the Imaginary Friend did not do as well, as the Castle of Count Pat, in what concerns removing control from the player about when to play and when not to play. The Imaginary Friend decides when to question the human companion about her emotions. The emotion cookies are collected at a certain moment and the jar (Figure 3.33) allows the player to see how her emotions changed through time. Eventually, some players may end up discovering a connection between time and the emotions they are experiencing. However, the player suffers no negative consequences for not answering when the toy solicited her to do so. But, given that the Imaginary Friend is a toy it was not mandatory to have a competitive edge. With the emotion castles, if the player is not zealous of her dominion, by answering to the Imaginary Friend, she may lose her virtual palaces. However, emotion castles are not yet implemented.

In this manner, the Castle of Count Pat is ahead of the Imaginary Friend in what refers to reducing the player's capacity to decide when to play or not. On the other hand, the Imaginary Fried is ahead of the Castle of Count Pat in what refers to the possibility of playing all the time in a way that integrates with the user's daily life.

Weather Wizards is the most temporally expanded of our games (Figure 5.3) because it is both difficult to distinguish when one is playing or not playing and because gameplay can be integrated, continuously, with the player's daily life. In Weather Wizards players profit from keeping an eye on weather conditions and adapt their grimoires accordingly to avoid being reduced to a lackey by another player. Also, a change in weather conditions that favors the spells in player's grimoire is also a motivation to face nearby wizards. Checking the weather, a daily routine to choose what to wear or decide if an umbrella is of use, now also becomes part of the game. If the player is at work and it starts snowing, then activating the snow spell is a wise option. If the player has a strong snow spell then it is also a good time to challenge other players nearby. Thus it becomes more difficult to distinguish if the game is being played or not because even when not engaging actively in duels, still an awareness of the game pays off. Furthermore, the players are also encouraged to meet their masters once a day to receive their daily scholarships and they cannot decide if the master will receive then or not. They just have to keep trying until they succeed. The master pays a certain amount a day. If the player meets with the master after missing a day, the missed day will not be paid. Moreover, a player that does not regularly invest in conquering new lackeys may return to the game, after a period of absent, to discover that all her lackeys were stolen and that her place has plummeted in the lackeys rank (Figure 3.72). So, even when not playing, rivals can rob the player of her vassals' court and the player has no choice to avoid this confrontation.

5.3. Social

Besides the spatial and time separation between play and ordinary life, there is also a social demarcation that differentiates players from non players [1]. Here we will discuss the social limits of our games in terms of who is involved in the game (Table 5.3).

Games	With whom
The Castle of Count Pat	Played by the class
Imaginary Friend	Play activity directly involves the Imaginary Friend's human companion and can be influenced by the user's social activities
Weather Wizards	Played with all the people who are registered in the game
Enchanted Moor	Played by the player and the helper

Table 5.3: Social limits.

In the Castle of Count Pat all the people in the classroom participate in the game. In the Imaginary Friend the play activity involves the human companion directly. However, people with whom the user engages in social contact can influence the play activity according to the emotions they cause the user to feel. Weather Wizards can be played with all the people who are registered in the game. The Enchanted Moor is played by the player and by a helper who may be external to the game, if that helper has never played the game before.

Socially expanded games involve, not only the players of a game, but also people and society outside of the magic circle [5]. Involvement from outsiders can range from mere spectatorship to a full participation in the game. It therefore can become confuse, in a socially expanded game, to differentiate between who is involved in the game and who is not involved in the game. How well did our games do at stimulating outsiders involvement?

In the Castle of Count Pat, there are no outsiders, except in the case that some stranger enters the classroom and that person somehow causes the students to be noisier, consequently affecting the outcome of the game. However, the game merges with the students' social activities. When students lowered their voices because of the game this is an influence in their social activity.

Contrarily to the Castle of Count Pat, in the Imaginary Friend, outsiders can greatly affect the play activity. When receiving a present, the user may feel loved. When studying for a difficult test, the user may feel tired. The person who offered the present and the teacher who scheduled the test are probably oblivious of their influence in the play activity. The Imaginary Friend may also stimulate social activity with other people nearby who notice the projection, become curious and start talking with the user. If several people have Imaginary Friends, then the virtual companions may even suggest meetings between people with similar interests (Section 3.2.8). However, this option for approximating people has not yet been implemented.

In Weather Wizards, one can play with all the others who are registered in the game, but there is no outside participation. To interact with the game the player must firstly register and after that happens she is no longer an outsider, but a part of the game. Some players may boast about their place in the rankings (Figure 3.71 and Figure 3.72) thus turning other people into spectators, and eventually into players, if they become interested in Weather Wizards, but in other games players can also boast about their scores. Weather Wizards also allows people to play with other players from around the world, but this a common feature in massively multiplayer online role-playing games.

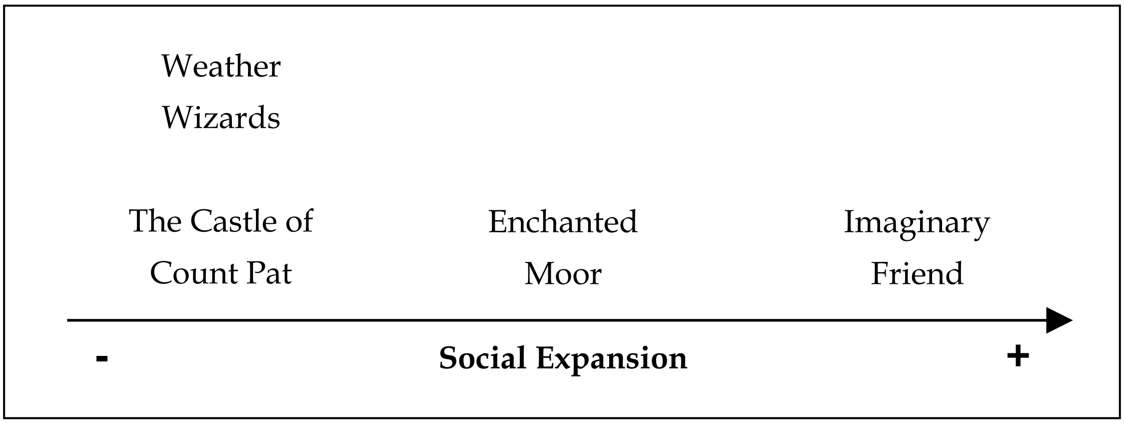


Figure 5.4: Social expansion in the proposed games.

To free the princess, in the Enchanted Moor, a helper is necessary. If this person was not previously acquainted with the game, then this person is an outsider. This outsider becomes an aware participant in the game in contrast to what happens in the Imaginary Friend where social contacts can result in unaware contribution to the game. The game also influenced what several players did afterwards, because they kept talking with the person that helped them free the princess.

As outside participation is important for expanding the social limits of the magic circle [5], we considered that the Castle of Count Pat and Weather Wizards were the ones where the social border was less pushed (Figure 5.4). A person who enters the class, in the Castle of Count Pat, can influence the game and in Weather Wizards players can boast about their rankings, thus resulting in outside participation, but we classified these events as being of little significance.

The Enchanted Moor involved one outsider, so this game did better, according to M. Montola's et al. [5] criteria, with expanding social limits, than the Castle of Count Pat or Weather Wizards (Figure 5.4).

We considered the Imaginary Friend was the one which more greatly expanded the magic circle (Figure 5.4) due to the emotions that resulted from the player's social activities. Outside participation may not be aware, in contrast to what happens in the Enchanted Moor, but the Enchanted Moor is played with only one person. In the Imaginary Friend all the other persons who the user contacts with have the potential to contribute to the play activity. We considered this generalized potential contribution from other people, though possible unaware, was more important and relevant than the contribution of a single helper, in the Enchanted Moor.

6. Integration of Real World Elements and Context Data

Experience is what you get when you didn't get what you wanted. And experience is often the most valuable thing you have to offer.

Randy Pausch, The Last Lecture

A pervasive game, such as the ones proposed in this dissertation, is a subtype of a pervasive computer system, and needs integration with the real world and context data to cater to the user's entertainment needs in an interlaced manner with everyday life. This chapter focuses on the challenges for acquiring context data. According to M. Weiser "*The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it*" [209]. Following the same line of reasoning one could similarly claim that the most profound games are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it. To attain this fusion with everyday life it is necessary for a computer system to be aware of its surroundings. Those surroundings provide the real world contextual information [210].

Context aware computing was defined by Schilit at al. as a system that adapts "*according to the location of use, the collection of nearby people, hosts, and accessible devices, as well as to changes to such things over time. A system with these capabilities can examine the computing environment and react to changes to the environment*" [211].

Human Factors	User
	Social environment
	Task
Physical Environment	Physical Conditions
	Infrastructure
	Location

Table 6.1: Context features [212].

Context is characterized by a set of hierarchical features (Table 6.1). At the top of the hierarchy there is context related to human factors and context related to the physical environment [212]. Human factors related context divides in: user, social environment and task. Physical environment related context divides in: physical conditions, infrastructure and location (Table 6.1). Each of these features can be further divided, if necessary, to better capture the context. For example, light and temperature could be included in the physical conditions category. The data retrieved about these features varies over time, according to the surroundings. For each particular computer system and situation it is necessary to decide on a set of relevant features so that the environment can be adequately captured [212].

Data about the features can be acquired explicitly, by asking the user to enter it, or implicitly, by monitoring the user and computer activity resorting to sensor technology [212].

In the following sections ensues a discussion about the types of context necessary for our games and the feasibility and challenges related to the acquisition of that data, for each real world element. By feasibility it is meant here how likely it is that players will have the necessary technology on their side. As casual players are usually not willing to invest in extra equipment for playing a game [10] we took into account how widespread the devices or functionality necessary to deal with the real world elements are or will be in the near future. Challenges are based on our experience working with the real world elements. These challenges may serve as a source of reflection or as prevention for possible pitfalls for other researchers and game developers. The cases of sound (Section 6.1), physiological data (Section 6.2), accelerometer data (Section 6.3), weather (Section 6.4), video (Section 6.5) and location (Section 6.6) are considered in our analysis.

6.1. Sound

There are various possibilities for dealing with sound, in entertainment. Resorting to speech recognition, identifying the users by the sound of their voice, performing emotion recognition from speech [213], verifying if the user is singing correctly along to a music [214] or even combining sound with a guitar shaped controller [215] are a few possibilities.

In our case, we used sound in the Castle of Count Cat. This type of information is related to human factors and more particularly to the social environment because the amount of noise produced by the students was considered as a manifestation of the students' social interaction in the classroom (Table 6.1). Data about this context feature was acquired implicitly.

In what refers to sound, currently portable computers usually have a built-in microphone and in what concerns mobile phones it will be difficult to find one that does not allow sound capture. So, if a game needs sound input, portable computers and smartphone owners will likely have the necessary hardware on their side. However, more is needed than assuring the player has a microphone available.

One of the issues we had to deal with, in the Castle of Count Pat, was calibration. How much noise is considered excessive noise? To answer this question we computed the average amount of sound, detected by the microphone, in the class, prior to testing the game. Then, together with the teachers, we decided when the amount of sound captured by the microphone was excessive. Our game ran in a portable computer, so deciding where to place the computer was another challenge. We tried several locations in the classroom and asked the students to be quiet or make noise, like talking, clapping their hands or dragging a chair and checked the best place where all those sound sources could be captured. We could have obtained better results if we had used several microphones, instead of just one. However, we kept in mind the requirements of minimal equipment that are coherent with the casual games principles. We thought it would be feasible, in a real world scenario, for a teacher to have a computer and a microphone available in the classroom. Requiring several strategically placed microphones that must be connected to a central computer would be difficult for the teachers to setup and manage in the busy classroom environment where several concurrent events compete for their immediate attention. The game was tested with different groups of students, but always in the same room, and always with the same computer. Different rooms could require different calibrations. Different microphones with different sensitivities could also result in different sound data being acquired.

We were able to prepare for the specific environment where our game would run. However, the same would likely not happen with a game that is deployed on the Internet for a large audience. That game will run in an unknown environment that may range from silent to noisy. If calibration is necessary the players will be alone with the game. Even if the calibration process is somehow fun and easy, still it is an extra barrier between the player and the game world.

Another possible issue is privacy as some players may be afraid of granting access to their microphone. The Castle of Count Pat was tested in the researchers' computer and a previous trust relationship was established with the teachers. However, if players are complete strangers to the developer privacy issues may arise.

6.2. Physiological Signals

As for physiological signals, there are already companies who are commercially investing on selling devices that allow users to obtain this sort of data [216–219]. In a near future this type of devices may be as popular as the Kinect or as the Wii Remote. Eventually, these sensors may become common functionality embedded in other devices like, for example, video cameras and accelerometers are nowadays commonly embedded in smartphones. Physiological data has already been previously used to influence gameplay based on how active players are [44,220].

We resorted to the electrodermal activity, a type of physiological data that belongs to the human factors context type and is specifically related with the user (Table 6.1). Electrodermal activity data was acquired implicitly and was ultimately used to determine the user's emotion, explicitly, via the choice of an emotion tag.

Even though physiological data opens new windows of opportunity for interaction in games, still there are setbacks in using it. Similarly to what happened in audio capture, in the Castle of Count Pat, some calibration or training may be necessary in games that resort to physiological data. Through a survey, in the Imaginary Friend game, we discovered that in a 1 to 5 scale (1 - Never; 2 - Not too often; 3 – Appropriate number of times; 4 – Many times; 5 – Too many times) 54.5% of the players considered they were questioned about their emotions the appropriate number of times. However, 45.5% of the players think they were questioned many times (Figure 3.41). Even though no users reported to be questioned too many times, still, a configurable higher threshold in the variation of the arousal should be available, so that, in the long run, the game does not become annoying for some of the users.

We also encountered some noise problems in the collected physiological data with the Imaginary Friend. For example, there were cases when a player started running or when the ambient temperature would suddenly increase and that resulted in a sudden variation in the arousal, even though the player reported us that her emotions did not change. In this context, those variations were noise.

Privacy may also potentially become an issue. When asked if they would share their answers to the Imaginary Friend with other people (Figure 3.48), 18.2% of the users would share with nobody and 63.6% would share only with friends. We wonder how the general public would react to a game that collected information about their electrodermal activity and how they would feel if that information could be transmitted to a third party.

6.3. Accelerometer Data

Accelerometers are common in smartphones and can be used as game input, for example, to control a game character by tilting the phone or to detect the player's activities. Through the accelerometer it is possible to detect if the user is standing, walking, sitting or jumping [221]. In our case, we resorted to the accelerometer to differentiate between walking and standing, in the Imaginary Friend. The user's activities are a context feature related to human factors and to the task performed by the user (Table 6.1) that was acquired implicitly.

We encountered some inaccuracy problems when distinguishing between walking and sitting. Sometimes, the user would stop walking and the Imaginary Friend would still keep walking for brief moments. However, we considered this a minor problem. Perhaps it even added more believability to the Imaginary Friend because it mimics common human behavior. When two human friends are walking side by side and one of them stops the other does not always stops instantly. After a human friend stops, during a stroll, frequently, the other still takes one or more steps before also stopping. Similarly, the Imaginary Friend may proceed for a couple extra steps before realizing the human companion stopped.

6.4. Weather

Weather Wizards is influenced by the weather at the player's location. The weather at the player's location is, simultaneously, part of the user context data and also part of the physical environment conditions (Table 6.1).

In what refers to using the weather, several problems may arise. To determine the weather, at a specific location, an external provider is necessary. This provider may be down, it may not scale to a large number of users or it may simply go out of business. Paying for the weather information, using a commercial service provider, is an option but it does not absolutely prevent the mentioned problems from occurring. Even when paying, the number of queries answered by the provider may be limited [222] and the cost may be difficult to support for small companies or independent developers.

In Weather Wizards we cached the weather data, but as weather conditions vary through time this cache will be temporary and it will rapidly become outdated. Furthermore, as providers are reached through the Internet, if there is no Internet connection, and the game is dependent on real time weather data, it will not be possible to play. Another problem is accuracy as the weather data may be wrong. If the game is aiming to create a connection with the real world via the weather and the weather data is incorrect that connection is broken.

If the Internet connection is slow, or if the weather provider is slow to respond, then the players may consequently perceive the game as slow or even unresponsive. We feared this might happen in Weather Wizards, but contrary to our initial fears, 71.4% of the players thought the game responded quickly to their actions (Figure 3.81). However, in other sorts of applications, player tolerance to speed may be lower. For example, in WaggleBee, an application where users can send webpages to a group of co-located mobile phones, speed turned out to be one of users' main complaints [223,224]. Nevertheless, even in Weather Wizards, if there is no Internet connection the game does not work because an Internet connection is necessary to retrieve information from the weather provider and to contact the game server where the players' information is stored.

6.5. Video

There are wide possibilities for video in digital entertainment. Using markers, face recognition, expression recognition, recognizing gestures, object recognition or motion detection are just some of them [225–227].

In our game, the Enchanted Moor, we resorted particularly to face detection. This was considered a human factors context feature that is related to the player's social environment (Table 6.1), because the player will have to find and then convince someone to look at the Magic Mirror to save the princess.

In what concerns using video, personal video cameras are becoming quite ubiquitous. Cameras are now common on portable computers and on smartphones, thus providing more ample opportunities for games that resort to video input.

In the Enchanted Moor game, privacy stood out as an issue. After players were asked to fill a survey about the game, that was available on the web, we received emails, read comments on social networks and received survey responses where several players declared they refused to grant access to their cameras. Some users went as far as implying that requiring such permission is an insult. Therefore, even though cameras provide an interesting form of input, perhaps some players need to feel more at ease with allowing a camera to capture their images.

The fact that the game was played on a browser and depended on an Internet connection might have added to this issue because players were aware that parts of the game were remote, stored on a server and outside their control. Even though player images were never transmitted to the server and all image processing was done on the browser, still some players were afraid. Maybe players would be more trustful if they were sure no game data ever went outside their device's local drive.

Another problem is that in wide audience casual games the game developer does not know what sort of capture conditions the game will have to face and recognition of faces or other symbols may be difficult or impossible.

Some games that resort to video cameras also make use of printed markers. This can become a deterrent if the player is not willing to print the marker. Games that are sold in boxes, in retail stores, can avoid this by including the printed markers inside the box, but online games cannot take advantage of this solution.

6.6. Location

Location can be used in entertainment to determine the players' position or the position of digital or real objects. We resorted to location in the Imaginary Friend, to determine where an emotion cookie was collected, and in Weather Wizards, to determine the players' location. In both cases, location was a context feature related to human factors and to the user (Table 6.1).

GPS capabilities are common in current smartphones. It is also possible to determine the player's location, resorting to the Geolocation API Specification, for a device without GPS, but this method is less accurate [228,229]. Even though GPS is more accurate, still, in some places, it is difficult to use it because the GPS signal is blocked by buildings or other natural or human made obstacles.

Knowing the player's location opens opportunities for entertainment but there are also some limitations. If GPS needs to be continuously turned on, for a long play session, the battery will drain quicker. Even with the Geolocation API Specification, and without GPS, an Internet connection is still necessary to determine the user's location.

With the user's latitude and longitude it is then possible to determine the name of the user's location. It looks more appealing, from an entertainment point of view, to tell the user she is in San Francisco, in the United States of America, than to tell her she is at latitude 37.775057 and longitude -122.415848. Knowing the latitude and longitude furthermore allows showing the player's position on a map.

To reverse geocode the player's latitude and longitude or to show the player's position on a map one can resort to an external provider. Similarly to what happens in the case of the weather (Section 6.4), an external dependency is a risk because that provider may be down, there may be a limit to the number of queries the provider answers or the provider may decide to terminate the service. All these are external factors over which the game developer will have little or no control, like in the weather. Even when opting for a commercial solution, still limits in the number of queries may apply [230,231].

In Weather Wizards we cached both the weather data and the coordinates and the names of locations. It is also possible to resort to several providers. That way, if one exceeds the quota or if the provider is down the other may still supply the necessary information. However, if the game becomes very successful and thousands of players are playing it simultaneously, in different parts of the world, caching and resorting to several providers, may not be sufficient to solve the problem, both when dealing with the weather and with location.

Another possible issue, when resorting to the player's location, is privacy concerns. The Imaginary Friend was tested in our own tablet. We appointed with the players and each interacted with the game for a certain amount of time. None of the players complained about the game displaying their collected emotion cookies on a map. Perhaps this happened because, during prior testing, we explained to the players that their anonymized data would only be used for scientific studies.

In the case of our game that revolves around the weather, the player's location is publically indicated in the player's profile. None of the players complained about this. Players of other location based games such as FourSquare [81] or SCVNG [82] do not also seem to mind information about their location being revealed. However, in Weather Wizards, we could see that several players chose profile names that probably do not correspond to their real names. They might have done this because they thought it was fun, but they also could have done it to prevent other people from recognizing them and finding out where they were.

As our weather game is available on Google Play and players were recruited via mailing lists and social networks, one could argue that people who thought the game breached their privacy would just decline to install it. But, in the case of video, players of the Enchanted Moor game were also recruited via mailing lists and social networks. Furthermore, face recognition is done in the browser and the game does not reveal the players' faces to other players. Still, in the Enchanted Moor game we received complaints. This could have happened because in the weather game players felt they could hide under a fake profile name. In the Enchanted Moor game it was more difficult to hide because the player had to show the face, plus the face of another person, to win the game.

7. Conclusions and Future Work

I have no use for people who have learned the limits of the possible.
Terry Pratchett, The Last Hero, Discworld series

Our objective, in this dissertation, was to merge games with the ordinary world in casual entertainment. Departing from this objective, our main research question was formulated: "How is it possible to break the barrier between games and reality?" (Section 1.3). The answer to this question, that constitutes the fulfillment of the initial objective, is approached in Section 7.1. Future work is proposed in Section 7.2.

7.1. How is it possible to break the barrier between games and reality?

To break the barrier between games and reality we firstly devised ways to introduce real world elements in games (Section 7.1.1). Resorting to real world elements we managed to affect the position of the screen as the main focus of attention (Section 7.1.2) and we also managed to push the limits of the magic circle (Section 7.1.3). However, the use of real world elements was constrained by certain technological requirements (Section 7.1.4). The following sections constitute the answers to the four sub research questions that, together, form the answer to the main research question (Section 1.3).

7.1.1. How can real world elements be inserted in casual games?

To break the barrier between games and reality we decided on making use of real world elements. In order to show how real world elements can integrate in the gameplay, four games were developed: the Castle of Count Pat (Section 3.1), the Imaginary Friend (Section 3.2), Weather Wizards (Section 3.3) and the Enchanted Moor (Section 3.4).

The Castle of Count Pat linked to the real world via sound input. The amount of noise produced by the students determined the score of the game. The quieter the students were, the higher the score, because excessive noise results in adverse consequences for both students and teachers.

The Imaginary Friend is for now, a toy, with a prospect of turning into a game via a competition for the rule of emotion castles. The Imaginary Friend makes use of the player's location and activities and, more importantly, of the player's emotions, which play a center role. Changes in arousal are used as an indicator that the user's emotions might have changed thus triggering the interaction with the virtual companion. When there is a sudden change in arousal the Imaginary Friend asks the user what she is feeling. An emotion cookie is afterwards collected and stored inside a jar (Figure 3.33). The player's location also plays a role here because the Imaginary Friend can show a map (Figure 3.36) and a list (Figure 3.35) with the place where each emotion was collected. Contrary to other imaginary friends, who only exist in the dominion of the imagination, this one can be seen, standing by the side of the user. The Imaginary Friend resorts to the player's activities by differentiating when the user is walking from when the user is standing, and mimics both these activities.

In Weather Wizards connection with the real world was made via the weather and via the player's location. In this game players duel each other and their powers may increase or decrease according to the current weather conditions. Each player possesses a grimoire with spells that are connected with a particular weather element. So, for example, if a player possesses a snow spell, that spell will become stronger when it is snowing at the rival's location.

Weather Wizards also shows the name of the place where each player is located.

The Enchanted Moor made use of video. The player and a helper had to join, to look at a magic mirror and save a princess. To detect how many people were looking at the magic mirror we resorted to video capture and face detection.

In the whole, these four games have shown that a connection to the real world can be established via sound, emotions, player's activities, weather, video and location.

7.1.2. How can the player's attention be diverted from the screen?

As a consequence of the inclusion of real world elements, the players' attention will be focused, not only on the screen, but also on what is happening around them.

In the Castle of Count Pat the players' focus was mainly on their behavior and in how much noise they were producing and not on the game's projection. The projection, that in this case replaced the output of the screen, became secondary. Students would occasionally glance at the projection to check their score, but they could gauge, simply by listening, if they were talking too loud.

Weather Wizards, for the most part of the gameplay, although it runs on a mobile phone, puts the screen in the center of the player's attention. Entering a duel, changing the grimoire or checking the ranks are operations that are done by looking at a mobile phone's screen. The weather may serve as a motivator for the player to enter a duel or to change her grimoire. However, when actually fighting the duel, or when buying, updating or activating and deactivating spells in the grimoire all interaction is done by looking at the screen.

In the Imaginary Friend, when collecting an emotion cookie, or when consulting past emotions, it is necessary to look at the screen. However, for most of the time, the screen became secondary, with the toy making part of the user's life, silently monitoring the human companion's EDA and walking when the human companion walks and standing still when the human companion is also standing still.

With the Enchanted Moor, the screen maintained its prime position because both the player and the helper have to look at a screen to save the princess. The player may have to step away from the device, where the game is running, to find a helper. However, for the most part of the game, interaction is done by looking at a screen.

To conclude, in what concerns turning attention away from the screen, positive results were mostly obtained with sound, arousal and the accelerometer because these real world elements where used in such a way that the games merged naturally with the player's everyday activities. With video, weather and location the screen kept its prime position.

7.1.3. How can the magic circle be expanded?

The magic circle marks the limits of the game in terms of where, for how long and with whom the game is played.

In what refers to "where", the Castle of Count Pat is played in the classroom. The Imaginary Friend and Weather Wizards can be played everywhere. The Enchanted Moor is played in the proximity of the device where the game is running.

As for the duration of the play activity, in the Castle of Count Pat is lasts for the duration of the class. In the Imaginary Friend and in Weather Wizards it may last all the time. In the Enchanted Moor the game begins when the player decides to save a princess and ends when she finishes saving princesses.

As for "with whom", the Castle of Count Pat is played by the people inside the classroom. The Imaginary Friend is played directly by the player, but also indirectly by other people who influence the player's emotions. In Weather Wizards one can duel any of the registered players. In the Enchanted Moor the game is played by the player and a helper.

These spatial, temporal and social limits of a game can be considered as expanded. A game's limits may be so expanded that it becomes hard to differentiate between the game and the real world [5].

The Imaginary Friend and Weather Wizards were the most spatially expanded of our games. The Imaginary Friend appropriates space resorting to the location where each emotion cookie is collected. Weather Wizards appropriates space via the place where each player is and the current weather conditions at that place. In both these games the whole world can be transformed into a playground. The Castle of Count Pat appropriated the classroom. The Enchanted Moor, by being played mostly in front of a screen, with a search for a helper, is the least spatially extended of all the games.

In what regards the temporal expansion, Weather Wizards is the more temporally expanded of our games because it is the one where it is more difficult to decide not to play. Play may be motivated by a change in weather conditions, a factor over which the player has no control. Play can also happen all the time, with active periods of gameplay interlaced with a perception of the changing weather conditions on the background. The Imaginary Friend and the Castle of Count Pat did both equally well in expanding the temporal limits, though in different manners. In the Imaginary Friend there is a link between emotion cookies and time, but no penalties for not playing, as it happens in the Castle of Count Pat. In the Castle of Count Pat, students are penalized if they are not constantly aware, even if in a more passive way, of how loud they are speaking. However play is limited to the duration of the class, in contrast to the Imaginary Friend that has potential to fully merge with the player's everyday life. In the Enchanted Moor the duration of play is limited, and the player can easily decide not to play, making this the less temporally expanded of all the games.

The Imaginary Friend is the most socially expanded of our games because it is the one that is more strongly influenced by outsiders. Every person the user meets can eventually influence the game via the emotions they cause the user to feel. The Enchanted Moor scored second, with one external helper being involved. Weather Wizards and the Castle of Count Pat do not involve outsiders making them the less socially expanded of our games.

7.1.4. What are the technological requirements on the player side?

In our games we resorted to several different types of context. The Castle of Count Pat made use of sound, and the Enchanted Moor resorted to face detection, both as a way to capture information related to the social environment of the players. The electrodermal activity was utilized in the Imaginary Friend as a type of physiological data that is related with the user. The user's activities, such as walking or standing, detected via the accelerometer, were another context feature, related to the task performed by the user, that was used in the Imaginary Friend. The weather, in Weather Wizards, was simultaneously, part of the user context data and also part of the physical environment conditions. We resorted to location, both in the Imaginary Friend and in Weather Wizards as a context feature related to the user.

To acquire this context data technological requirements have to be considered on the player side. Casual players are usually not willing to invest in extra or specialized hardware [10]. Consequently, casual games should make use of hardware that will likely be available on the player side.

The technological requirements for dealing with sound, accelerometer data, weather, video and location can easily be fulfilled by casual players. Sound requires a microphone. If the game runs on a smartphone this is not a problem. Current portable computers usually also have an embedded microphone. The accelerometer is commonly available in today's smartphones. Weather data can be retrieved from Internet providers. Current smartphones and portable computers usually have and embedded video camera. For the player's location either a GPS or an Internet connection and the Geolocation API Specification will be necessary.

In what concerns physiological data, several companies are already commercializing devices that acquire it. For now, these devices may not be as popular as mobile phones or portable computers, but in the near future their popularity may increase.

However, working with real world elements poses some limitations such as noise, possible need for calibration, privacy concerns, dependence from an external provider, a slow or inexistent Internet connection or battery drain.

7.2. Future Work

Several directions can be pointed out as future work. We have worked with sound, the electrodermal activity, accelerometer data, weather, video and location. A future challenge would be to integrate, simultaneously, all the real world elements as, for now, the presented games worked with only a subset of the real world elements and not with all of them.

Furthermore, besides the real world elements we have worked with, there are others that could provide interesting possibilities. Other physiological signs such as, for example, the skin temperature or the heart rate could have been used. Voice analysis or facial expression analysis could also provide interesting input for a game. It is also possible to work with a wider range of sensors and devices such as, just for the sake of mentioning a few options, a proximity sensor or a metal detector. Another possibility is to resort to players' social activities, like, for example, family or friends' reunions. As users are often not alone when searching the web on their mobile devices [232], the mobile phones could be used for a game where players compete to be the first one who finds a webpage that shows the correct answer to a quiz question. If grouped in teams, social interactions could contribute greatly to the fun aspect of this hypothetical game [223,224].

More research can also be done in devising more ways of deviating attention from the screen, especially with weather, video and location for those were the real world elements where the screen maintained its prime position, in our games.

Another direction of research would be to work further in order to enhance the spatial, temporal and social expansions, in our games. For example, the Enchanted Moor could be improved in what regards, foremost, the spatial and temporal expansions.

The wall between games and reality can be breached in several manners. We caused some breaks in its structure but there is still plenty of room for causing more fissures. Our aim here was to develop ways of defying this barrier. We did not mean to find all possible ways to connect games with reality. The total number of ways to link the fictional world of games with the real world is limited only by the imagination with the growing support of technological advancements.

Perhaps, in the future, the wall between games and reality is no longer a solid barrier, and it will be reduced to a very porous net, similarly to what happens in Jumanji [233] where, each time the players throw the dice, game characters like elephants, monkeys and birds can actually leave the board game and roam the real world. The reverse could also happen with one of the players being sucked into the game and remaining trapped there for years, in a fictional jungle. Is this too farfetched? The future will tell.

We might even discover that we are ourselves characters inside an holographic game [234]. One anonymous author on the Internet proposes the following hypothesis "*What if déjà vu meant that you lost a life and are starting back up from your last checkpoint?*". It may happen that the game world is closer than we thought and just one step away…

Sofia Reis

8. References

[1] J. Huizinga, Homo Ludens: A study of the play element in culture, Beacon Press, 1955.

[2] K. Salen, E. Zimmerman, Rules of Play: Game Design Fundamentals, MIT Press, 2003.

[3] J. Juul, A Casual Revolution: Reinventing Video Games and Their Players, MIT Press, 2009.

[4] Casual Games Market Report 2007, http://www.casualgamesassociation.org/pdf/2007_CasualGamesMarketReport.pdf (Accessed: 20-Feb-2013).

[5] M. Montola, J. Stenros, A. Waern, Pervasive Games: Theory and Design, Morgan Kaufmann, 2009.

[6] Casual Games Association - Research and News, http://www.casualgamesassociation.org/news.php#casualgames2 (Accessed: 25-Jan-2013).

[7] Casual & Social Games Trend Report - Newzoo, http://www.newzoo.com/trend-reports/casual-social-games-trend-report/ (Accessed: 25-Jan-2013).

[8] Insights on Casual Games, http://blog.nielsen.com/nielsenwire/wp-content/uploads/2009/09/GamerReport.pdf (Accessed: 25-Jan-2013).

[9] S. Reis, Expanding the magic circle in pervasive casual play, in: Proceedings of the 11th International Conference on Entertainment Computing (ICEC'12), Bremen, Germany, Springer-Verlag, 2012, pp. 486-489.

[10] D. Rohrl, 2008 - 2009 Casual Games White Paper - IGDA, http://archives.igda.org/casual/IGDA_Casual_Games_White_Paper_2008.pdf (Accessed: 25-Jan-2013).

[11] J. Juul, The magic circle and the puzzle piece, in: The Magic Circle and the Puzzle Piece, Potsdam, Germany, Potsdam University Pres, 2008, pp. 56-67.

[12] T. L. Taylor, Pushing the Borders: Player Participation and Game Culture, Structures of Participation in Digital Culture, Social Science Research Council, 2007.

[13] M. Nitsche, Growing Game Worlds, Computer Games and New Media Cultures: A Handbook of Digital Games Studies, Springer, 2012.

[14] E. Castronova, Synthetic worlds: the business and culture of online games, University Of Chicago Press, 2005.

[15] K.-P. Huynh, S.-W. Lim, M. M. Skoric, Stepping out of the Magic Circle: Regulation of Play/Life Boundary in MMO-Mediated Romantic Relationship, Journal of Computer-Mediated Communication, 18 (3), Wiley-Blackwell, (2013) 251–264.

[16] M. Copier, Connecting Worlds. Fantasy Role-Playing Games, Ritual Acts and the Magic Circle, in: Changing Views: Worlds in Play: Proceedings of the 2005 Digital Games Research Association Conference, Vancouver, Canada, DIGRA, 2005.

[17] M. Consalvo, There is No Magic Circle, Games and Culture, 4 (4), SAGE Publications, (2009) 408-417.

[18] E. Zimmerman, Jerked Around by the Magic Circle - Clearing the Air Ten Years Later, http://www.gamasutra.com/view/feature/135063/jerked_around_by_the_magic_circle_.php (Accessed: 11-Apr-2013).

[19] C. Magerkurth, A. D. Cheok, R. L. Mandryk, T. Nilsen, Pervasive games: bringing computer entertainment back to the real world, Computers in Entertainment (CIE), 3 (3), ACM, (2005) 4-4.

[20] F. Lantz, A. Bloomberg, K. Boelhauf, D. Crowley, C. Hall, W. Lee, M. Molefe, M. Olson, M. Phalines, M. Romeo, O. Stephensen, P. Thienthong, P. Vigeant, PacManhattan, http://www.pacmanhattan.com/ (Accessed: 25-Jan-2013).

[21] N. Correia, L. Alves, H. Correia, L. Romero, C. Morgado, L. Soares, J. C. Cunha, T. Romão, A. E. Dias, J. A. Jorge, InStory: a system for mobile information access, storytelling and gaming activities in physical spaces, in: Proceedings of the 2005 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology (ACE ’05), Universidade Politècnica de Valencia (UPV), Spain, ACM, 2005, pp. 102-109.

[22] S. Stewart, The A.I. Web Game, http://www.seanstewart.org/interactive/aiintro/ (Accessed: 25-Jan-2012).

[23] C. Magerkurth, M. Memisoglu, T. Engelke, N. Streitz, Towards the next generation of tabletop gaming experiences, in: Proceedings of Graphics Interface 2004 (GI ’04), Ontario, Canada, ACM, 2004, pp. 73-80.

[24] F. Barrenho, T. Romão, T. Martins, N. Correia, InAuthoring environment: interfaces for creating spatial stories and gaming activities, in: Proceedings of the 2006 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology (ACE ’06), Hollywood, United States of America, ACM, 2006.

[25] H. Barbas, N. Correia, Documenting InStory – Mobile Storytelling in a Cultural Heritage Environment, in: First European Workshop on Intelligent Technologies for Cultural Heritage Exploitation, The 17th European Conference on Artificial Intelligence, Riva del Garda, Italy, 2006.

[26] J. Scheible, V. H. Tuulos, T. Ojala, Story Mashup: design and evaluation of novel interactive storytelling game for mobile and web users, in: Proceedings of the 6th international conference on Mobile and ubiquitous multimedia (MUM ’07), Oulu, Finland, ACM, 2007, pp. 139-148.

[27] The Great Scavenger Hunt, http://www.thegreatscavengerhunt.com/ (Accessed: 18-Feb-2013).

[28] M. Struppeek, K. S. Willis, Botfighters - A Game that Surrounds You, Space Time Play: Computer Games, Architecture and Urbanism: The Next Level, Birkhäuser Architecture, 2007.

[29] J. McGonigal, I. Bogost, Cruel 2 B Kind - a game of benevolent assasination, http://www.cruelgame.com/ (Accessed: 18-Feb-2013).

[30] L. Konzack, Larp Experience Design, Lifelike, Projektgruppen KP07, Landsforeningen for Levende Rollespil, 2007.

[31] S. Jaakko, M. Markus, W. Annika, J. Staffan, Play it for Real: Sustained Seamless Life/Game Merger in Momentum, in: The Third Digital Games Research Association International Conference (DiGRA 2007), Situated Play, Tokyo, Japan, DIGRA, 2007, pp. 121-129.

[32] D. Szulborski, This is Not a Game: A Guide to Alternate Reality Gaming, Amazon Digital Services, 2005.

[33] J. McGonigal, Why I Love Bees: A Case Study in Collective Intelligence Gaming, The Ecology Of Games, MIT Press, The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning, 2007.

[34] A. D. Cheok, K. H. Goh, W. Liu, F. Farbiz, S. W. Fong, S. L. Teo, Y. Li, X. Yang, Human Pacman: a mobile, wide-area entertainment system based on physical, social, and ubiquitous computing, Personal and Ubiquitous Computing, 8 (2), Springer-Verlag, (2004) 71-81.

[35] S. Benford, A. Crabtree, M. Flintham, A. Drozd, R. Anastasi, M. Paxton, N. Tandavanitj, M. Adams, J. Row-Farr, Can you see me now?, ACM Transactions on Computer-Human Interaction (TOCHI), 13 (1), ACM, (2006) 100-133.

[36] R. Bernhaupt, S. Jenisch, Y. Keyser, M. Will, Capture the flag: simulating a location-based mobile game using the wizard-of-oz method, in: Proceedings of the International Conference on Advances in Computer Entertainment Technology (ACE ’07), Salzburg, Austria, ACM, 2007, pp. 228-229.

[37] F. Lantz, N. Fortugno, K. Salen, J. Abrams, M. de Laittre, A. Terzich, Big Urban Game – A Playful Connection of the Twin Cities, Space Time Play: Computer Games, Architecture and Urbanism: The Next Level, Birkhäuser Architecture, 2007.

[38] R. A. Ballagas, S. G. Kratz, J. Borchers, E. Yu, S. P. Walz, C. O. Fuhr, L. Hovestadt, M. Tann, REXplorer: a mobile, pervasive spell-casting game for tourists, in: CHI ’07 Extended Abstracts on Human Factors in Computing Systems (CHI EA '07), San Jose, California, United States of America, ACM, 2007, pp. 1929-1934.

[39] T. Martins, R. Nascimento, A. Zingerle, C. Sommerer, L. Mignonneau, N. Correia, Headbang hero, in: Proceedings of the International Conference on Advances in Computer Enterntainment Technology (ACE ’09), Athens, Greece, ACM, 2009, pp. 454-454.

[40] T. Martins, T. Romão, C. Sommerer, L. Mignonneau, N. Correia, Towards an interface for untethered ubiquitous gaming, in: Proceedings of the 2008 International Conference on Advances in Computer Entertainment Technology (ACE ’08), Yokohama, Japan, ACM, 2008, pp. 26-33.

[41] T. Martins, C. Sommerer, L. Mignonneau, N. Correia, Gauntlet: a wearable interface for ubiquitous gaming, in: Proceedings of the 10th international conference on Human computer interaction with mobile devices and services (MobileHCI ’08), Amsterdam, The Netherlands, ACM, 2008, pp. 367-370.

[42] W. Fontijn, P. Mendels, StoryToy - the Interactive Storytelling Toy, in: PerGames 2005: Second International Workshop on Pervasive Gaming Applications, Munich, Germany, 2005.

[43] I. Leite, S. Mascarenhas, A. Pereira, C. Martinho, R. Prada, A. Paiva, ”Why Can’t We Be Friends?” An Empathic Game Companion for Long-Term Interaction, in: 10th International Conference on Intelligent Virtual Agents (IVA 2010), Philadelphia, United States of America, Springer Berlin Heidelberg, 2010, pp. 315-321.

[44] S. I. Hjelm, Research + design: the making of Brainball, Magazine interactions, 10 (1), ACM, (2003) 26-34.

[45] Mindflex, http://mindflexgames.com (Accessed: 19-Feb-2013).

[46] R. L. Mandryk, D. S. Maranan, False prophets: exploring hybrid board/video games, in: CHI '02 Extended Abstracts on Human Factors in Computing Systems (CHI EA '02), Minneapolis, United States of America, ACM, 2002, pp. 640-641.

[47] M. Horn, Z. A. Leong, F. Block, J. Diamond, E. M. Evans, B. Phillips, C. Shen, Of BATs and APEs: an interactive tabletop game for natural history museums, in: Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems (CHI '12), Austin, United States of America, ACM, 2012, pp. 2059-2068.

[48] T. Zhang, J. Liu, Y. Shi, Enhancing collaboration in tabletop board game, in: Proceedings of the 10th asia pacific conference on Computer human interaction (APCHI '12), Matsue, Japan, ACM, 2012, pp. 7-10.

[49] S. Björk, J. Falk, R. Hansson, P. Ljungstrand, Pirates! Using the physical world as a game board, in: INTERACT'01: Proceedings of the 8th IFIP TC 13 international conference on Human-computer interaction, Tokyo, Japan, IOS Press, 2001, pp. 423-430.

[50] N. Paterson, K. Naliuka, S. K. Jensen, T. Carrigy, M. Haahr, F. Conway, Design, implementation and evaluation of audio for a location aware augmented reality game, in: Proceedings of the 3rd International Conference on Fun and Games (Fun and Games '10), Leuven, Belgium, ACM, 2010, pp. 149-156.

[51] A. Macvean, J. Robertson, iFitQuest: a school based study of a mobile location-aware exergame for adolescents, in: Proceedings of the 14th international conference on Human-computer interaction with mobile devices and services (MobileHCI '12), San Francisco, United States of America, ACM, 2012, pp. 359-368.

[52] W. Piekarski, B. Thomas, ARQuake: the outdoor augmented reality gaming system, Communications of the ACM - Internet abuse in the workplace and Game engines in scientific research, 45 (1), ACM, (2002) 36-38.

[53] R. Nóbrega, N. Correia, Photo-based Multimedia Applications using Image Features Detection, in: Proceedings of the 8th International Conference on Computer Graphics Theory and Applications (VISIGRAPP'13), Barcelona, Spain, 2013.

[54] R. Santos, N. Correia, UBI, The Guardian Dragon: Your Virtual Sidekick, in: Proceedings of the 9th international conference on Advances in Computer Entertainment (ACE'12), Kathmandu, Nepal, Springer-Verlag, 2012, pp. 368-383.

[55] EyePet, http://www.eyepet.com/ (Accessed: 19-Feb-2013).

[56] C. Botella, J. Breton-López, S. Quero, R. M. Baños, A. García-Palacios, I. Zaragoza, M. Alcaniz, Treating cockroach phobia using a serious game on a mobile phone and augmented reality exposure: A single case study, Computers in Human Behavior, 27 (1), Elsevier Science Publishers, (2011) 217-227.

[57] A. Kultima, Casual game design values, in: Proceedings of the 13th International MindTrek Conference: Everyday Life in the Ubiquitous Era (MindTrek '09), Tampere, Finland, ACM, 2009, pp. 58-65.

[58] Alexandre Ribeiro, criador do jogo Fangz | Faculdade de Ciências da Universidade de Lisboa, http://www.fc.ul.pt/pt/noticia/07-05-2013/alexandre-ribeiro-criador-do-jogo-fangz (Accessed: 22-May-2013).

[59] Fangz HD - Android Apps on Google Play, https://play.google.com/store/apps/details?id=com.gamewhizzes.fangzHD (Accessed: 22-May-2013).

[60] Fangz HD for iPhone 3GS, iPhone 4, iPhone 4S, iPhone 5, iPod touch (3rd generation), iPod touch (4th generation), iPod touch (5th generation) and iPad on the iTunes App Store, https://itunes.apple.com/us/app/fangz-hd/id632150990?ls=1&mt=8 (Accessed: 22-May-2013).

[61] FarmVille | Zynga, http://company.zynga.com/games/farmville (Accessed: 20-Feb-2013).

[62] Mobile Gaming: Casual Games Sector Report 2012, Casual Games Association, http://dl.dropbox.com/u/3698805/research/2012_CGA_MobileSector.pdf (Accessed: 21-Feb-2013).

[63] Worldwide Smartphone Population Tops 1 Billion in Q3 2012, http://blogs.strategyanalytics.com/WDS/post/2012/10/17/Worldwide-Smartphone-Population-Tops-1-Billion-in-Q3-2012.aspx (Accessed: 21-Feb-2013).

[64] Global mobile statistics 2012 Part A: Mobile subscribers; handset market share; mobile operators | mobiThinking, http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats/a#smartphonepenetration (Accessed: 21-Feb-2013).

[65] P. Farago, The Truth About Cats and Dogs: Smartphone vs Tablet Usage Differences, http://blog.flurry.com/bid/90987/The-Truth-About-Cats-and-Dogs-Smartphone-vs-Tablet-Usage-Differences (Accessed: 21-Feb-2013).

[66] PhoneGap, http://phonegap.com/ (Accessed: 21-Feb-2013).

[67] Adobe PhoneGap Build, http://build.phonegap.com/ (Accessed: 21-Feb-2013).

[68] M. Vakulenko, S. Schuermans, A. Constantinou, M. Kapetanakis, Mobile Platforms: Clash of Ecosystems, Visionmobile, 2012.

[69] M. Vakulenko, [Report] Mobile Platforms: The Clash of Ecosystems | VisionMobile, http://www.visionmobile.com/blog/2011/11/new-report-mobile-platforms-the-clash-of-ecosystems/ (Accessed: 21-Feb-2013).

[70] S. Bicheno, Global Smartphone Installed Base Forecast by Operating System for 88 Countries: 2007 to 2017, https://www.strategyanalytics.com/default.aspx?mod=reportabstractviewer&a0=7834 (Accessed: 12-Feb-2013).

[71] J. Peitz, H. Saarenpää, S. Björk, Insectopia: exploring pervasive games through technology already pervasively available, in: Proceedings of the International Conference on Advances in Computer Entertainment Technology (ACE '07), Salzburg, Austria, ACM, 2007, pp. 107-114.

[72] B. Kirman, C. Linehan, S. Lawson, Blowtooth: a provocative pervasive game for smuggling virtual drugs through real airport security, Personal and Ubiquitous Computing, 16 (6), Springer-Verlag, (2012) 767-775.

[73] A. Park, K. Jung, Flying cake: Augmented game on mobile devices, Flying cake: Augmented game on mobile devices, 7 (1), ACM, (2009).

[74] L.-H. Chen, C.-J. Yu, S.-C. Hsu, A remote Chinese chess game using mobile phone augmented reality, in: Proceedings of the 2008 International Conference on Advances in Computer Entertainment Technology (ACE '08), Yokohama, Japan, ACM, 2008, pp. 284-287.

[75] N. Hajinejad, I. Sheptykin, B. Grüter, A. Worpenberg, A. Lochwitz, D. Oswald, H.-R. Vatterrott, Casual mobile gameplay – On integrated practices of research, design and play, in: Proceedings of the Think Design Play: The Fifth International Conference of the Digital Research Association (DIGRA), Hilversum, Netherlands, 2011.

[76] L. Baillie, L. Morton, D. C. Moffat, S. Uzor, Capturing the response of players to a location-based game, Personal and Ubiquitous Computing, 15 (1), Springer-Verlag, (2011) 13-24.

[77] A. Simon, Social heroes: games as APIs for social interaction, in: Proceedings of the 3rd International Conference on Digital Interactive Media in Entertainment and Arts (DIMEA '08), Athens, Greece, ACM, 2008, pp. 40-45.

[78] A. I. Wang, H. Guo, M. Zhu, A. S. Akselsen, K. Kristiansen, Survey on attitude towards pervasive games, in: Proceedings of the Games Innovations Conference (ICE-GIC), 2010 International IEEE Consumer Electronics Society's, Hong Kong, IEEE, 2010, pp. 1-8.

[79] R. Nabais, Fábrica de Sonhos, http://www.ydreams.com/gestor/contents/aboutusmediainthemedia/12532626186517.pdf (Accessed: 25-Jan-2013).

[80] A. Lapa, YDreams and Mobile Games – a moment in history, http://www.ydreams.com/blog/tag/undercover/ (Accessed: 25-Jan-2013).

[81] Foursquare, https://foursquare.com/ (Accessed: 25-Jan-2013).

[82] SCVNGR, http://www.scvngr.com/ (Accessed: 25-Jan-2013).

[83] GEwar, http://www.gewar.net (Accessed: 25-Jan-2013).

[84] Turf Wars - a GPS Game for the iPhone, http://turfwarsapp.com/ (Accessed: 25-Jan-2013).

[85] GeoGuessr - Let's explore the world!, http://www.geoguessr.com/ (Accessed: 22-May-2013).

[86] Shadow Cities - Magical location based MMORPG for iPhone, iPod touch and iPad, http://www.shadowcities.com/ (Accessed: 22-May-2013).

[87] Ingress, http://www.ingress.com/ (Accessed: 22-May-2013).

[88] Zombies, Run!, https://www.zombiesrungame.com/ (Accessed: 25-Jan-2012).

[89] Sharkrunners Game: Shark Week: Discovery Channel, http://dsc.discovery.com/convergence/sharkweek/shark-runners/help.html (Accessed: 25-Jan-2013).

[90] C. Branton, D. Carver, B. Ullmer, Interoperability standards for pervasive games, in: Proceedings of the 1st International Workshop on Games and Software Engineering (GAS '11), Waikiki, Honolulu, Hawaii, US, ACM, 2011, pp. 40-43.

[91] Y.-N. Chang, R. K. C. Koh, H. B.-L. Duh, Handheld AR games — A triarchic conceptual design framework, in: Proceedings of the 2011 IEEE International Symposium on Mixed and Augmented Reality--Arts, Media, and Humanities (ISMAR-AMH '11), Basel, Switzerland, IEEE, 2011, pp. 29-36.

[92] P. Janne, K. Hannu, S. Hannamari, H. Jussi, Player perception of context information utilization in pervasive mobile games, in: Breaking New Ground: Innovation in Games, Play, Practice and Theory: Proceedings of the 2009 Digital Games Research Association Conference, London, UK, Brunel University, 2009.

[93] M. Montola, A ludological view on the pervasive mixed-reality game research paradigm, in: Journal Personal and Ubiquitous Computing, Springer-Verlag, 2011, pp. 3-12.

[94] B. H. Thomas, A survey of visual, mixed, and augmented reality gaming, Computers in Entertainment (CIE) - Theoretical and Practical Computer Applications in Entertainment, 10 (3), ACM, (2012).

[95] S. Reis, S. Cavaco, N. Correia, Educative Sound Game, in: Proceedings of the 3º Science and Videogames Conference - 2010, Lisbon, Portugal, Portuguese Society for Videogames Science, 2010, pp. 159-164.

[96] S. Reis, N. Correia, The Perception of Sound and Its Influence in the Classroom, in: Proceedings of the 13th IFIP TC 13 International Conference on Human-Computer Interaction - Volume 6946 - Part I (INTERACT'11), Lisbon, Portugal, Springer-Verlag, 2011, pp. 609-626.

[97] P. Nelson, K. Kohnert, S. Sabur, D. Shaw, Classroom Noise and Children Learning Through a Second Language, Language, Speech, and Hearing Services in Schools, 36 , American Speech-Language-Hearing Association, (2005) 219-229.

[98] B. Shield, J. Dockrell, The Effects of noise on the attainments and cognitive performance of primary school children: executive summary, http://www.lsbu.ac.uk/isess/docs/dh_082684.pdf (Accessed: 25-Jan-2013).

[99] R. Walinder, K. Gunnarsson, R. Runeson, G. Smedje, Physiological and psychological stress reactions in relation to classroom noise, Scandinavian Journal of Work, Environment & Health, 33 (4), Nordic Association of Occupational Safety and Health, (2007) 260-266.

[100] I. Enmarker, E. Boman, Noise annoyance responses of middle school pupils and teachers, Journal of Environmental Psychology, 24 (4), Elsevier, (2004) 527-536.

[101] R. Arends, Aprender a Ensinar, McGraw-Hill de Portugal, Amadora, 1995.

[102] R. Alvear, G. Martínez, J. Barón, A. Hernández-Mendo, An interdisciplinary approach to teachers' voice disorders and psychosocial working conditions, International Journal of Phoniatrics, Speech Therapy and Communication Pathology, 62 (1-2), Karger, (2010) 24-34.

[103] N. Roy, R. M. Merrill, S. Thibeault, S. D. Gray, E. M. Smith, Voice disorders in teachers and the general population: effects on work performance, attendance, and future career choices, Journal of Speech, Language, and Hearing Research, 47 , American Speech-Language-Hearing Association, (2004) 542-551.

[104] E. Nerrière, M.-N. Vercambre, F. Gilbert, V. Kovess-Masféty, Voice disorders and mental health in teachers: a cross-sectional nationwide study, BMC Public Health, 9 (370), BioMed Central, (2009).

[105] C. Gassull, C. Casanova, M. Amador, The impact of the reactivity to stress in teachers with voice problems, Folia Phoniatr Logop, 62 (1-2), Karger, (2010) 35-39.

[106] L. Hall, S. Jones, A. Paiva, R. Aylett, FearNot!: providing children with strategies to cope with bullying, in: Proceedings of the 8th International Conference on Interaction Design and Children (IDC ’09), Como, Italy, ACM, 2009, pp. 276-277.

[107] P. Lobo, T. Romão, A. E. Dias, J. C. Danado, A Framework to Develop Persuasive Smart Environments, in: Proceedings of the European Conference on Ambient Intelligence (AmI ’09), Salzburg, Austria, Springer-Verlag, 2009, pp. 225-234.

[108] Bottle Bank Arcade Machine | The Fun Theory, http://www.thefuntheory.com/bottle-bank-arcade-machine (Accessed: 04-Mar-2013).

[109] A. Gustafsson, M. Bång, M. Svahn, Power explorer: a casual game style for encouraging long term behavior change among teenagers, in: Proceedings of the International Conference on Advances in Computer Enterntainment Technology (ACE ’09), Athens, Greece, ACM, 2009, pp. 182-189.

[110] R. N. Madeira, A. Vieira, N. Correia, Personalization of an energy awareness pervasive game, in: Proceedings of the 2012 ACM Conference on Ubiquitous Computing (UbiComp ’12), Pittsburgh, United States of America, ACM, 2012, pp. 619-620.

[111] R. N. Madeira, A. Silva, C. Santos, B. Teixeira, T. Romão, E. Dias, N. Correia, LEY!: persuasive pervasive gaming on domestic energy consumption-awareness, in: Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology (ACE ’11), Lisbon, Portugal, ACM, 2011.

[112] R. Salvador, T. Romão, Let’s move and save some energy, in: Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology (ACE ’11), Lisbon, Portugal, ACM, 2011.

[113] T.-yun Lin, K.-hao Chang, S.-yen Liu, H.-hua Chu, A persuasive game to encourage healthy dietary behaviors of young children, in: Adjunct Proceedings of the 8th international conference on Ubiquitous computing (Ubicomp ’06), California, United States of America, 2006.

[114] C. Soler, A. Zacarías, A. Lucero, Molarcropolis: a mobile persuasive game to raise oral health and dental hygiene awareness, in: Proceedings of the Interna-

tional Conference on Advances in Computer Enterntainment Technology (ACE '09), Athens, Greece, ACM, 2009, pp. 388-391.

[115] T. Bekker, J. Sturm, B. Eggen, Designing playful interactions for social interaction and physical play, Personal and Ubiquitous Computing, 14 (5), Springer-Verlag, (2010) 385-396.

[116] R. Khaled, P. Barr, R. Biddle, R. Fischer, J. Noble, Game design strategies for collectivist persuasion, in: Proceedings of the 2009 ACM SIGGRAPH Symposium on Video Games (Sandbox '09), New Orleans, United States of America, ACM, 2009, pp. 31-38.

[117] R. de Oliveira, M. Cherubini, N. Oliver, MoviPill: improving medication compliance for elders using a mobile persuasive social game, in: Proceedings of the 12th ACM international conference on Ubiquitous computing (Ubicomp '10), Copenhagen, Denmark, ACM, 2010, pp. 251-260.

[118] E. Rosenbaum, E. Klopfer, B. Boughner, L. Rosenheck, Engaging students in science controversy through an augmented reality role-playing game, in: Proceedings of the 8th iternational conference on Computer supported collaborative learning (CSCL'07), New Brunswick, Canada, International Society of the Learning Sciences, 2007, pp. 612-614.

[119] L. Gamberini, L. Breda, A. Grassi, VIDEODOPE: applying persuasive technology to improve awareness of drugs abuse effects, in: Proceedings of the 2nd international conference on Virtual reality (ICVR'07), Beijing, China, Springer-Verlag, 2007, pp. 633-641.

[120] T. Hirsch, Water wars: designing a civic game about water scarcity, in: Proceedings of the 8th ACM Conference on Designing Interactive Systems (DIS '10), Aarhus, Denmark, ACM, 2010, pp. 340-343.

[121] D. Shastri, Y. Fujiki, R. Buffington, P. Tsiamyrtzis, I. Pavlidis, O job can you return my mojo: improving human engagement and enjoyment in routine activities, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10), Atlanta, United States of America, ACM, 2010, pp. 2491-2498.

[122] The World's Deepest Bin | The Fun Theory, http://www.thefuntheory.com/worlds-deepest-bin (Accessed: 04-Mar-2013).

[123] The Speed Camera Lottery | The Fun Theory, http://www.thefuntheory.com/speed-camera-lottery-0 (Accessed: 04-Mar-2012).

[124] G. W. Schmidt, R. E. Ulrich, Effects of group contingent events upon classroom noise, Journal of Applied Behavior Analysis, 2 (3), Society for the Experimental Analysis of Behavior, (1969) 171-179.

[125] H. R. Strang, I. James R. George, Clowning around to stop clowning around: a brief report on an automated approach to monitor, record, and control classroom noise, Journal of Applied Behavior Analysis, 8 (4), Society for the Experimental Analysis of Behavior, (1975) 471-474.

[126] J. W. Groff, Tamperproof classroom noise alarm. United States Patent, Patent number: 4654642, Filing date: Oct 18, 1985, Issue date: Mar 31, 1987, (1987).

[127] ExternalInterface - Adobe ActionScript 3 (AS3) API Reference, http://help.adobe.com/en_US/FlashPlatform/reference/actionscript/3/flash/external/ExternalInterface.html (Accessed: 06-Mar-2013).

[128] E. Hoff, A friend living inside me: The Forms and functions of imaginary companions, Imagination, Cognition and Personality, 24 (2), Baywood Publishing Company, (2005) 151-189.

[129] E. Hoff, Imaginary companions, creativity, and self-image in middle childhood, Creativity Research Journal, 17 (2-3), Lawrence Erlbaum Associates, (2005) 167-180.

[130] D. Pearson, H. Rouse, S. Doswell, C. Ainsworth, O. Dawson, K. Simms, L. Edwards, J. Faulconbridge, Prevalence of imaginary companions in a normal child population, Child: Care, Health and Development, 27 (1), Blackwell Science Ltd, (2001) 13-22.

[131] M. Taylor, S. Hodges, A. Kohányi, The illusion of independent agency: Do adult fiction writers experience their characters as having minds of their own?, Imagination, Cognition and Personality, 22 (4), Baywood Publishing Company, (2003) 361-380.

[132] S. Reis, N. Correia, An Imaginary Friend that Connects with the User's Emotions, in: Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology (ACE'11), Lisbon, Portugal, ACM, 2011.

[133] S. Reis, N. Correia, Encouraging Co-located Players Social Interaction, in: Designing and Evaluating Sociability in Online Video Games - A CHI 2013 Workshop, Paris, France, 2013.

[134] S. K. D'Mello, A. Graesser, Multimodal semi-automated affect detection from conversational cues, gross body language, and facial features, User Modeling and UserAdapted Interaction, 20 (2), Springer Netherlands, (2010) 147-187.

[135] G. Rigas, C. D. Katsis, G. Ganiatsas, D. I. Fotiadis, A User Independent, Biosignal Based, Emotion Recognition Method, in: Proceedings of the 11th international conference on User Modeling (UM '07), Corfu, Greece, Springer-Verlag, 2007, pp. 314-318.

[136] K. H. Kim, S. W. Bang, S. R. Kim, Emotion recognition system using short-term monitoring of physiological signals., Medical & Biological Engineering & Computing, 42 (3), Springer, (2004) 419-427.

[137] E. Hedman, O. Wilder-Smith, M. S. Goodwin, M.-Z. Poh, R. Fletcher, R. Picard, iCalm: Measuring electrodermal activity in almost any setting, in: 3rd International Conference on Affective Computing and Intelligent Interaction and Workshops, 2009 (ACII 2009), Amsterdam, Netherlands, IEEE, 2009, pp. 1-2.

[138] R. Picard, Affective Computing, http://affect.media.mit.edu/pdfs/95.picard.pdf (Accessed: 11-Mar-2013).

[139] M. Drift, A future love story, Emotional Cartography - Technologies of the Self, http://emotionalcartography.net/EmotionalCartographyLow.pdf (Accessed: 11-Mar-2013).

[140] I. Leite, A. Pereira, G. Castellano, C. Martinho, R. Prada, A. Paiva, Closing the Loop: from Affect Recognition to Empathic Interaction, in: Proceedings of the 3rd International Workshop on Affect Interaction in Natural Environments (AFFINE'10), Firenze, Italy, ACM, 2010, pp. 43-48.

[141] B. Kort, R. Reilly, R. W. Picard, An affective model of interplay between emotions and learning: reengineering educational pedagogy-building a learning companion, in: Proceedings of the IEEE International Conference on Advanced Learning Technologies (ICALT 2001), Madison, United States of America, IEEE, 2001, pp. 43-46.

[142] F. Hegel, T. Spexard, B. Wrede, G. Horstmann, T. Vogt, Playing a different imitation game: Interaction with an Empathic Android Robot, in: 6th IEEE-RAS International Conference on Humanoid Robots (Humanoids'06), Genova, Italy, IEEE, 2006, pp. 56-61.

[143] S. G. Pulman, J. Boye, M. Cavazza, C. Smith, R. S. de la Cámara, How was your day?, in: Proceedings of the 2010 Workshop on Companionable Dialogue Systems (CDS '10), Uppsala, Sweden, Association for Computational Linguistics, 2010, pp. 37-42.

[144] R. Bernhaupt, A. Boldt, T. Mirlacher, D. Wilfinger, Using Emotions in Games: Emotional Flowers, in: Proceedings of the International Conference on Advances in Computer Entertainment Technology (ACE '07), Salzburg, Austria, ACM, 2007, pp. 41-48.

[145] F. Kawsar, E. Rukzio, G. Kortuem, An explorative comparison of magic lens and personal projection for interacting with smart objects, in: Proceedings of the 12th international conference on Human computer interaction with mobile devices and services (MobileHCI '10), Lisbon, Portugal, ACM, 2010, pp. 157-160.

[146] A. Greaves, E. Rukzio, View & share: supporting co-present viewing and sharing of media using personal projection, in: Proceedings of the 11th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI '09), Bonn, Germany, ACM, 2009.

[147] W. S. (Florence) Ng, E. Sharlin, Tweeting halo: clothing that tweets, in: Adjunct proceedings of the 23nd annual ACM symposium on User interface software and technology (UIST '10), New York, United States of America, ACM, 2010, pp. 447-448.

[148] P. Mistry, P. Maes, SixthSense: a wearable gestural interface, in: ACM SIGGRAPH ASIA 2009 Sketches (SIGGRAPH ASIA '09), Suntec City, Singapore, ACM, 2009.

[149] G. MacKerron, S. Mourato, Mappiness, the happiness mapping app, http://www.mappiness.org.uk/ (Accessed: 25-Jan-2013).

[150] Glow - How Do You Feel?, http://glowapp.com/ (Accessed: 25-Jan-2013).

[151] K. Church, E. Hoggan, N. Oliver, A study of mobile mood awareness and communication through MobiMood, in: Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries (NordiCHI '10), Reykjavik, Iceland, ACM, 2010, pp. 128-137.

[152] A. Mislove, S. Lehmann, Y.-Y. Ahn, J.-P. Onnela, J. N. Rosenquist, Pulse of the Nation: U.S. Mood Throughout the Day inferred from Twitter, http://www.ccs.neu.edu/home/amislove/twittermood/ (Accessed: 25-Jan-2013).

[153] M. Dawson, A. Schell, F. Diane, Handbook of Psychophysiology, in: Handbook of Psychophysiology, Cambridge University Press, Cambridge, 2000.

[154] PLUX - wireless biosignals, http://plux.info/ (Accessed: 12-Mar-2013).

[155] R. Plutchik, The Nature of Emotions, American Scientist, 89 (4), Sigma Xi, The Scientific Research Society, (2001) 344.

[156] M. Terwogt, J. Hoeksma, Colors and emotions: preferences and combinations, Journal of General Psychology, 122 (1), Taylor & Francis, (1995) 5-17.

[157] N. Kaya, H. Epps, Relationship between color and emotion: A study of college students, College Student Journal, 38 (3), Project Innovation, (2004) 396-405.

[158] Activity | Android Developers, http://developer.android.com/reference/android/app/Activity.html (Accessed: 14-Mar-2013).

[159] SurfaceView | Android Developers, http://developer.android.com/reference/android/view/SurfaceView.html (Accessed: 14-Mar-2013).

[160] Canvas and Drawables | Android Developers, http://developer.android.com/guide/topics/graphics/2d-graphics.html (Accessed: 14-Mar-2013).

[161] J. Benedek, T. Miner, Measuring Desirability: New methods for evaluating desirability in a usability lab setting, www.microsoft.com/usability/uepostings/desirabilitytoolkit.doc (Accessed: 25-Jan-2013).

[162] Galvanic Skin Response for Measuring Emotions | Q Sensor | Affectiva, http://www.affectiva.com/q-sensor/ (Accessed: 06-Jun-2011).

[163] B. Cardoso, T. Romão, N. Correia, CAAT - A Discrete Approach to Emotion Assessment, in: CHI '13 Extended Abstracts on Human Factors in Computing Systems (CHI EA '13), Paris, France, ACM, 2013, pp. 1047-1052.

[164] B. K. Walther, Atomic actions - molecular experience: Theory of Pervasive Gaming, Computers in Entertainment, 3 (3)(2005) 4.

[165] Sharkrunners HQ: Sharkrunners: Shark Week: Discovery Channel, http://dsc.discovery.com/convergence/sharkweek/shark-runners/shark-runners-hq.html (Accessed: 20-Apr-2012).

[166] boktai - The Sun is in Your Hand, http://www.konami.jp/gs/game/boktai/english/game_index.html.

[167] Adaptronic Games «Pervasive Games: Theory and Design, http://pervasivegames.wordpress.com/2009/04/09/adaptronic-games/ (Accessed: 20-Apr-2012).

[168] Microsoft's Peter Molyneux | GamesIndustry International, http://www.gamesindustry.biz/articles/microsofts-peter-molyneux-interview?page=2 (Accessed: 20-Apr-2012).

[169] K. Lund, P. Coulton, A. Wilson, Participation inequality in mobile location games, in: Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology (ACE '11), Lisbon, Portugal, ACM, 2011.

[170] J. Sheldon, J. Perry, E. Klopfer, J. Ong, V. H.-H. Chen, P. W. Tzuo, L. Rosenheck, Weatherlings: a new approach to student learning using web-based mobile games, in: Proceedings of the Fifth International Conference on the Foundations of Digital Games (FDG ’10), Monterey, California, United States of America, ACM, 2010, pp. 203-208.

[171] T. H. Laine, C. I. Sedano, E. Sutinen, M. Joy, Viable and portable architecture for pervasive learning spaces, in: Proceedings of the 9th International Conference on Mobile and Ubiquitous Multimedia (MUM ’10), Limassol, Cyprus, ACM, 2010.

[172] W. Broll, J. Ohlenburg, I. Lindt, I. Herbst, A.-K. Braun, Meeting technology challenges of pervasive augmented reality games, in: Proceedings of 5th ACM SIGCOMM Workshop on Network and System Support for Games (NetGames 06), Singapore, ACM Press, 2006.

[173] J. Krikke, Samurai Romanesque, J2ME, and the battle for mobile cyberspace, IEEE Computer Graphics and Applications, 23 (1)(2003) 16-23.

[174] Weather - FlightGear wiki, http://wiki.flightgear.org/Weather (Accessed: 21-Apr-2012).

[175] The Weather Channel and Skyworks Technologies Launch the First Online Games Featuring Real-Time Weather!, http://press.weather.com/press_archive_detail.asp?id=99 (Accessed: 21-Apr-2012).

[176] P. Yongyuth, R. Prada, A. Nakasone, A. Kawtrakul, H. Prendinger, AgriVillage: 3D multi-language internet game for fostering agriculture environmental awareness, in: Proceedings of the International Conference on Management of Emergent Digital EcoSystems (MEDES ’10), Bangkok, Thailand, ACM, 2010, pp. 145-152.

[177] C. Harteveld, R. Guimarães, I. Mayer, R. Bidarra, Balancing pedagogy, game and reality components within a unique serious game for training levee inspection, in: Proceedings of the 2nd international conference on Technologies for e-learning and digital entertainment (Edutainment’07), Hong Kong, China, Springer-Verlag, 2007, pp. 128-139.

[178] S. Reis, N. Correia, Playing with the Weather, in: Proceedings of the 11th International Conference on Entertainment Computing (ICEC’12), Bremen, Germany, Springer-Verlag, 2012, pp. 172-184.

[179] S. Reis, N. Correia, Weather Wizards - Android Apps on Google Play, https://play.google.com/store/apps/details?id=com.weatherwizards (Accessed: 25-Jan-2013).

[180] S. Reis, N. Correia, Engaging the Players with the Use of Real-Time Weather Data, in: Proceedings of the 4º Science and Videogames Conference - 2011, Porto, Portugal, Portuguese Society for Videogames Science, 2011, pp. 173-179.

[181] S. Reis, T. Romão, N. Correia, Pervasive Play for Everyone Using the Weather, in: Proceedings of the 7th International Conference on Advances in Computer Entertainment Technology (ACE'10), Taipei, Taiwan, ACM, 2010, pp. 104-105.

[182] Weather API: Weather Underground, http://www.wunderground.com/weather/api/ (Accessed: 25-Jan-2013).

[183] The Google Geocoding API - Google Maps API Web Services - Google Developers, https://developers.google.com/maps/documentation/geocoding/ (Accessed: 25-Jan-2013).

[184] SharedPreferences | Android Developers, http://developer.android.com/reference/android/content/SharedPreferences.html (Accessed: 25-Mar-2013).

[185] H. Cramer, M. Rost, N. Belloni, F. Bentley, D. Chincholle, Research in the large. using app stores, markets, and other wide distribution channels in Ubicomp research, in: Proceedings of the 12th ACM international conference adjunct papers on Ubiquitous computing - Adjunct (Ubicomp '10 Adjunct), Copenhagen, Denmark, ACM, 2010, pp. 511-514.

[186] P. Sweetser, P. Wyeth, GameFlow: a model for evaluating player enjoyment in games, Comput. Entertain., 3 (3), ACM, (2005) 3.

[187] J. Nakamura, M. Csikszentmihalyi, The concept of flow, in: Handbook of Positive Psychology, Oxford University Press, 2002.

[188] A. Becam, Designing and Creating Environment Aware Games, in: Proceedings of the Fifth IEEE Consumer Communications & Networking Conference (CCNC 2008), Las Vegas, Nevada, United States of America, IEEE, 2008, pp. 1045 - 1049.

[189] Weddar - How does it feel?, http://www.weddar.com/.

[190] M. D. Griffiths, Computer game playing and social skills: a pilot study, Revista de Psicologia, Ciències de l'Educació i de l'Esport, (27)(2010) 301-310.

[191] E. Zamani, A. Kheradmand, M. Cheshmi, A. Abedi, N. Hedayati, Comparing the Social Skills of Students Addicted to Computer Games with Normal Students, Journal of Addiction and Health, 2 (3-4)(2010) 59-65.

[192] S. Reis, N. Correia, Enchanted Moor, http://schoolofmagic.net/florestamoura.asp (Accessed: 25-Jan-2013).

[193] S. Reis, N. Correia, Co-located Interaction in Casual Games for the Dissemination of Traditional Stories, in: Proceedings of the 5º Science and Videogames Conference - 2012, Lisbon, Portugal, Portuguese Society for Videogames Science, 2012.

[194] A. Parafita, A Mitologia dos Mouros, Gailivro, 2006.

[195] J. L. Vasconcelos, Volume V – Etnologia (Parte I), Imprensa Nacional, Lisboa, 1938.

[196] F. Frazão, Lendas Portuguesas, Amigos do Livro, Lisboa, 1982.

[197] S. C. Barcala, Mitología de Galicia, Los Cuadernos de Urogallo, 2002.

[198] M. Dionisio, V. Nisi, J. P. van Leeuwen, iLand: a tangible location aware narrative experience, in: Proceedings of the fifth international conference on Tangible, embedded, and embodied interaction (TEI ’11), Funchal, Madeira, Portugal, ACM, 2011, pp. 407-408.

[199] D. Djaouti, J. Alvarez, O. Rampnoux, V. Charvillat, J.-P. Jessel, Serious Games & Cultural Heritage: A Case Study of Prehistoric Caves, in: Proceedings of the 2009 15th International Conference on Virtual Systems and Multimedia (VSMM ’09), Vienna, Austria, IEEE, 2009, pp. 221-226.

[200] B. A. Lameman, J. E. Lewis, S. Fragnito, Skins 1.0: a curriculum for designing games with first nations youth, in: Proceedings of the International Academic Conference on the Future of Game Design and Technology (Futureplay ’10), Vancouver, Canada, ACM, 2010, pp. 105-112.

[201] V. Vlahakis, N. Ioannidis, J. Karigiannis, M. Tsotros, M. Gounaris, L. Almeida, D. Stricker, T. Gleue, I. T. Christou, R. Carlucci, Archeoguide - first results of an augmented reality, mobile computing system in cultural heritage sites, in: Proceedings of the 2001 conference on Virtual reality, archeology, and cultural heritage (VAST ’01), Athens, Greece, ACM, 2001, pp. 131-140.

[202] D. G. Aliaga, E. Bertino, S. Valtolina, DECHO—a framework for the digital exploration of cultural heritage objects, Journal on Computing and Cultural Heritage, 3 (3)(2011) 1-26.

[203] Libspark, mash/Marilena - Spark project, http://www.libspark.org/wiki/mash/Marilena (Accessed: 25-Jan-2013).

[204] M. Klingemann, Quasimondo - Mario Klingemann’s Flash Blog: Optimizing Flash Based Face Detection, http://www.quasimondo.com/archives/000687.php (Accessed: 25-Jan-2013).

[205] Britannica, leprechaun (Irish folklore) -- Britannica Online Encyclopedia, http://www.britannica.com/EBchecked/topic/336866/leprechaun.

[206] J. H. Saraiva, História Concisa de Portugal, Publicações Europa-América, Mem Martins, 2007.

[207] L. Valente, C. S. de Souza, B. Feijó, Turn off the graphics: designing non-visual interfaces for mobile phone games, Journal of the Brazilian Computer Society, 15 (1), Sociedade Brasileira de Computação, (2009).

[208] File:HopscotchCourt.svg, http://commons.wikimedia.org/wiki/File:HopscotchCourt.svg (Accessed: 14-Apr-2013).

[209] M. Weiser, The computer for the 21st century, ACM SIGMOBILE Mobile Computing and Communications Review - Special issue dedicated to Mark Weiser, 3 (3), ACM, (1999) 3-11.

[210] A. Schmidt, Context-Aware Computing - Context-Awareness, Context-Aware User Interfaces, and Implicit Interaction, http://www.interaction-design.org/encyclopedia/context-aware_computing.html (Accessed: 01-Jun-2013).

[211] B. Schilit, N. Adams, R. Want, Context-Aware Computing Applications, in: Proceedings of the 1994 First Workshop on Mobile Computing Systems and Applications (WMCSA '94), Santa Cruz, California, United States of America, IEEE, 1994, pp. 85-90.

[212] A. Schmidt, M. Beigl, H.-W. Gellersen, There is more to context than location, Computers & Graphics, 23 (6), Elsevier, (1999) 893–901.

[213] X. Anguera, E. Movellan, M. Ferrarons, Emotions recognition using binary fingerprints, in: Proceedings of Iberspeech 2012, Madrid, Spain, 2012.

[214] SingStar, http://www.singstar.com/ (Accessed: 20-Jun-2013).

[215] Guitar Hero, http://guitarhero.com/ (Accessed: 20-Jun-2013).

[216] Electrodermal Testing & Face Expression Recognition Tools | Affectiva, http://www.affectiva.com/ (Accessed: 25-Jan-2013).

[217] edaPlux | PLUX, http://plux.info/EDA (Accessed: 25-Jan-2013).

[218] Emotiv | EEG System | Electroencephalography, http://emotiv.com/ (Accessed: 25-Jan-2013).

[219] NeuroSky - Brainwave Sensors for Everybody, http://www.neurosky.com/ (Accessed: 25-Jan-2013).

[220] Z. O. Toups, R. Graeber, A. Kerne, L. Tassinary, S. Berry, K. Overby, M. Johnson, A Design for Using Physiological Signals to Affect Team Game Play, in: Proceedings of Augmented Cognition International (ACI ’06), San Francisco, United States of America, 2006.

[221] J. R. Kwapisz, G. M. Weiss, S. A. Moore, Activity recognition using cell phone accelerometers, ACM SIGKDD Explorations Newsletter, 12 (2), ACM, (2011) 74-82.

[222] Weather API: Weather Underground - Pricing, http://www.wunderground.com/weather/api/d/pricing.html (Accessed: 25-Jan-2013).

[223] S. Reis, K. Church, Insights into Co-located Shared Mobile Search, in: CHI “13 Extended Abstracts on Human Factors in Computing Systems (CHI EA”13), Paris, France, ACM, 2013, pp. 1401-1406.

[224] S. Reis, K. Church, N. Oliver, Rethinking Mobile Search: Towards Casual, Shared, Social Mobile Search Experiences, in: Searching 4 Fun! 2012, Barcelona, Spain, CEUR-WS.org, 2012, pp. 1-4.

[225] ARToolKit Home Page, http://www.hitl.washington.edu/artoolkit/ (Accessed: 24-Jun-2013).

[226] OpenCV, http://opencv.org/ (Accessed: 24-Jun-2013).

[227] openFrameworks, http://www.openframeworks.cc/ (Accessed: 24-Jun-2013).

[228] HTML5 Geolocation, http://www.w3schools.com/html/html5_geolocation.asp (Accessed: 25-Jan-2013).

[229] Geolocation API Specification, http://dev.w3.org/geo/api/spec-source.html (Accessed: 25-Jan-2013).

[230] Google Maps API licensing - Google Maps API - Google Developers, https://developers.google.com/maps/licensing (Accessed: 25-Jan-2013).

[231] Yahoo! BOSS Geo Services, http://developer.yahoo.com/boss/geo/ (Accessed: 25-Jan-2013).

[232] K. Church, N. Oliver, Understanding mobile web and mobile search use in today’s dynamic mobile landscape, in: Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services (MobileHCI ’11), Stockholm, Sweden, ACM, 2011, pp. 67–76.

[233] Jumanji directed by Joe Johnston, http://www.imdb.com/title/tt0113497/ (Accessed: 17-Apr-2013).

[234] J. D. Bekenstein, Information in the Holographic Universe, http://www.scientificamerican.com/article.cfm?id=information-in-the-hologr-2003-08 (Accessed: 17-Apr-2013).