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Casual Games with a Pervasive Twist

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Abstract

In this paper we present proposals for including real world elements in games taking into account the profile of casual players. Several real world elements can be utilized so that the fictional game world merges with reality. We focused on sound, video, physiological data, accelerometer data, weather and the player's location. From our experience developing and testing casual games, resulted a set of guidelines that address technological requirements on the player side. These guidelines may be of use for other researchers and developers in order to better adapt games to their audience. By resorting to real world elements, the screen no longer is the only focus of the player's attention because reality also influences the outcome of the game. Results are presented about how the insertion of real world elements affected the role of the screen as the primary focus of the player's attention. Positive results, in what regards defeating the screen, were obtained, mainly, with sound, the electrodermal activity and the accelerometer for these elements were used in such a way that the player's daily activities became part of the game.

Keywords

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

1. Introduction

In digital entertainment, typically, the screen assumes the primary position as the focus of the player's attention. The player sits in front of a screen and that screen is a frontier that clearly separates the real world from the game world. The player is outside and the screen functions as a narrow window through which the game's fantasy world can be visualized. That is not the case of pervasive games. In pervasive games the real world and the game world are no longer two separate dimensions. In pervasive games the real world and the game world come together, the frontier shatters, the real and the imaginary merge and the game is all around the player, fully immersing that player in a fiction that is deeply interlaced with reality. 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*" [1].

Our objective here is to include real world elements in games, in accordance with casual players' requirements. If the real world is part of the gameplay the players' attention will also be focused on what is happening around them thus defying the screen as the exclusive center of attention. Merging casual and pervasive in such a way that games do not cease being casual is an ambitious and difficult objective [2]. Casual games are simple and easy so real world elements must therefore be integrated in a way that is also simple and easy for the player, else the game will not be casual anymore. Furthermore, casual players are usually not willing to invest in expensive or specialized hardware [3]. So, for a casual game with a pervasive twist to be successful, the inclusion of real world elements should make use of capabilities already available in devices like computers, portable computers or mobile phones. Section 3 focuses on sound, video, physiological data, accelerometer data, weather and the player's location as candidate real world elements to insert in games and proposes a set of guidelines about how to merge casual and pervasive. Section 3 also presents our results on how successful each real world element was in diverting the player's attention from the screen. Related work that frames our research is presented in the next section. The conclusions and future work are presented in Section 4.

2. Related work

Here a general overview of pervasive games (Subsection 2.1) and casual games (Subsection 2.2) is presented. Previous efforts to merge these two genres are indicated in Subsection 2.3.

2.1. Pervasive games

Pervasive games are games that merge with real life. In a pervasive game the sacred isolated space where the game happens, the magic circle [4], is expanded spatially, temporally or socially. Non pervasive games are played in a certain place, during a certain time and with certain people. Pervasive games may be played everywhere, all the time and with everybody. A game does not have to equally expand the magic circle spatially, temporally and socially to be pervasive. Some games invest more on only one or two of these expansions [2]. Pac-Manhattan [5], InStory [6] and The Beast [7], are three good examples of pervasive games.

PacManhattan 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 [5].

In InStory [6] users discover Quinta da Regaleira, an extremely 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 [8]. 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 [9]. Players can also upload photographs, videos, sound clips and texts to create their own personalized activities [8]. As InStory is a flexible platform, that supports mobile storytelling, gaming activities and information access [6], 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 [8].

The Beast [7] 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 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.

2.2. 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. Card and puzzle are among the most popular casual games genres [10].

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 interfaces that make use of images and symbols, in detriment of long and fastidious text descriptions [11,12]. 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 [11]. Casual games may offer long term rewards, but short term gratification is essential [3]. As casual games usually run in parallel with the player's other everyday activities the mental engagement necessary to play the game should be low. This means that a casual 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 [11].

According to Jesper Jull [12], casual games may be played for long hours and therefore in a way that is more hardcore than casual. If the casual game is flexible it will allow the player to have a meaningful experience within a short time frame but does not discourage players from investing more time in the game. Usually, hard core 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 hard core way, therefore eventually attracting hard core players.

Casual games are games for the mass consumer [13], so research done in this area will benefit a large number of persons. Casual games are also, from an economic point of view, an interesting area with revenues that, in 2010, amounted to nearly $6.00 billion [14]. Furthermore, according to the Newzoo report [15], 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 [10].

2.3. Casual pervasive games

Some games have already managed to fit both the requirements of casual and pervasive games. In Insectopia [16], 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 [17] also explores the detection of other Bluetooth devices to smuggle drugs. Flying Cake [18] 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 [19]. In the mobile game Cubodo [20] 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 [21]. It is also possible to create casual games that interface with the real world using only a mere PC or portable computer. Social Heroes [22] 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 [23]. These results seem to support the existence of casual games with pervasive components, which were released by companies. Undercover [24,25] 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 [26] and SCVNGR [27] players progress in the game by visiting certain places. In GEwar [28], a web browser game that resorts to Google Earth, players recruit and train armies to capture cities. Turf Wars [29] is a mobile game that also revolves around conquering real world places. In Zombies, Run! [30] players run around trying to escape an horde of zombies while receiving instructions via their headphones. Sharkrunners [31] 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 presents a general reflection about the difficulties for inserting real world elements in games or discusses how the introduction of real world elements affects the position of the screen as the main focus of attention. Branton et al. [32] 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. [33] 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 [34] 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.

3. Inserting real world elements in casual games

This section presents the real world elements we worked with and the way they were inserted into games (Subsection 3.1), guidelines that address constraints for working with real word in games (Subsection 3.2), and results in what refers to diverting the players' attention from the screen (Subsection 3.3).

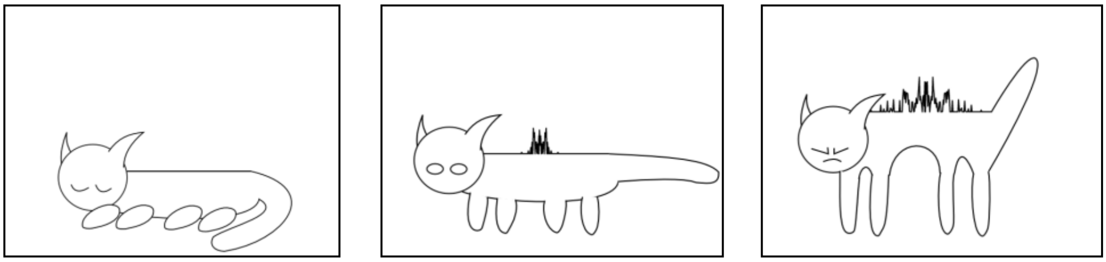
3.1. Real world elements

Here, we propose ways for inserting real world elements in casual games. In the presented analysis the specific cases of sound, video, physiological data, accelerometer data, weather and the player's location are considered.

3.1.1. Sound

We developed a casual game, the Castle of Count Pat [35,36], that resorts to sound capture and that merges seamlessly with the players' natural environment. This game motivates students to make less noise in the classroom because classroom noise is detrimental to students' learning [37,38]. Furthermore, teachers, in consequence of the strain to their voices, may suffer health problems [39].

The Castle of Count Pat shows students, in real time, quantitatively and graphically, the amount of sound in the classroom and runs in a computer that is connected to a video projector so that all students can see the output of the game. The game is populated by characters that enjoy the silence. Fig. 1 shows one of the game's characters reacting to sound. In Fig. 1 (a) the amount of sound detected by the microphone is low, the cat is sleeping very happily, and the score increases. As the amount of sound detected by the microphone increases the cat awakes (Fig. 1 (b)) and the score still increases, but not as much as when the cat is asleep. When the amount of sound detected by the microphone becomes excessive the cat's fur stands on end, the character is angry (Fig. 1 (c)), and the score decreases. The cat's fur integrates the frequency spectrum after a Fourier transform is performed on the sound data. With our game excessive noise can actually be visualized.



(a) Very happy (b) Happy (c) Angry

Fig. 1. A character, in the Castle of Count Pat, reacting to the amount of sound detected by the microphone.

The game was tested with four different classes from an elementary and secondary school. All the classes functioned in the same room. For each of the classes, first, we measured the average amount of sound, during a lesson, without the game, and then we measured the average amount of sound, in another lesson, with the game. The average amount of sound detected by the microphone, during the lessons where the game was tested, lowered in all the classes. In class A there was a 39.6% decrease in the average amount of sound detected by the microphone, and this was the best result across all classes, as can be observed in Table 1. Even though the students in Class D also became quieter, with a 5.3% decrease in the average amount of sound detected by the microphone, this was the class with the smallest decrease. This may be related with the age of the students because some students, in class D, complained that the game's characters where too childish.

Castle of Count Pat game							
Class	**Number of students**	**Grade**	**Age**		**Average amount of sound detected by the microphone**		**Decrease**
			Average	**Range**	**Without the game**	**With the game**	
A	18	8	14.6	12-16	13.9	8.4	39.6%
B	27	9	14	13-17	22.1	16.3	26.2%
C	21	9	15.5	15-17	15.6	12.3	21.2%
D	15	12	17	16-18	15.2	14.4	5.3%

Table 1. Characterization of the classes where the Castle of Count Pat was tested and results in what regards the decrease in the average amount of sound detected by the microphone.

3.1.2. Video

Video input, coupled with face recognition, was used in a game [40,41] 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.

Our game disseminates legends about enchanted moors. Enchanted moors are an intriguing and popular part of the Iberian Peninsula mythology. They are mythical beings who have been trapped by spells, for centuries, in the Iberian Peninsula. According to legend brave heroes who manage to break the spell and free the enchanted moor will be rewarded with vast treasures [42–44].

In our browser game a moor princess, that awaits the player by a cascade, in the middle of a forest, addresses the player and states that she needs two players to look into her mirror so that the spell that traps her may be broken. Through a face recognition algorithm that resorts to an Haar Cascade Classifier [45,46] we know how many players are looking to the mirror. 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 filled with virtual gold coins (Fig. 2).

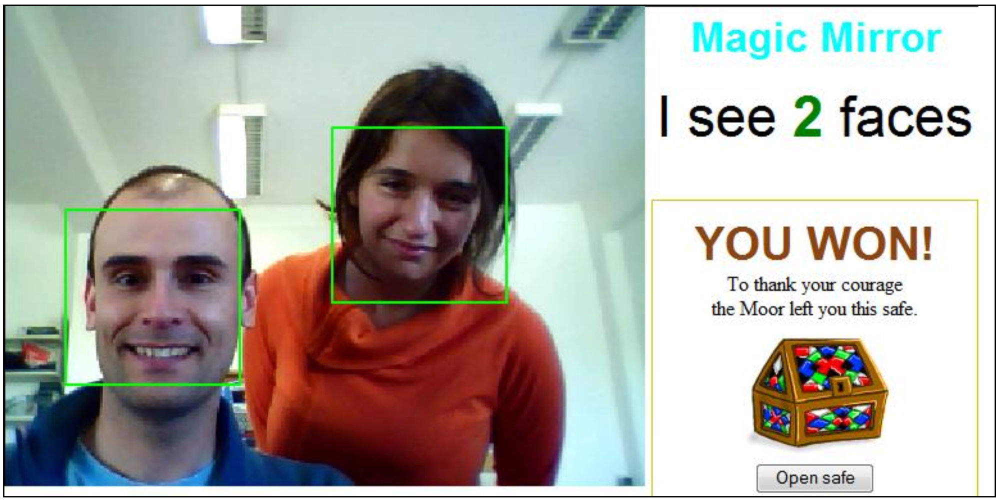


Fig. 2. The magic mirror in the moor princess game.

With our Enchanted Moor game, players cannot win alone and they have to convince someone to help them. To evaluate how successful the Enchanted Moor game was in promoting social contact, we made the game available on the Internet and asked players to fill an online survey. The game was advertized on mailing lists and on social networks. No material rewards were offered for filling the survey or playing the game. Players tested the game, on their own devices, without interference from the researchers. 49 players answered our survey, but 6 answers were discarded because those players did not allow the game to access their camera and without the camera the game cannot be played and consequently evaluated. Therefore, our analysis took into account only the 43 players who turned in valid answers (Table 2).

In what regards promoting social contact, 43% of the players would keep chatting with the person that helped them, after the princess was rescued. Another of the game's objectives was to raise awareness about enchanted moors, as they are a relevant part of the Iberian Peninsula mythology. After playing the game, 58.2% of the players became curious to know more about enchanted moors.

<table>
<tr><th colspan="4">Enchanted Moor game</th></tr>
<tr><td rowspan="10">Respondents characterization</td><td colspan="2">Number of respondents</td><td>43</td></tr>
<tr><td rowspan="2">Age</td><td>Average</td><td>20</td></tr>
<tr><td>Range</td><td>10-35</td></tr>
<tr><td rowspan="3">Gender</td><td>Male</td><td>34.9%</td></tr>
<tr><td>Female</td><td>62.8%</td></tr>
<tr><td>Did not answer</td><td>2.3%</td></tr>
<tr><td rowspan="4">Countries</td><td>Brazil</td><td>46.5%</td></tr>
<tr><td>Portugal</td><td>41.9%</td></tr>
<tr><td>Other countries</td><td>9.2%</td></tr>
<tr><td>Did not answer</td><td>2.4%</td></tr>
<tr><td colspan="3">Percentage of players who maintained social contact</td><td>43.0%</td></tr>
<tr><td colspan="3">Percentage of players who became curios to know more about enchanted moors</td><td>58.2%</td></tr>
</table>

Table 2. Characterization of the respondents to the Enchanted Moor game survey and results in what regards promoting socialization and raising awareness about enchanted moors.

3.1.3. Physiological data

We resorted to physiological data in our game, the Imaginary Friend [41,47], which is about a virtual companion that walks by the side of the player and to whom the player can confide her emotions.

The Imaginary Friend shares a special bond with the user and can feel what the user is feeling. As the user walks around, in her everyday life, she leaves behind emotion cookies. These cookies are invisible to creatures from the real world. However, the digital companion, 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.

The companion is projected on the floor using a pico projector attached to the user’s backpack shoulder strap with tape. When the player looks down the friend is there. The projector is connected to a mobile phone that runs the interactive application. The player also wears a wristband with an electrodermal activity (EDA) sensor. The sensor is connected, with wires, to a PLUX device [48] that transmits the data, via Bluetooth, to the mobile phone (Fig. 3).

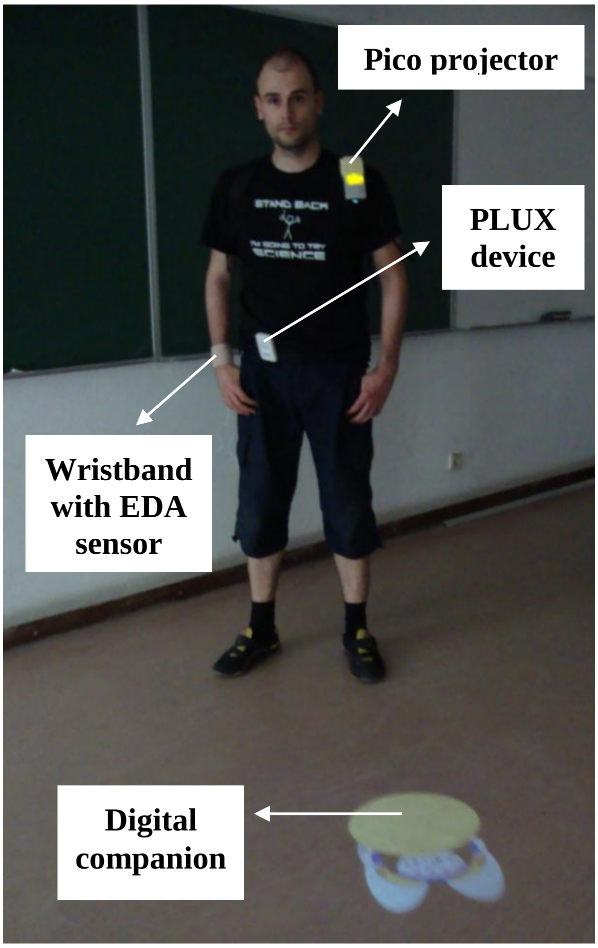


Fig. 3. A player with the digital companion. The mobile phone that runs the interactive application is inside the player's backpack.

Via the electrodermal activity sensor, 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 [49]. 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 companion will pose a question and present several emotion tags, in the mobile phone's screen, corresponding to the following emotions: happy, sad, afraid, angry, annoyed, bored, calm, confused, depressed, distracted, empty, energetic, envious, hopeful, lonely, loved, sick and tired. The phone beeps and vibrates to warn the user that the companion is posing a question.

To choose an emotion tag the user presses the corresponding button on the mobile phone's screen. After the user selects an emotion tag the Imaginary Friend can be seen, on the projection, picking up the corresponding emotion cookie from the ground and storing it inside the jar.

To test the connection between humans and the proposed Imaginary Friend we conducted a survey to 11 players (Table 3). The users were questioned, with a paper survey, after they used the Imaginary Friend application. Typical time usage of the game, by each of the players, could last from half an hour up to an hour. 81.8% of the players reported they felt an emotional attachment with the virtual companion and 91% think that the Imaginary Friend can help them reflect about their emotions and take important conclusions about their lives (Table 4). Thanks to the electrodermal activity indicator, 54.5% of the players thought the Imaginary Friend questioned them the appropriate number of times. However, 45.5% of them thought the application questioned them many times, but no users considered the application excessively intrusive, as none of them responded that the application questioned them too many times (Table 4).

Imaginary Friend game respondents characterization			
Respondents characterization	Number of respondents		11
	Age	Average	36.5
		Range	15-58
	Gender	Male	45.5%
		Female	54.5%

Table 3. Characterization of the respondents to the Imaginary Friend game survey.

Imaginary Friend survey answers					
	1 Strongly disagree	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly agree**
I felt an intense emotional connection with the Imaginary Friend.	0%	0%	18.2%	54.5%	27.3%
The Imaginary Friend can help me think about my emotions and take important conclusions about my life.	0%	9.0%	0%	45.5%	45.5%
	1 Never	**2 Not too often**	**3 Appropriate number of times**	**4 Many times**	**5 Too many times**
How many times did the Imaginary Friend ask you how you were feeling?	0%	0%	54.5%	45.5%	0%

Table 4. Imaginary Friend survey answers.

3.1.4. Accelerometer data

In the Imaginary Friend, previously mentioned in Subsection 3.1.3, we resorted to accelerometer data to determine if the user is walking or standing still. When the user is walking, the companion is also walking beside the user. In the animation of the companion, which is projected on the floor by the side of the user (Fig. 3), the feet move back and forth to convey the impression of a human being walking. The background is black, so that in that area no colors are projected. This way, we tried to create the illusion that the companion is really standing on the floor. When the user stops walking, the companion also stops and looks up to convey that he is paying attention to what the user is doing.

3.1.5. Weather

To test how weather can contribute to entertainment we created a casual game, Weather Wizards [50,51], where the weather is key to the gameplay. In our game 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. The game was implemented as an application for Android mobile phones. Our game is, as far as we know, the first Android native application that resorts to real time weather data.

Our weather related game 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 [52] and the name of the place corresponding to the latitude and longitude of the player's current location was obtained with Google Maps API [53]. Weather Underground's API and Google's Geocoding API are contacted by the server.

In Fig. 4, 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.

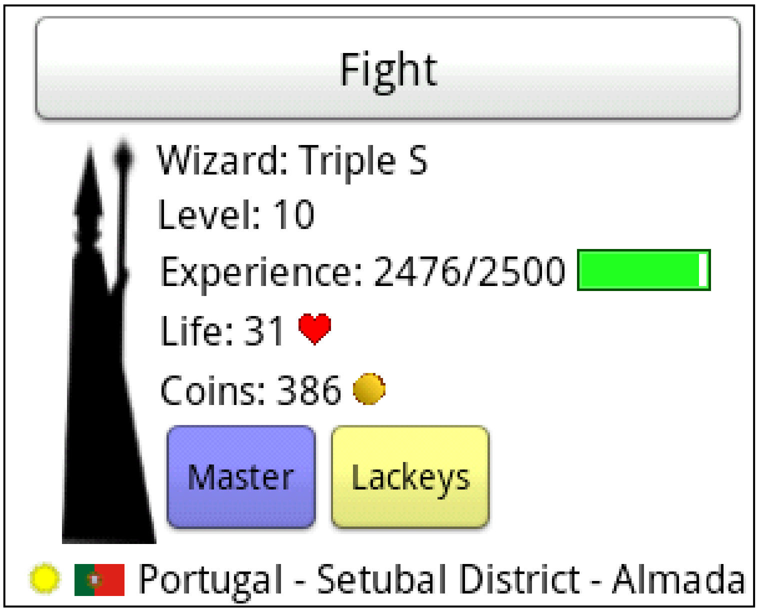


Fig. 4. Player's profile.

If the user presses the Fight button (Fig. 4) a list of possible rivals is presented. The first wizard in the list 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. To start a duel the player chooses an opponent in the duel list and the player's wizard then teleports to the rival's real location. The duel's background shows the weather at the rival's location. In Fig. 5 the wizards are fighting at a location where it is snowing. Wizards may also fight at a place where the sun is shining, at a cloudy location, at a place where it is raining, in the middle of a fog, during a thunderstorm or during a thunderstorm with rain. The player is the black colored figure on the left and the rival is the red colored figure on the right. As the weather displayed is the weather at the rival's location that means that, at the time of the duel, it is snowing at João's location (Fig. 5). 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, will gradually decrease for each successful attack. Eventually, the health of one of the opponents will decrease to zero and the duel ends.

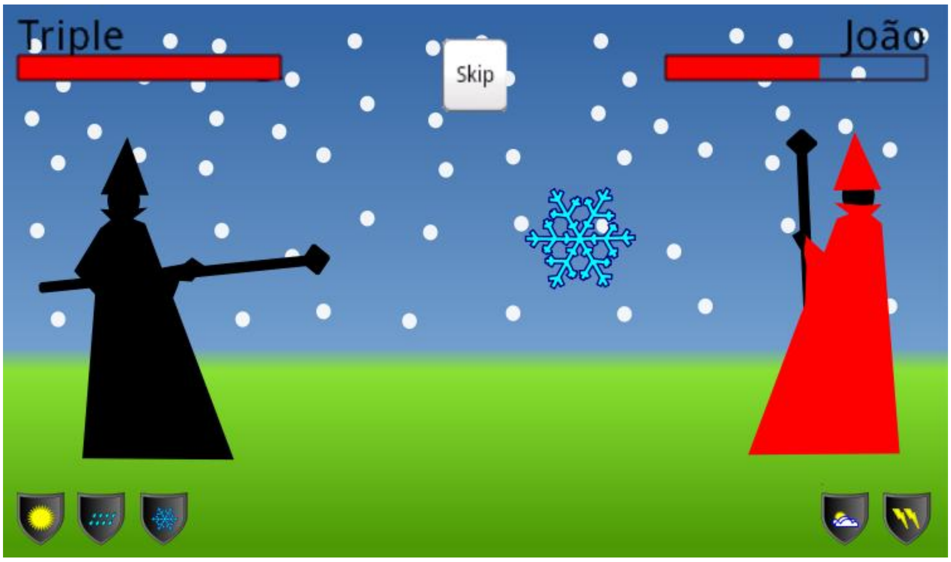


Fig. 5. Duel at a snowy location.

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 with rain. Each of those spells becomes stronger if the weather element it corresponds to is present during the duel. 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. 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.

To evaluate how the use of real weather data contributed to the gameplay we deployed the game on Google Play. The game was advertized on mailing lists and social networks and players tested the game, on their own mobile devices, without interference from the researchers. No material rewards were offered for filling the survey or playing the game. User tests, to 21 players (Table 5), indicated that the weather can contribute positively to the gameplay. 57.2% of the players agree that real weather data made them feel that the game was dependent from the real world and 71.4% thought that using real weather data was fun (Table 6).

<table>
<tr><th colspan="4">Weather Wizards game respondents characterization</th></tr>
<tr><td rowspan="5">Respondents characterization</td><td colspan="2">Number of respondents</td><td>21</td></tr>
<tr><td rowspan="2">Age</td><td>Average</td><td>28.6</td></tr>
<tr><td>Range</td><td>17-37</td></tr>
<tr><td rowspan="2">Gender</td><td>Male</td><td>81%</td></tr>
<tr><td>Female</td><td>19%</td></tr>
</table>

Table 5. Characterization of the respondents to the Weather Wizards game survey.

Weather Wizards survey answers					
	1 Strongly disagree	**2**	**3**	**4**	**5 Strongly agree**
The use of real weather data made me feel that the game was dependent from the real world.	14.3%	9.5%	19.0%	28.6%	28.6%
I think that the use of real weather data was fun.	0%	0%	28.6%	28.6%	42.8%

Table 6. Weather Wizards survey answers.

3.1.6. Location

The player's location was used in two of our previous games. The Imaginary Friend that accompanies the player, previously mentioned in Subsection 3.1.3 and in Subsection 3.1.4, stores the human friend's emotions in the form of emotion cookies. Each emotion cookie corresponds to a specific emotion that is identified with a unique color. The past collected emotion cookies can later be consulted in a map or in a list. We utilized Google's service [53] to display the cookies' position on a map and to indicate the street name next to each emotion cookie in the list. In the case of the game where the weather is key to the gameplay, previously presented in Subsection 3.1.5, the player's location is indicated in the profile (Fig. 4).

3.2. Guidelines

To insert real world elements in games, technological issues will have to be taken into account. How will one acquire those real world elements? What devices will be necessary on the player side? In Table 7, a set of guidelines for inserting real world elements in casual games is presented. Requirements are diverse according to the particular real world element. For each real world element, the feasibility of use is indicated. As causal players are usually not willing to invest in extra equipment for playing a game [3] we took into account how widespread the devices or functionality necessary to deal with the real world elements are. The table addresses possible pitfalls that may arise when using the real world element. These guidelines result from a reflection about real world elements described through Subsection 3.1. Potential risks, and their relation to real world elements, are indicated in Fig. 6.

In what refers to sound, nowadays 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 they may become suspicious. Privacy concerns turned out to be a problem in the case of video capture as will be discussed next.

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 would refuse 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.

Another problem is that in wide audience casual games the game developer does not know what sort of light 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.

As for the physiological signs, nowadays, it is still not common for mobile phones or computers to be equipped with sensors that allow the collection of user physiological data such as, for example, the galvanic skin response, the skin temperature or the heart rate. However, there are already companies who are commercially investing on selling devices that allow users to obtain this sort of data [48,54–56]. In a near future this sort of devices may be as popular as the Kinect [57] or as the Wii Remote [58]. Eventually, these sensors may also become common functionality embedded in other devices like, for example, video cameras and accelerometers are nowadays commonly embedded in smartphones.

Even though physiological data opens new windows of opportunity for interactions in games, still there are setbacks in using it. In the Imaginary Friend, our sensor was connected to a mobile phone and the drain on the battery increased due to the extra processing necessary to acquire and process the data. This is not a concern if the sensors are connected to a console or to a computer which is plugged directly to the power socket. However, in mobile contexts, continuous real time acquiring and processing of sensor data, given the restriction of batteries, is still a problem.

Also, 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 (Table 3), 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 (Table 4). 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.

The Imaginary Friend used a Plux device with an electrodermal activity sensor [48], but personalization according to different users may also be necessary in other types of devices. For example, the headset that reads brain waves, presented by Tan Le [59], needs training prior to its use. After that training users can issue commands such as pull a box or make a box disappear.

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.

As for accelerometers, they are common in today's smartphones and can be used as game input. We resorted to the accelerometer to detect if the player is walking or standing, in the Imaginary Friend. We encountered some inaccuracy problems in the differentiation of these two types of activities. J. R. Kwapis et al. [60] also used accelerometer data to determine if the user is walking, jogging, ascending stairs, descending stairs, sitting or standing and were able to correctly recognize the activity over 90% of the time. However, to achieve this precision, users had to carry the mobile phone in their front pants leg pocket. In the Imaginary Friend players were free to carry the mobile phone however they wanted and in consequence the inaccuracy increased.

Accelerometers can also be used to control movement in a game. In some games for smartphones, players can control the movement of the game character with buttons that are displayed on the screen. These buttons function as an approximation of a physical keyboard, however, contrary to what happens in a physical keyboard, the user does not get the feeling of pressing a button. It is possible, in a button that is displayed in a smartphone's screen, to provide feedback by vibrating the phone or by emitting a sound, but, still, the user does not get the feeling of actually pressing down a button. As an alternative way to move a game character, the accelerometer provides the advantage of saving the space occupied by displaying buttons on the screen.

In what refers to 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 is an option but still paying does not absolutely prevent the mentioned problems for occurring. Furthermore, even when paying the number of queries answered by the provider may be limited [61] 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.

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 [62,63]. 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 risks. 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. With the latitude and longitude it is also possible to show the user’s location 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, an external dependency is a risk because that provider may be down, there may be a limit in 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. Even when opting for a paid solution, still limits in the number of queries may apply [64,65]. Furthermore, in the case of a paid solution, costs could be too heavy for indie developers or for small companies. Even large companies may be reluctant in having their core gameplay dependent on something that is external to them.

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 only by itself may not be sufficient to solve the problem.

Another possible issue 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. However, 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 [26] or SCVNG [27] do not also seem to mind information about their location being revealed. However, in our game, 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. However, 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 on 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 there was no away to hide because the player had to show her face, plus the face of another person, to win the game.

Guidelines for inserting real world elements in casual games			
		Feasibility	**Possible pitfalls**
Real world elements	Sound	✓ All smartphones can capture sound. ✓ Most current portable computers have an embedded microphone.	– Background noise may interfere with the game. – Calibration may be necessary. – Players' may refuse to grant access to the microphone.
	Video	✓ Most current smartphones and portable computers have an embedded video camera.	– In deficient light conditions it may be impossible to play the game. – In case the game requires printed markers players may not be willing to print the marker. – Players may refuse to grant access to the camera.
	Physiological data	✓ There are already several companies that commercialize devices that acquire physiological data.	– If constant real time processing of the physiological data is necessary this may tax the battery of an unplugged device. – Prior calibration or training may be necessary. – Possible noise problems in the acquired physiological data.
	Accelerometer data	✓ The accelerometer is commonly available in current smartphones.	– In case the accelerometer is used to detect the player's activities, such as for example if the player is moving or standing still, possible inaccuracy problems may arise.
	Weather	✓ There are several services on the Internet that provide information about weather conditions for free.	– The provider may be down or may have a limit in the number of queries it answers. – The weather information received from the provider may be wrong.
	Location	✓ Current smartphones usually have GPS. ✓ The player's location can be obtained via the Geolocation API Specification.	– There are areas where it is difficult or impossible to get a GPS signal. – Possible inaccuracy problems. – Monitoring the player's location, during a long play session, increases the battery's drain. – An external provider is generally necessary for reverse geocoding or for displaying the player's position on a map. The provider may be down or may have a limit in the number of queries it answers. – Players may have privacy concerns about revealing their location.

Table 7. Guidelines for inserting real world elements in casual games.

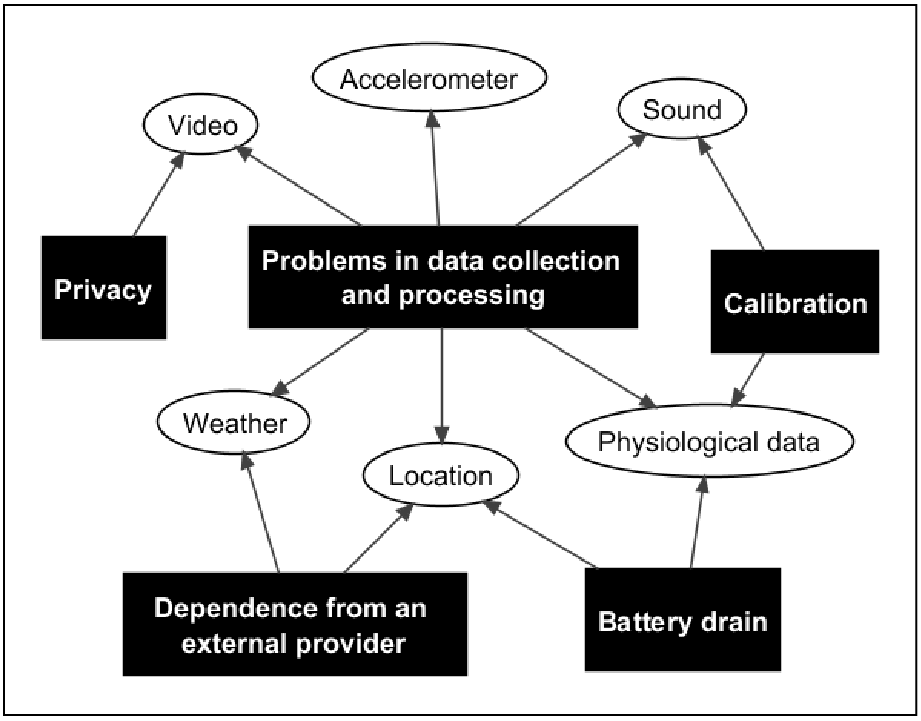


Fig. 6. Potential risks and their relation to real world elements, detected in our games. Risks are represented by rectangles and real world elements by ovals.

3.3. Influence in the role of the screen

By inserting real world elements into casual games one of our objectives was to defeat 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. Table 8 shows the role of the screen in consequence of the use of the real world element in each of the games presented in Subsection 3.1.

In the case of the Castle of Count Pat, 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.

With video, in the Enchanted Moor game, 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.

In the Imaginary Friend, 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 as 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 the weather a partial victory against the screen was obtained as 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 made them feel that Weather Wizards was influenced by reality (Table 6).

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 names of 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 [66] were players move around, with their mobile phones, trying to capture virtual flags.

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

Table 8. Role of the screen, in consequence of the use of the real world element, in the presented games.

4. Conclusions and future work

In this paper our objective was to merge the real world with the fictional games world taking into account the characteristics of casual players. To do this we created games that include real world elements via functionality already commonly available, or foreseeable in the near future, in mobile devices and computers. While working with these real world elements we were confronted with several risks from which resulted a set of guidelines for including pervasive components in casual games. The detected pitfalls can be grouped in the following categories: problems in data collection and processing, calibration, privacy, battery drain and dependence from external providers (Fig. 6).

All the real world elements we worked with could fall prey to problems in data collection and processing. The collected data may be noisy or inaccurate or it may be difficult or impossible to obtain the data.

Another category of difficulties is related to calibration. We encountered the need for calibration when working with sound, in the Castle of Count Pat. It was necessary to decide, together with the teachers, when the amount of sound detected by the microphone was considered excessive. Calibration would also have been useful in the Imaginary Friend because some players thought the virtual companion's questions, triggered by changes in arousal, were too frequent.

We detected privacy concerns when working with video. In the Enchanted Moor, that integrated face detection in the gameplay, we received complaints from players who refused to grant access to the camera.

Battery drain was mostly a problem in the Imaginary Friend because the game required a constant monitoring and processing of the player's arousal and GPS also had to be turned on in order to register the coordinates where an emotion cookie was retrieved.

Another category of problems is related to dependence from an external provider. We became dependent from these external entities, in our games, when obtaining weather data, when reverse geocoding the player's latitude and longitude and when showing the player's position on a map. Extra dependencies are risky for the provider may be down, terminate the service, not be able to scale to the necessary number of queries or the price to pay for the data may be too high.

If reality influences a game, then the players attention will also be focused on what is happening around them, and not only on the screen. In what concerns defeating the screen, as the main focus of the player's attention, positive results were obtained mostly 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. However, the Enchanted Moor game, which made use of video, managed to encourage social collocated interaction. In Weather Wizards weather could function as trigger to play the game. As the player's powers were influenced by meteorological conditions players could decide to play if the current weather favored their spells. Finally, the player's location added more realism to the Imaginary Friend and to Weather Wizards.

As future work, we intend to continue our efforts of merging casual games with the real world. Other real world elements will be considered. We will resort to sensors that measure other physiological input signals such as the skin temperature variation or the abdominal or thoracic respiratory cycles. Speech recognition or object recognition are also other possibilities. Weather elements such as the wind speed, temperature, humidity or the moon phase can also be used.

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