Empirical Validation of the Involvement Component of the Pervasive GameFlow Model

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ABSTRACT

This paper presents an empirical investigation into the question of involvement in pervasive games. The study is motivated by the Pervasive GameFlow model and its involvement component. The main research question is whether aspects of involvement in desktop computer games are also valid for the immersion and enjoyment of players of pervasive games. In order to address this question, two empirical studies were performed: the first explored the possible correlations between several aspects of involvement and the enjoyment and immersion of players. The second compared two versions of an outdoor game, one with and the other without digital augmentations, in order to explore which version provided a higher degree of involvement and enjoyment. The results of these studies suggest that becoming less aware of everyday life is not a relevant aspect of the immersion and enjoyment of players of pervasive games and that there is no significant difference in these elements of the gaming experience (immersion and enjoyment) when comparing the digitally and non-digitally augmented versions of the outdoor game. These results suggest that the involvement experienced by players of pervasive games is not characterised by a sense of being transported into the virtual world of the game; instead, in these types of games the virtual world of the digital application is the one which is drawn out into the physical world. The paper proposes that an embodied view of gameplay can explain these results in a coherent manner.

Categories and Subject Descriptors

K.8 [**Personal Computing**]: Games; H.1 [**Models and Principles**]: User Machine Systems—*Human Factors*

General Terms

Human Factors

Keywords

Pervasive & Ubiquitous Games, Flow, Immersion, Embodiment

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1. INTRODUCTION

Pervasive games merge the benefits of computer-based games with "normal" outdoor games. These games could use ambient, pervasive or ubiquitous technologies to, for example, enable players to transform a simple hide-and-seek into a complex adventure game that provides rules, a scenario and emerging objectives with the aid of a mobile phone on top of the imagination and physical activity of the participants. A crucial question in this context is how the enjoyment of players is affected by such augmentations. According to the literature of the area, an analysis of player enjoyment has to take into account several factors [15, 10]. A particularly interesting factor for pervasive games is the player's degree of involvement in the game. For example, when analysing enjoyment in desktop games, a high degree of involvement, to the point of gamers losing awareness of everyday life, has been considered as desirable [15]. It is not clear whether this should be the case for pervasive games. In desktop environments, the game is neatly encapsulated within the boundaries of the virtual world, and while interacting with the game, contact with the physical world can be minimised. In pervasive games this is not the case; the game has expanded so that it includes elements of the virtual and the physical worlds, and therefore interacting with it has to take those worlds into account. Therefore, in this context, the nature of involvement and other associated concepts such as flow and immersion needs to be revisited and contrasted with those of traditional environments.

This paper addresses the question of involvement in pervasive games empirically. It reports on two empirical studies that explored whether the notion of involvement as understood in traditional desktop games can be valid for pervasive games. In order to perform this exploration, the involvement component of a model of player enjoyment specific to pervasive games, the Pervasive GameFlow (PGF) model [10], was adopted as the criteria to define involvement in this context. Therefore, the empirical studies reported in this paper aimed to validate some aspects of the PGF model; to our knowledge, there are no other studies pursuing this endeavor.

The first study explored the possible correlations between several aspects of involvement and both the enjoyment and immersion of players. The second compared two versions of an outdoor game, one with and the other without digital technology augmentations, in order to explore whether the latter version, by not requiring players to switch between the

virtual and physical worlds, could provide a higher degree of involvement and enjoyment.

The paper comprises six sections; the second section provides a brief overview of pervasive games and player experience, focusing on enjoyment and involvement; the third section introduces the two empirical studies and describes their common features; the fourth and fifth describe the empirical studies and finally, the sixth presents a global discussion and conclusions.

2. PERVASIVE GAMES AND PLAYER EXPERIENCE

Player experience has been typically studied in traditional desktop games, similar studies in pervasive gaming are much less frequent. A crucial question is how the pervasive elements of this type of gaming affect the player's experience. This section describes a few central concepts of pervasive games to illustrate the differences between this gaming genre and traditional desktop gaming.

Pervasive games are sometimes known as urban street games, spatially expanded games or location-based games. Unlike traditional video games, they often engage the user in games away from the desktop computer or have other aspects of the game that pervade into the real world. Also, unlike normal video games, where the user interface is likely to consist of hardware (such as controllers), and visual elements of the software, pervasive games might use alternative user interfaces and make more use of the world around. Although the game is still inherently digital in its structure, the visual representation of the game world is no longer dominated by the screen [14].

Pervasive games can be categorised into treasure hunts, assassination games, pervasive larps and alternative reality games [13]. Treasure hunts is the oldest and most well-known type of pervasive game. In treasure hunts players try to find certain objects, typically in an unlimited game space. Global Positioning System (GPS) technology has made treasure hunts more accessible, as players can use mobile phones to help with the search.

In assassination games players chase and try to eliminate other players from the game world. Players take turns to play the roles of hunter and victim. Even as a victim, players can outwit and eliminate the hunter from the game world. Pervasive larps are role-playing games similar to improvisational theatre but the boundaries of the stage are expanded and frequently comprise public urban areas such as city streets. Alternate reality games superimpose fictional narratives into the world of everyday life. These narratives are interactive so player's input influences the story. Alternate reality games employ the internet as the central communication medium but can also use telephone, post and other media. In this way, people can experience a story as one of the characters in it, using media and devices that they commonly use to interact with the world of everyday life.

As pervasive games are a fairly new game genre, it can be challenging for game designers to tell what will make a game enjoyable and what will affect immersion. The next section will discuss player experience, immersion and the Pervasive GameFlow model, a model for player enjoyment in pervasive games.

2.1 Pervasive GameFlow and Immersion

Two important concepts in the study of enjoyment and involvement in video game research are flow and immersion. Flow is a term used to describe a psychological state of optimal experience. An important aspect of this state is precisely a high level of involvement characterised by a deep and effortless concentration in the task at hand [6]. Although originally developed in Psychology, it has been adapted into a number of fields. In computer gaming research, a popular interpretation of the flow concept has been the GameFlow model [15]. More recently, the Pervasive Gameflow model [10] has been developed as an adaptation to the GameFlow model for the pervasive gaming context.

Immersion is a term that originated in the gaming area and that can be used to describe the degree of involvement with a computer game [3, 11]. This degree of involvement can be superficial (engagement), deep (engrossment), or total (being cut-off from reality). The following subsections describe these concepts in more detail.

2.1.1 Flow in Games

Computing studies of flow have suggested that players of desktop computer games frequently achieve a state of flow, such as when using multi-user dungeons (MUDs) [16] or when playing games created specifically to study the concept [4]. A widely accepted interpretation of the flow concept for computer games is the GameFlow model by Sweetser and Wyeth [15], which was formulated analytically based on the elements of flow which were adapted to the gaming context. This adaptation resulted in eight elements, each of them comprising a set of criterium intended to achieve enjoyment in games. The elements of the GameFlow model are presented in Table 1.

Table 1: Elements of the GameFlow model, adapted from [15].

Concentration	Games should require concentration and the player should be able to concentrate on the game.
Challenge	Games should be sufficiently challenging and match the player's skill level.
Player Skills	Games must support player skill development and mastery.
Control	Players should feel a sense of control over their actions in the game.
Clear Goals	Games should provide the player with clear goals at appropriate times.
Feedback	Players must receive appropriate feedback at appropriate times.
Immersion	Players should experience deep but effortless involvement in the game.
Social Interaction	Games should support and create opportunities for social interaction.

The use of the word "immersion" in the GameFlow model is potentially confusing in the context of this paper as it does not necessarily refer to the same term as the immersion concept [3]. In order to avoid this confusion, in this paper we will refer to the immersion component in the GameFlow model (and in the Pervasive GameFlow model) as "involvement" and will use the word "immersion" to refer to the

Table 2: Involvement component of the PGF model, adapted from [10].

Criteria
1. Players should become less self-aware and less worried about everyday life or self.
2. Players should experience an altered sense of time.
3. Players should feel emotionally and viscerally involved in the game.
4. Pervasive games should support a seamless transition between different everyday contexts, and not imply or require player actions that might result in a violation of social norms in everyday contexts.
5. Pervasive games should enable the player to shift focus between the virtual and physical parts of the game world without losing too much of the feeling of immersion.

immersion construct.

Jegers [10] followed on from Sweetser and Wyeth's [15] work by using an analytical approach to adapt the criterium of the different components of the GameFlow model to the nature of pervasive games. The resulting Pervasive GameFlow model includes the same elements presented in Table 1, but the criteria for each of them is slightly different. We present the desired criteria for their involvement component of the PGF model in Table 2. We decided not to include the criterium for the other components as it was not considered germane to the argument of the paper.

2.1.2 Immersion

Brown & Cairns [3] used a grounded theory method to understand what players mean when they refer to being immersed in a game. The study of immersion was continued with a series of experimental approaches [11] in order to formulate and validate the different dimensions of immersion. The results of their studies suggest that immersion can be objectively and subjectively studied, but furthermore, unlike flow, they also found that immersion is not necessarily a consequence of a positive experience.

They define immersion as different from flow: "flow has some parallels with immersion in the fact that attention is needed, sense of time is altered, and sense of self is lost." [3]. And actually, Jennett et al. [11] define immersion as a precursor to flow. The characteristics of immersion are defined as "immersion requires concentration, a sense of challenge, control over the game and finally, emotional involvement and real world dissociation" [11].

Although different concepts, it seems that flow as defined by Sweetser and Wyeth [15] and Jegers [10] and immersion both include similar elements that could be related to involvement. Therefore, the empirical studies reported here compare and contrast the involvement aspects of flow and immersion. As the empirical studies employ a pervasive type of game, this comparison is made using the involvement component of the PGF model.

3. VALIDATING INVOLVEMENT IN THE PGF EMPIRICALLY

To validate the involvement component of the PGF model we designed two experiments. The first experiment is aimed at addressing the criterium 1 to 3 presented in Table 2; the second experiment addresses criteria 5, while data for criteria 4 was collected qualitatively in both experiments.

In experiment 1, participants were asked to play a pervasive game and then evaluate their experiences using the immersion questionnaire developed by Jennett, et al. [11] and the flow questionnaire developed by Delle Fave and Massimini [7]. We also looked at the correlation between some aspects of involvement in those questionnaires (particularly those related with players losing awareness of everyday life) and their overall scores to have a sense of the relevance of those involvement aspects for immersion and flow in the context of pervasive games.

In experiment 2, we asked participants to play the pervasive game and a "non-technological" version of the game and to complete the same questionnaire as in experiment 2. We compared the results for each game to find out whether there was a change in the level of involvement due to the use of technology. In other words, the second experiment investigated a single aspect of the Pervasive GameFlow model: whether participants experience higher levels of immersion when they do not have to shift focus between the virtual and physical elements of the game world.

During both experiments, we talked to the participants about their experiences, and we also observed their behaviour to see if they would follow criteria 4 of Table 2. The rest of this section describes the questionnaires used for both experiments in detail.

3.1 Questionnaires

3.1.1 Flow Questionnaire

The flow questionnaire was used by Delle Fave and Massimini [7], and was based on Csikszentmihalyi's [5] work on flow. The first section consisted of three quotations describing the flow experience and asked participants if they had ever had similar experiences. If they had, participants were asked to say in what context and how frequently they had the flow experience. In the second section, 12 dimensions relating to the flow experience were given, and participants were asked to rate these for their flow experience. Answers for each of these 12 dimensions were marked by participants on a 5-point Likert scale. Scores were calculated out of a total of 60. If participants answered a 3 to every question, it would lead to an flow score of 36/60 (the expected norm), so a mean engagement score higher than this could give an indication that participants experienced flow while playing the game.

3.1.2 Immersion Questionnaire

The immersion questionnaire developed by Jennett, et al. [11] was derived Agarwal and Karahanna's [1] studies on cognitive absorption dimensions and Brown and Cairns' [3] grounded investigation of game immersion. It has also been used in other studies on immersion, such as in Ferrai's [9] investigation into the relationships between immersion, body movements and extraversion. The questionnaire is divided into six sections: basic attention, temporal dissociation, temporal transportation, challenge, emotional involve-

ment and enjoyment.

In keeping with Jennett, et al.'s study, answers for each of the 31 questions were marked by the participants on a 5-point Likert scale. Jennett, et al. then calculated the scores for each question on a scale of 0 to 4, and the higher the score, the higher the indication of immersion, with a maximum overall score of 124. If participants answered a 3 to every question, it would lead to an immersion score of 62/124 (the expected norm), so an answer higher than this would give an indication that a participant was immersed in the game.

4. EXPERIMENT 1: FLOW AND IMMERSION IN PERVASIVE GAMES

In this experiment, we asked participants to play the game of Fruit Farmer, a spatially-expanded pervasive game played using a mobile phone. We calculated the scores for each question and compared them to the expected norm as described above. We also explored the correlations between aspects related with involvement and the overall scores of both questionnaires.

4.1 Method

4.1.1 Participants

There were 14 participants in total and all participants were volunteers. Four were female (28.6%) and 10 were male (71%). Participants' ages ranged from 26 to 41 years, the mean age being 31.21 years and the standard deviation was 4.12. None of the participants had played the game before.

4.1.2 Materials

Here we describe the equipment, location, game and questionnaires used in the experiments.

Equipment Participants played Fruit Farmer on a Nokia N73 mobile phone connected to a 51 Channel BlueNext GPS receiver BN-905GR.

Game: Fruit Farmer is a pervasive game that can be classified as a treasure hunt and that is played using a mobile device with access to a GPS. The dynamics of the game are as follows: pieces of fruit are depicted on the screen of the mobile phone as orange circles, and the aim of the game is for participants to collect as many of these as possible. To collect a piece of fruit, the participant has to walk or run to the physical location the virtual piece of fruit is located at, and their position on the screen is updated as they do this. Once the participant has reached a piece of fruit, the piece of fruit disappears from the screen and the participant gains points. An example of a game session would be as follows: A participant has just started playing Fruit Farmer and looks at the screen of the mobile phone. Their current position is marked on the screen by a marker that says 'you' and there are eight oranges displayed. The participant starts walking across the grass in Regent's Park. They look at the phone and see that the marker that represents them on the screen has got closer to one of the oranges on the screen. They keep on walking and look at the screen regularly as they do so, to check their progress. They notice the marker representing them on the screen is very close to an orange. They take a few more steps across the grass, and look at the screen again, and see that the orange has disappeared. They continue in this fashion, until they have collected all eight of the oranges. See Figure 1 for an example of how the participants interacted with the game.

Figure 1: Pictures of a mobile phone with the game loaded and of a participant while playing the game.

Location: Fruit Farmer can be played in any location that is outdoors and is fairly clear of trees and buildings. Based on this requirement, Regent's Park in London, was chosen as the location for this experiment. Although most of the games were played in the same area, due to the popularity of Regent's Park, when the area was not available for use, some games were played in other areas of the park.

Questionnaires: The questionnaires described in section 3.1 were used. The flow questionnaire was adapted so that the participants were asked whether the three quotations described an experience they had while playing the game, and then to rate the 12 dimensions in relation to the game experience.

4.1.3 Procedure

Participants were asked to read an information sheet, which gave details of the experiment, and then to sign a consent form. Once they had agreed to participate in the experiment, they were asked to fill in a preliminary questionnaire, which asked questions about their personal details and their game-playing background. Participants were then given an instruction sheet and as an introduction to the game, participants were asked to play a tutorial level, which involved them needing to run or walk to the locations of eight pieces of fruit. This took about 5 minutes for them to complete, depending on their speed and skill. After completing the tutorial, participants were then asked to play a more difficult level that involved wasps (which moved around the screen). If one of the wasps reached the location the player was at, s/he would lose a life and go back to the starting point. If the player lost all her/his lives, then the game would end. After playing the more difficult level for five minutes, participants were interrupted and asked to fill in the questionnaires about their experiences with the game. After completing the questionnaires, participants were asked if they had any further comments.

4.1.4 Analysis

The analysis of the experiment was divided into 3 parts: an assessment of the scores of both questionnaires to ascertain whether participants had experienced immersion and

flow; an exploration of the correlations between the involvement component of the PGF model and both immersion and flow; and finally a qualitative analysis about the experience of players regarding possible violations of social norms while playing.

The flow and immersion questionnaires were analysed and scores were calculated for each participant. The immersion scores were calculated in the same way that Jennett, et al. calculated them: each question had a Likert scale from 0 to 4 and the resulting scores were normalised to 1. Also, similarly to Jennet et al., the resulting scores were compared to the expected norm, the normalised middle value of the Likert scale, to ascertain whether participants had experienced immersion. The flow questionnaire was treated in a similar way to the questionnaire used in Delle Fave and Massimini's (1988) study. The questionnaire comprised two sections: The first section consisted of three quotations describing the flow experience. In Delle Fave and Massimini's study participants were asked whether they have ever had similar experiences, while in our study, participants were asked whether they had similar experiences *while playing the game*. Participants were thought to have experienced some level of flow if they had ticked at least one statement out of the three. In the second section, and similarly to the immersion questionnaire, questions were answered on a 5 point Likert scale, then normalised to 1 and finally compared to the expected norm. Here again our procedure was different from that of Delle Fave and Massimini's. In their study the questions referred to an activity their participants had experienced flow while doing; in our case the questions referred to the game they just had played.

As mentioned above, the main purpose of study 1 was to validate the involvement component of the PGF model by assessing the relationship between statements 1 to 3 of Table 2. This was performed by exploring the possible correlation between individual questions of both questionnaires related to those statements and the overall scores of the questionnaires. All statistical analyses were performed with SPSS 12 and the p-level for the analysis was set at $p = 0.01$.

Finally, possible violations to social norms while playing were analysed by looking at qualitative observations and discussing these issues with participants.

4.2 Results

4.2.1 Mean scores for the flow and immersion questionnaires

The results from both sections of the flow questionnaire were lower than those from Delle Fave and Massimini's study (and they were expected to be given the difference in the scope of the questions, in our case relating only to the experience of playing the pervasive game and in the other case in general). In the first section of the questionnaire, 8 out of 14 participants (57.1%) reported having experienced flow while playing the game. For Delle Fave and Massimini's experiment, 91% reported they had ever experienced flow. In the second section, the mean score was higher than the expected norm (mean: 0.692, SD: 0.156), but was again lower than that of Delle Fave and Massimini's experiment (mean: 0.875).

For the case of immersion, the mean score for this experiment (0.580, SD: 0.184) is lower than both the expected norm and the means in Jennett, et al.'s (2008) (0.74, SD: 0.184) and Ferrai's (2007) (0.76, SD:0.122) experiments.

We also looked at the correlation of the scores obtained in the flow and immersion questionnaires. We found that the Spearman correlation was 0.833 with p<0.01 (2 tail).

Table 3: Representative sample of questions and their correlations with the questionnaires. Stat. refers to the statement number of Table 2, *Ad* refers to the additional statement. * denotes significant correlation to $p < 0.01$

Question	Stat.	Flow	Immersion
Did you feel consciously aware of being in the real world while playing?	Ad	0.077	0.279
Did you feel self-conscious while playing the game?	1	0.660*	0.517
Did you lose track of time?	2	0.555*	0.643*
How involved were you in playing the game?	3	0.802*	0.534

4.2.2 Correlations with involvement

In the main part of the analysis the overall scores of the questionnaires were matched up with statements 1 to 3 of the involvement element of the Pervasive GameFlow model (see Table 2). Additionally to those statements, we included the statement *Players should become less aware of their surroundings* as it was part of Sweetser and Wyeth's [15] involvement criteria but not of Jegers' [10] and therefore could be used to clearly distinguish between involvement in conventional and pervasive environments. In order to match up those statements with the questionnaires, individual questions of the questionnaires related with the statements were correlated with the overall questionnaires' scores. 5 questions of the immersion questionnaire were related with the additional statement above (*Players should become less aware of their surroundings*), therefore the scores for each one of those questions were correlated with the overall scores of the two questionnaires. 1 question of the immersion questionnaire and 2 of the flow questionnaire were related with statement 1 (*Players should become less self-aware and less worried about everyday life or self*), 1 of immersion and 1 of flow with statement 2 (*Players should experience an altered sense of time*) and finally 1 of flow with statement 3 (*Players should feel emotionally and viscerally involved in the game*). Table 3 shows a representative sample of the selected questions as well as their Spearman correlations with the overall scores of the immersion and flow questionnaires. The rest of the section presents the results of the correlations between these groups of questions and the overall scores of the questionnaires.

The results for the analysis between the group of questions related with the additional statement (*Players should become less aware of their surroundings*) and both questionnaires suggests that in general there were no significant correlations. Although participants felt they were inside the game world, and did not feel the urge to stop playing and see what was happening around them, they were also aware of themselves and their surroundings. There was, however, a

significant correlation between noticing events around them less and the overall scores of both questionnaires. Additionally, descriptive statistics showed that participants frequently reported feeling consciously aware of being in the real world whilst participating in this experiment.

The results for statement 1 (*Players should become less self-aware and less worried about everyday life or self*) show a significant correlation, suggesting that players do become less self-aware and less worried about everyday life or self when playing the game. There was a significant correlation between players forgetting about their everyday concerns while playing the game and the overall scores of the immersion questionnaire; and between not feeling self-conscious and the flow overall scores.

Regarding statement 2 (*Players should experience an altered sense of time*), the results suggest there is a significant correlation between losing track of time while playing the game and the overall scores of both the immersion and flow questionnaires.

Finally the results regarding statement 3 (*Players should feel emotionally and viscerally involved in the game*) show a significant correlation between being involved in the gaming experience and the overall scores of both questionnaires.

4.2.3 Transitions between everyday contexts

Observations and discussions with participants revealed that social norms potentially getting in the way of the game during the experiment did not seem to affect involvement. For example, at one point in the game, participants found a fence blocked them from getting to a piece of fruit. The fruit was marked on the screen of the phone but the fence was not. Participants considered jumping the fence, but then made a decision to instead go around it. This did not seem to affect involvement.

4.3 Discussion

Overall, the results of experiment 1 support the involvement component of the Pervasive GameFlow model proposed by Jegers [10]. The questions associated with the statements 1 to 3 of the involvement criteria frequently correlated with the flow and immersion overall scores. This contrasts with the additional statement, whose associated questions did not correlate with those scores. This suggests that although "becoming less aware of one's surroundings" might be related with the enjoyment of traditional desktop games, it does not seem to be associated with flow and immersion in pervasive games. There is, however, a tendency to notice events in one's surroundings less, possibly those events not directly related with the game.

Additionally, the level of involvement of participants did not seem to be affected by social norms conflicting with the objectives of the game. Participants were able to modify their strategy or course of action in the game to accomodate social norms without losing the feeling of being involved.

Finally, although there is evidence to suggest players were involved, they did not seem to be as involved as participants of similar studies. There is no clear explanation for this result. Although this could be partially explained by the difference in scope of the questions in the flow questionnaire, that explanation does not apply to the case of immersion. It is possible, for example, that the quality of the chosen game is not as high as that of the games in the referred studies, or that involvement as understood in the GameFlow model is usually higher in traditional desktop games. More research is needed to clarify this issue.

5. EXPERIMENT 2: CONTEXT SWITCHING IN PERVASIVE GAMES

Statement 5 of the involvement criteria in the PGF model assumes that shifting focus between the physical and virtual aspects of the game disrupts the involvement of players. We tested this assumption by comparing the playing experience of a pervasive version with that of a "non-technological" version of the Fruit Farmer game. We asked participants to play the same version of Fruit Farmer played in experiment 1 and a "non-technological" version of the same game. They completed the flow and immersion questionnaires after playing in each condition, and their results were compared to ascertain whether there was a significant difference in their level of involvement.

5.1 Method

5.1.1 Participants

There were 12 participants in total and all participants were volunteers, who had not participated in experiment 1. Two were female (17%) and 10 were male (83%). Participants' ages ranged from 25 to 60 years, the mean age being 34.75 years and the standard deviation was 11.83.

5.1.2 Materials

Here we describe the equipment, location, game and questionnaires used in the non-technological condition of the experiment. The pervasive condition employed the same materials as experiment 1.

Game Regent's Park in London, was chosen as the location for this experiment, so that conditions could be kept as similar as possible to the pervasive condition. Pieces of fruit were placed in locations in the park and the layout of these were marked on a simple map. The aim of the game was to collect as many pieces of fruit as possible, and the participant would have to walk or run to the location the pieces of fruit were situated at and collect the fruit. As wasps were present in the game of Fruit Farmer, a picture of a wasp was used to represent a wasp in this game and was moved around the playing field by one of the experimenters.

Questionnaires The questionnaires described in section 3.1 were used. The flow questionnaire was adapted so that the participants were asked whether the three quotations described an experience they had while playing the game, and then to rate the 12 dimensions in relation to the game experience.

5.1.3 Procedure

The procedure for experiment 2 was intended to replicate experiment 1. The information sheet and the instruction sheet were adapted from experiment 1 to be suitable for experiment 2. The consent form, preliminary questionnaire, immersion questionnaire, and flow questionnaires were kept the same and an emphasis was made on telling participants to write *N/A* for questions they did not think were applicable in this case. Participants were given an instruction sheet and were asked to collect the fruit. After playing for five minutes, participants were interrupted and were asked to fill in the questionnaires about their experiences with the game.

After completing the questionnaires, participants were asked if they had any further comments.

5.1.4 Analysis

The analysis of the experiment tested the assumption that shifting focus between the physical and virtual aspects of the game disrupts the involvement of players; in other words, the analysis tried to ascertain whether players in the pervasive condition of the experiment had been less immersed than those in the non-technological condition. To this end, the flow and immersion scores obtained in both conditions were compared to find out whether there were any significant differences. To compare these scores a Mann-Whitney-U test was used it does not require for the data to be normal and the samples are independent. We used the same p-level as in experiment 1 (p=0.01).

5.2 Results

The experimental analysis did not find any significant differences between the two conditions, 1 for the technological and 2 for the non-technological. Neither the flow ($M_1 : 0.692$, $SD_1 : 0.156$; $M_2 : 0.748$, $SD_2 : 0.122$; U=70.5, p=0.494) nor immersion ($M_1 : 0.554$, $SD_1 : 0.157$; $M_2 : 0.639$, $SD_2 : 0.144$; U=54, p=0.131) scores were significantly different between conditions. Therefore we did not find evidence to support the claim that shifting focus between the physical and virtual aspects of the game disrupts the involvement of players. It could be that the chosen application (Fruit Farmer), blends the physical and virtual aspects of the game in such a way that participants can seamlessly move between those aspects. However this is unlikely given that frequently players had to stop walking to look at the phone and interpret the information provided by the application. What seems more likely is that the context switching assumption is somehow inaccurate.

As mentioned earlier, the criteria 4 of the involvement component (see Table 2) was observed while conducting both experiments. Here we report on the results of this aspect for experiment 2.

Regarding social norms, it was a bit awkward that "grown-ups" were playing a game in which they were chased by a person with a wasp mask while collecting oranges. However, the participants felt they were playing a game and they did not care for social judgement. Also, three participants were stopped either by the police or by members of the public and asked what they were doing. Additionally, some people would steal the oranges thinking they were free. These types of interruptions did not seem to affect the involvement of players, however they did not occur in experiment 1. This may be because the general public is more used to seeing people walking around while looking at a mobile phone than watching someone reading a paper map and collecting oranges from the ground.

The next section discusses the results of this experiment and those of experiment 1 in a global way.

6. OVERALL DISCUSSION

The results of the empirical studies generally support the involvement component in Jegers' [10] Pervasive GameFlow model. The results of the studies suggest that overall players become less self-aware and less worried about everyday life or self; experience an altered sense of time; and feel emotionally involved in the game. However, it is not the case that they become less aware of their surroundings, although they notice events around them less. Additionally, the studies suggest that players' involvement can be sufficiently robust to withstand transitions between everyday contexts and that overall participants were not too concerned about breaking social norms. Finally, although the last statement of the involvement criteria was not analysed as such, the second study suggests that the assumption that shifting focus between the physical and virtual aspects of the game disrupts the involvement of players is somewhat inaccurate.

Together these results suggest that the way players conceptualise the game and their interaction with it might be different for traditional and pervasive environments. In traditional environments the game is neatly encapsulated within the boundaries of the virtual world, and while interacting with the game, contact with the physical world can be minimised. In pervasive games this is not the case; the game has expanded so that it includes elements of the virtual and the physical worlds, and therefore interacting with it has to take those worlds into account. Therefore, in this context, involvement implies a wide rather than a narrow focus of attention and gameplay as a concept needs to consider how those worlds are integrated and how this integration affects other concepts such as flow and immersion. A view of gameplay that explains how those elements can be integrated is by Bayliss [2].

Bayliss proposes a view of gameplay based on notions of Embodied Interaction [8] and considers gameplay as an embodied experience. One of the implications of this view is that, instead of the player being transported into the virtual world of the game, the virtual world is drawn out into the player's physical world, and becomes one more of its elements. Under this view the notion of the game expands to include digital and physical elements and therefore can take both traditional and digital-based games into account. In a similar way that traditional games can include artifacts that players need to learn how to use, interpret and integrate with the overall gameplay (such as maps, boards, cards, etc.), digital-based games include virtual elements that players also need to learn, interpret and integrate. In both cases, integration might require players to switch contexts. For example, in the game of *orienteering*, players need to switch between the context of the paper map and the terrain which it represents. Context-switching might in fact be one of the challenging elements that makes games enjoyable rather than something that disrupts the involvement of players. This might explain why shifting focus between the physical and virtual aspects of the game did not disrupt the involvement of players in the second empirical study.

If the game is an embodied activity, then it shares with other embodied activities the notion of meaning [8]. For Dourish [8], meaning comprises three main aspects: ontology, intersubjectivity and intentionality. Ontology is related to how the entities that populate our world are classified, described and related to each other; intentionality to the "directedness" between concepts and entities; and intersubjectivity to the fact that meaning can be shared among a group of people. For example, a couple of rucksacks close to each other lying on the floor might not say much to a passer-by of a busy park; however for a person playing a match of football there they could be very significant. In her/his ontology they could be described as one of the goals of the pitch; for him/her, there is a "directed" relationship between

the word goal and the couple of rucksacks; and finally, this understanding is shared with the other players of the game. The notion of meaning can help explain the apparent contradiction in players being aware of their surroundings yet noticing events around them less. For the purposes of playing the game, certain elements of the physical world could be very important (feature prominently in the player's ontology) while others could have no relevance. Therefore it is perfectly possible that, as suggested by the results of the first empirical study, players could be very aware of some elements of the physical environment but not of others.

The main limitation of this study is the use of only one type of pervasive game. As mentioned in Section 2, there are different types of pervasive games. This study employed a treasure hunt game; although this is the oldest and best well-known game of this type, it is not clear whether the results of the study can generalise to other types of pervasive games. In particular, it can be understandable that players do not become less aware of their surroundings in treasure hunts as this type of game is precisely about being able to keep a wide focus of awareness in order to notice specific features of the environment. It is not clear whether this would be the case for a genre that could have a narrower focus, such as assassination games, for example.

The finding that the involvement of players can be sufficiently robust to withstand the breaking of social norms might also not generalise to other types of pervasive games. The way in which players are required to break social norms in treasure hunts might be less extreme than those of other genres. For example, *Cruel 2 B Kind* [12], an assassination game, may ask players to hug strangers in order to collect points. Hugging strangers can be more disturbing than finding a fence blocking the path to a treasure.

The one finding that could prove more robust to generalisations is the non-disruptive nature of context-switching. Nowadays, people switch between digital media and the concrete world frequently in their everyday tasks (for example while driving using GPS, sending text messages on their mobile phones, choosing songs to listen to on their MP3 players, etc.). It seems reasonable to assume that context-switching does not disrupt people's involvement in those activities nor in those of gaming. However this assumption, as well as the others regarding the limitations of the study, need to be evaluated empirically.

To summarise, the findings of the empirical studies reported in this paper can be explained in a coherent manner by a view that understands gameplay as an embodied activity. Therefore it seems that an embodied view of gameplay could be very suitable to study involvement in pervasive and in general in movement interaction games; however more research is needed to confirm and establish the generality of this conclusion. Topics of further exploration include a study of other aspects of flow and immersion through an embodied gameplay view. Such studies could help formulate embodied views of flow, immersion and in general of enjoyment in games.

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