

Learning Effects of Virtual Game Worlds: An Empirical Investigation of Immersion, Enjoyment and Performance

Completed Research Paper

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Abstract

In recent years, there is an increased interest to apply computer games to facilitate training and learning, with the expectation that simulated environment can improve trainees' performance and enjoyment in the learning activities at a relatively low cost. Such expectation is that better immersive capabilities of the computer game environment would lead to better performance, as well as making the exercise more enjoyable. The aim of this research is to confirm such belief, by defining and testing an integrated model of game immersion, enjoyment and performance. To this end, this study posits that visual aspects (in our case, vividness and visual appeal) embedded within the game design would enhance immersion, and ultimately impact on enjoyment and performance. Eighty subjects participated in an empirical test, for which World of Warcraft (WOW) – Mists of Pandaria was selected as the context. The results indicate that vividness is highly related to immersion, while immersion has significant impact on enjoyment and performance.

Keywords

Computer games, immersion, enjoyment, performance.

Introduction

Research suggests that computer games are powerful learning tools, due to their implementation of the entire learning process of practice, feedback for reinforcement, and their rewards for behavior improvement (Charles and McAlister 2004; Gee 2003; Holland et al. 2003; Ju and Wagner 1997). Computer games require players to be active participants rather than passive observers. Some games may be able to adapt to players' capabilities, adjust the difficult levels accordingly, and give immediate feedback in response to players' performance during the game play (Gee 2003; Squire 2005). Thus, computer games implement the fundamental elements of a learning environment, namely the ability to practice, as well as reinforcement that is directly tied to the practice (Erev and Roth 1998; Kangas 2010). Unlike other practice systems (e.g., multiple choice tests), computer games also create a realistic context and include elements of play, that make the exercise not only effective, but also enjoyable. Both practice and research have advocated the development of learning models interesting enough for participants to immerse themselves in (Virvou et al. 2005) and to frequently reflect upon (Kiili 2005). Consequently, the recommendation for a fusion of gaming and learning has been proposed in the recent years (Thomas and Brown 2011).

Prensky (2005) argued that two key reasons impel the usage of computer games for learning: (a) Learners have changed radically; and (b) learners need to be motivated in new ways. Researchers have confirmed that “learning by exploration” in such gaming environments, i.e., learning with understanding and the ability to transfer to other problem solving situations (Prensky 2005), can lead to “effective learning” (Paras 2005). For instance, although video games serve primarily as a source of entertainment, a genre of video games known as serious games which are designed as pedagogical tools, have gone beyond entertainment by “attempting to educate players about traditional classroom topics” (e.g. physics, mathematics, and business) and “nontraditional topics such as healthcare and political issues in the Middle East” (Mayo 2007). In addition, Moshirnia (2007) conducted an experiment which involved six 10-12th grade students playing a modified video game called Civilization VI and found that the game improved the ability to immediately recall historical events. Moreover, in another experiment participated by 120 college students, result has shown that self-made computer games enable students to devote longer periods of time to their studies and to perceive as more interesting (Fu and Yu 2006). Similarly, companies such as Holiday Inn have used simulations to train its staff, while airlines or the military use simulations to train their staff for better performance in highly dangerous and rare situations.

Clearly, the richness, narrative, and other design features of games, creating many scenarios with multiple goals and corresponding rewards, account substantially towards the level of learning that takes place within them (Gee 2008). Yee (2006) observed the ability to engage people of diverse motivations, achievement, social and immersion, while Brown and Douglas (2006) argue that the skill accumulation in World of Warcraft was transferable and can be considered a positive factor in hiring decisions. In addition to these factors, there has also been the attempt to make computer games and training simulators more “realistic” (if representing a real world), or more captivating when creating imagined worlds. Especially the visual impact has been at the forefront of design activity, with all elements of hardware, software, and design seeking a more immersive user experience.

The purpose of this study is to focus on an emerging learning context, virtual game worlds, to empirically test a theoretical model related to game players’ enjoyment and perceived performance based on immersion. We believe that enjoyment and performance will have impact on game players’ involvement in the game. If players’ performance increases, it means they respond to the practice and reinforcement mechanisms of the game, and therefore learn. Plus, if they enjoy the game, they will want to extend and repeat the experience. Both effects combined should insure that game-based learning effects will be enhanced accordingly. The proposed theoretical model suggests that key elements of computer games are the primary factors explaining why players will get immersed in online play, enjoy the experience, and perceive their performance to increase. By investigating the links between graphic features (visual appeal and vividness) and immersion, and the links between immersion and enjoyment as well as performance, the current study presents a picture of how basic game attributes impact players’ enjoyment and performance via the creation of game immersion.

The remainder of the article is organized as follows. First we provide a brief background on role-playing games and game immersion. Next we present our research model and study setup. Then we introduce preliminary findings, followed by discussion. We close with an interpretation of our results, limitations, and concluding remarks.

Theoretical concept of Game Immersion and Learning Effects

Computer games are actively enjoyed by hundreds of millions of people around the world, with World of Warcraft (WoW) alone attracting about 10 million players at its peak in 2009 (Moore et al. 2009). Successful computer games all have a unique ability to captivate and draw people in, which is referred to as immersion (Jennett et al. 2008). Although the concept of immersion is widely used in discussing computer games and gameplay experiences, so far a clear definition is lacking. In an attempt to understand immersion, Brown and Cairns (2004) identified, based on a qualitative study, three distinct levels of immersion: engagement, engrossment and total immersion.

Our discussion of immersion must take note of the similar concept of presence. In media studies, presence has been defined as the subjective feeling of either existence within a given environment or “being there” (Heeter 1992; Shim and Kim 2003; Steuer 1992). Whereas some prior studies have argued for presence and immersion to be different but related constructs, as demonstrated the correlation

between the two (Slater and Wilbur 1995), other researcher have asserted that immersion and presence are interchangeable terms (McMahan 2003). A better understanding of immersion would be crucial in investigating the relationship between people and video games (Jennett et al. 2008). Since the term presence was originally developed in the context of teleoperations, we adopt McMahan's definition of immersion, which reflects the essence of gaming and describe immersion as being "caught up in the world of the game's story" (McMahan 2003, p.68). For consistency, the term "immersion" is used henceforth.

According to Pargman (Pargman 2005), virtual game worlds are creating a new context in which young people are socialized to group norms, learning intellectual skills, and expressing their individuality, with the immersion in the digital environment enhancing the learning experience in at least three ways: by enabling multiple perspectives, situated learning, and knowledge transfer (Dede 2009). For example, research found that students were more engaged in the immersive interface and learned as much or more compared with a similar, paper-based curriculum that included laboratory experiences (Ketelhut et al. 2007; Nelson 2007). Additionally, other research found that immersive digital settings enhance participants' engagement and learning (Barab et al. 2007; Neulight et al. 2007). With this research, we intend to shed light on how immersion, in our study based on visual aspects of the gaming experience, can facilitate learning and training in the context of virtual game worlds. We note that there are several other aspects of games that create an immersive experience, such as the narrative, timing and flow, as well as auditory experience. However, within this study our focus shall remain on the visual aspects of the game.

Research Model and Hypotheses

In attempting to better understand game enjoyment and performance, drawing upon the established theories and prior empirical findings, we propose a conceptual framework that investigates the graphic features related to immersion and effects of computer game immersion. As depicted in Figure 1, our model suggests that game immersion is highly related to the visual aspects of vividness and visual appeal. In addition, the model also suggests that immersion further affects enjoyment and performance.

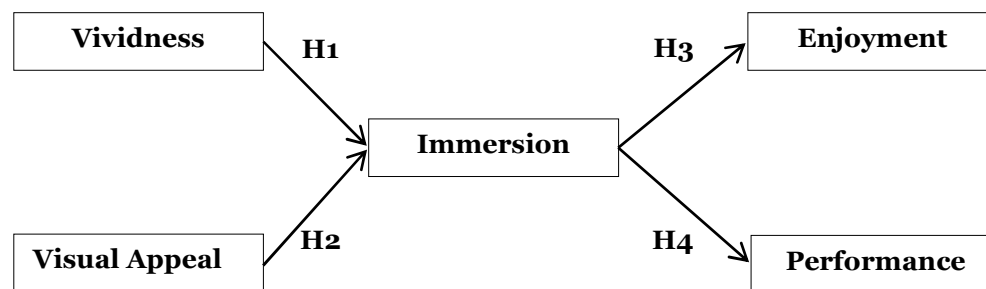


Figure 1. Research Model and Hypotheses

Visual Aspects of Gaming and their Impact on Immersion

Game graphics provide the visual information players receive during the game, presented in the form of pictures, images, or drawings (Wu et al. 2008). Players have high and constantly growing expectations for games in terms of graphics (Robertson and Good 2005). One of the primary goals in the development of the computer games is to improve the technology for their visual presentation, as most people consider computer games as mainly visual experience oriented entertainment (Smith 2002). We seek to capture this experience with two visual aspects, namely visual appeal and vividness.

Vividness relates to "the representational richness of a mediated environment as defined by its formal features; that is, the "way in which an environment presents information to the senses" (Steuer 1992, p. 11). Vividness is determined by the number of senses engaged by the medium and how closely the medium replicates parts of the human sensory system (Steuer 1992). *Visual appeal*, which relates to the choice of fonts and other visual elements such as graphics, acts to enhance the overall look of user interface (Van der Heijden and Verhagen 2004). In the online context, the use of color, graphic layout and photographic quality combine to influence the visual appeal (Mathwick et al. 2001). On one hand, greater vividness of an computer game represents better "reality" and enhances the liveliness of the avatar (e.g. avatars' subtle

smiles and blinking eyes) (Coyle and Thorson 2001; Scheck et al. 2008; Steuer 1992). On the other hand, greater visual appeal displays higher quality graphics (e.g. beautiful facial features of avatars). Research in computer game context argues that it is particularly the high-quality and realistic graphics that enable higher experience of “in the game”, which is referred to as “immersion” (Ermi and Mäyrä 2005; Jennett et al. 2008).

Thus, consistent with the Steuer’s (1992) statement, computer games with abundant visual stimuli (visual appeal and vividness) are likely to immerse users (Teng 2010). Hence, we formulated the following hypotheses:

H1: Vividness positively influences computer game immersion.

H2: Visual appeal positively influences computer game immersion.

The Impact of Immersion on Enjoyment and Performance

In this study, enjoyment is defined as the degree to which performing an activity is perceived as providing pleasure and joy in its own right, aside from performance consequences (Venkatesh 2000). Enjoyment can occur not only in the exercise of physical activities such as singing, but also in the pursuit of mental activities such as playing chess (Wu et al. 2008). In recent years, enjoyment has received considerable research attention and has been investigated in various contexts, including instant messaging (Li et al. 2005), online shopping (Koufaris 2002) and e-learning (Venkatesh 2000). Enjoyment is an important game outcome which motivates the continuation of game playing (Teng 2010). Therefore, when the game is a training environment, it also affects the extension of the learning experience. In addition, a key criterion in determining a game’s effectiveness is to see whether or not the player experiences enjoyment (Fu et al. 2009). As an outcome of good gaming experience, immersion is often viewed as critical to game enjoyment (Jennett et al. 2008). Hartmann, Klimmt and Vorderer (2010) argue that much of the contemporary development in media technology seems to pursue an increase in immersion as a route to enjoyment. Following on Hartmann and his colleagues’ study (2010), Skalski et al. (2010) linked and tested specific dimensions of immersion to computer game enjoyment. Although some research supports the connection between immersion and enjoyment, more evidence is needed. In line with prior arguments, we proposed:

H3: Computer game immersion positively influences user enjoyment.

A number of studies have empirically demonstrated a positive relationship between immersion and various performance measures. For example, Pausch et al. (1997) suggest that immersion is helpful to enhance search ability while Lin et al. (2002) find that immersion impacts recall ability. Moreover, Slater and his colleagues (1996) discuss a positive relationship between immersion and spatial judgments. All these studies point to a link between immersion and performance. Therefore, we hypothesize:

H4: Computer game immersion positively influences user performance.

Methodology

Procedure

To test the hypotheses, we chose a specific virtual game world so as to control the game environment. We wanted to study participants who have a similar experience on which to draw. We selected World of Warcraft-Mists of Pandaria (WoW) from among the various available virtual game worlds. WoW is the commercially most successful game of this genre with its remarkable playability (Snow 2007) according to its Guinness World of Recorded number of subscription (Langshaw 2009). WoW revolutionized MMORPGs with its exceptional combination of narrative, visual appeal, playability, and incentive system (Song et al. 2008), which includes an in-game currency which had significant out-of-game commercial value. At its peak, WoW had more than 10 Million paid subscribers. Our novice WoW players did not experience of these aspects, such as the auction house, or in-game currency. They also had limited exposure to the game narrative.

As visual appeal and vividness may depend considerably on the display through which players perceive game play, we chose to let players experience WoW in a controlled setting with one of two screen types.

Typically gamers might play WoW on a regular desktop, however, evidence suggests that the mass purchase of large screen displays (e.g. 50 inch or larger) has been driven by the popularity of computer games (Rivington 2013). Hence we used two display types in our study, a typical desktop monitor (20 inch LCD) and a high resolution, fast response Plasma monitor of 65 inch diameter. Subjects would look at the display in an otherwise darkened room, using headsets to block out ambient noise.

Intermediate gamers, with experience in online role playing games but no experience with WoW-Mists of Pandaria, were invited to participate through a job task advertisement on a University website. A total of 80 undergraduate students participated in the study, 47 males and 33 females. Their demographics are shown in Table 1.

Profile	All participants	20" screen users	65" screen users
Number of participants	80	40	40
Age	Max: 24 years Min: 17 years Mean: 20 years	Max: 24 years Min: 18 years Mean: 20 years	Max: 23 years Min: 17 years Mean: 20 years
Sex	47 Males 33 Females	25 Males 15 Females	22 Males 18 Females
Distributions by years of experience with computer games	≤1 year:17 1-3years:7 3-5years:12 5-10years:26 ≥10years:18	≤1 year:12 1-3years:2 3-5years:3 5-10years:14 ≥10years:9	≤1 year:5 1-3years:5 3-5years:9 5-10years:12 ≥10years:9

Table 1. Study Participant Demographics

All subjects were requested to perform a pre-defined set of WoW quests. They were limited to one player class (warrior) in order to guarantee a similar experience. For the measure of the performance, we asked the subjects to self-report their performance based on their game experience (Yoshida et al., 2010). Observers accompanied the participants to monitor their practices and made sure that they completed the required quests and stop thereafter. All participants successfully completed the assigned quests, but varied considerably in the time taken, from 15 minutes to 85 minutes. Thereafter, participants were asked to fill out an online questionnaire concerning their experience.

Survey Instruments

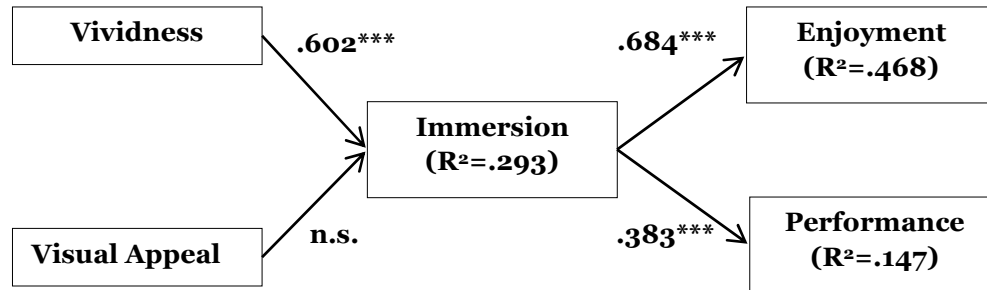
Constructs were measured using seven-point Likert scales with 1 indicating strongly disagree and 7 strongly agree. Measurements for each constructs in the research model evolved from previous studies. Three measurement items for vividness were adopted from Quick et al. (2008). Three visual appeal questions were developed based on Loiacono et al. (2007). The seven items evaluating immersion were derived from Fu et al. (2009). Other items testing enjoyment (four items) and performance (5 items) originated from Chang et al. (2001); Igbaria et al. (1994); and Yoshida et al. (2010) respectively. We tailored the entire twenty one items to the context of our study. In addition, we adapted some items to make them more suitable for the virtual game world context. A pretest was conducted to assess the questionnaire wording. Under the supervision, two undergraduate students and one Ph.D student participated in the pre-test playing the game and evaluating the clarity of the questionnaire. Some minor modifications were made based on the pre-test.

Test of the Model and Hypotheses

SPSS Version 20 was used to analyze the data. Figure 2 shows path coefficients and significance levels for each hypothesis based on the dataset (80 participants). Overall, the results strongly confirmed the

predictive power of the model. All but one of the hypotheses were supported. Vividness was significantly related to immersion, thus supporting H1. Consistent with the prediction, immersion had significant impact on both enjoyment and performance, thus supporting H3 and H4. However, H2, which assumed that computer game visual appeal was positively related to immersion, was not supported in our study context. Although, in a model without vividness as independent variable, the impact of visual appeal on immersion became significant ($\beta = 0.287, p = 0.001$). In other words, visual appeal was crowded out by vividness.

Figure 2 also depicts the variances for dependent variables. 29.3% of the variance in computer game immersion was explained. Immersion explained 46.8% of the variance in computer game enjoyment. The total variance in performance explained by the research model was 14.7%.

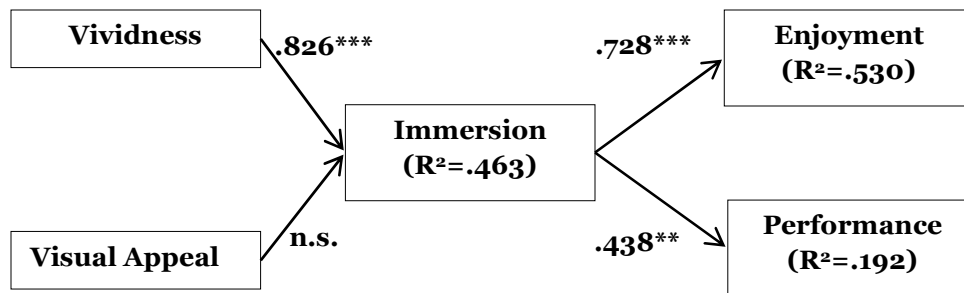


Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 2. Structural Model for 80 Participants

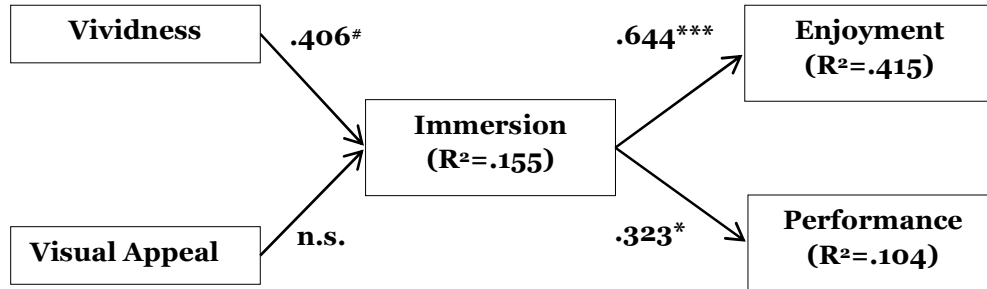
We further tested the explanatory power of our model by splitting the data set based on the screen size our subjects were exposed to.

Figure 3 and Figure 4 depict the structural models for the 20” screen users and the 65” screen group users. We observed one difference in the models, namely that the effect of vividness on immersion was significant at the 10% level only for 65” users ($p = 0.053$).



Note: # $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 3. Structural Model for 20” Screen Users (40)



Note: # $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 4. Structural Model for 65” Screen Users (40)

A comparison of mean scores for the constructs nevertheless pointed out that 65” screen users did experience more vividness (5.375 out of 7) and more immersion (5.035 out of 7) than 20” monitor users (5.167 for vividness and 4.945 for immersion), as shown in Table 2, albeit the relationship between the constructs was not significant at the $p < 0.05$ level. Table 3 summarizes R-square results for the full dataset and 20” and 65” screen users respectively.

Constructs	All Participants		Screen Size			
	Mean	Std. Deviation	20”		65”	
			Mean	Std. Deviation	Mean	Std. Deviation
Vividness	5.271	1.048	5.167	1.177	5.375	0.903
Visual appeal	5.129	1.111	5.075	1.281	5.183	0.924
Immersion	4.989	0.846	4.945	0.813	5.033	0.885
Enjoyment	4.809	1.261	4.719	1.359	4.900	1.164
Performance	4.668	0.986	4.54	1.067	4.795	0.894

Table 2. Summary of Mean Values for All Constructs by Screen Size

Constructs	All participants	Screen Size	
		20”	65”
R Square			
Immersion	.293	.463	.155
Enjoyment	.468	.530	.415
Performance	.147	.192	.104

Table 3. Summary of R Square by Screen Size

Discussion

Summary of Results

The results largely validate our hypothesized model. Vividness was found to affect immersion, and immersion was found to strongly affect enjoyment and less strongly affect performance. Visual appeal, however, did not affect immersion. Interestingly, these effects could be seen independent of screen size. Whereas the large screen size not surprisingly consistently yielded higher mean responses (though statistically *not* significantly higher), the model relationships remained the same. It appears then, that subjects in a large and complex game world such as WoW are more affected by the overall representational richness of the mediated environment (Steuer 1992), than by factors such as the use of color, the specific graphic layout or the photographic quality, that control the visual appeal (Mathwick et al. 2001). Vividness might be considered as a higher level construct which incorporates aspects of visual appeal, as well as other factors that lead to representational richness. This would explain why vividness crowded out visual appeal as a factor affecting immersion.

Contributions

The study has both theoretical and practical implications. Our results confirmed that game immersion is a strong and direct determinant of user enjoyment and (self-reported) performance in computer game playing. Interestingly, it shows that the hedonic aspect of immersion, enjoyment, is more strongly affected than performance. For the designers of learning environments, thus, highest levels of immersion may not result in best performance, but may serve to “bring back” users to the learning environment. To increase the effect on performance, game designers could possibly strengthen the incentive system in order to induce better performance. This could be achieved for instance through an increase in the bonus points gained for the completion of quests. Yet while this measure could increase performance, which had the lowest mean value of all constructs (4.668), it may not strengthen the relationship between immersion and performance.

Our research also adds to the wider research on immersion as it expands the antecedents of immersion from specific graphic features to vividness. It is noteworthy that the immersion model holds independent of screen size. A very considerable increase in screen size from 20” to 65” had only a minor impact on perceptions of vividness and visual impact. This finding also suggests very much diminishing marginal returns for investments into the user interface, as a 10-times magnitude increase in the cost of the user interface yielded only insignificantly higher scores for all constructs.

Limitations

Our study, not surprisingly, has numerous limitations. First, we examined only one computer game, and thus our findings may not be generalizable to all computer game environments. Second, our sampling consisted of gamers with experience in online role playing games but no experience in WoW-Mists of Pandaria. Thus, caution is needed when extrapolating our findings to wether inexperienced WoW players, or inexperienced players. Third, in line with the focus of our research, we paid attention to visual media related variables only. Many other factors will affect immersion, such as the narrative, or auditory stimuli. We explained only 29.3% of the variance in immersion, after all. Fourth, whereas we demonstrated immersion as predictor of enjoyment and performance, the addition of other antecedents could result in additional insights. Fifth, we excluded the possible influence of control variables such as player gender and experience in this study. Finally, the study examined game players individually for approximately 15 to 85 minutes in the game of WoW. It is therefore inadequate in explaining more complex game playing patterns that emerge when players have spent hundreds of hours with the game.

Conclusions

We draw three major insights from our study with respect to virtual game worlds and learning. First, immersion creates enjoyment and thus brings players (learners) back to the environment. Second, immersion alone is not enough to strongly affect performance. Game environments need to be tuned for performance independent from immersion. Third, the visual aspects of a virtual game world are only one component that drives immersion. Especially designers of serious games will need to explore ways to create immersion so as to keep users enjoying the games and thus to keep them playing.

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