VR or non-VR? Investigating Influence of the Virtual Environment Medium on Persuasive Gamification Outcomes

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ABSTRACT

In this paper, we aim to research how a choice of a gamification medium influences the users' psychological and behavioral experiences which are also gamification outcomes. We discuss gamification, its components, persuasive systems, cognitive absorption, perceived persuasiveness of gamified systems, as well as the influence of the psychological constructs on intention to play the game and intention to engage in sustainable behavior. Since we take a look at two types of virtual environments (non-immersive and immersive), we include concepts relevant for choosing an appropriate platform, such as sense of presence and simulator sickness, both of which have a significant impact on user experience. Based on the discussed theoretical background, we propose a research framework and a list of hypotheses to be empirically tested. We describe an experimental set up to test the hypotheses within the context of pro-environmental behavior. Finally, we present potential contributions and limitations of this research-in-progress.

CCS CONCEPTS

• Human-centered computing • Virtual reality

KEYWORDS

Gamification, virtual environment, virtual reality, behavior change, persuasive systems, perceived persuasiveness, cognitive absorption, pro-environmental behavior

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1 Introduction

Gamification has become a part of our daily activities, because many information systems and services use gamified elements. According to Koivisto and Hamari [1] popularity of gamification has grown dramatically in recent years, not only because of the increased number of gamified applications, but also because of the expansion in the amount of research. Nevertheless, a comprehensive review of gamification research in Information Systems (IS) field [1] suggests that there are plenty unexplored research trajectories. One of the thematic agenda points emphasizes a need to "to diversify the use of gameful affordances, and concurrently develop an understanding of what constitutes and creates gameful experiences" [1, p. 204]. Recently, gaming technologies have been rapidly changing, and new developments appear at a fast pace. Koiviso and Hamari [1] note that the latest developments and successes in immersive virtual environment (VE) technologies (e.g. virtual reality (VR), augmented reality (AR), mixed reality (MR), extended reality (XR)) can provide an interesting gamification research path in IS. Indeed, immersive VEs have been gaining popularity both in industry and in research, including scientific studies in a range of persuasive and behavior change contexts, such as health, education, advertising, and pro-environmental behavior [2].

Researching both gamification and immersive VEs can provide novel ideas on how current technology is changing human motivations, attitudes, behaviors, and motivations. VE are powerful simulation tools that provide an opportunity for the users to experience and remember clearly impacts of their own actions [3]. Because simulation enables people to visualize the connection between the cause and effect, it is influential in changing people's attitudes, motivations, and behaviors [4]. Moreover, immersive VEs have an ability to maximize sense of presence, leading to change in actual human behavior in response to VEs [2, 5]. Accounting for both the need to expand gamification research on emerging technologies (i.e. immersive VEs), and their potential to enhance perceived persuasiveness of Behavior Change Support Systems, we are initiating this study. This paper aims to compare user experiences from persuasive gamification on different VE platforms, such as non-immersive or non-VR (laptop/PC/mobile device) and immersive or VR (Head Mounted Display (HMD)). First, we provide a brief overview of persuasive systems and behavior change, gamification, and virtual environments. Next, we propose our research model and hypotheses, followed by the description of the intended experiment. Lastly, we provide

expected contribution to researchers and practitioners as well as possible limitations of the study.

2 Theoretical Background

2.1 Gamification

Gamification is defined as designing IS that enable experiences and motivations similar to the ones provided by games, consequently attempting to modify user behavior [1]. Composition of gamification can be described in terms of the tree main components [6], i.e. affordances and two types of outcomes – psychological and behavioral, that are situated within a specific context. These elements are connected: affordances lead to psychological outcomes, which in turn bring about behavioral outcomes. Affordances are defined as the elements and mechanics used to build games and the experiences the game is meant to provide. Psychological outcomes denote changes in users psychological experiences expected to be evoked by the game, for example, enjoyment, curiosity, immersion, etc. The behavioral outcomes refer to behavior changes that the gamified systems aim to promote by creating gamified experience, for instance, adopting healthy lifestyle, discontinuing harmful habits, engaging in pro-environmental behaviors, etc. Interestingly, previous research has found a link between playing games positive behavioral changes in health-related contexts [7], and thus, there is grounds to assume that this connection is present in the other contexts.

2.2 Cognitive Absorption

Game designers should aim to keep the users in the state of flow or a state of optimal psychological experience "in which people are so involved in an activity that nothing else seems to matter" [8, p. 4]. However, the range of psychological experiences evoked by a game might be difficult to describe with a single dimension. A similar multi-dimensional construct, based on the flow theory [9], that can provide a broader insight into psychological outcomes that the user experiences is cognitive absorption. Cognitive absorption is defined as a state of deep involvement with the game [10], and it consists of the following dimensions: temporal dissociation, or the inability to register the passage of time while engaged in interaction; focused immersion, or the experience of total engagement where other attentional demands are ignored; heightened enjoyment, capturing the pleasurable aspects of the interaction; control, representing the user's perception of being in charge of the interaction; and curiosity, tapping into the extent the experience arouses an individual's sensory and cognitive curiosity.

2.3 Persuasive Systems and Perceived Persuasiveness

Persuasive systems are interactive IS based on different technological platforms, such as the Internet and mobile systems, designed for changing users' attitudes or behaviors [4]. One specific instance of persuasive systems is Behavior Change Support Systems (BCSSs) that can be defined as "sociotechnical information system(s) with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception" [11, p. 1225]. Attempts to convince the user to change the behavior define intended persuasiveness, i.e. an extent to which the design of the system allows for persuasive potential. Subsequently, perceived persuasiveness is the extent to which this potential is realized, i.e. how much the user (the recipient of the persuasive message) perceives the message as being convincing. In extant models of attitude change, messages are presented, received, processed, and if successful, recipients' attitudes shift towards the advocated position [12]. The altered attitude may lead to subsequent behavior change under appropriate conditions. Thus, effective persuasion happens when the target of change (e.g., attitudes, beliefs) is modified in the desired direction. It is believed that "an attitude an evaluative integration of cognitions and affects experienced in relation to an object" [12, p. 347]. In line with the previous studies [13, 14], we use the term "perceived persuasiveness" to define as an individual's favorable impression of the system.

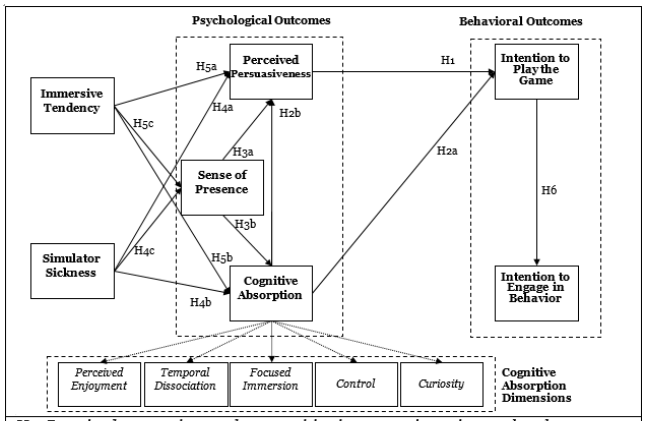
2.2 Virtual Environments

Selection of an appropriate technological platform for a specific system has a significant influence of the effectiveness of the system [2]. VE platforms range from non-immersive simple desktop/laptop computers etc. with standard monitors to much more immersive environments, such as Head Mounted Displays (HMDs), which can be thought of as wearable computer displays that provide the user with greater absorption into the gamified experience. Level of immersion is the degree to which a system can "deliver an extensive, inclusive, surrounding, and vivid illusion of virtual environment to a user" [15]. Furthermore, immersion is one of the main features that helps the users in perception of all aspects of the space to create lifelike impression [2]. Immersion is often linked to the sense of presence which is defined as the subjective experience of being in a certain place or environment, while being physically situated in another [16].

Additionally, the choice of the VE platform is highly likely to influence psychological and behavioral responses of the users engaging with the VEs [17]. Studies up-to-date have not concluded definitely, whether the level of immersion, sense of presence, and simulator sickness (i.e. motion sickness experienced during an interaction with a VE) experienced through different VE platforms influence user experience, psychological disposition and behaviors [2]. The effects of VE platforms on the user condition and behavior might be influences by other factors, such as the game context and user characteristics (e.g., age, gender, and previous experience with VEs) [18]. Thus, without further investigation, we cannot conclude that the more immersive (enabled by technology) VEs provide the users a higher sense of presence and perceived immersion in the game, and that using more immersive technologies will automatically translate into better behavioral outcomes [2].

3 Research Model Development

Combining the gamification conceptualization by Koivisto and Hamari [1] with the theoretical knowledge on persuasive systems and VEs, we determined that some psychological outcomes can be the following: perceived persuasiveness, cognitive absorption, and sense of presence. Behavioral outcomes that we are interested in exploring are intention to play the game and its influence on intention to engage in behavior. Figure 1 shows the how the adapted framework translated into a research model, and it follows by the list of hypotheses that will be tested empirically.



H1: Perceived persuasiveness has a positive impact on intention to play the game
H2a: Cognitive absorption has a positive impact on intention to play the game
H2b: Cognitive absorption has a positive impact on perceived persuasiveness
H3a: Sense of presence has a positive impact on perceived persuasiveness
H3b: Sense of presence has a positive impact on cognitive absorption
H4a: Simulator sickness has a negative impact on perceived persuasiveness
H4b: Simulator sickness has a negative impact on cognitive absorption
H4c: Simulator sickness has a negative impact on sense of presence
H5a: Immersive tendency has a positive impact on perceived persuasiveness
H5b: Immersive tendency has a positive impact on cognitive absorption
H5c: Immersive tendency has a positive impact on sense of presence
H6: Intention to play the game has a positive impact on intention to adopt behavior

Figure 1: Proposed Research Model and Hypotheses

4 Experimental Design, Treatments and Measurements

To conduct our experiment, we will consider sustainable behavior context. Therefore, we will use *The Path to Luma*[1] game which reflects this context. Also the choice of the game is driven by its availability in both non-VR[2] and in the VR[3] versions. While both of the versions of the game can be found in Google Play store, the VR one is also available in the Oculus Gear VR store[4]. The main task of the game is solving the puzzles by using clean energy sources, such as solar panels and wind turbines. Hence, the game reminds the players about the need to use renewable energy for creating a sustainable future.

We will recruit participants without specific criteria, expect for having a normal or normal corrected vision (i.e. wearing glasses or contact lenses). We will try to maintain an equal gender ration among participants. Participants will be randomly assigned to one of the two experimental groups: the non-VR group, which will experience the non-VR version game using a tablet without an HMD, and the VR group, which will experience the VR version of the game using an HMD. Thus, we will employ a one factor (medium: VR vs. non-VR) between-subjects experimental design (around 50 participants per group). The experiment will be conducted according to the following protocol. First, participants will complete a survey with general questions related to age, gender, immersive tendency, previous experience with VE, simulator sickness symptoms, and environmental awareness. Immersive tendency will be assesses with Immersive Tendency Questionnaire (ITQ) [16] which measures the tendency or capabilities of individuals to be involved or immersed in a virtual environment. Simulator sickness symptoms will be assessed with the Simulator Sickness Questionnaire (SSQ) [19] to measure the level of simulator sickness symptoms in a VE. Environmental awareness will be assessed on a 7-point Likert scale ranging from Strongly Disagree to Strongly Agree) with the construct adapted from Steg et al. [20] (see Appendix, Table 1). Previous experience with VE will be assessed on a 7-point Likert scale. Next, prior to experiencing the game, participants will undergo training to familiarize themselves with the platform and game controls that they will be using during the experiment. After the training session, participants will play the game using one of the platforms for about 20 minutes. After the game session, the participants will complete the post-experiment questionnaires. The participants complete two questionnaires investigating their sense of presence in the VEs: the Witmer and Singer's Presence Questionnaire (PQ) [16] which measures the degree of presence and engagement that individuals experience in a VE and the Slater, Usoh and Steed's PQ [21], which focuses on psychological and behavioral response to immersion and involvement. After that, participants will complete the Simulator Sickness Questionnaire (SSQ) again. As it was mentioned, participants will have completed the SSQ during the pre-experiment session for the first time, to give us a baseline for comparison of their pre-and post-test scores in order to determine simulator sickness caused solely by interacting with VEs (not from a possible individual condition). Finally, participants will answer questions regarding the rest of the dependent variables, such as perceived persuasiveness, cognitive absorption, intention to play the game, and intention to engage in sustainable behavior, measured on a 7-point Likert scale ranging from Strongly Disagree to Strongly Agree (see Appendix, Table 1).

To analyze the data, we will compare dependent variables between the VR and non-VR groups, i.e. perceived persuasiveness, cognitive absorption, simulator sickness, sense of presence, intention to play the game, and intention to engage in sustainable behavior. Using structural equation modeling, assuming a sufficient sample size, will help to test the hypothesized relationships of our research model. We will also investigate the effects of other factors, such as participants' individual characteristics, such as age, gender, environmental awareness, previous experience with VE, and immersive tendency, on the dependent variables.

5 Expected Contributions and Limitations

This study is expected to contribute to research on persuasive gamification using different VEs. By conducting the described experiment, we expect to understand better whether and how much VR gamification experiences impact experimental and instrumental outcomes. This knowledge will provide an insight of the impact VR gamified experience makes compared to a non-VR one, and thus will contribute to developers' decisions on whether it is worth designing both versions or just one of them for a similar experience. Additionally, it will give insights on which aspects of the technology/game need improvement (e.g. eliminating severe

[1] http://www.thepathtoluma.com/
[2] https://play.google.com/store/apps/details?id=com.NRG.PathToLuma
[3] https://play.google.com/store/apps/details?id=com.NRG.PathToLumaVR
[4] https://www.oculus.com/experiences/gear-vr/1775279625876291/

simulator sickness, increasing sense of presence, etc.). Nevertheless, we predict that the study will be subject to several limitations. For instance, our experiment will use the game with focused on improving pro-environmental behavior. Therefore, the obtained results might not be applicable to other behavior change contexts that will have to be investigated in the other future studies. However, it is impossible to choose a single context which can be universally generalizable. Moreover, future academic studies will be able to build upon our experiment, enhancing it and testing it in a variety of game-like experiences to draw more generalizable conclusions regarding the impact of gamification and playing games on behavior change.

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APPENDIX

Cognitive Absorption [10, 22] *Perceived Enjoyment* I found using the game to be enjoyable. I had fun using the game. Using the game was boring. (reverse scaled) The game really annoyed me. (reverse scaled) The game experience was pleasurable. The game left me unsatisfied. (reverse scaled) *Focused Immersion* I was able to block out most of distractions when I played the game. I was absorbed in what I was doing when I played the game. I was immersed in the game. I was distracted by other attentions very easily while playing the game. (reverse scaled) *Temporal Dissociation* Time appeared to go by very quickly while playing the game. I lost track of time when I was playing the game. Time "flew" when I played the game. *Control* I had a lot of control in the game. I could choose freely what I wanted to see or do in the game. I was in control in the game. I had no control over my interaction in the game. (reverse scaled) I was allowed to control my interaction in the game. *Curiosity* This game experience excited my curiosity. This game experience made me curious. This game experience aroused my imagination	**Perceived Persuasiveness [11, 13]** The game has an influence on me. The game is personally relevant for me. The game makes me reconsider my habits. In my opinion, the game is convincing. **Intention to Use the Game [23, 24]** I would play the game in the future. I would be willing to play the game in the future. I would consider playing the game in the future. I can imagine myself playing the game in the future **Intention to Engage in Behavior [25]** I intend to engage in sustainable behavior in the near future. I will try to engage in sustainable behavior in the near future. I expect to engage in sustainable behavior in the near future. I plan to engage in sustainable behavior in the near future. **Environmental Awareness [20]** Global warming is a problem for society. Energy savings help reduce global warming. The exhaustion of fossil fuels is a problem. The exhaustion of energy sources is a problem. Environmental quality will improve if we use less energy. It is not certain whether global warming is a real problem. (reverse scaled)

Table 1: Survey Constructs and Items adapted for the Study