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Fully Immersed, Fully Present: Examining the User Experience Through the Multimodal Presence Scale and Virtual Reality Gaming Variables

Andre Adame
CSUSAN BERNARDINO

FULLY IMMERSED, FULLY PRESENT: EXAMINING THE USER EXPERIENCE THROUGH THE MULTIMODAL PRESENCE SCALE AND VIRTUAL REALITY GAMING VARIABLES

A Thesis

Presented to the

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San Bernardino

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by

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Approved by:

Ahlam Muhtaseb, Committee Chair, Communication Studies

Mihaela Popescu, Committee Member

Bradford Owen, Committee Member

ABSTRACT

Over the past few years, video games have served as a catalyst for virtual reality (VR) technology to become more accessible to the average consumer, resulting in an increased interest in VR's potential applications across several disciplines. To best capitalize on these applications, however, researchers require a thorough understanding of the user's experience in virtual environments. And while many studies on VR experiences tend to focus on presence, video games offer another angle of approach: immersion. This study uses both qualitative and quantitative methods to examine the relationships between the VR experience of presence and the gaming experience of immersion. First, a focus group of individuals with VR gaming experience explored variables impacting presence. Then a survey questionnaire consisting of items from the multimodal presence scale (MPS), Jennett et al.'s (2008) immersion questionnaire, and the focus group was distributed online. Finally, the collected data was analyzed using factor analysis and linear regression to explore the relationships between presence and immersion. Results of the analysis identified involvement to be an important factor impacting a user's perceived presence in a VR gaming experience.

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CHAPTER ONE

INRTODUCTION

Bit by bit, the world is progressing further into a virtual age. Research in the field of virtual reality (VR) has been rapidly propelling forward over the past few years, particularly as the technology has become more available and affordable to the general public. The technology's proliferating presence in society has also resulted in the resurfacing of pertinent conversations. Some conversations pertain to the potential for VR's impact on learning new skills, attitudes, and processes—such implications that have been mused about in science fiction for decades. Other conversations, such as in the realm of entertainment, have focused more on how the technology can be further integrated into society through engagement, accessibility, and user-friendliness. A commonality between all these conversations is the core concern of how users are engaging with VR experiences. So, while all of these topics hold value in exploring VR, they are ultimately of little concern until other fundamental inquiries are thoroughly addressed: (1) how do users of the technology perceive their experiences, and (2) what elements of these virtual experiences should be optimized? This is to say that VR cannot be expected to maximize one of its most powerful traits—its ability to give its user the immersive experience of a completely different environment—if the user does not perceive the digital environment as being both credible and desirable. Researchers, developers, and advocates for VR all have a general understanding of the importance for digital experiences to be convincing (credible) and to be something that users want to be a part of (desirable). Fortunately, VR is not the first area of study to explore this territory, as these questions of credible and desirable experiences bare strong similarities to existing conversations around video games.

A brief glance at the timeline of video games reveals the industry's efforts to entice players with more realistic and engaging experiences. These efforts have manifested in several forms, such as the evolution of visual graphics, the refinement of gameplay mechanics, and an increasing emphasis on story development. And while the argument can be made that video games tend to favor desirability over credibility (the cartoon-nature of *Super Mario* can hardly be considered a realistic environment), the shared links with current conversations in VR cannot be ignored. But even if one were to dismiss these similarities, the integration of VR in modern society has relied heavily on the existing infrastructure of the video game industry. Even as VR is experiencing its own revolution with an increased availability of technology, video games continue to display their dominating presence in society. As of 2017, an estimated 65% of American households included someone who plays video games, with 71% of parents viewing video games as having a positive impact on their children (Entertainment Software Association, 2017). Additionally, video game sales continue to outperform any other form of entertainment media, with Rockstar's *Grand Theft Auto V* (2013) reaching the highest grossing media title of all time

(McGonagle, 2018). In recent years, the video game industry has served as a catalyst for VR technology to enter the homes of general consumers through popular title releases such as *Resident Evil VII, Lone Echo*, and *Beat Saber*. And in 2018, Steam, the largest distributor of video game software for PC gamers, reported an estimated 276% increase in VR users over an 18-month period (Lang, 2018). Despite having such a clear, symbiotic relationship with one another, research on video games and virtual reality have mostly remained independent from one another.

Unfortunately, the development of in-depth research exploring the experiential links between VR and video games is hampered by inconsistent terminology and constructs used to describe players' perceived experiences. Specifically, scholars have been unable to come to a consensus in defining experiential terms such as immersion and presence when researching participant experiences with video games and VR. A close examination of presence, immersion, and how these terms relate to VR and video games is necessary to begin understanding the true potential of where the two areas of study intersect. First, a review of existing literature will explore the foundations that make up VR and video games, where research about the two have intersected in the past, especially in terms of terminologies describing user experiences. Then, this study uses a mixed methods approach to compare the use of the term "presence" in the VR experience to the use of the term "immersion" in the video game experience. Using a focus group exploring the gamer's experience in VR followed by a questionnaire combining measures of presence, immersion, and focus group responses, this study aims to further clarify key differences and similarities between presence and immersion. This is done to create the foundation for a new research scale combining elements of both VR and gaming experiences, supporting future studies to push the developments and applications of VR.

CHAPTER TWO

LITERATURE REVIEW

Before we dive into the literature surrounding VR and video games, it is important to grasp some fundamental differences between similar virtual experiences: augmented reality (AR) and mixed reality (MR). Differentiating these experiences is best achieved by identifying their objectives. For starters, the goal of VR is to place an individual within a mediated digital "alternate world" while AR "aims to blend reality with the virtual environment, allowing users to interact with both physical and digital objects" (Johnson, Adams Becker, Cummins, Estrada, Freeman, and Hall, 2016, p. 40). A prime example of AR would be the 2016 phenomenon *Pokemon Go,* which combined programmed visuals with real world environments (Martin, 2017). And while both VR and AR rely on the mediation of perception, the process is done in different ways. In short, where VR aims to separate an individual's perception of the physical world from the digitally-mediated space, AR seeks to combine the two, placing a digital overlay onto a real-life environment.

Meanwhile, MR has been described as a combination of "the best elements of VR and AR to render an environment that remains grounded in the real world" (Martin, 2017). The argument can be made that MR is a heightened form of AR and that distinguishing the two can come down to a matter of operational perspectives rather than distinct characteristics (Engberg & Bolter, 2014). But while a clear and consistent differentiation of MR from AR is still lacking, their difference from VR is more distinct—VR aims to place users in a new virtual environment, while AR and MR aim to alter the perception of the existing environment. Now that VR has clearly been differentiated from AR and MR, the next section will explore the unique qualities and terminologies surrounding VR experiences.

Virtual Reality

At the very mention of VR, one might visualize some form of bulky headgear that projects a digital display directly into the user's eyes, which wouldn't be far from early understandings of the technology. In fact, most early definitions of VR focused on the specific technology associated with it, typically involving goggles or gloves (Steuer, 1992). One such definition comes from Greenbaum (1992, as cited by Steuer, 1992), describing VR as "an alternate world filled with computer-generated images that respond to human movements" and is "visited with the aid of an expensive data suit which features stereophonic video goggles and fiber-optic data gloves" (p. 58). With that said, the technology most popularly associated with VR is the head-mounted display (HMD)–equipment that not only projects biocular and monoscopic visuals to the user but is also typically capable of providing a detailed auditory environment while also tracking movements of the user's head and hands. The HMD is an appealing option for those most interested in VR, as it can simulate stressful, or even dangerous, scenarios "without the danger that poor performance will lead to injury or death" (Moss & Muth, 2011, p. 308). As other researchers have pointed out, however, VR can be experienced through a multitude of methods, including desktop computers and entire rooms dedicated to projecting images (Wilson, 1997).

Steuer (1992) argues, however, that VR should be defined in terms of a human experience rather than the type of hardware, especially from a communication studies perspective. As a result, VR has come to be identified less by a particular type of hardware and more as a form of presence–otherwise known as *telepresence.* As such, Steuer defines VR as "a real or simulated environment in which a perceiver experiences telepresence" (p. 76).

Exploring Virtual Reality Terminologies

Telepresence cannot be thoroughly defined without first understanding *presence*. At its core, presence can be defined as "the sense of being in an environment" (Steuer, 1992). More precisely, the concept of presence does not pertain to the actual physical environment, but rather an individual's perception of that environment. Steuer emphasizes, however, that this sense of being is taken for granted in an unmediated environment. When this perception is mediated via communication technology—such as VR—then the individual experiences two forms of presence: the perception of actual reality in their physical location and the perception of the mediated reality created by the technology (Witmer & Singer, 1998). In this circumstance, the perception of the mediated reality would be *telepresence*, which has been defined by Steuer (1992) as "an experience of presence in an environment by means of a communication medium" (p. 76). The environment described by Steuer is synonymous with Schroeder's (2008) definition of a virtual environment as "a computer-generated display that allows or compels the user (or users) to have a sense of being present in an environment other than the one they are actually in, and to interact with that environment" (p. 2). Thus, VR can be summarized as a user's experience of telepresence within a virtual environment.

Even though telepresence is a completely acceptable term to use when studying VR, many researchers have opted to use the general term "presence" even when examining mediated environments (Faas, Bao, Frey, & Yang, 2014; Lee, 2004; Silva, Donat, Rigoli, Oliveira, & Kristensen, 2016). To remain consistent with most existing research and avoid confusion, this manuscript will continue to use the term presence to reference the mediated perception created by VR technologies.

Now that there is an understanding as to what presence is, we will examine how the experience is measured. Witmer and Singer (1998) developed one of the first questionnaires to quantify presence experienced within a virtual environment, which has become foundational to understanding that experience. Through this process, Witmer and Singer identified two key concepts that make up the experience of presence: involvement and immersion. Involvement is defined as "a psychological state experienced as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events" (p. 227). This would imply, for example, that an individual focusing on personal problems in the real world would have lower levels of involvement, and thus lower levels of experienced presence. Immersion, on the other hand, is described as "a psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences" (Witmer & Singer, 1998, p. 227). According to Witmer and Singer, immersion requires a level of isolation, interaction, control, and the perception of self-movement. From this approach, immersion ties closely with an individual's perceived ability to seamlessly interact with a virtual environment. To summarize, Witmer and Singer's presence questionnaire relies on the interconnection between immersion and involvement.

Though Witmer and Singer's model has been important in laying out the foundation for understanding presence, others, like Slater (2003), have opted for a different approach. Where Witmer and Singer (1998) originally identified presence as an experience combining involvement and immersion, Slater (2003) instead defines presence as the human reaction to immersion. A key difference in the terminology stems from Slater's definition of immersion (which is notably different from Witmer and Singer's definition) stating that it is the extent to which "a system delivers displays (in all sensory modalities) and tracking that preserves fidelity in relation to their equivalent real-world sensory modalities" (p. 1). Using this definition, an increase in immersion can be obtained simply by using technology with greater appeal to the senses. An example of this would be using "more immersive" technology such as a head-mounted display with 360 sound, while the less immersive technology would be viewing the same simulation on a standard computer screen with a stereo speaker. This definition has some glaring differences from the one put forth by Witmer and Singer (1998). While Slater's (2003) definition of immersion describes an objective quality of technology, Witmer and Singer's (1998) describes an individual's subjective response to an experience (Slater, 1999). Slater's (2003) approach to defining immersion measures the concept as an ordinal variable, making it difficult to place on an accurate scale of measurement for quantitative research such as the current study. It is, however, the approach that seems to be more popular in VR research (Baños, Botella, Alcañiz, Liaño, Guerrero, & Rey, 2004; Faas et al., 2014; Ragan, Sowndararajan, Kopper, & Bowman, 2010; Rosa, Morais, Gamito, Oliveira, & Saraiva, 2016).

The Multimodal Presence Scale (MPS)

Lee (2004) provides an alternate, more comprehensive approach to understanding presence by breaking the concept into three distinct groups based on the main sense experiences: physical presence, social presence, and self-presence. Using Lee's approach, Makransky, Lilleholt, and Aaby (2017) developed the multimodal presence scale (MPS) to quantify and measure presence in VR. As a verified and more recent method for measuring perceived presence, the MPS will be key in this study. For this reason, the next few sections will focus on the specific items that make up physical presence, social presence, and self-presence.

Physical presence refers to the perception of physical objects within a virtual environment as actual objects (Lee, 2004). Makransky et al.'s (2017) approach to quantifying physical presence identifies five attributes: (1) physical realism (perceiving the virtual environment as mimicking physical and causal qualities of real life), (2) "not paying attention to the real-world environment", a (3) "sense of control in the virtual environment", a (4) "sense of being in the virtual environment", and (5) "not being aware of the physical mediation" (p. 277). Lee (2004) also mentions that a form of mental transportation—or a feeling of self-existence in the virtual environment—is not necessary for physical presence to take place, and thus can even include low-tech virtual experiences.

Where physical presence pertains to virtual objects, social presence refers to virtual experiences with social actors or avatars (i.e., simulated humans) being perceived as actual social encounters (Lee, 2004). Makransky et al. (2017) identify four attributes of social presence worth examination. The "sense of coexistence" attribute refers to a user's feeling of being in the presence of other human beings within a virtual environment. "Human realism," the second attribute of social presence, refers to the extent to which a user perceives human avatars as being credible as opposed to simply recognizing them as computerized images. "Not being aware of the artificiality of social interaction" is another attribute that is measured based on whether users interpret their interactions as being with another human or just a simulated experience. Finally, "not being aware of the social mediation" is an attribute that would measure higher as the user becomes less aware to the mediation process of a social interaction within a virtual environment.

The third aspect of presence explored by Lee (2004) is self-presence, which is described as "a psychological state in which virtual self/selves are experienced as the actual self" (p. 46). Following this definition of self-presence, Makransky et al. (2017) identified four attributes to consider. The first of these attributes is "sense of self being in the virtual environment," referring to a user perceiving their actual self as being present in a virtual environment. A "sense of bodily connectivity" refers to the extent to which a user identifies their physical body and virtual body as being the same unit. The third attribute, identified as a "sense of bodily extension," refers to "the extent to which users experience their body being extended through a medium into the virtual world" (p. 278). Finally, the "emotional connectivity" attribute refers to a user's emotional experiences within the mediated space caused by events taking place within the virtual environment. While the MPS provides a thorough measurement for the dimensions of presence, the scale is still relatively new and requires further validation in VR research.

Now that VR and presence have been examined, the next section will focus on video game experiences. This includes an in-depth look at the experience of immersion as it pertains to video games, as well as the general criteria for what qualifies as a video game.

Video Games

Unfortunately, there is no simple means to describing what a video game is—a wealth of research operates under the assumption that individuals are already familiar with the social perception of video games that little effort is put into defining them. Instead, many researchers tend to classify each game within a specific category based on function, such as educational games, digital entertainment games, or serious games (Boyle, Connolly, Hainey, & Boyle, 2012; Connolly, Boyle, MacArthur, Hainey, & Boyle 2012; Boyan & Sherry, 2011; Virvou, Katsionis, & Manos, 2005). Even when placed within one of these categories, video games lack a general, unified definition. This serves as a potential problem when video game studies overlap with VR research, particularly when aiming to differentiate video games from other VR experiences.

But while video games lack a consistent definition among various existing research, that does not eliminate the need to expand on the term within the context of the research presented in this manuscript. First, this manuscript identifies video games based on their foundational quality as interactive digital media. To remain distinct from other interactive experiences, video games should also have a quality that promotes interaction with digital objects or environments. Such qualities might include a narrative requiring user interaction to progress forward (i.e., role playing games) or digitally mediated mechanics required to achieve a goal (i.e., *Tetris*). Either way, video games provide users with a goal—or in some cases an intricate digital environment for users to develop their own goals (i.e., *Minecraft*). Equipped with these parameters, a video game is inherent to software as opposed to a type of hardware or user experience. This would mean that video game software can be experienced in VR; however, not all digital experiences (including some in VR) would classify as a video game. Regardless, different areas of research are only just beginning to examine the use of VR hardware, and video games serve as an important early adopter of such VR technology (Parker, 2017). And now that the criteria for understanding what qualities make up a video game, the next section will concentrate on the terminology associated with the user experience.

Defining Immersion in Video Game Research

Where research on VR tends to use the term presence to describe a user's experience, research on video games instead tends to use the term immersion. With that said, it is worth repeating that different types of research use different definitions for immersion. Where Slater (2003) identifies immersion as being determined by the technology, Witmer and Singer (1998) identify immersion as a psychological state of envelopment within a virtual space. Meanwhile, Jennett, Cox, Cairns, Dhoparee, Epps, Tijs, & Walton (2008) argue that immersion is "the result of a good gaming experience" (p. 657). As such, Jennett et al. approaches immersion as a concept closely tied to video games. This take on immersion describes the process as more of an emotional investment in an experience–one that can be positive, negative, or a combination of both. Similar to Witmer and Singer (1998), Jennett et al. (2008) contest that immersion is a graded process and thus can be measured by subjective measures (i.e., a questionnaire) or objective measures (i.e., eye tracking). Through their research on users' gaming experiences, Jennett et al. developed a questionnaire to quantify immersion. The following section will examine the specific elements of the immersion questionnaire.

The Immersion Questionnaire

As the dimensions of the MPS are vital to understanding presence, the dimensions within the questionnaire developed by Jennett et al. (2008) will be important to understanding immersion. Because the goal of this research is to understand the relationship between terminology in VR research and video games, Jennett et al.'s (2008) "gaming-focused" approach to immersion will be vital. They assert that immersion "involves a lack of awareness of time, a loss of awareness of the real world, involvement and sense of being in the task environment" (p. 657). The actual process of immersion is noted to take several elements of cognitive absorption (Agarwal & Karahana, 2000) as well as concepts derived from work by Brown and Cairns (2004). Jennett et al.'s (2008) take on immersion pulls five dimensions from previous research on cognitive absorption: (1) temporal dissociation, (2) focused immersion, (3) heightened enjoyment, (4) control, and (5) curiosity.

The first dimension taken from cognitive absorption is temporal dissociation, which refers to an individual's inability to properly perceive the passage of time while engaged with a software (Agarwal & Karahana, 2000). Focused immersion pertains to an individual being in a state of complete engagement to the point that all other demands for attention are ignored. Heightened enjoyment, as the name implies, is the process of an individual taking in the pleasurable elements of an interaction. Control refers to an individual's perception of overseeing their experience. Finally, curiosity refers to the arousal of an individual's sensory (i.e., visual responses to stimuli) and cognitive curiosity (i.e., piquing interest) caused by the experience.

The immersion questionnaire doesn't draw concepts just from cognitive absorption. Four items were also derived from research by Brown and Cairns (2004): (1) emotional involvement, (2) transportation to a different place, (3) attention, and (4) control and autonomy (Jennett et al., 2008). Emotional involvement can be a positive or negative experience, including increased empathy for a game's characters or having a deep feeling of suspense from the game's story. Transportation to a different place might be experienced in the form of having a lesser attachment to the "real world" and more of a desire to focus on the digitally created world. Attention refers to the player's level of awareness to events taking place outside of the game while playing. And finally, control and autonomy refer to the ease of controlling and interacting with the digital space.

Jennett et al.'s (2008) quantification of immersion also draws heavily from research by Brown and Cairns (2004). The qualitative study takes a grounded approach, identifying three stages of immersion within gaming experiences. The first of these stages, engagement, requires an individual to "invest time, effort, and attention" into their experience (p. 1298). Brown and Cairns contest that for engagement to take place, a game must first be accessible, meaning that the game style should be enjoyable to the player and have learnable controls. Engagement also requires a game to invoke a level of effort from players to learn how to play. After a player has reached the level of engagement, they are an emotional investment away from *engrossment* (Brown & Cairns, 2004). As this emotional investment takes place, gamers can expect to experience a lower degree of physical environmental awareness. Additionally, Brown and Cairns note that when a player becomes engrossed, "the game becomes the most important part of the gamers' attention and their emotions are directly affected by the game" (p. 1299). The final stage of immersion, according to Brown and Cairns' (2004) grounded approach, is *total immersion*. The state of total immersion is characterized by a feeling of "being cut off from reality", with participants of the study expressing a level of detachment "to such an extent that the game was all that mattered" (p. 1299). Brown and Cairns contest that total immersion equates to presence, an assertion that potentially convolutes the conversation about VR and further justifies the necessity of this current study. Fortunately, Jennett et al. (2008) details primary differences between immersion and presence—as well as other similar concepts that have been used to describe user experiences with media.

The first concept Jennett et al. (2008) differentiates from immersion is presence. Much like immersion, the concept of presence has varied in definition depending on the researcher. Despite this inconsistency, however, Jennett et al. assert that while many experiences utilize both immersion and presence, it is possible to experience one without the other. An example presented is Tetris, a game with an environment that bears no semblance to the real world yet can still be immersive in nature. On the other hand, "one could imagine a person feeling present in a virtual environment but not experience a lost sense of time" (p. 643)

Aside from presence, Jennett et al.'s (2008) definition of immersion shares many similarities with other concepts often used in digital media studies. To address this issue, key differences are dissected in hopes of differentiating a definition of immersion that can be consistent across video game research. Another concept that runs similar to Jennett et al.'s definition of immersion is flow. Flow theory is concerned with the quality of an experience, with the state of flow referring to the optimal positive experience that one can attain from an activity (Csikszentmihalyi, 1990). Studies of flow have ranged across numerous experiential platforms, from playing a pleasant game of chess to diving into virtual environments (Jennett et al., 2008). Jennett et al. (2008) note that immersion is similar to flow in that both concepts involve a process of "tuning out" thoughts and distractions that are not relevant to the activity at hand. Brown and

Cairns (2004) echo the similarities between immersion and flow, stating that "flow has some parallels with immersion, in the fact that attention is needed, sense of time is altered, and sense of self is lost" (p. 1300). The difference, however, is that immersion is "not always so extreme" as the optimal experience described by flow (p. 642). Therefore, Jennett et al. describe immersion as a precursor to flow, and that an individual could achieve immersion without experiencing flow.

Finally, Jennett et al. (2008) differentiates immersion from cognitive absorption. Once again, both concepts are concerned with an individual's level of involvement; however, Jennett et al. argue that, cognitive absorption is concerned with an individual's involvement with information technology on a general scale, while immersion is concerned with "the actual experience of a particular occasion" (p. 643). An interesting note is the overlap of cognitive absorption with flow, in that cognitive absorption "incorporates the control, curiosity, and focused attention dimensions of flow" (Agarwal & Karahana, 2000, p. 673). A closer examination of the similarities between immersion and other media concepts such as flow and cognitive absorption, however, is for another study—this initial comparison is simply meant to differentiate immersion from similar concepts.

While Jennett et al.'s (2008) definition of immersion appears to be similar to Witmer and Singer's (1998), the focus on video games makes for the primary difference between the two. Research in video games often give special attention to the variable of immersion in ways that other media might not be able to examine. One study on the correlation between game difficulty and player immersion concluded that moderate variations in game difficulty throughout an experience is vital to maintaining a high level of immersion (Qin, Rau, & Salvendy, 2010). Qin et al. note that the applications of this research extend beyond entertainment games and can be applied to educational games as well. Other research also mention that the social aspects of video games can act as variables affecting immersion, finding that players are generally more immersed in a gameplay experience when playing against another player as opposed to a computer (Cairns, Cox, Day, Martin, & Perryman, 2013).

Based on the existing literature, there is clear overlap between concepts used to examine VR and video gaming experiences. With such a wide variety of concepts for researchers to choose from, there is plenty of room for confusion as these areas of study begin to converge. For this reason, there is an increasing need for clarification, streamlining, and unification of terminology that can be used in future studies. The current study focuses on presence and immersion in particular because of the close relationship between the two; a valid scale for measuring these user experiences can further facilitate future research involving video games in VR.

Research Questions

This study draws primarily from research on presence by Lee (2004) and Makransky et al. (2017) focusing on physical presence, social presence, and self-presence in virtual environments. Makransky et al.'s multimodal presence scale (MPS) creates a foundation for measuring presence, however this potentially can be further refined for research on VR games. To achieve this refinement, additional variables can be drawn from Jennett et al.'s (2008) research on immersion in video games. Furthermore, it is worth investigating if there are other variables that can be incorporated into the MPS. This leads to the objective of the study, which is to explore additional variables that impact a users' perceived presence in a virtual reality (VR) gaming experience that do not already exist in the MPS.

Because the MPS consists of three forms of presence—physical presence, social presence, and self-presence—this research aims to answer the following research question:

RQ1: What does the gaming experience of immersion offer for enhancing the operationalization of presence?

RQ2: What factors impact a user's perceived physical, social, and self-presence in a VR gaming experience?

CHAPTER THREE

METHODOLOGY

This study used two research methods: a focus group and a survey. First, a focus group of five participants was conducted for the purpose of exploring any factors that might impact physical presence, social presence, and self-presence to be employed in building the second research method, which is the questionnaire.

Focus Group

Participants in the focus group were recruited from two Facebook interest pages focused on video games: Podcast Beyond and Kinda Funny Games. Message posts were used in the interest groups to recruit participants on a voluntary basis. Participants who volunteered to take part in the focus group were all males between the ages 18 and 35—which is representative of the primary demographics for VR users (Henry, 2017). Because the focus group questions were based on Makransky et al.'s (2017) and Lee's (2004) work, and since the analysis of the focus group drew from elements of Jennett et al.'s (2008) immersion questionnaire, each participant was required to have prior experience with playing both video games and VR games. Gameplay habits among individuals can be somewhat unpredictable in terms of frequency and length due to variables such as time, access, and responsibilities. Taking this into account, at least 3 hours of video gameplay over the past six months qualified a participant for prior experience with video games while playing a VR game at least once within the past six months qualified a participant for experience playing VR games. This was to ensure that the pool of participants was not too limited while also ensuring that the VR gaming experience was recent enough for participants to recall details for the focus group.

Due to the recruiting method through online interest groups, and because of the geographic distribution of the participants, the focus group discussion took place via the video chat software (Zoom) and lasted for one hour. The first few questions of the focus group were aimed at engagement to get participants more comfortable with each other and the discussion topic. After some initial discussion from the engagement questions, the moderator proceeded to ask questions focused on physical presence, social presence, and self-presence (see Appendix A). These questions were developed based on the definitions of physical presence, social presence, and self-presence of VR experiences provided by Lee (2004) and Makransky et al. (2017), with alterations in wording to make them more conversational. Responses to these questions would later be compared against Jennett et al.'s (2008) video games-based immersion questionnaire. Finally, exit questions were asked to (a) ensure that the necessary topics have been thoroughly covered and (b) collect additional recruiting information for the survey portion of the research. The exit questions resulted in good suggestions about where to recruit survey participants such as Gamecatz and Reddit. In addition, the respondents suggested that a good time interval of playing VR games would be “within the last year”, for the purpose of recruiting participants for the questionnaire portion of the study. After confirming with the participants that the topics had been sufficiently covered, the focus group adjourned.

Data from the focus group were collected in three forms: video recording, audio recording, and written notes. Participants were provided with an informed consent form that required their signature (written or digital) before participating in the focus group. All information pertinent to identifying participants remained confidential, with recordings stored in an encrypted folder on a password protected desktop computer. Recorded data was then transcribed, assigning all participants a number (i.e., Participant 1, Participant 2, etc.), after which the recorded data was permanently deleted to maintain anonymity. Written notes were taken during the focus group to note exceptionally interesting responses and mitigate the loss of data in the event of recording equipment failure. These notes do not reflect any identifiable information of participants.

A content analysis was performed on the focus group transcript to identify attributes that might impact perceived presence; these were later categorized under three predicted factors: (1) “quality of software experience”, (2) “quality of interface experience”, and (3) “user’s response to experience”. At the same time, these identified attributes were compared to Jennett et al.’s (2008) scale to examine if those matched the attributes in Jennett et al.’s immersion questionnaire or differed from them. A full breakdown of the coding scheme can be found in Appendix B. The results of the content analysis were then used for the survey portion of the study.

Survey Questionnaire

The second research method of the study consisted of a survey questionnaire distributed to 123 qualifying respondents (n = 123)—101 male and 22 female—who have played both video games and VR games. Based on the feedback generated from the focus group exit question, questionnaire participants' most recent VR experience were within the last year—this was to ensure a large enough pool of respondents while maintaining recency with the VR experience to recall the necessary details. Screening questions were included at the beginning of questionnaire to ensure that the respondents met the appropriate criteria. Additional demographic data was also collected at the end of the questionnaire, including respondents' gender, age, level of education, and annual income.

The questionnaire was created in Qualtrics and initially distributed through the following Facebook groups: Podcast Beyond, Kinda Funny Games, PlayStation VR, PlayStation VR Owners, HTC Vive Owners, Oculus GO, Oculus Go Community, Oculus Virtual Reality, and Oculus Go for Education. Due to a low response rate from women (initially only 2% of responses), a Facebook search was conducted to identify groups specifically targeting females, resulting in the addition of the interest group Women in VR/AR. This addition resulted in a significant increase in female responses. The questionnaire was also distributed on Reddit under the categories: r/oculus, r/vive, r/VRGaming, and r/virtualreality. Data from the questionnaire was collected using the survey software (Qualtrics), making sure that the data would remain anonymous. The survey consisted of items from three sources: (1) Makransky et al.'s (2017) multimodal presence scale (MPS), (2) Jennett et al.'s (2008) immersion questionnaire, and (3) additional items derived from the focus group in the first portion of the study.

Multimodal Presence Scale (Makransky et al., 2017)

First, the MPS (Makransky et al., 2017) was used to measure respondents' perceived level of physical presence, social presence, and self-presence. Items categorized under physical presence measured the attributes "physical realism" (PR), "not paying attention to the real environment" (NPARE), "sense of being in the virtual environment" (SBVE), and "not aware of the physical mediation" (NAPM) (Makransky et al., 2017, p. 281). Items categorized under social presence measured the attributes "sense of coexistence" (SC), "human realism" (HR), "not aware of social mediation" (NASM), and "not aware of the artificiality of social interaction" (NAASI) (p. 281). Items categorized under self-presence measured the attributes "sense of bodily extension" (SBC) and "sense of bodily extension" (SBE) (p. 281).

Table 1. Makransky et al. (2017) Multimodal Presence Scale (MPS)

Category	**Attribute**	**Item**
Physical Presence	PR	The virtual environment seemed real to me.

Physical Presence	NAPM	I had a sense of acting in the virtual environment, rather than operating something from outside.
Physical Presence	PR	My experience in the virtual environment seemed consistent with my experiences in the real world.
Physical Presence	SBVE	While I was in the virtual environment, I had a sense of "being there".
Physical Presence	NPARE	I was completely captivated by the virtual world.
Social Presence	SC	I felt like I was in the presence of another person in the virtual environment.
Social Presence	HR	I felt that the people in the virtual environment were aware of my presence.
Social Presence	HR	The people in the virtual environment appeared to be sentient (conscious and alive) to me.
Social Presence	NASM	During the simulation there were times where the computer interface seemed to disappear, and I felt like I was working directly with another person.
Social Presence	NAASI	I had a sense that I was interacting with other people in the virtual environment, rather than a computer simulation.
Self-Presence	SBE	I felt like my virtual embodiment was an extension of my real body within the virtual environment.
Self-Presence	SBC	When something happened to my virtual embodiment, it felt like it was happening to my real body.
Self-Presence	SBE	I felt like my real arm was projected into the virtual environment through my virtual embodiment.
Self-Presence	SBC	I felt like my real hand was inside of the virtual environment.
Self-Presence	SBC	During the simulation, I felt like my virtual embodiment and my real body became one and the same.

Because the MPS was initially designed to collect data from respondents in a controlled experiment, the scale had to be modified to collect responses without the use of an experiment. To do this, each item of Makransky et al.'s (2017) MPS was modified to have respondents recall their most recent VR gaming experience, instead of their experience in a controlled environment.

Another modification to the MPS involved the social presence category. Based on responses from the focus group, it was determined that social interactions within VR game environments were not limited to just humans, but non-human entities (i.e., animals, robots, etc.) as well. For this reason, items within the social presence category had all language referring to "human(s)" and "person/people" altered to "lifeform(s)". The full list of the MPS items used in this study can be found in Table 2 below (changes to the items have been highlighted).

Table 2. Modified Makransky et al. (2017) Multimodal Presence Scale (MPS)

Category	**Attribute**	**Item**
Physical Presence	PR	In my latest VR gaming experience, the virtual environment seemed real to me.
Physical Presence	NAPM	In my latest VR gaming experience, I had a sense of acting in the virtual environment, rather than operating something from outside.
Physical Presence	PR	In my latest VR gaming experience, my experience in the virtual environment seemed consistent with my experiences in the real world.
Physical Presence	SBVE	In my latest VR gaming experience, while I was in the virtual environment, I had a sense of "being there".
Physical Presence	NPARE	In my latest VR gaming experience, I was completely captivated by the virtual world.
Social Presence	SC	In my latest VR gaming experience, I felt like I was in the presence of another lifeform in the virtual environment.
Social Presence	HR	In my latest VR gaming experience, I felt that the lifeforms in the virtual environment were aware of my presence.
Social Presence	HR	In my latest VR gaming experience, the lifeforms in the virtual environment appeared to be sentient (conscious and alive) to me.

Social Presence	NASM	During my latest VR gaming experience there were times where the computer interface seemed to disappear, and I felt like I was working directly with another lifeform.
Social Presence	NAASI	In my latest VR experience, I had a sense that I was interacting with other lifeforms in the virtual environment, rather than a computer simulation.
Self-Presence	SBE	In my latest VR gaming experience, I felt like my virtual embodiment was an extension of my real body within the virtual environment.
Self-Presence	SBC	In my latest VR gaming experience, when something happened to my virtual embodiment, it felt like it was happening to my real body.
Self-Presence	SBE	In my latest VR gaming experience, I felt like my real arm was projected into the virtual environment through my virtual embodiment.
Self-Presence	SBC	In my latest VR gaming experience, I felt like my real hand was inside of the virtual environment.
Self-Presence	SBC	During my latest VR gaming experience, I felt like my virtual embodiment and my real body became one and the same.

Immersion Questionnaire (Jennett et al., 2008)

This study's questionnaire also incorporated Jennett et al.'s (2008) immersion scale, exploring the attributes challenge (CHL), heightened enjoyment (HE), emotional involvement (EI), attention (ATN), transportation to a different place (TDP), and temporal dissociation (TDS). Jennett et al.'s (2008) immersion questionnaire consists of 31 questions: 6 questions addressing CHL, 4 questions addressing HE, 5 questions addressing EI, 4 questions addressing ATN, 6 questions addressing TDP, and 6 questions addressing TDS. The language of each item was modified to have respondents recall their most recent VR gaming experience. Items from Jennett et al.'s immersion questionnaire can be viewed in Table 3 below.

Table 3. Items from Jennett et al.'s (2008) Immersion Questionnaire

Category	Attribute	Item
Challenge	CHL	During your latest VR gaming experience, to what extent did you find the game challenging?
Challenge	CHL	Were there any times during your last VR gaming experience in which you wanted to give up?
Challenge	CHL	During your latest VR gaming experience, to what extent did you feel motivated while playing?
Challenge	CHL	During your latest VR gaming experience, to what extent did you find the game easy?
Challenge	CHL	During your latest VR gaming experience, to what extent did you feel like you were making progress towards the end of the game?
Challenge	CHL	How well do you think you performed in your last VR gaming experience?
Heightened Enjoyment	HE	During your latest VR gaming experience, to what extent did you enjoy the graphics and the imagery?
Heightened Enjoyment	HE	During your latest VR gaming experience, how much would you say you enjoyed playing the game?
Heightened Enjoyment	HE	Were you disappointed when your last VR gaming experience was over?
Heightened Enjoyment	HE	Would you like to play your last VR gaming experience again?
Emotional Involvement	EI	During your latest VR gaming experience, to what extent did you feel emotionally attached to the game?
Emotional Involvement	EI	During your latest VR gaming experience, to what extent were you interested in seeing how the game's events would progress?
Emotional Involvement	EI	During your latest VR gaming experience, how much did you want to "win" the game?
Emotional Involvement	EI	Were you in suspense about whether or not you would win or lose your last VR gaming experience?
Emotional Involvement	EI	During your latest VR gaming experience, at any point did you find yourself become so involved that you wanted to speak to the game directly?

Attention	ATN	During your latest VR gaming experience, to what extent did the game hold your attention?
Attention	ATN	During your latest VR gaming experience, to what extent did you feel you were focused on the game?
Attention	ATN	How much effort did you put into playing your last VR gaming experience?
Attention	ATN	During your latest VR gaming experience, did you feel that you were trying your best?
Transportation to a Different Place	TDP	During your latest VR gaming experience, to what extent did you feel that you were interacting with the game environment?
Transportation to a Different Place	TDP	During your latest VR gaming experience, to what extent did you feel as though you were separated from your real-world environment?
Transportation to a Different Place	TDP	To what extent did you feel that your last VR gaming experience was something you were experiencing, rather than something you were just doing?
Transportation to a Different Place	TDP	During your latest VR gaming experience, to what extent was your sense of being the game environment stronger than your sense of being in the real world?
Transportation to a Different Place	TDP	During your latest VR gaming experience, at any point did you find yourself become so involved that you were unaware you were even using controls?
Transportation to a Different Place	TDP	During your latest VR gaming experience, to what extent did you feel as though you were moving through the game according to your own will?
Temporal Dissociation	TDS	During your latest VR gaming experience, to what extent did you lose track of time?
Temporal Dissociation	TDS	During your latest VR gaming experience, to what extent did you feel consciously aware of being in the real world whilst playing?
Temporal Dissociation	TDS	During your latest VR gaming experience, to what extent did you forget about your everyday concerns?
Temporal Dissociation	TDS	During your latest VR gaming experience, to what extent were you aware of yourself in your surroundings?

Temporal Dissociation	TDS	During your latest VR gaming experience, to what extent did you notice events taking place around you?
Temporal Dissociation	TDS	During your latest VR gaming experience, did you feel the urge at any point to stop playing and see what was happening around you?

Focus Group Items

Finally, several items of this survey questionnaire emerged from the focus group responses. Items categorized under the "quality of software experience" included quality of sound design (QSD), quality of visual graphics (QVG), quality of objective (QO), quality of actors (QA), and visual presentation of avatar(s) (VRA). Additional items categorized under "quality of interface experience" included freedom of movement (FM), intuitive controls (IC), and comfortable integration of hardware (CIH). The full list of survey items derived from the focus group can be found in Table 4 below. The complete survey questionnaire for this study can be found in Appendix C.

Table 4. New Items Created from Focus Group

Category	**Attribute**	**Item**
Quality of Software Experience	QSD	How would you rate the overall sound design quality of your latest VR gaming experience?
Quality of Software Experience	QVG	How would you rate the overall visual graphics quality of your latest VR gaming experience?
Quality of Software Experience	QO	How would you rate the overall story quality of your latest VR gaming experience?

Quality of Software Experience	QA	How would you rate the quality of writing/voice acting in your latest VR gaming experience?
Quality of Software Experience	VRA	How would you rate the visual representation of your avatar in your latest VR gaming experience?
Quality of Interface Experience	FM	How would you rate your ability to move freely within the environment of your latest VR gaming experience?
Quality of Interface Experience	IC	How easy was it to understand the controls for your latest VR gaming experience?
Quality of Interface Experience	CIH	How would you rate the comfort of the hardware (head-mounted display and controllers) of your latest VR gaming experience?

CHAPTER FOUR

ANALYSIS

The survey questionnaire yielded 101 male responses, 22 female responses, and one unknown with insufficient information to include in the analysis (*n* = 123). Data collected from the survey was analyzed in SPSS, with all items with negative wording being recoded to be consistent with the rest of the questionnaire. To address RQ1, this study first used an exploratory factor analysis (EFA) on the 15 items derived from Makransky et al.'s (2017) MPS to examine if the modified items measured the appropriate underlying factors: physical presence, social presence, and self-presence. While an argument can be made for using a confirmatory factor analysis (CFA), the EFA was used due to the existence of modified items in the scale and a lack of access to statistical software capable of running a CFA. For these reasons, an EFA was deemed satisfactory for the purposes of this study.

Exploratory Factor Analysis: Multimodal Presence Scale

The factorability of the 15 MPS items was examined using well-established criteria: first, all 15 items had a minimum 0.3 correlation with another item in the analysis, suggesting a reasonable degree of factorability. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.83, greater than the recommended 0.6, and Bartlett's test of sphericity was significant ($p < 0.001$). Lastly, all reported communalities were greater than 0.3, confirming a common level of variance among the 15 MPS items. These measures justify the use of the data for a factor analysis.

A principle components analysis (PCA) was used to identify the underlying components measured by the MPS. Four components were identified based on eigenvalues greater than 1, with the first two factors explaining 37% and 12% of the variance, respectively. The third and fourth factors each explained another 8% of the variance. Solutions for three and four factors were examined using a varimax rotation of the factor loading matrix. The three-factor solution explained 58% of the variance and was preferable to the four-factor solution due to its theoretical support from Makransky et al. (2017) and Lee (2004). The four-factor solution, however, identifies an eventual divergence among physical presence, which is discussed in the next chapter.

Though all items had a primary factor loading of 0.4 or greater on the rotated component matrix, one item had a cross-loading difference of 0.3 or less. The item "during my last VR gaming experience, there were times where the computer interface seemed to disappear, and I felt like I was working directly with another lifeform" (SOC_4) loaded on both self-presence and social presence at 0.6 and 0.55 respectively. Due to the factors self-presence and social presence serving as sub-dimensions of predicting a user's perceived presence, the cross-loading of SOC_4 was deemed acceptable; however, this will be discussed in the next chapter. Additionally, while the item "I had a sense that I was interacting with other people in the virtual environment, rather than a computer simulation" loaded on both self-presence and social presence with a primary factor loading greater than .4, the cross-loading difference was greater than 0.3 at 0.42 and 0.76 respectively. The factor loading matrix can be seen below.

Table 5. MPS Factor Analysis Rotated Component Matrix

	Self-Presence	Social Presence	Physical Presence
SELF_5	.806		
SELF_3	.750		
SELF_1	.698		
SELF_4	.653		
SOC_4	.602	.545	
SELF_2	.508		
SOC_3		.864	
SOC_1		.787	
SOC_5	.417	.763	
SOC_2		.745	
PHYS_4			.698
PHYS_5			.664
PHSY_3			.624
PHYS_2			.561
PHYS_1			.536

Makransky et al.'s (2017) proposed factor labels matched the extracted factors and were retained. The internal consistency of each factor was tested for reliability with Cronbach's alpha. Two of the alphas were good: 0.82 for self-presence and 0.87 for social presence. The alpha for physical presence was between poor and moderate at 0.69. The elimination of items from any factor yielded no substantial increases to the alphas.

Overall, the CFA confirmed three factors consistent with Makransky et al.'s (2017) sub-dimensions of presence: physical presence, social presence, and self-presence. One item (SOC_4) shared strong correlations between self-presence and social presence. Additionally, the reliability of physical presence was significantly lower than the other two factors. All three factors were extracted to the SPSS data pool for further testing.

Exploratory Factor Analysis: Immersion

To further investigate RQ1, an EFA was performed on the 31 items derived from Jennett et al.'s (2008) immersion questionnaire to identify underlying components that potentially correlate with physical presence, social presence, and self-presence. The factorability of the 31 immersion items was examined using the same criteria as the previous EFA. First, all 31 items had a minimum 0.3 correlation with at least one other item in the analysis, suggesting a reasonable degree of factorability. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.75, greater than the recommended 0.6, and Bartlett's test of sphericity was significant ($p < 0.001$). Lastly, all reported communalities were greater than 0.3, confirming a common level of variance among the 31 immersion items.

A PCA was used to identify the underlying components measured by the 31 immersion items. Ten components were identified based on eigenvalues greater than one, with the first four factors explaining 23%, 9%, 8%, and 5% of the variance, respectively. Based on the scree plot and diminishing levels of variance, a parallel analysis was performed to check against the eigenvalues. Outputs from the parallel analysis identified three components based on eigenvalues, so the PCA was rerun for a three-factor solution. An additional PCA was run to extract a six-factor solution based on Jennett et al.'s (2008) theoretical framework on immersion. A varimax rotation was applied to both the three-factor and six-factor solutions. The three-factor solution was favorable based on the following criteria: (1) the eigenvalues produced by the parallel analysis, (2) the diminishing level of variance on the scree plot, and (3) the six-factor solution was inconsistent with Jennett et al.'s factorial labels.

Four items were removed due to having a primary loading factor below .4 on the rotated component matrix. The items "to what extent did you feel emotionally attached to the game" (EI_1), "to what extent did you feel that you were interacting with the game environment" (TDP_1), "to what extent did you feel as though you were moving through the game according to your own will" (TDP_6), and "were you disappointed when your last VR gaming experience was over" (HE_3) all had a primary loading factor below 0.4.

The PCA was run once more with the four items removed and a varimax rotation applied. This time, the item "at any point did you find yourself become so involved that you wanted to speak to the game directly?" (EI_5) had a loading factor below 0.4 and was removed.

The final PCA was performed on the remaining 26 items using a varimax rotation with three factors explaining 45% of the variance. All items in the rotated component matrix had a primary loading factor of 0.4 or greater, with none of the items cross-loading into other components. The final rotated component matrix for immersion can be viewed below.

Table 6. Immersion Questionnaire Rotated Component Matrix

	Involvement	Effort	Awareness of the Real World
ATN_1	.760		
CHL_3	.745		
HE_2	.706		
ATN_2	.684		
EI_2	.572		
CHL_6	.570		
HE_4	.502		
CHL_2	.499		
HE_1	.495		
TDP_3	.449		
TDP_6	.448		
TDS_1	.441		
CHL_5	.415		
CHL_1		.758	
ATN_3		.710	
CHL_4		.677	
EI_3		.618	
ATN_4		.587	
EI_4		.552	
TDP_4			.718
TDS_4			.701
TDS_2			.697
TDP_2			.656
TDS_5			.606
TDP_5			.490

TDS_3			.468

The factor labels proposed by Jennett et al. (2008) were inconsistent with the factors extracted from the EFA. Internal consistency for the new factors were examined using Cronbach's alpha. The alphas ranged from moderate to good: 0.82 for involvement, 0.75 for effort, and 0.75 for awareness of the real world. The elimination of items from any factor yielded no substantial increases in the alphas.

The principle component analysis extracted three factors that differed from Jennett et al.'s (2008) proposed six factors. Labeling these factors was determined based on the relationship among the items in each component, which resulted in involvement, awareness of the real world, and effort respectively. All three factors were extracted into the SPSS data pool for further testing.

Exploratory Factor Analysis: Focus Group Items

The third contributor to this study's survey questionnaire consisted of 8 items derived from the focus group in the first portion of the study. An EFA was performed to extract the underlying factors of these items to be then tested for correlation with physical presence, social presence, and self-presence. The factorability of the 8 focus group items was examined using the same criteria as the two previous EFAs. First, all 8 items had a minimum 0.3 correlation with at least one other item in the analysis, suggesting a reasonable degree of factorability. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.73, and Bartlett's test of sphericity was significant (p < 0.001). Lastly, all reported communalities were greater than 0.3, confirming a common level of variance among the 8 focus group items.

A PCA was used to identify the underlying components measured by the 8 focus group items. Three components were identified based on eigenvalues greater than 1, with the three factors explaining 39%, 18%, and 13% of the variance, respectively. Based on the scree plot, diminishing levels of variance, and predicted relationship among the items, a parallel analysis was performed to check against the eigenvalues. Outputs from the parallel analysis identified two components based on eigenvalues, so the PCA was rerun for a two-factor solution and three-factor solution with a varimax rotation. The two-factor solution was favorable based on the following criteria: (1) the eigenvalues produced by the parallel analysis, (2) the examined relationship among the items, and (3) the three-factor solution had a cross-loading item.

The two-factor solution of the 8 focus group items was consistent with the predicted factors: quality of the software experience and quality of the interface experience. All items had a primary loading factor greater than 0.4, and there were no cross-loading items. The rotated component matrix can be viewed below.

Table 7. Focus Group Factor Analysis Rotated Component Matrix

	Quality of Software Experience	Quality of Interface Experience
QOS_3	.876	
QOS_4	.862	
QOS_5	.609	
QOS_2	.589	
QOS_1	.493	
QOI_2		.834
QOI_3		.743
QOI_1		.688

The factor labels predicted in this study were inconsistent with the factors extracted from the EFA: quality of the software experience (QOS) and quality of the interface experience (QOI). Internal consistency for the two factors were examined using Cronbach's alpha. The alpha for the quality of the software experience was moderate with a value of 0.77, while the alpha for the quality of the interface experience was between poor and moderate at 0.69. The elimination of items from either factor yielded no substantial increases to the alphas.

Overall, the principle component analysis extracted two factors that were consistent with this study's predicted factors. The reliability for the second factor (quality of the interface experience), however, was poor and will be further examined in the discussion. Both factors were extracted into the SPSS data pool for further testing.

Pearson Correlation Test

In order to address RQ1, this study tested for a relationship between the three MPS factors (physical presence, social presence, and self-presence) and the factors extracted from the immersion questionnaire and focus group. To conduct this analysis, eight Pearson product-moment correlations were run through SPSS.

Physical presence was found to be positively related to immersion factor one (involvement) r (117) = 0.43, $p < 0.001$, which is considered a moderate relationship. Physical presence was found to be positively related to immersion factor two, r (117) = 0.32, $p < 0.001$, which is considered a moderate relationship. Physical presence was found to be positively related to immersion factor three, r (117) = 0.23, $p < 0.05$, which is considered a minimal relationship. Physical presence was found to be positively related to the quality of the software experience (QOS) r (121) = 0.21, $p < 0.05$, which is considered a minimal relationship. Physical presence was found to be positively related to the quality of the interface experience (QOI) r (121) = 0.31, $p < 0.01$, which is considered a moderate relationship. Self-presence was found to be positively related to involvement, r (117) = 0.29, $p < 0.01$, which is considered a minimal relationship. Self-presence was found to be positively related to immersion factor two, r (117) = 0.42, $p < 0.001$, which is considered a moderate relationship. Finally, social presence was found to be positively related to the quality of the software experience (QOS), r (117) = 0.21, $p < 0.05$, which is considered a minimal relationship.

In addition to identifying factors related to physical presence, social presence, and self-presence, the correlation test revealed other significant relationships worth noting. Involvement was found to be positively related to the quality of the software experience QOS, r (118) = 0.46, $p < 0.001$, which is considered a moderate relationship. Finally, immersion involvement was found to be positively related to the quality of the interface experience, r (118) = 0.47, $p < 0.001$, which is a moderate relationship. The full breakdown of correlations can be found in Appendix D.

Linear Regression

Physical Presence

Based on the correlations observed in the previous section, a multiple regression was conducted to evaluate how well the independent variables (involvement, effort, awareness of the real world, quality of the software, and quality of the interface could predict the dependent variable (perceived physical presence). The linear combination of the independent variables was significantly related to the perceived physical presence: F (5, 111) = 12.97, $p < 0.001$. The sample multiple correlation coefficient, R, was 0.61, which indicates that approximately 36.9 percent of the variance of an individual's perceived physical presence could be accounted for by the linear combination of involvement, effort, awareness of the real world, quality of the software, and quality of the interface.

However, only involvement (t = 3.62, $p < 0.001$, = β 0.37), effort (t = 2.85, p = 0.005, = β 0.22), and ARW (t = 4.26, $p < 0.001$, = β 0.32) accounted for any of the unique variance in an individual's perceived physical presence.

An additional multiple regression was conducted to isolate and evaluate how well the independent variables (quality of the software experience and quality of the interface experience) could predict the dependent variable (perceived physical presence). The linear combination of the independent variables was significantly related to the perceived physical presence: F (2, 118) = 9.47, $p < 0.001$. The sample multiple correlation coefficient, R, was 0.37, which indicates that approximately 13.8 percent of the variance of an individual's perceived physical presence could be accounted for by the linear combination of quality of the software experience, and quality of the interface experience. Both the quality of the software experience (t = 2.43, $p < 0.05$, = β 0.21), and awareness of the real world (t = 3.62, $p < 0.001$, = β 0.31) accounted for the unique variance in an individual's perceived physical presence.

<u>Social Presence</u>

A bivariate linear regression was conducted to evaluate the prediction of an individual's perceived social presence from their perceived quality of the software experience. The regression equation for predicting an individual's perceived social presence is

$$\text{Social presence} = (0.21 \times \text{QOS}) + 0.002$$

The linear combination of the quality of the software experience and social presence was significant: F (1, 119) = 5.4, $p < 0.05$. The sample multiple correlation coefficient (R) was 0.21, which indicates that approximately 4.3 percent of the variance in an individual's perceived social presence in the sample can be accounted for by an individual's perceived quality of the software experience.

Self-Presence

A multiple regression was conducted to evaluate how well the independent variables (involvement and ARW) could predict the dependent variable (perceived self-presence). The linear combination of the independent variables was significantly related to the perceived self-presence: F (2, 114) = 19.00, $p < 0.001$. The sample multiple correlation coefficient, R, was 0.50, which indicates that approximately 25 percent of the variance of an individual's perceived self-presence could be accounted for by the linear combination of involvement and ARW. Both involvement ($t = 3.48$, $p < 0.005$, = β 0.28), and ARW ($t = 5.09$, $p < 0.001$, = β 0.41) accounted for the unique variance in an individual's perceived self-presence.

Involvement

A multiple regression was conducted to evaluate how well the independent variables (quality of the software experience and quality of the interface experience) could predict the dependent variable (level of involvement). The linear combination of the independent variables was significantly related to an individual's level of involvement: *F* (2, 115) = 43.72, $p < 0.001$. The sample multiple correlation coefficient, *R,* was 0.66, which indicates that approximately 43.2 percent of the variance of an individual's level of involvement could be accounted for by the linear combination of the quality of the software experience and the quality of the interface experience. Both the quality of the software experience (t = 6.61, $p < 0.001$, = β 0.47), and the quality of the interface experience (t = 6.62, $p < 0.001$, = β 0.47) accounted for the unique variance in an individual's level of involvement.

<u>Involvement as a Mediator</u>

A multiple regression was conducted to test if involvement is a mediating variable between the independent variables (quality of the software experience and quality of the interface experience) and the dependent variable (physical presence). The linear combination of the independent variables was significantly related to the perceived physical presence: *F* (3, 113) = 10.64, $p < 0.001$. The sample multiple correlation coefficient, *R,* was 0.50, which indicates that approximately 22 percent of the variance of an individual's perceived physical presence could be accounted for by the linear combination of involvement, the quality of the software experience, and the quality of the interface experience. However, only involvement (t = 3.06, $p < 0.005$, = β 0.34), accounted for any of the unique variance in an individual's perceived physical presence, confirming involvement as a mediating variable.

CHAPTER FIVE

DISCUSSION

Confirming the Multimodal Presence Scale

The primary objective of this study was to identify impactful relationships between a user's perceived presence, perceived immersion, and any other factors that could be gleaned from a focus group on VR experiences. First, the revised MPS items had to be validated within the conceptual framework of physical presence, social presence, and self-presence as determined by Lee (2004) and Makransky et al. (2017). The PCA, based on the three-factor solution, revealed conceptual consistency with Makransky et al.'s theoretical framework. One item that predicted to measure social presence (SOC_4), however, loaded under both social presence and self-presence. Upon closer examination of SOC_4, the item was found to have language conducive to both elements of self-presence ("the computer interface seemed to disappear") and social presence ("I felt like I was working directly with another lifeform"). Future users of this item should try removing the self-presence language and test the SOC_4 item as "In my last VR gaming experience, there were times where I felt like I was working directly with another lifeform."

While the social presence and self-presence factors tested with good levels of reliability, physical presence tested lower in the poor to moderate range. One explanation for physical presence's low reliability lies in the results of the four-factor solution PCA, which extracted social presence and self-presence as factors while dividing items predicting physical presence into two separate factors: sense of being in the virtual environment and physical realism. This indicates that while “sense of being in the virtual environment” and “physical realism” are correlated to a certain degree (as determined in the three-factor solution), the two begin to diverge at a certain point. A likely reason for the divergence of physical realism lies in the sample, as each participant was asked to recall a gaming experience in VR. Consistent with Jennett et al.’s (2008) conceptual framework on immersion, gaming experiences can decrease a user’s awareness of the real world and increase their “sense of being in the task environment” through variables such as heightened enjoyment, attention, curiosity, and emotional involvement. This means that gaming experiences do not always rely on physical realism to pull the user into the virtual environment, but rather appeals more to other intrinsic motivations of the user. This is not to say that a virtual experience is confined to being one or the other—a VR experience such as *Resident Evil 7* combines physically realistic environments with story and gameplay elements aimed to spark the user’s curiosity and emotional involvement. This relationship between physical presence and immersion is explored later in the discussion.

Immersion Questionnaire Exploratory Factor Analysis

Based on Jennett et al.’s (2008) conceptual framework, the EFA was predicted to extract six factors: challenge, heightened enjoyment, emotional involvement, attention, transportation to a different place, and temporal dissociation. Instead, the EFA extracted three different factors that still shared conceptual similarities to the foundation of Jennett et al.'s model: involvement, effort, and awareness of the real world.

Immersion Factor One: Involvement

Factor one from the immersion EFA consisted of items measuring attention (ATN_1), motivation (CHL_2 and CHL_3), enjoyment (HE_1, HE_2 and HE_4), focus (ATN_2), perceived performance (CHL_5 and CHL_6), interest/curiosity (EI_2), and engrossment (TDP_3 and TDS_1). The correlation between the items of factor one bare a strong resemblance to the conceptual framework of cognitive absorption, which consists of temporal dissociation (TDS_1), focused immersion (ATN_1, ATN_2, and TDP_3), heightened enjoyment (HE_1, HE_2, and HE_4), control (CHL_5 and CHL_6), and curiosity (EI_2) (Jennett et al., 2008; Agarwal & Karahana, 2000). Leaving only CHL_2 and CHL_3 as the only outliers, this may suggest that "motivation" is also linked to cognitive absorption—most likely being a result of focused immersion, heightened enjoyment, and curiosity. Future research in cognitive absorption should incorporate items measuring motivation to confirm whether a conceptual relationship exists between the other existing variables.

Agarwal and Karahana (2000) have equated the construct of cognitive absorption to "a state of deep involvement with software" (p. 665). Additionally, the cognitive absorption construct begins to draw a parallel to Witmer and Singer's (1998) definition of involvement as being "a psychological state experienced as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events" (p. 227). Taking this into consideration, and because one of the goals of this study is to simplify the terminology surrounding immersion and presence, it is most beneficial to label factor one of the immersion questionnaire EFA as measuring the user's perceived "involvement."

An increased level of involvement in a VR gaming experience would be characterized by an increase in focus and attention stemming from a stimulated response (such as enjoyment or curiosity) to the tasks provided by the software. As the user's focus and attention increase, they become more engrossed in the experience (TDP_3) and are more likely to experience a lost sense of time (TDS_1). By this logic, a key component for involvement to take place would be software capable of stimulating a response from the user, which is tied to the user's initial motivation for engaging with the experience. For example, some individuals might prefer experiences with an intriguing story, and thus are more motivated to play a story-driven game such as *Hellblade: Senua's Sacrifice* over a gameplay-oriented game such as *Tetris Effect*.

Immersion Factor Two: Effort

The second factor extracted from the immersion questionnaire EFA contained items from several categories of Jennett et al.'s (2008) immersion conceptual framework including challenge (CHL_1 and CHL_4), attention (ATN_3 and ATN_4), and emotional involvement (EI_3 and EI_4). Due to the overlap in predicted factors, each item was closely examined and compared for similarities. The items CHL_1 and CHL_4 were found to appropriately address the user's perception of challenge, while ATN_3, ATN_4 addressed the user's exerted effort. The link between these items is best explained through Csikszentmihalyi's (1990) conceptual framework of flow, noting an important variable in predicting flow which is a balance between ability level and challenge. Csikszentmihalyi also mentions "clear goals" as another variable in predicting flow, which provides context for the remaining two items, EI_3 and EI_4, as addressing the user's desire to "win the game."

Despite conceptual similarities with flow, however, factor three of the immersion EFA does not include other variables from the flow construct (i.e., concentration, distorted sense of time, sense of control, etc.), meaning it would not be accurate to label the factor as measuring the user's state of flow. However, the relationship between the items of factor three appear to point at the user's level of effort in the gaming experience. For this reason, the most appropriate label for factor three of the immersion EFA would be the user's level of "effort." In practice, effort may manifest as follows: a user begins with the established goal of "beating the game," possibly creating several smaller goals working toward that end (defeating the final boss). As certain objectives increase in challenge, the user exerts more effort. The effort exerted, however, is also determined by how much the user wants to achieve their ultimate goal. If the desire to achieve the goal is too low, the user may give up; but if the desire to achieve the goal is high, then the user may exert more effort into areas such as mastering the game mechanisms and testing alternate strategies.

This process of goals dictating effort also provides a possible explanation for the moderate level of reliability of the effort factor. The items examining the user's goals focus primarily on a user vs. program competition (i.e., "win the game"). However, winning the game is only one of several goals with a foundation in competition. In examples such as racing or fighting games, users are often in competition with other users rather than the game itself. Additionally, some gaming experiences have the user compete against their own prior accomplishments, such as establishing the goal of beating a previous high score. While the current items examining player goals may have been optimal for Jennett et al.'s (2008) controlled experiment, they do not appropriately consider the wide variety of goals across several gaming experiences. One potential method for raising effort's reliability would be to use items with language encompassing these broader goals (i.e., "how determined were you to obtain your objective?").

Immersion Factor Three: Awareness of the Real World

The third factor extracted from the immersion questionnaire EFA contained items primarily predicting transportation to a different place (TDP_2, TDP_4, and TDP_5) and temporal dissociation (TDS_2, TDS_3, TDS_4, and TDS_5). A closer examination of these items revealed a pattern consistent with (a) a decreased sense of being in the physical environment and (b) an increased sense of being in the game environment. The items TDP_2, TDS_2, TDS_4, and TDS_5 all pertained to a decreased sense of being in the physical environment while TDP_4 pertained to an increased sense of being in the game environment. In this case, the outlying items are TDP_5 and TDS_3, which address the user's decreasing awareness to using controls and the extent to which the user forgot about their everyday concerns, respectively. Both TDP_5 and TDS_3 are linked to the user's decreased awareness of the real world, just not as directly as the other items in factor two, which makes sense as they were the only items with a correlation coefficient value below 0.5.

When placing the identified elements of factor two together, a clear sequence begins to emerge. As users become more involved with the virtual environment, their sense of being in the physical environment decreases, which in turn decreases their everyday concerns attached to the physical environment. This reinforces Jennett et al.'s (2008) conceptual framework of immersion as gaming experiences can decrease a user's awareness of the real world. Based on this, factor two of the immersion questionnaire EFA can be labeled as the user's "awareness of the real world." The label can be somewhat deceptive, however, as many of the items were recoded from negative wording based on the original context (specifically transportation to a different place).

Overall, the EFA performed on the immersion questionnaire items extracted three factors: involvement, effort, and awareness of the real world. These factors exhibit clear links to existing frameworks such as cognitive absorption and flow, both of which were used in Jennett et al.'s (2008) development of the original immersion questionnaire. But while the conceptual groundwork for immersion is clear, Jennett et al.'s immersion questionnaire was ineffective in isolating factors from the original questionnaire. This is not to say that attention, emotional involvement, heightened enjoyment, challenge, temporal dissociation, and transportation to a different place are not a part of the immersion construct. Instead, the relationships between the elements laid out by Jennett et al. are more complex and are likely to vary depending on the individuals surveyed and the gaming experiences.

While this study did not aim to create a finalized questionnaire for measuring immersion, it does inadvertently serve to shift things in the right direction. Further studies are needed to continue testing the immersion questionnaire for reliability and validity. In the meantime, the extracted factors involvement, effort, and awareness of the real world are useful in addressing this study's core research question, which is addressed later in the discussion.

Focus Group Exploratory Factor Analysis

The EFA performed on the focus group items extracted factors that were consistent with the factors used in the coding process: quality of software experience (QOS) and quality of interface experience (QOI). The reliability of both factors has room for improvement, particularly with the quality of the interface experience. While the reliability cannot be increased by removing items from the scale, new items that assess similar aspects can be added. For example, the quality of the software experience can incorporate an additional item regarding graphical smoothness—while the item QOS_2 (visual graphics) can start to be surmised through a single screenshot of a gaming experience, graphical smoothness can only be experienced by witnessing those graphics in motion. The quality of the interface experience can implement similar items that readdress more specific qualities, such as dividing QOI_3 into two separate items addressing (1) the comfort of the head-mounted display and (2) the comfort of the controllers. Further testing of the quality of the software experience and quality of the interface experience factors with additional items is needed for the construct to become more reliable for future research.

Factors Impacting Presence

This study's research question focused on exploring factors that impact a user's perceived physical presence, social presence, and self-presence. The Pearson correlation test revealed several significant relationships between factors contributing to presence (physical presence, social presence, and self-presence) and factors contributing to immersion (involvement, effort, and awareness of the real world) and the experience quality (quality of the software experience and quality of the interface experience)—these relationships were further explicated through the linear regression tests. It is worth noting that the existence of a correlation only indicates a relationship among the factors, not necessarily a causal relationship. Additionally, while the regression analysis does not confirm a causal relationship, it does provide further support for the relationship among factors.

Factors Related to Physical Presence

The correlation test identified positive relationships between physical presence and involvement, effort, awareness of the real world, quality of the software experience, and quality of the interface experience. Of these relationships, involvement, awareness of the real world, and quality of the interface experience all had a correlation coefficient value in the moderate range while effort and quality of the software experience had a correlation coefficient value in the minimal range. An important reminder regarding the correlation with "awareness of the real world" is that several items were recoded based on the original predicted factors, specifically transportation to a different place, meaning that the relationship between physical presence and awareness of the real world is negative, though still significant.

First, a significant causal relationship between physical presence and involvement was reinforced by the linear regression. Jennett et al. (2008) supports this causal relationship through the assertion that immersion can increase a user's "sense of being in the task environment." Responses from members of the focus group indicated that user's often "place themselves" into the virtual environment. What this suggests is that in addition to physical realism, the degree to which a user is motivated to engage with their task environment also impacts the degree to which they perceive that environment as being real.

For example, an experience with heavily stylized graphics such as *Borderlands 2 VR* can still be perceived as real because the user is motivated by a sense of enjoyment to engage with it. This is especially useful in understanding how a popular game such as *Minecraft,* with a seemingly low bar for realistic graphics, can still entice users into engaging with and building on the virtual environment.

Second, a causal relationship between physical presence and awareness of the real world was also supported by the regression analysis. While conceptually awareness of the real world is indicative to be a result of immersion, it bears strong similarities to sub-components contributing to physical presence: sense of being in the virtual environment and not paying attention to the real environment. This indicates that a portion of the physical presence factor and awareness of the real world are concerned with measuring similar experiences based on whether the user has a greater sense of being in the virtual environment or the real environment. In this instance, awareness of the real world's relationship to physical presence is more a result of "being in the virtual environment" and "not paying attention to the real environment."

The third relationship between physical presence and effort was weak, and likely best explained by the concept of flow (Jennett et al., 2008 & Csikszentmihalyi, 1990). Jennett et al. (2008) assert that immersion can be considered a precursor to the state of flow as it's described by Csikszentmihalyi (1990). In this case, while effort is a factor in predicting immersion, it also shares a relationship to the flow construct and the user's degree of involvement. This would indicate that involvement serves as the link between effort and physical presence. An example of this would be that as a user puts more effort into completing a difficult game, their involvement would increase, which can result in a greater sense of being in the virtual environment.

Finally, the regression indicated that physical presence did have a significant linear relationship to the quality of the software experience and the quality of the interface experience. However, the linear relationship became insignificant when the multiple regression incorporated involvement, indicating a mediating relationship. This means that the quality of the software experience and the quality of the interface experience have an indirect relationship with physical presence through involvement, where a user's level of involvement is impacted by the perceived quality of the experience. The relationship between physical presence and quality of the experience might start to make sense based on assumptions akin to "better graphics equate to a better experience." The relationship here, however, can be a bit more complex, as "better" graphics do not always mean more physically real graphics—especially when dealing with video game experiences. In this case, the relationship between quality of the experience and involvement becomes more relevant due to involvement's relationship to physical presence described earlier. A more accurate deduction would be that a higher quality experience would result in greater levels of involvement, thus indicating a more indirect relationship to physical presence. Interestingly, when focus group participants were asked how their experience of physical presence might be enhanced, many defaulted with responses reflective of improved qualities of the software (i.e., interesting dialogue) and the interface (i.e., more comfortable headset).

<u>Factors Related to Social Presence</u>

Of the three qualities of presence examined in this study, social presence was the least impacted by the additional factors introduced. Only a minimal relationship was identified between social presence and the perceived quality of the software experience. A closer look at the quality of the software experience construct identifies social-specific items: QOS_3 (quality of the story), QOS_4 (quality of writing/voice acting), and QOS_5 (visual representation of avatar). All three of these items contribute to the facilitation of social interactions within the software, thus the weak relationship seems reasonable. It is important to note that unlike physical presence and self-presence, a VR gaming experience can be without social interactions (artificial or otherwise). An example of this would be a VR game prompting the user to complete tasks within a virtual environment that is devoid of simulated life. As such, while social presence appears to be the least impacted by the introduced factors, there remains a question of whether social presence is necessary to the MPS construct or not—something that is worth examining in future studies.

<u>Factors Related to Self-Presence</u>

The correlation test identified a moderate relationship between self-presence and a user’s awareness of the real world. While a decreased sense of being in the real world and increased sense of being in the virtual environment would be more commonly linked to physical presence, there appears to be an additional relationship to the user's perception of their virtual self being their actual self. Though the assumption would be one of a causal relationship—after all, the predicted factor "transportation to a different place" does imply the transportation of one's body—this assertion requires confirmation.

Finally, the correlation test identified a weak relationship between self-presence and involvement. When involvement is examined next to the awareness of the real world factor, the two appear to create a relational bridge between physical presence and self-presence. A possible sequence explaining this link might go as follows: (1) the user becomes more involved with the VR gaming experience, resulting in (2) a higher level of perceived physical presence. As the user's involvement and perceived physical presence increases, their (3) awareness of the real world decreases and (4) sense of self within the virtual environment increases. Further research is required to explore this explanation for the relationship between involvement and awareness of the real world.

Although Jennett et al.'s (2008) game-centered take on immersion served as a conceptual catalyst to compare to presence, the identified factor "involvement" held the most significant implications. Oddly enough, this circles back to Witmer and Singer's (1998) understanding of presence as the interconnection between immersion and involvement. The difference, however, is that Witmer and Singer identify involvement as working alongside immersion rather than a factor of it. That is to say, what Witmer and Singer identify as presence appears to have conceptual similarities to Jennett et al.'s (2008) conceptualization of immersion. An important distinction, however, is that Jennett et al.'s research is informed by several existing theoretical constructs such as cognitive absorption and flow which can overcomplicate the process. Additionally, another look at Witmer and Singer's (1998) definition of immersion identifies what appears to be an overlap between qualities of involvement, physical presence, and self-presence. This implies that one of the key sources of conceptual inconsistencies in VR research, immersion, might not be necessary to examining presence as a construct. Additionally, this reintroduces involvement as having a vital role in understanding presence—something that the MPS overlooks.

CHAPTER SIX

CONCLUSION

While this study identified a clear link between immersion and presence, there are several limitations to consider. First, the sample specifically targeted individuals who played video games. While this helped within the framework of this study, the generalizability is limited to gamers. Additionally, while the size of the sample was adequate for this study, a larger size would further reinforce the significance of the findings. Future research should incorporate a larger, random sample of VR users to gain a more thorough understanding of the complex relationship between immersion and presence.

The focus group was limited based on representation, as it was made up of all males. While this is reflective of how the area of VR gaming is dominantly male, the focus group could have benefited from a female perspective.

Another limitation of this study was a lack of access to software capable of running a confirmatory factor analysis. While this was less of an issue for confirming the MPS, it would have been beneficial to confirm Jennett et al.'s (2008) immersion questionnaire, as their original study only ran an exploratory factor analysis. Though this study identified different factors from the immersion items, it does not invalidate Jennett et al.'s construct. Future research should re-examine both (a) Jennett et al.'s conceptual framework and (b) the extracted immersion items from this study, testing for consistency.

Of the factors examined in this study, involvement holds the most significance in its relation to understanding presence—specifically physical presence and self-presence. Involvement even serves as a mediating variable for the factors derived from this study's focus group. This appears to reinforce a notion that many gamers seem to instinctively understand: a conceptual link between immersion and presence. While Jennett et al.'s (2008) conceptual framework of immersion laid a groundwork that was helpful in approaching this study, the findings imply that a "back to basics" approach might be more beneficial, particularly Witmer and Singer's (1998) emphasis of involvement being a critical element to understanding presence. Most importantly, however, this study draws a clearer link between presence and a user's desire to engage with a VR experience. This also paves the way for a path analysis to further express the relationships between the examined variables.

This begins to shape the direction for research on presence and immersion to move forward. In addition to validating involvement as an impacting factor contributing to presence in VR gaming experiences, this concept should be explored in non-gaming contexts. Within this context, future research should focus on the intrinsic motivations of user's for engaging in VR experiences with less of an emphasis on game-related aspects such as heightened enjoyment and challenge. For this to most effective, however, future research should also aim to create a more concrete differentiation between what qualifies as a VR gaming experience and what does not.

Along that line, this research highlights a frequent issue with many non-gaming VR experiences. With the increasing demand for the integration of VR as a learning tool, a strong emphasis tends to be placed on the physical realism of the virtual environment. While physical realism remains vital, it often leads to other features aimed at motivating the user to become more involved with the experience (i.e., a degree of challenge spurring effort, a storyline invoking curiosity, etc.) to be overlooked. The result is an experience that does not capitalize on the medium's potential for user engagement; when integrating new technology into a learning context, it is imperative to examine all areas promoting user engagement as possible. This can be examined in future research through a comparison of VR experiences with a variety of user-motivation features.

With that said, Makransky et al.'s (2017) MPS remains a reliable tool for measuring a user's perceived physical presence, self-presence, and social presence. The construct, however, favors realistic/credible experiences over desirable experiences. Immersion, though inherently linked to presence, appears to complicate the MPS model by diminishing the need for realism and blurring the lines between physical presence and self-presence. Users and developers of VR would do well to consider these complex relationships, specifically as the technology is continuing to evolve. Where a certain degree of presence might be achieved based off the creation of a physically real environment, the experience can potentially be enhanced by adding elements that encourage users to become more involved. This is especially important when technology is a limitation, such as a VR experience that cannot afford to use highly realistic graphics.

APPENDIX A

FOCUS GROUP QUESTIONS

Engagement Questions*:

- What is your favorite genre of game?
- What has been your favorite VR game so far and why?
- What kind of VR hardware do you prefer to use and why?

Exploration Questions*:

Physical presence: Think of a time that a VR environment felt physically real to you.

- What elements or qualities contributed to the feeling of being physically present in the VR game?
- What elements or qualities detracted from the feeling of being physically present?
- What would further enhance the feeling of being physically present?
- Complete the statement – "I feel most physically present in a VR game when…"

Social presence: Think of a time that you didn't feel alone in a single player VR game.

- What elements or qualities contributed to your social experience in that VR game?
- What elements or qualities detracted from your social experience in that VR game?
- What would further enhance the social experience?
- Complete the statement – "I feel most socially present in a VR game when…"

Self-presence: Think of a time that you felt like your virtual avatar was your actual self in a VR gaming experience.

- What qualities of your experience contributed to this feeling of self-presence?
- What qualities tend to detract from experiencing self-presence?
- Complete the statement – "I feel most self-present in a VR game when…"

Exit Question*:

- Is there anything else you'd like to add that contributes to your sense of being in a virtual environment?
- How recent should a VR experience be to recall details similar to what we discussed?
- Where would you recommend recruitment for distributing a questionnaire on these topics?

*Questions may be altered, or additional questions added depending on the discussion progression.

APPENDIX B

FOCUS GROUP CODE BOOK

Appendix B

Focus Group Code Book

Predicted Factor	Code	Abbr.	Definition	Example	Extracted From
Quality of Software Experience	Quality of Sound Design	QSD	The extent to which the software's sound design enhances the virtual experience	"When you hear zombies in that 360 space around you… it's nice."	Focus Group
Quality of Software Experience	Quality of Visuals/ Graphics	QVG	The extent to which the software's visual design enhances the virtual experience	"What's kind of interesting is the actual depth of vision is based on your actual vision."	Focus Group
Quality of Software Experience	Quality of Objective	QO	The user's perceived level of quality to a software's story or motivation	"There needs to be a good reason that I'm doing what I'm doing in the game."	Focus Group
Quality of Software Experience	Quality of Actors	QA	The user's perceived level of quality to character interactions	"You can't be social if there's no one to be social with."	Focus Group
Quality of Software Experience	Visual Presentation of Avatar	VRA	The extent to which users perceive an accurate representation of their avatar	"If you look down into the water you see your character as a mirror."	Focus Group
Quality of Interface Experience	Freedom of Movement	FM	The extent to which users perceive their freedom to move throughout the virtual environment	"There are some (games) where you actually turn around like in Skyrim."	Focus Group
Quality of Interface Experience	Intuitive Controls	IC	The extent to which users perceive the controls as being intuitive	"As soon as the sensors are a bit off it takes you out because the controls start lagging."	Focus Group
Quality of Interface Experience	Comfortable Integration of Hardware	CIH	The extent to which users perceive the hardware as being comfortable to use	"Even with a super long cable, you always have it hanging around you."	Focus Group
User's Response to Experience (Immersion)	Heightened Enjoyment	HE	The extent to which a user takes in the pleasurable elements of an interaction	"The whole process of hunting in that game was a lot of fun."	Jennet et al. (2008); Focus Group
User's Response to Experience (Immersion)	Emotional Involvement	EI	The extent to which a user experiences a positive or negative emotional response to a virtual experience	"In your mind there's a person this far from your face and it's just uncomfortable."	Jennet et al. (2008); Focus Group
User's Response to Experience (Immersion)	Attention	ATN	The extent to which a user is unaware of events taking place outside the virtual experience	"If my phone goes off it takes me instantly out of the world."	Jennet et al. (2008); Focus Group
User's Response to Experience (Immersion)	Temporal Dissociation	TDS	The extent to which the user is unable to perceive the passage of time while engaged with a software	"What had felt like a half hour was actually something like two hours."	Jennet et al. (2008)
User's Response to Experience (Immersion)	Challenge	CHL	The level of difficulty perceived by the user	"The game was just challenging enough that I was motivated to press forward."	Jennet et al. (2008)
User's Response to Experience (Immersion)	Transportation to a Different Place	TDP	The extent to which a user has a lesser attachment to the "real world" and more of a desire to focus on the digitally created world	"The game just gave me a world that I really wanted to be in."	Jennet et al. (2008); Focus Group

APPENDIX C

SURVEY QUESTIONNAIRE

A. Please indicate how much you agree with the following statements using the following scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

1. In my latest VR gaming experience, the virtual environment seemed real to me.

   (Strongly disagree 1 2 3 4 5 Strongly agree)

2. In my latest VR gaming experience, I had a sense of acting in the virtual environment, rather than operating something from outside.

   (Strongly disagree 1 2 3 4 5 Strongly agree)

3. In my latest VR gaming experience, my experience in the virtual environment seemed consistent with my experiences in the real world.

   (Strongly disagree 1 2 3 4 5 Strongly agree)

4. In my latest VR gaming experience, I had a sense of “being there” in the virtual environment.

   (Strongly disagree 1 2 3 4 5 Strongly agree)

5. In my latest VR gaming experience, I was completely captivated by the virtual world.

   (Strongly disagree 1 2 3 4 5 Strongly agree)

6. In my latest VR gaming experience, I felt like I was in the presence of another lifeform in the virtual environment.

   (Strongly disagree 1 2 3 4 5 Strongly agree)

7. In my latest VR gaming experience, I felt that the lifeforms in the virtual environment were aware of my presence.

   (Strongly disagree 1 2 3 4 5 Strongly agree)

8. In my latest VR gaming experience, the lifeforms in the virtual environment appeared to be sentient (conscious and alive) to me.

   (Strongly disagree 1 2 3 4 5 Strongly agree)

9. In my latest VR gaming experience, there were times where the computer interface seemed to disappear, and I felt like I was working directly with another lifeform.

   (Strongly disagree 1 2 3 4 5 Strongly agree)

10. In my latest VR gaming experience, I had a sense that I was interacting with other lifeforms in the virtual environment, rather than a computer simulation.

    (Strongly disagree 1 2 3 4 5 Strongly agree)

11. In my latest VR gaming experience, I felt like my virtual embodiment was an extension of my real body within the virtual environment.

    (Strongly disagree 1 2 3 4 5 Strongly agree)

12. In my latest VR gaming experience, when something happened to my virtual embodiment, it felt like it was happening to my real body.

    (Strongly disagree 1 2 3 4 5 Strongly agree)

13. In my latest VR gaming experience, I felt like my real arm was projected into the virtual environment through my virtual embodiment.

    (Strongly disagree 1 2 3 4 5 Strongly agree)

14. In my latest VR gaming experience, I felt like my real hand was inside of the virtual environment.

    (Strongly disagree 1 2 3 4 5 Strongly agree)

15. In my latest VR gaming experience, I felt like my virtual embodiment and my real body became one and the same.

    (Strongly disagree 1 2 3 4 5 Strongly agree)

B. Answer the following questions based on your latest VR gaming experience.

16. During your latest VR gaming experience, to what extent did you find the game challenging?

    (Not at all 1 2 3 4 5 Very difficult)

17. Were there any times during your last VR gaming experience in which you wanted to give up?

    (Not at all 1 2 3 4 5 A lot)

18. During your latest VR gaming experience, to what extent did you feel motivated while playing?

    (Not at all 1 2 3 4 5 A lot)

19. During your latest VR gaming experience, to what extent did you find the game easy?

    (Not at all 1 2 3 4 5 Very much so)

20. During your latest VR gaming experience, to what extent did you feel like you were making progress towards the end of the game?

    (Not at all 1 2 3 4 5 A lot)

21. How well do you think you performed in your last VR gaming experience?

    (Very poor 1 2 3 4 5 Very well)

22. During your latest VR gaming experience, to what extent did you enjoy the graphics and the imagery?

    (Not at all 1 2 3 4 5 A lot)

23. During your latest VR gaming experience, how much would you say you enjoyed playing the game?

    (Not at all 1 2 3 4 5 A lot)

24. Were you disappointed when your last VR gaming experience was over?

    (Not at all 1 2 3 4 5 Very much so)

25. Would you like to play your last VR gaming experience again?

    (Definitely not 1 2 3 4 5 Definitely yes)

26. During your latest VR gaming experience, to what extent did you feel emotionally attached to the game?

    (Not at all 1 2 3 4 5 Very much so)

27. During your latest VR gaming experience, to what extent were you interested in seeing how the game's events would progress?

    (Not at all 1 2 3 4 5 A lot)

28. During your latest VR gaming experience, how much did you want to "win" the game?

    (Not at all 1 2 3 4 5 Very much so)

29. Were you in suspense about whether or not you would win or lose your last VR gaming experience?

    (Not at all 1 2 3 4 5 Very much so)

30. During your latest VR gaming experience, at any point did you find yourself become so involved that you wanted to speak to the game directly?

    (Not at all 1 2 3 4 5 Very much so)

31. During your latest VR gaming experience, to what extent did the game hold your attention?

    (Not at all 1 2 3 4 5 A lot)

32. During your latest VR gaming experience, to what extent did you feel you were focused on the game?

    (Not at all 1 2 3 4 5 A lot)

33. How much effort did you put into playing your last VR gaming experience?

    (Very little 1 2 3 4 5 A lot)

34. During your latest VR gaming experience, did you feel that you were trying your best?

    (Not at all 1 2 3 4 5 Very much so)

35. During your latest VR gaming experience, to what extent did you feel that you were interacting with the game environment?

    (Not at all 1 2 3 4 5 Very much so)

36. During your latest VR gaming experience, to what extent did you feel as though you were separated from your real-world environment?

(Not at all 1 2 3 4 5 Very much so)

37. To what extent did you feel that your last VR gaming experience was something you were experiencing, rather than something you were just doing?

    (Not at all 1 2 3 4 5 Very much so)

38. During your latest VR gaming experience, to what extent was your sense of being the game environment stronger than your sense of being in the real world?

    (Not at all 1 2 3 4 5 Very much so)

39. During your latest VR gaming experience, at any point did you find yourself become so involved that you were unaware you were even using controls?

    (Not at all 1 2 3 4 5 Very much so)

40. During your latest VR gaming experience, to what extent did you feel as though you were moving through the game according to your own will?

    (Not at all 1 2 3 4 5 Very much so)

41. During your latest VR gaming experience, to what extent did you lose track of time?

    (Not at all 1 2 3 4 5 A lot)

42. During your latest VR gaming experience, to what extent did you feel consciously aware of being in the real world whilst playing?

    (Not at all 1 2 3 4 5 Very much so)

43. During your latest VR gaming experience, to what extent did you forget about your everyday concerns?

(Not at all 1 2 3 4 5 A lot)

44. During your latest VR gaming experience, to what extent were you aware of yourself in your surroundings?

    (Not at all 1 2 3 4 5 Very aware)

45. During your latest VR gaming experience, to what extent did you notice events taking place around you?

    (Not at all 1 2 3 4 5 A lot)

46. During your latest VR gaming experience, did you feel the urge at any point to stop playing and see what was happening around you?

    (Not at all 1 2 3 4 5 Very much so)

47. How would you rate the overall sound design quality of your latest VR gaming experience?

    (Poor 1 2 3 4 5 Excellent)

48. How would you rate the overall visual graphics quality of your latest VR gaming experience?

    (Poor 1 2 3 4 5 Excellent)

49. How would you rate the overall story quality of your latest VR gaming experience? (Poor 1 2 3 4 5 Excellent)

50. How would you rate the quality of writing/voice acting in your latest VR gaming experience?

    (Poor 1 2 3 4 5 Excellent)

51. How would you rate the visual representation of your avatar in your latest VR gaming experience?

    (Poor 1 2 3 4 5 Excellent)

52. How would you rate your ability to move freely within the environment of your latest VR gaming experience?

    (Poor 1 2 3 4 5 Excellent)

53. How easy was it to understand the controls for your latest VR gaming experience? (Poor 1 2 3 4 5 Excellent)

54. How would you rate the comfort of the hardware (head-mounted display and controllers) of your latest VR gaming experience?

    (Poor 1 2 3 4 5 Excellent)

C. Please answer the following questions:

   a. What was the genre of the last VR game you played?
   b. What is your gender? (Male / Female)
   c. How old are you? (18-25 / 26-35 / 36-45 / 46-55 / 56+)
   d. What is your highest level of education? (High school / Some college / Associates Degree / Bachelor's Degree / Master's Degree / Doctorate)
   e. What is your estimated annual income? (Below $20,000 / $20,001-$35,000 / $35,001-$50,000 / $50,001-$70,000 / $70,001-$90,000 / $90,000+)

APPENDIX D

PEARSON CORRELATION MATRIX

Correlations

		Physical Presence	Social Presence	Self Presence	Involvement	Effort	Awareness of the Real World	Quality of Software	Quality of Hardware
Physical Presence	Pearson Correlation	1	.000	.000	.451**	.227*	.323**	.207*	.308**
	Sig. (2-tailed)		1.000	1.000	.000	.014	.000	.023	.001
	N	121	121	121	117	117	117	121	121
Social Presence	Pearson Correlation	.000	1	.000	.159	.051	-.091	.208*	.132
	Sig. (2-tailed)	1.000		1.000	.088	.586	.330	.022	.150
	N	121	121	121	117	117	117	121	121
Self Presence	Pearson Correlation	.000	.000	1	.282**	.099	.413**	.115	.043
	Sig. (2-tailed)	1.000	1.000		.002	.288	.000	.210	.643
	N	121	121	121	117	117	117	121	121
Involvement	Pearson Correlation	.451**	.159	.282**	1	.000	.000	.464**	.465**
	Sig. (2-tailed)	.000	.088	.002		1.000	1.000	.000	.000
	N	117	117	117	118	118	118	118	118
Effort	Pearson Correlation	.227*	.051	.099	.000	1	.000	-.066	.178
	Sig. (2-tailed)	.014	.586	.288	1.000		1.000	.480	.053
	N	117	117	117	118	118	118	118	118
Awareness of the Real World	Pearson Correlation	.323**	-.091	.413**	.000	.000	1	-.005	.023
	Sig. (2-tailed)	.000	.330	.000	1.000	1.000		.961	.803
	N	117	117	117	118	118	118	118	118
Quality of Software	Pearson Correlation	.207*	.208*	.115	.464**	-.066	-.005	1	.000
	Sig. (2-tailed)	.023	.022	.210	.000	.480	.961		1.000
	N	121	121	121	118	118	118	122	122
Quality of Hardware	Pearson Correlation	.308**	.132	.043	.465**	.178	.023	.000	1
	Sig. (2-tailed)	.001	.150	.643	.000	.053	.803	1.000	
	N	121	121	121	118	118	118	122	122

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

APPENDIX E

INSTITUTIONAL REVIEW BOARD APPROVAL

CALIFORNIA STATE UNIVERSITY
SAN BERNARDINO

October 16, 2018

CSUSB INSTITUTIONAL REVIEW BOARD
Expedited Review
IRB-FY2019-34
Status: Approved

Mr. Andre Adame & Dr. Ahlam Muhtaseb
Department of Communication Studies
California State University, San Bernardino
5500 University Parkway
San Bernardino, California 92407

Dear Mr. Andre Adame & Dr. Ahlam Muhtaseb:

Your application to use human subjects, titled "Examining the Multimodal Presence Scale and VR Gaming Variables" has been reviewed and approved by the Institutional Review Board (IRB). The informed consent document you submitted is the official version for your study and cannot be changed without prior IRB approval. A change in your informed consent (no matter how minor the change) requires resubmission of your protocol as amended using the IRB Cayuse system protocol change form.

Your application is approved for one year from October 16, 2018 through October 16, 2019.

Please note the Cayuse IRB system will notify you when your protocol is up for renewal and ensure you file it before your protocol study end date. **Please ensure your CITI Human Subjects Training is kept up-to-date and current throughout the study.**

Your responsibilities as the researcher/investigator reporting to the IRB Committee include the following 4 requirements as mandated by the Code of Federal Regulations 45 CFR 46 listed below. Please note that the protocol change form and renewal form are located on the IRB website under the forms menu. Failure to notify the IRB of the above may result in disciplinary action. You are required to keep copies of the informed consent forms and data for at least three years.

You are required to notify the IRB of the following by submitting the appropriate form (modification, unanticipated/adverse event, renewal, study closure) through the online Cayuse IRB Submission System.

1. If you need to make any changes/modifications to your protocol submit a modification form as the IRB must review all changes before implementing in your study to ensure the degree of risk has not changed.
2. If any unanticipated adverse events are experienced by subjects during your research study or project.

1. If your study has not been completed submit a renewal to the IRB.
2. If you are no longer conducting the study or project submit a study closure.

The CSUSB IRB has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval notice does not replace any departmental or additional approvals which may be required. If you have any questions regarding the IRB decision, please contact Michael Gillespie, the IRB Compliance Officer. Mr. Michael Gillespie can be reached by phone at (909) 537-7588, by fax at (909) 537-7028, or by email at mgillesp@csusb.edu. Please include your application approval identification number (listed at the top) in all correspondence.

Best of luck with your research.

Sincerely,

Donna Garcia

Donna Garcia, Ph.D., IRB Chair
CSUSB Institutional Review Board

DG/MG

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