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Abstract

Researchers have analyzed various aspects of the video game experience; however, analysis of how the presentation of game status information affects the player's sense of immersion into the virtual environment has not been explored. This study aims to discover how feelings of immersion are affected by diegetic, or environmentally based, methods of presenting the player's status versus non-diegetic methods. Avid gamers were told to play two games, one diegetic based interface and the other a non-diegetic interface, to see how their spatial immersion experiences differed between the two designs. In addition to the use of questionnaires to evaluate the level of spatial immersion, eye tracking data was collected in order to explore how fixations differed between designs. Although the questionnaire results presented that the experiences did not significantly differ between game designs, the eye tracking data led us to believe that the player's information processing may be affected. Fixation duration significantly increased during non-immersive experiences, which may suggest that players spend more time attempting to understand the environment. This may cause game designers to explore alternate methods to display status information that are easier for the player to comprehend, thus allowing players to become more spatially immersed into the game world.

Introduction

Research has uncovered the fact that video games are indeed common in the average American household. According to the Entertainment Software Association, as of 2011, an estimated 49% of all United States households own a dedicated video game console, and those who do, own an average of two consoles. Reports also show that American consumers spent $24.75 billion towards the video game industry in 2011 (Entertainment Software Association, 2012). Knowing that the goal of video games is to entertain their consumers, user experience should be the primary focus of game designers (Drachen et al., 2010).

Interface designs differ between genres throughout the game industry (Beechler, 2010). Shooter games, both first-person and third-person, often utilize the concept of a “heads-up display” (HUD) in order to convey crucial information to the player. Many new games have entirely stripped the HUD from the user interface and incorporated all necessary information into the game characters’ world (Wilson, 2006). Some believe that the player’s sense of immersion is increased when overlaying HUD details are decreased, and player status information is integrated into the game environment (Wilson, 2006; Andrews, 2010). With the sense of immersion rapidly becoming a key aspect of popular games, does a more visualized presentation of a player’s status significantly affect how immersed they are into the game space?

Literature Review

Computer software companies have stressed the importance of usability and user experience for decades; however, the video game industry has recently begun investigating this field.

Evaluating Game "Usability"

"People *use* software, but they *play* games" (Barr, 2007). Assessment of software is different from evaluating the usability of video games. For instance, while software users do not prefer challenges or difficulties, gamers welcome those attributes more openly (Pagulayan et al., 2003).

Due to the differences of how software and video games are viewed, Jakob Nielson's (1990) usability heuristics cannot be applied to games. Neilson's heuristics rely heavily on usability, rather than gameplay. Although the interface and controls can be evaluated using the heuristics, the player's experience is hard to assess using the list. Instead, many professionals devised their own sets of heuristics in order to evaluate various aspects of games. Thomas Malone (1980; 1982) was one of the first to develop heuristics that applied to computer games. The research focused on what makes educational games fun and what causes their user interfaces to be so captivating towards children. He ultimately came to the conclusion that three essential characteristics compose the experience of educational games: challenge, fantasy, and curiosity (1980).

Some studies have compiled new heuristics in order to properly evaluate the usability of video games. These studies utilized various methods to perform their research, procedures ranged from design teams (Federoff, 2002), literature (Desurvire et al., 2004; Korhonen &

Koivisto, 2006; Schaffer, 2007), game expert reviews (Pinelle et al., 2008; Papaloukas et al., 2009), and players' comments (Malone, 1980, 1982) to compile different lists of heuristics.

Heuristic lists that were developed contribute to the field, but no list is perfect. Although heuristic evaluations may be successful at discovering usability problems, they are not the best method to evaluate the user experience that the player will ultimately have when playing the game for the first time (Isbister & Schaffer, 2008). Game designers need to go beyond the focus of usability, and understand that user experience and the evaluation of "fun" must come first (Renshaw et al., 2009).

Pagulayan et al. (2003) states several aspects that are utilized to evaluate the design of their games at *Microsoft Game Studios*. One such characteristic, "ease of use", pertains to the game's interface and controls. Interface elements must provide vital feedback in order to allow the gamer to acknowledge their status. This is where the heads-up display comes into play; this interface element should provide crucial information to the player in order for them to progress through their objectives (Pagulayan et al., 2003).

Game Interface Design and the Heads-Up Display

The heads-up display, or HUD, is often found in games regardless of game genre. A HUD is a group of elements overlaying the game world that represents the player's status (Wilson, 2006). Information such as ammunition count and character health are common attributes found on the HUD. This interface element displays details that the player needs at all times to progress through the game. The HUD is often designed to match the context of the game world to be less intrusive during gameplay (Wilson, 2006).

Designing a HUD for a video game can be approached through various methods. User interface elements can be composed of spatial and/or fictional qualities. Spatial elements exist within the game design space, while fictional elements are representations of artifacts that exist within the game's literature (Fagerholt & Lorentzon, 2009).

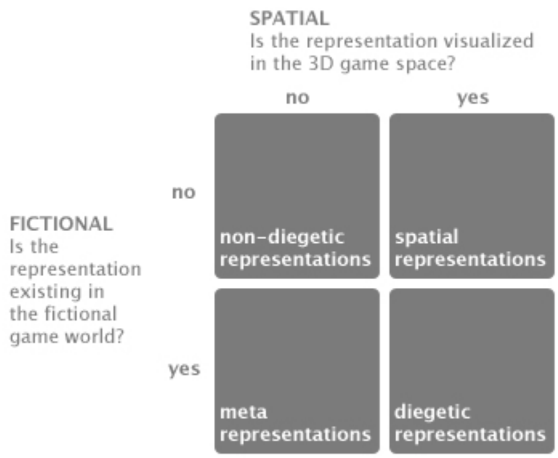

Figure 1. Design Space of User Interfaces
Note. Adapted from Fagerholt & Lorentzon (2009)

As shown in Figure 1, all information presented to the player falls within one or more categories. Non-diegetic elements are outside of the game space and are not acknowledged by any of the game characters. These elements are seen to overlay the game world, such as health bars or even background music. Figure 2 is an example of a non-diegetic interface where health and ammunition count are displayed utilizing bars and text, while the map is displayed in the top right corner, overlaying the game world.

Figure 2. Example of Non-Diegetic Shooter Interface: Resident Evil 5

Meta-representations are elements that are familiar to the game fiction or storyline, but are represented outside of the game space. Games attempt to present information that match the context of the game world, so a game may present a navigational menu that is similar to a device in the game's fiction, but is outside of the game space. A meta-perception is a combination of non-diegetic and meta-representation elements. Blood splatters or red color filters, overlaid on the screen when a character is injured, is not part of the game space, but tries to portray a game status perception in a visualized manner. Spatial representations are geometric elements seen within the game space, but are not represented within the game's fiction. For example, an object, such as a treasure chest, may be outlined or glowing to present importance. Although the chest is within the game space, the outline indicator is not part of the game's fiction or environment. Lastly, diegetic elements are ones that are considered part of the game space and are experienced by the characters (Fagerholt & Lorentzon, 2009). An example of an extremely diegetic interface can be seen in Figure 3. This game presents all status information within the game space, so the health bar is placed along the character's spine, while the ammunition count is display directly on the weapon interface.


Figure 3. Example of Diegetic Shooter Interface: Dead Space

Thompson (2006) believes that a HUD does not hinder immersion, but instead serves it. He believes that a HUD-less game would make people feel as if it were “real-life”, but it will not stop them from thinking about the lost information that would help complete their objectives. The lack of common HUD information would often become confusing and would not take the player deeper into the game experience (2006). An opposing argument from Wilson (2006) of *Gamasutra* states that a HUD would continue to remind the player that what they are playing is just a game. He believes that the video game should reduce the information on the HUD and incorporate details within the game environment, in order to boost immersion during play (2006).

Beechler (2010) analyzed these arguments and sought the creation of a taxonomy of information presentation techniques that would work best for various genres of games. Interfaces were analyzed for their effectiveness on information delivery or immersive minimalism. The primary focus was to analyze what attributes of a game HUD support the player’s experience.

Immersion Versus Presence

Capturing the player's attention and providing them with a great user experience should be the first priority for any game designer (Drachen et al., 2010). Immersion has become a large subject of exploration for many researchers.

Studies have explored the immersion of gamer experiences when playing video games. Immersion is known to be the period of time when the player is "into" the game, and is used to describe the degree of involvement that a gamer has when playing (Brown & Cairns, 2004). Witmer and Singer state that immersion "is 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" (1998, p. 227). A person who is immersed within a task is often less aware of their surroundings and less prone to distractions (Jennett, 2010).

Research argues that there are multiple stages to immersion that a player can experience. Brown and Cairns (2004) propose that a person must progress through three levels of immersion namely, engagement, engrossment, and then total immersion. Players must be open to experience the game, and then as they continue, their emotions will become involved. Ultimately, total immersion would lead the player to feel that they are detached from reality and feel as a part of the game world. This level of immersion is often used interchangeably with the term *presence* (McMahan, 2003).

Presence is described to be the experience of being in one place, while physically located in another (Witmer, 1998). The term is often used when evaluating the experience of users in virtual reality environments (Witmer, 1998; Slater, 2009). The shift to 3D video games has caused researchers to adopt the term presence. This led many to see the terms as interchangeable when analyzing 3D games, and added to the confusion between immersion and presence (McMahan, 2003).

McMahan stresses how the terms immersion and presence have been so loosely defined that researchers have seen them as synonymous. Presence is considered to be the result of perceptual and psychological immersion. McMahan defines that perceptual immersion "is accomplished by blocking as many of the senses as possible to the outside world", thus only allowing them to focus on the virtual world (2003, p. 77), while psychological immersion is when a person's attention shifts from the real world to a mental representation of certain parts of the game environment (McMahan, 2003).

While Brown and Cairns (2004) believe that one must progress through multiple levels in order to reach total immersion, many propose that this stage of immersion is indeed a multidimensional experience (Adams, 2004; Ermi & Mäyrä, 2005; Thon, 2008). Adams proposes that the three types of immersion include tactical, strategic, and narrative (2004). Tactical immersion is commonly seen in fast-paced games and produce challenges that players must solve with limited time. Strategic immersion involves much more cognitive processing, giving an experience that requires more observing and calculating moves. Strong storylines and characters give rise to a narrative immersion experience. A person acting out of character, or even bad dialog, can destroy this type of immersion (Adams, 2004).

Ermi and Mäyrä believe that the three dimensions of immersion are sensory, challenge, and imaginative, also known as the SCI-model (2005). Sensory immersion is when audio and visuals are taken into account, the more realistic these aspects become; the more the gamer will accept the world that they are experiencing. This type of immersion is considered perceptual immersion since the player's senses are being blocked from the outside world (Thon, 2008). The second dimension, challenge-based immersion, is very similar to what Adams (2004) had proposed about tactical and strategic immersion, gamer satisfaction occurs when there is a balance between game challenges and player's abilities. Imaginative immersion, identical to Adams' facet of narrative immersion, is when the player begins to feel for the characters and becomes absorbed into the stories of the game world. Both challenged-based immersion and narrative immersion are grouped under psychological immersion (Thon, 2008).

Thon (2008) breaks psychological immersion down into various dimensions in regards to video games, as ludic, narrative, social, and spatial types of immersion (Thon, 2008). Ludic immersion is similar to Ermi and Mäyrä's challenge-based immersion, while narrative immersion is identical to imaginative immersion. Social immersion is the attention given to other external players that the primary player interacts with during play. Thon mentions a new dimension, spatial immersion, which can be described "in terms of the player's shift of attention from his or her real environment to the game spaces" (2008, p. 35). This type of immersion focuses on the game world that the player experiences; the concept of spatial immersion is similar to the idea of spatial presence (Thon, 2008). Spatial presence "occurs when part or all of a person's perception fails to accurately acknowledge the role of technology that makes it appear that s/he is in a physical location and environment different from her/his actual location and environment in the physical world" (Wirth et al., 2007, p. 4). When a player reaches this point, their whole experience is located within the game space rather than their true physical environment. The feeling of spatial immersion will continue as long as the information presented to the user is clear and is consistent with the world's rules and user expectations of the game (McMahan, 2003; Nunez, 2004).

Studies have analyzed players' immersive experiences utilizing various methods. One common method is the use of questionnaires. Many questionnaires are available to evaluate immersion and presence (Jennett, 2010).

Another method emerging in the game research to evaluate immersion is eye tracking. Multiple metrics can be collected with the use of an eye tracker during usability studies (Jacob & Karn, 2003). Number of eye fixations (fixation frequency), fixation durations, pupil dilation, and scan paths have been found to determine the level of immersion a player is experiencing in a game (Tijs & Sc, 2006; Kearney, 2007; Jennett et al., 2008). Kearney mentions that the game genre and design may affect the eye movement required, but it can be argued that immersive games reduce eye movement and increase fixation durations. This increase signifies greater absorption of the game environment (2007). Research has shown that as time progresses, participants' eye movements significantly decreased over time in an immersive environment, while eye movements increased within a non-immersive environment (Jennett et al., 2008). All research was coupled with questionnaires to verify that eye tracking is an effective method to recognize game immersion.

Recent thesis research gathered focus groups in order to discover how information presentation affected the player's immersion (Fagerholt & Lorentzon, 2009). Fagerholt analyzed how the HUD affected players' immersion in first-person shooter games. With the use of interviews and focus groups, a set of design guidelines was created that were believed to increase a player's immersion. The focus was primarily on how to incorporate diegesis into the HUD and game environment. The research does not scientifically confirm that diegetic interfaces do indeed affect spatial immersion in a significantly manner. This is what led to the development of this study's research questions.

Methodology

As seen in previous research, many have suggested that a heads-up display does indeed affect players' immersion, but none have scientifically examined this belief. With various types of immersion being proposed, this study specifically focused on the concept of spatial immersion, or presence. Various games were compared to see if there was a significant difference in spatial immersion experienced by the player.

Research Questions

Initially, three research questions were proposed in the beginning stages of this research, but one question was removed due to time constraints, this question can be found in Appendix A.

Research Question 1.

Does a diegetic presentation of game information significantly affect a player's spatial immersion in a shooter video game compared to a non-diegetic presentation?

According to the previous studies, the expectations from the player can affect their feeling of immersion (McMahan, 2003; Nunez, 2004). Shooters have been known to use a non-diegetic presentation for the heads-up display, so their feeling of immersion may not be significantly different between the two game presentations.

Research Question 2.

How do eye movements compare between participants who have an immersive experience compared to a non-immersive experience, in relation to diegetic and non-diegetic HUDs?

Based on previous research, participants should tend to have fewer fixations, and fixations will last a longer period of time when in an immersive experience (Jennett et al., 2008). Scan paths are also inclined to stay towards the middle of the screen allowing the players to absorb the information about their surroundings (Kearney, 2007; Holmberg, 2007). More fixations are expected to be present for non-diegetic HUDs, due to the dispersion of player status information around the screen. It is expected there would be a significant difference between eye movements from immersive and non-immersive experiences.

In order to understand and answer these questions, an experimental design was developed and a plan for data collection was defined.

Experimental Design

The study used a within-subjects design, where participants played only two of the four selected games during their session. The independent variables in this experiment were the games selected. The dependent variables were the eye movements obtained by the eye tracker, the results from questionnaires, and post-study interviews.

Four different video games, from the shooter genre, were selected for this study. In order to answer the first research question concerning diegetic interfaces, four games were selected to represent each side of the diegesis spectrum. More specifically, two games that utilize a highly diegetic interface (Dead Space & Metro 2033) were selected to be compared to two non-diegetic interface video games (Resident Evil 5 & Bioshock). Both games are part of the shooter genre to avoid variance in data.

The study sessions lasted for approximately an hour and a half, the testing script can be found in Appendix G. Some time was taken for pre-study introductions and a questionnaire. Participants played two games; one diegetic and one non-diegetic, and game distribution was counter balanced. Each study session started with a pre-study questionnaire, and then led into the first 25 minute play session. Once the first session was complete, a post-task questionnaire was given to evaluate the level of spatial immersion experienced. The participant then was given the opportunity to have a short break once the questionnaire was completed. The second 25 minute game session then followed, and once again the participant was told to fill out the same questionnaire based on their second game experience. At the conclusion of the study, some time was taken for a debriefing, which explained the motive for the study and allowed for additional comments to be stated by each participant.

The questionnaire was selected based on research mentioned in the literature review. A list of available questionnaires is explained in past literature (Jennett, 2010). The Measurement, Effects, Conditions Spatial Presence Questionnaire (MEC-SPQ), developed by Vorderer et al. (2004), was selected for this study. The questionnaire analyzes various aspects of presence, and was utilized in past video game studies (Kallinen et al., 2007; Nacke & Lindley, 2009; Nacke et al., 2009). In order to analyze levels of spatial immersion, the short 4-item scale of the MEC-SPQ was modified for the study. Only two spatial presence scales were incorporated into the questionnaires, self-location (SPSL) and possible actions (SPPA). The first dimension, self-location, refers to a person feeling physically situated in the virtual environment, instead of the environment that physically surrounds them. While the second dimension, possible actions, is the increased sensation of interacting with the virtual environment's objects, rather than the ones they are physically among in the real world. Each item from the questionnaire used a five-point scale ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree") and was presented in random order. The questionnaires, which were developed and utilized for the study, can be found in Appendix D, E, and F. All questionnaires were completed through *SurveyGizmo*, rather than through paper (Widgix Inc. LLC, 2011).

Data Collection and Analysis

In order to answer the research questions, questionnaires and eye movements were analyzed. Questionnaires were utilized in order to calculate the feeling of spatial immersion each participant experienced, which was a combination of the MEC-SPQ and self-generated questions.

During the study session, fixation frequency, fixation duration, and scan paths were collected using an eye tracker. A specific time frame within the 25 minutes play session was selected prior to testing to analyze the eye movements of the participants. Jennett et al. (2008) used a time interval of 300-600 seconds (5-10 minutes), assuming that participants would be accustomed to the controls and that they would become immersed. This study used an experimental design similar to the Jennett et al. study; however, we analyzed only the last 5 minutes of gameplay. Loading screens, cut scenes, and menus were not included in these 5 minutes because they did not include the heads-up display information and didn't allow for full control over the game avatar. In order to examine the selected time frame, VLC Player was used to step through the footage to record fixation data for segments of gameplay. This application allows for frame-by-frame walkthrough of various video formats, which will allow for analysis of eye fixations and patterns (VideoLAN, 2011).

The results from the questionnaires helped answer whether a diegetic presentation of game information does indeed affect a player's spatial immersion. The eye movement data was used to complement the spatial immersion results to see if there were changes in the way participants viewed the interface when playing the games based on the diegetic and non-diegetic presentations.

Game Selection

Selecting the four games for the study was a long and demanding process. There are hundreds of games available in the current video game generation (PlayStation 3 and Xbox 360), so choosing the proper games for the study was difficult (CBS Interactive, 2011). Since the study needed games in the shooter genre with positive ratings, proving the game is considered "fun" to players, the pool of choices was decreased to around hundred games. The selection of the games still proved to be a vigorous task. Since there was no control over the presentation of the games, there was a limited range of options for the study.

Game reviews, screenshots, and video footage were examined for how the games presented their information. The games were also analyzed for their use of diegesis in their heads-up display and environment. During the research, the game that always appeared as the prime example for a diegetic interface was *Dead Space*, a survival horror third-person shooter. This game was ultimately chosen as one of the four games that were used within the study.

In order to restrict the threats to the internal validity of the study, games similar to the sub-genre of *Dead Space* were selected; so in other words, survival horror shooters were selected for the study. The other diegetic game selected was *Metro 2033*, a survival horror first-person shooter. This led to the selection of the non-diegetic games to counterbalance the diegetic games: *Resident Evil 5*, a survival horror third-person shooter, and *Bioshock*, a survival horror first-person shooter. Both first and third-person perspective shooters were used to counter balance the study.

The four games that were selected were then analyzed for their use of diegesis when presenting information to the player. Two games are considered to use more of a diegetic approach compared to the other two. The games utilize different perspectives, so two of the games are first-person while the other two are third-person shooters. Each game was analyzed for the method of presentation of health, ammunition, damage, navigation, and other additional player status information.

Dead Space.

Dead Space is a survival horror third-person shooter that has a heavy focus on science fiction. The game takes place onboard a vast mining ship that has lost its communications with Earth. Isaac Clarke, an engineer, is sent to the craft to perform repairs, only to find the ship as a massive bloodbath. He soon finds out that he must survive his way through the ship while fighting off hoards of aliens (Electronic Arts, 2011).

This game takes a very unique approach when presenting information to the player. An overlaying HUD is completely absent; instead, gamer status is entirely displayed through the use of holograms within the game space, as seen in Figure 4.

Figure 4. Dead Space

Isaac's health status is presented as a tube along his spine, which is filled with fluid. Whenever he is damaged, the fluid decreases and Isaac is stunned for a moment. His ammunition count is seen through a holographic display above his weapon. Both presentations of heath and ammunition are diegetic elements. As for the navigation, when the player presses a button, Isaac highlights a path that points the player in the correct direction. The lined path is seen spatially within the environment, but is never really explained in the game's fiction. This navigational element can be seen as a geometric element. All menus are conveyed as in-game holograms that Isaac can manipulate. A great majority of the presentation exists in the game space and is explained through the game's lore. Dead Space is a prime example of a very diegetic representation of information.

Dead Space was chosen as one of two of the games that will represent the diegetic side of the spectrum of shooter genre games for this study.

Metro 2033.

Metro 2033 is a survival horror first-person shooter with role-playing and action elements. The story takes place in the metro system of the post-apocalyptic future of Moscow. Much of the gameplay takes place underground, with a few events taking place above ground where the air is harmful to breath. The player takes the role of Artyom, and must face enemies that range from mutants to hostile humans (THQ, 2011).

A very limited HUD is utilized to display Artyom's status. The game uses an assortment of both diegetic and non-diegetic elements in interesting ways, as seen in Figure 5.

Figure 5. Metro 2033

Blood splatters, and image blur, across the screen indicate injury to the player, which regenerates over time. This meta-perception is used, rather than a classic health bar, to represent damage. As for ammunition, some guns, such as the submachine gun, visualize the rounds left in the gun; however, a numerical value is present on the bottom right corner whenever the player is in an action sequence. For the navigation and map, a diegetic approach is taken; the player must press a button in order for Artyom to physically pull out a clipboard with a compass and objective checklist. For some areas of the game, a gas mask is needed and the player must set a wristwatch and constantly check the timer in order to keep track of their mask filter status. Metro 2033's presentation is diegetic with some minor non-diegetic elements combined to create the HUD.

Metro 2033 was chosen as the second of two games that will represent the diegetic side of the spectrum of shooter genre games for this study.

Resident Evil 5.

Resident Evil 5 is a horror third-person shooter that puts the player against leagues of zombies in a fight for survival. Chris Redfield, a member of a bio-terrorism security assessment group, heads to Africa on a lead that a bioorganic weapon is being sold on the black market. He teams up with Sheva Alomar to work against the threat. Once the locals start acting out of character they notice that they're dealing with a bigger threat than they first thought (Capcom, 2009).

A traditional approach is used when presenting the characters' statuses. The HUD is always overlaid on top of the game environment, in a fully non-diegetic manner, as seen in Figure 6.

Figure 6. Resident Evil 5

The health of Chris and Sheva are shown on a circular icon, with the ammunition count displayed within the circle. No visual meta-perceptions are used to demonstrate damage to the player. The characters' ammunition is labeled numerically, with an image of the equipped weapon, on the bottom right of the screen. Navigation is aided with the use of a map that is located on the top right of the screen. When the map is present, the element takes a large amount of real estate. The menu is also displayed as just an overlay, outside of the game space. Resident Evil 5 is an example of a non-diegetic representation of information.

Resident Evil 5 was chosen as one of the two games that will represent the non-diegetic side of the spectrum for shooters for this study.

Bioshock.

Bioshock is a survival horror first-person shooter that explores a fictional underwater city named Rapture, which takes place in an alternate history 1960. The player takes the role of Jack, a survivor of a plane crash in the middle of the Atlantic Ocean. He must make his way through the hidden underwater city fighting mutated beings and drones (Take-Two Interactive Software, 2008).

Similar to Resident Evil 5, Bioshock takes a conventional approach to present the player's status. All of the status information always overlays the screen and is non-diegetic, with some meta-representations. The common view of the HUD can be seen in Figure 7.

Figure 7. Bioshock

Health is portrayed as a non-diegetic element and a meta-perception. Whenever the player is damaged, the health bar is decreased and screen blurring appears. As for ammunition, it is completely non-diegetic and is a numerical value located on the bottom left of the screen with an icon. Navigation is presented with the use of a compass needle on the top center of the screen. The arrow always points the player in the direction of the next checkpoint; this is a variant of a meta-representation. Throughout gameplay, Jack picks up recordings from inhabitants of Rapture, which the player can listen to at any time. When played, a radio appears at the bottom corner of the screen with person's portrait. This can be seen as a meta-representation since this device is explained through the game's plot, but is not located directly in the game space. Geospatial cues are utilized to highlight the important of key objects. For example, a new weapon on the ground would glow to provide a cue to the player to pick the object up. Bioshock takes a non-diegetic approach when presenting information to the player.

Bioshock was chosen as the second of two games that will represent the non-diegetic side of the spectrum of shooter genre games for this study.

Location and Setup

The study was conducted with twenty-four participants in a formal lab setting. Participants played only two of the four preselected games for 25 minutes each on an Xbox 360. Responses to questionnaires were obtained from each participant and eye movements were also collected, with use of an eye tracker, during the study.

A controlled setting was utilized to conduct the experiment. The study took place in the eye tracking lab in Rochester Institute of Technology Golisano College, Building 70.

The game environment included an Xbox 360 that was connected to a Hauppauge HD PVR in order to output the video to necessary devices. The HD PVR outputted video to a Windows 7 PC setup and a LCD television. The PC system also outputted video to the television, thus simulating a dual screen setup.

The testing station itself had a television that was connected to a PC; the source was set to PC to calibrate the Mirametrix S1 eye tracker. The eye tracker was placed below the television, which was connected to the PC. Once calibration was complete, the source was set to the HD PVR, which displayed the output from the game console. The moderator viewed all eye movements through the PC setup utilizing the Hauppauge capturing software. Figure 8 presents a visualization of the set up that was utilized for the study.

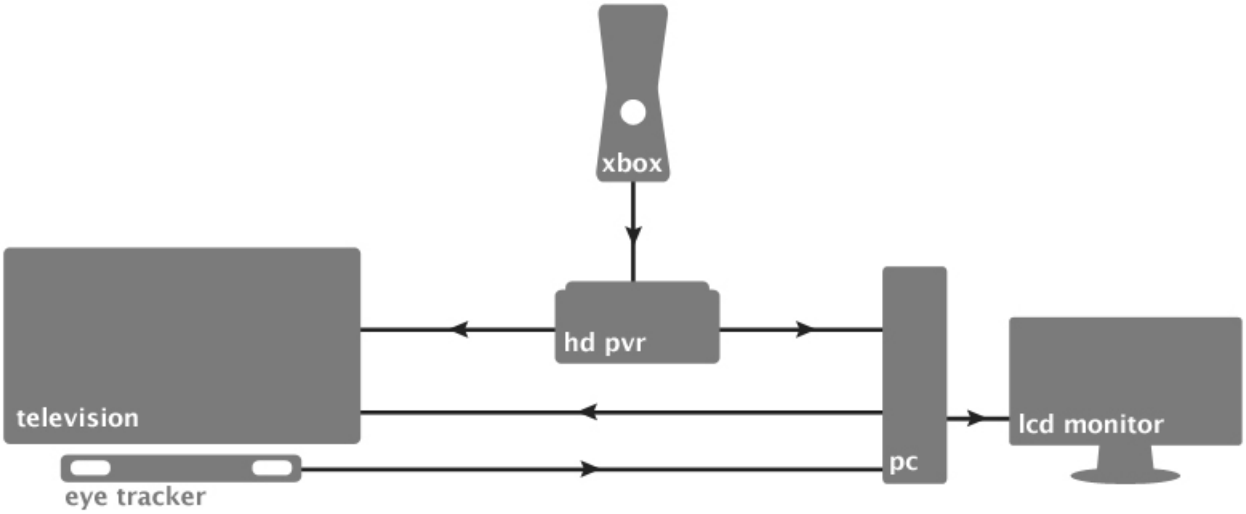

Figure 8. Equipment Setup

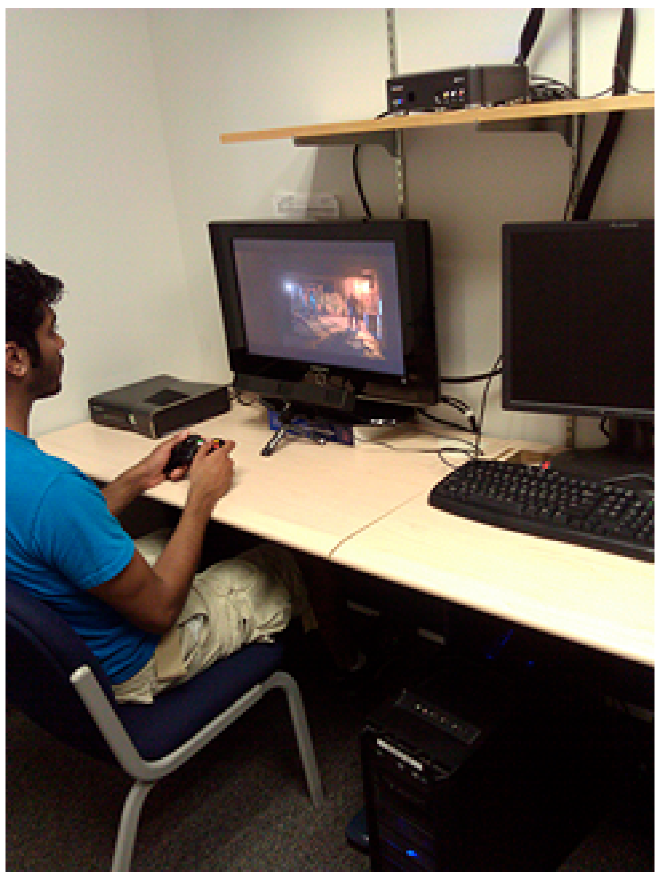

Figure 9. Lab Environment

The figure above presents the physical lab environment, which was utilized for the period of the experiment.

Participants

Prospective participants for this study completed surveys and were screened according to the following user profile:

User Characteristics		
Demographics	Age	18-30
	Gender	Both Male and Female
	Physical Limitations	- May be fully able-bodied, but must not have serious limitations in relation to sight, speech, hearing, or dexterity. - Must not require glasses to view a screen within ~3 feet viewing distance.
	Motivation	- To explore new video games and have fun
	Attitude	- Open to new experiences
Cognition	Video Game Usage	- 10+ hours a week - Play various types of shooter games - The player does not have significant prior knowledge of the selected game
	Access to Game Consoles	- Own a Xbox 360 or PlayStation 3 console
	Hardware Skills	- Ability to use a console controller

Table 1. Prospective Participant User Profile

Prospective participants were to range between the ages of 18 to 30 years old and were to be current or recent graduates of Rochester Institute of Technology. A mass email was sent out to the student population that included the screener survey distributed through a RIT protected Google Docs survey (Google Docs, 2011). All participants had to be avid game players; this was determined with the use of a background screener. Questions pertaining to preferred game genres and hours of play during a week were included in the screener. The participants may have some prior knowledge of the game. The participant must be fans of shooter games, by including these types of players, the game's learning curve within the allotted time would decrease, thus allowing more time for the participant to possibly become immersed. The participants were allowed to have some prior knowledge of the games, due to the popularity the selected games have already had in the industry. Due to the use of an eye tracker, the participants must not require glasses in order to view a television screen from a few feet away. Participants with glasses were allowed into the study if they were able to view the screen with contacts or without the assistance of glasses. Participants who were eligible for the study were contacted via email to schedule a session to take part in the study.

Results

The study was conducted during the summer months (June, July, August) of 2011 at the Rochester Institute of Technology, which presented some difficultly. The initial screener received approximately 130 responses; however, many participants were not available during the summer months. Due to the high restrictions for participants based on the first proposed user profile, many people were filtered out of the initial screener. When initial study invitations were sent out, many individuals did not respond, while others did not reply for a few weeks. Thus a different approach had to be taken in order to gather enough participants for the study. Table 2 presents the revised user profile that was utilized to represent the participant pool within this study.

User Characteristics		
Demographics	Age	19-26
	Gender	Male – 22 Participants Female – 2 Participants
	Physical Limitations	Fully able-bodied, but must not have serious limitations in relation to sight, speech, hearing, or dexterity.
	Motivation	- To explore new video games and have fun
	Attitude	- Open to new experiences
Cognition	Video Game Usage	- 5+ hours a week - Play various types of shooter games - The player does not have significant prior knowledge of the selected game
	Access to Game Consoles	- Own a Xbox 360 or PlayStation 3 console
	Hardware Skills	- Ability to use a console controller

Table 2. Actual Participant User Profile Based on Recruiting

The initial user profile indicated that participants must play video games for at least 10 hours a week; this restriction was softened to 5 hours. When recruiting the participants, many stated that they work a full time job, and will only be available in the evening hours of the day for the study. Thus revealing that many of them do not have the time to devote to video games compared to the profile that was developed for this study. So if a participant owns multiple consoles in their household, indicating that they are a "gamer" and a fan of video games, the hours of play per week was not a strict requirement.

Participant Demographics

Prior to gathering participants for the study, an IRB form was completed and accepted by the board (see Appendix B). The following figure presents the age groups that participated in the study.

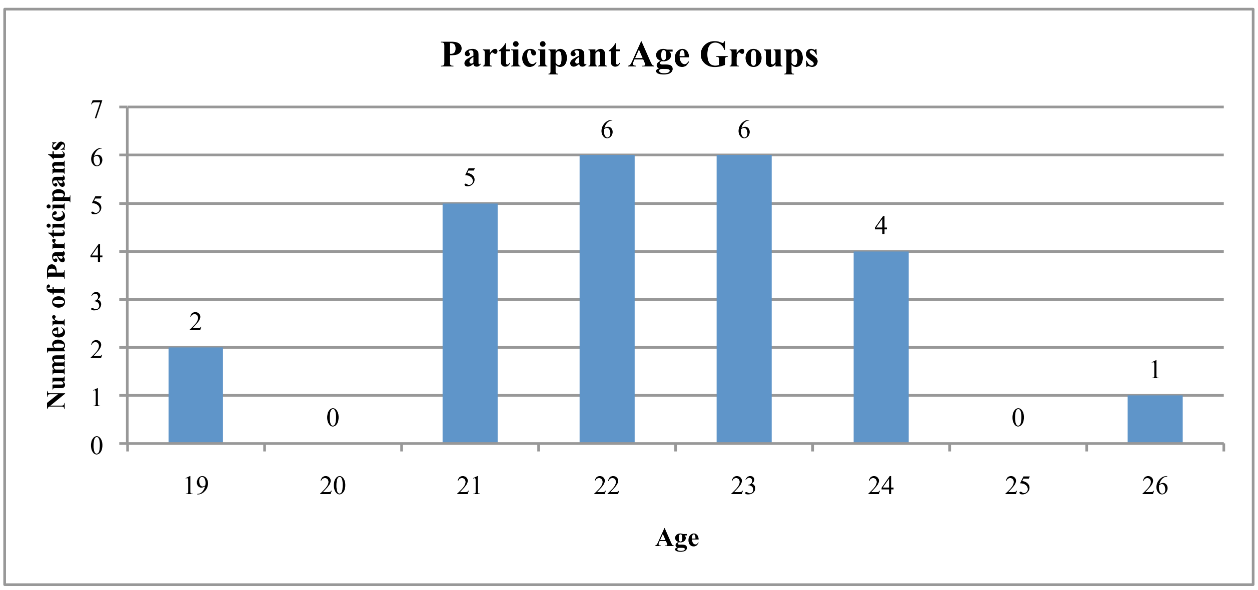

Figure 10. Participant Age Groups

Selected participants ranged in age from 19 to 26 years old; of the 24 participants chosen, only 2 were female due to the lack of responses from this user group. A great majority of the participants ranged between the ages of 21 to 24, while 2 were 19 years old and 1 participant was 26 years old.

All participants considered themselves as avid game players; this was also determined with the use of a background screener (see Appendix C). Questions pertaining to consoles commonly played, preferred game genres, and hours of play during a week were included in the screener.

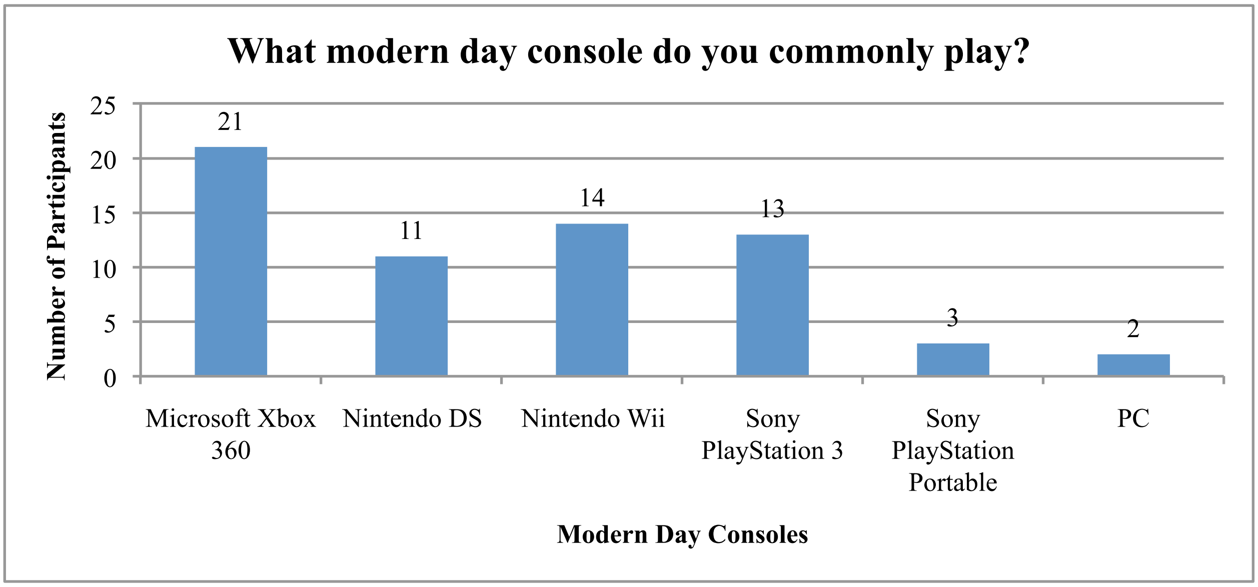

Figure 11. Modern Game Consoles Commonly Played

As seen in Figure 11, all participants commonly played either Microsoft Xbox 360 and/or Sony PlayStation 3. Microsoft Xbox 360 was commonly played among 21 of the participants, while Sony PlayStation 3 was played commonly among 13 of them. Among the Microsoft Xbox 360 players, 12 of them commonly played Sony PlayStation 3 as well.

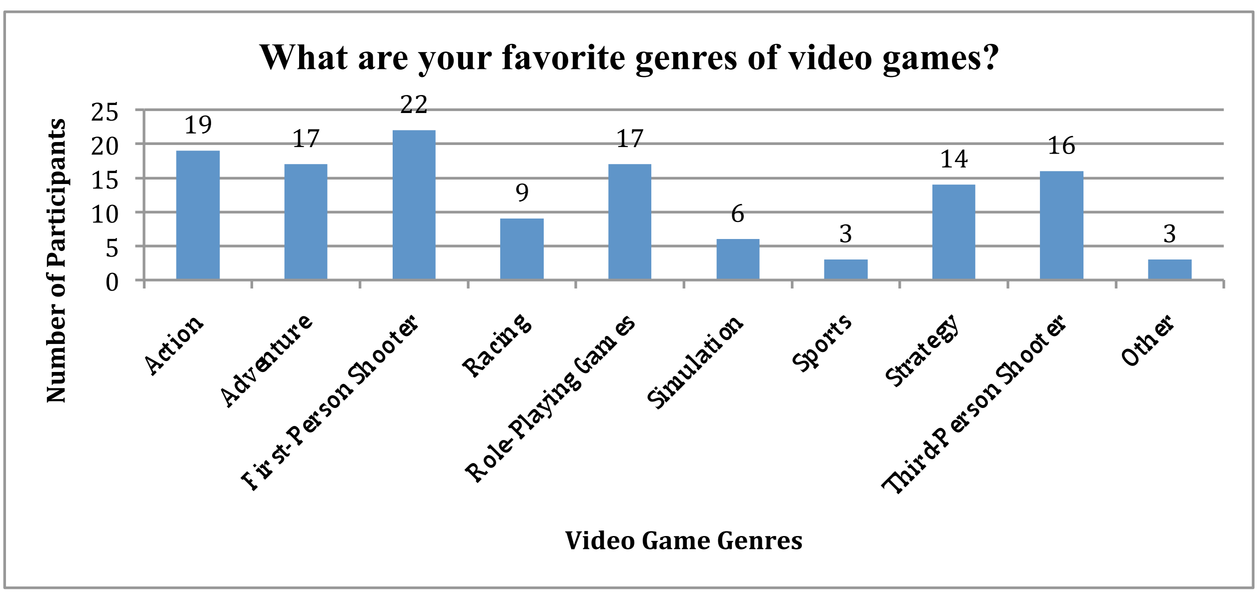

Figure 12. Favorite Video Game Genres

All participants included first-person and/or third-person shooters as one of their favorite video games genres. First-person shooters, action, adventure, and role-playing games were the top favored genres. First-person shooters were favored among 22 of the participants, and 16 of the participants favored third-person shooters. Among those who favored first-person shooters, 14 of them also favored third-person shooters. Three participants listed other genres that they favored, which included puzzle, fighting, and mining/digging games.

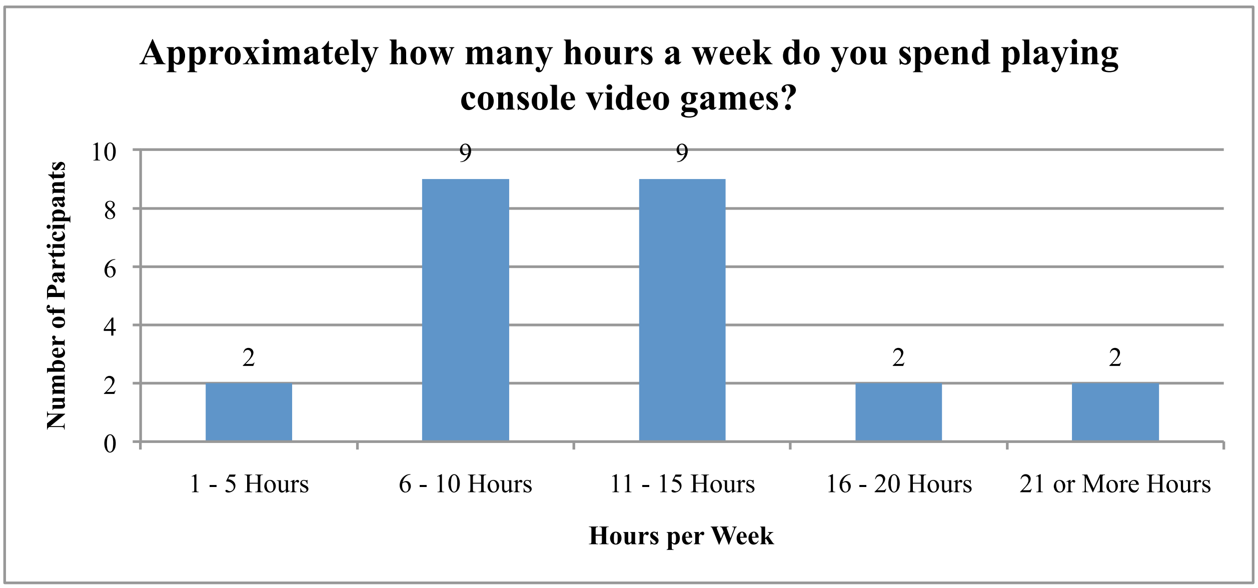

Figure 13. Hours per Week Spent on Console Video Games

Figure 13 presents the approximate hours spent playing console video games. A great majority of the participants spent either 6-10 or 11-15 hours a week playing console video games. Although 2 participants mentioned that only they only played console video games from 1-5 hours, they were included in the study because they owned multiple video games consoles, thus signifying that they consider themselves “gamers”.

Immersion Between Diegetic and Non-Diegetic Games

The following was the first research question proposed:

Does a diegetic presentation of game information significantly affect a player’s spatial immersion in a shooter video game compared to a non-diegetic presentation?

Among the 24 participants, each game was played 12 times due to counterbalancing. The MEC-SPQ examines two parts of the gaming experience; self-location and possible actions. The means and standard deviations were calculated by averaging the ratings given for the 4 questions for each category. Participants were asked to rate the following four questions from "strongly disagree" (1) to "strongly agree" (5) in order to evaluate their level of self-location. Participants were asked to rate the following four statements for this aspect:

- "I felt like I was actually there in the environment of the video game."
- "It was as though my true location had shifted into the environment in the video game."
- "I felt as though I was physically present in the environment of the video game."
- "It seemed as though I actually took part in the action of the video game."

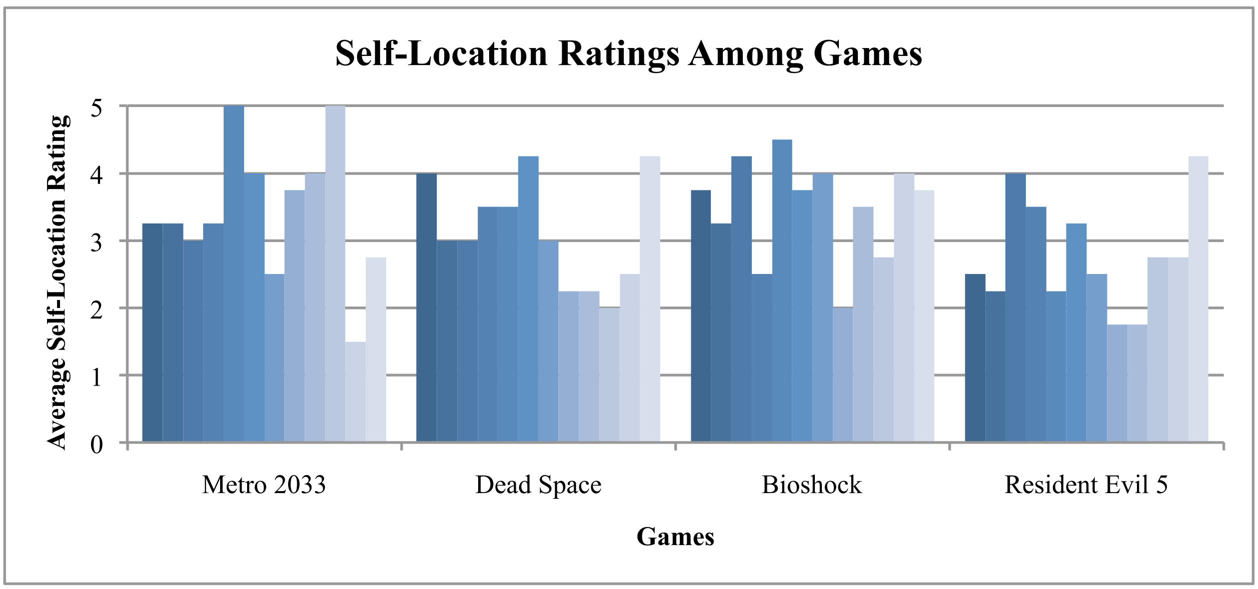

Figure 14. Average Self-Location Ratings Given to Games

The average self-location ratings given from individual participants for the four games can be seen in Figure 14. Since each game was played 12 times, twelve individual ratings were given to each game.

Spatial Presence Self-Location			
Diegetic HUD		**Non-Diegetic HUD**	
Metro 2033	*Dead Space*	*Bioshock*	*Resident Evil 5*
3.44 (1.00)	3.13 (.79)	3.50 (.75)	2.79 (.81)
Overall = 3.28 (.89)		Overall = 3.15 (.84)	

Table 3. Means (Standard Deviation) of Games for Spatial Presence Self-Location

The average results for each game, for the four self-location questions, can be see above in Table 3. The data on the individual games indicated that all participants had varying experiences when playing the games. The mean self-location rating for the diegetic games was 3.28 (n=12, sd=.89); for the non-diegetic games, the rating was 3.15 (n=12, sd=.84). Overall, a diegetic HUD did provide a higher perception of self-location; however, an independent groups t-test performed in SPSS showed that there was no significant difference between the groups ($t(46)=.539$, $p_{2\text{-tail}}=.592$). A Wilcoxon signed-rank test ($W+=142$, $W-=111$, $N=22$, $p<=0.6263$) also revealed similar results.

Participants were also asked to rate the following four statements to evaluate their level of possible actions:

- “I had the impression that I could be active in the environment of the video game.”
- “I felt like I could move around among the objects in the video game.”
- “The objects in the video game gave me the feeling that I could do things with them.”
- “It seemed to me that I could do whatever I wanted in the environment of the video game.”

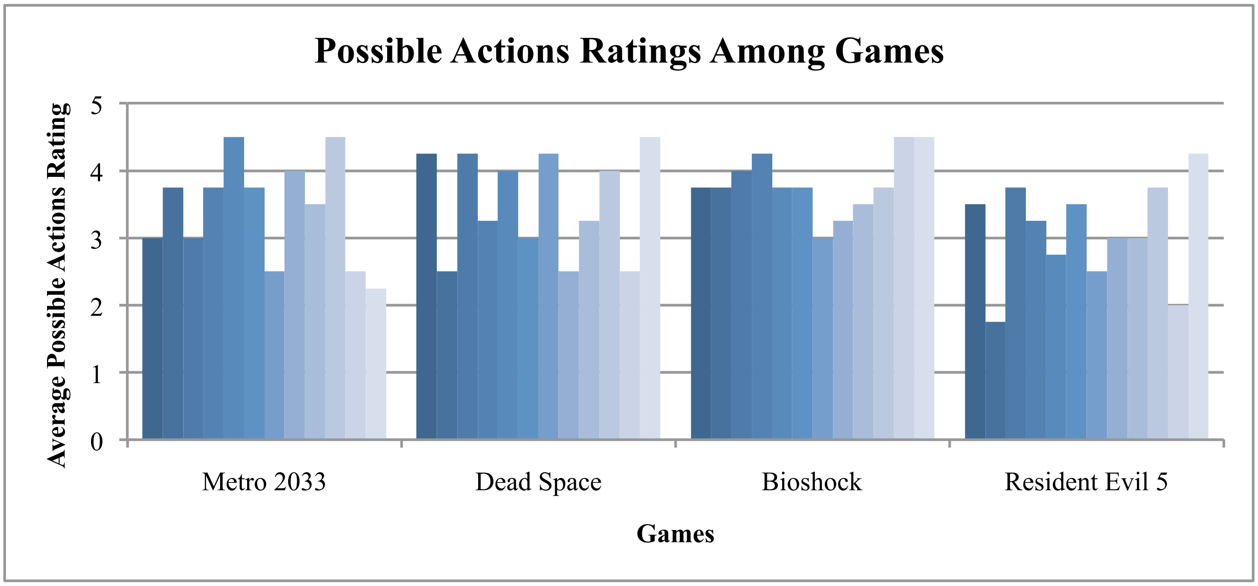

Figure 15. Average Possible Actions Ratings Given to Games

Average possible actions ratings given from individual participants for the four games can be seen in Figure 15 above. Twelve individual ratings were given to each game since each one was played 12 times.

Spatial Presence Possible Actions			
Diegetic HUD		**Non-Diegetic HUD**	
Metro 2033	*Dead Space*	*Bioshock*	*Resident Evil 5*
3.42 (.76)	3.52 (.77)	3.81 (.45)	3.08 (.74)
Overall = 3.47 (.75)		Overall = 3.45 (.71)	

Table 4. Means (Standard Deviation) of Games for Spatial Presence Possible Actions

The average results for each game, for the four possible actions questions, can be see above in Table 4. The mean possible actions rating for the diegetic games was 3.47 (n=12, sd=.75); for the non-diegetic games, the rating was 3.45 (n=12, sd=.71). Possible actions also seemed to present similar results as self-location, the data showed that a diegetic HUD did only slightly increase the feeling of possible actions in a video game environment. An independent groups t-test performed in SPSS showed that there was no significant difference between the groups ($t(46)=.099$, $p_{2\text{-tail}}=.922$). A Wilcoxon signed-rank test (W+ = 118, W- = 113, N = 21, p <= 0.9446) also revealed that there is no significance between the groups.

In addition to the MEC-SPQ, open-ended questions were given to obtain further understanding of what game they believed presented a more immersive experience. Participants were asked the following question in order to discover if the diegetic or non-diegetic game provided a more immersive experience:

- "Which game made you feel more immersed and part of the game world? Why?"

The following table indicates which game was preferred as more immersive over the other. The left column presents the game believed to be more immersive, versus the other game played during the game session. Since each participant had to play one diegetic and one non-diegetic game, some game combinations were not tested.

			Other Game Played During Same Session			
			Diegetic HUD		Non-Diegetic HUD	
			Metro 2033	*Dead Space*	*Bioshock*	*Resident Evil 5*
Most Immersive Experience Based on Participant Preference	Diegetic HUD	*Metro 2033*			2	5
		Dead Space			3	4
	Non-Diegetic HUD	*Bioshock*	4	3		
		Resident Evil 5	1	2		

Table 5. More Immersive Experience Based on Participant Preference

As seen in Table 5, 14 of the 24 participants believed that the diegetic game (Metro 2033 or Dead Space) that was played was more immersive than the non-diegetic game (Bioshock or Resident Evil 5), while the other 10 stated the non-diegetic game was the more immersive game. Of those who played Metro 2033, 7 participants of the 12 participants who played the game believed the game was more immersive than either Bioshock or Resident Evil 5. The other 5 participants believed either Bioshock or Resident Evil 5 was more immersive than Metro 2033.

Seven of the 12 participants who played Dead Space believed that the game was more immersive than the non-diegetic games they played. Of the 5 who believed Dead Space was less immersive, 3 believed Bioshock was more immersive, while the other 2 believed Resident Evil had the more immersive environment.

This question, in addition to the following post-study questions, allowed participants to state various reasons that affected their immersion:

- "Of the games that you played, which game do you believe presented status information (health, ammo, etc.) in a more effective manner? Why?"
- "What attributes of a game do you believe affect your feeling of being part of the environment?"

This provided insight on why only 3 participants believed Resident Evil 5 was the more immersive game when compared to the diegetic game played. The two who played both Resident Evil 5 and Dead Space stated that Resident Evil 5's environment was more realistic and Dead Space's "floating" heads-up display was "felt dissociative from the experience and often frustrating". The participant who played both Resident Evil 5 and Metro 2033 indicated an increase in control and believed that information was presented in a better manner, compared to Metro 2033's cinematic gameplay approach.

Of the 12 who played Resident Evil 5, 9 believed that the game was less immersive than the diegetic game (Metro 2033 or Dead Space) played during their session. Four participants mentioned that the controls affected their experience. The controls were thought to be hard to grasp at times, and believed that graphically presenting a controller button on the screen during certain events was too obvious, as seen in Figure 16, pulling the player out of immersion. The other 5 participants stated that the environment and enemies were not realistic to the situation.

The enemies were too "cookie cutter" and the game world shows many areas that the character cannot enter, disrupting the player's control.

Figure 16. Obtrusive Resident Evil 5 Controls

These questions also brought up comments on what other aspects, across video games in general, affect their feelings of immersion. The largest factors that were emphasized by the participants were the game design and controls. They believed that very interactive environments that allow for full control of the world allows for a more immersive experience. In-game cut scenes were mentioned to bring players out of immersion, while a fully responsive environment that allows user to alter their immediate environment at their own will, was seen as immersive.

The other set of aspects that were commented on were graphics and storyline. Seven participants believe that more realistic environments bring them into the game; non-playable characters that do not allow for player interaction bring the gamer out of the environment. The story must also be captivating and realistic to the game's fiction. Music was also seen to add to the feeling of the world. While two participants believe that a first-person point of view immerses them into the environment much better, when compared to a third-person view.

The question about immersion led to asking the participants the following question on whether they believed a game's heads-up display presentation affect their gaming experience:

- "Do you believe a game's heads-up display (HUD) presentation affects your gaming experience? If so, why?"

Of the 24 participants, 3 of them believe that the HUD does not affect their gaming experience. These participants believe that viewing the necessary information becomes a reflex and the player does learn to become familiar with the HUD in time. The other 21 participants have an opposing view; these individuals believe that a HUD does affect the gaming experience in some way.

A minimal HUD is seen as a positive among 7 participants. They believe that too much information on the screen distracts the player from the experience, thus decreasing immersion.

A HUD that conveys all necessary information to the player was seen as important to 6 participants. These participants do not believe that the size or the artistic direction of the HUD affects their experience, but the information that is presented does. They all believe that their status must be acknowledged at all times, if not, their gameplay performance would be hindered.

A well-designed HUD is seen as favorable among 8 participants. Keeping the HUD is seen as beneficial, but the interface must be designed well enough for the player. The art style is an important factor as well; the interface must be consistent for a good experience. A participant stated that game designers must find unique ways to convey the information. Although these participants didn't necessarily lean towards minimal or moderately sized interfaces, they believe that various design factors with the HUD could affect their feeling of immersion.

Eye Movements Based on Experiences

The following was the second research question proposed:

How do eye movements compare between participants who have an immersive experience compared to a non-immersive experience, in relation to diegetic and non-diegetic HUDs?

The second research question's goal was to analyze if the eye movements between immersive experiences differ from non-immersive experiences among diegetic and non-diegetic interfaces. Complete data of the MEC-SPQ ratings and eye tracking data can be found in Appendix I. In order to investigate the difference of eye movements between these two experiences, the participants' data was separated into three groups: immersive, neutral, and non-immersive. The "immersive" group are those who gave a rating higher than 3, "neutral" are participants who gave a 3 rating, while the "non-immersive" group are those who gave a rating below 3 for either self-location or possible actions on the MEC-SPQ. The "neutral" group was excluded from the analysis of this question because they were not the focus for this research. In addition to these ratings, eye tracking data was collected during the study sessions allowing for the analysis of fixation frequency and fixation duration. The fixations of the last 5 minutes of gameplay during the session were analyzed for this study. The "immersive" and "non-immersive" groups were analyzed for both the self-location and possible actions rating sets.

Figure 17 and Figure 18 present the individual fixation frequency and fixation duration data, while Table 6 summarizes the average eye tracking data, for the diegetic games between the three groups, based on their MEC-SPQ rating for self-location.

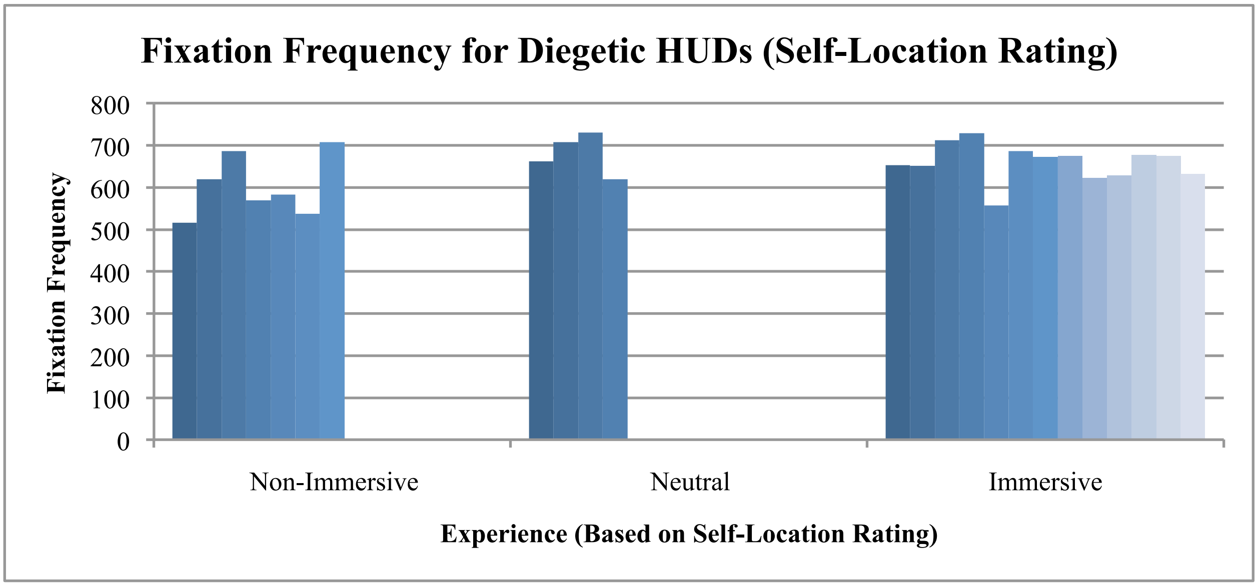

Figure 17. Average Fixation Frequency for Diegetic HUDs (Self-Location Rating)

	Number of Participants	Average Spatial Presence Self-Location Rating	Average Fixation Frequency	Average Fixation Duration
Immersive	13	3.92 (.60)	659.31 (43.66) *	.46s (.03s) *
Neutral	4	3 (0)	680 (49.77)	.44s (.03s)
Non-Immersive	7	2.25 (.41)	602.86 (72.47) *	.50s (.06s) *

Table 6. Eye Tracking Data for Diegetic HUDs Based on Self-Location Ratings
Note. *$p < .05$

The average fixation frequency in an immersive experience, for a diegetic HUD, was 659.31 fixations (n=13, sd=43.66), while the non-immersive group had an average of 602.86 fixations (n=7, sd=72.47). An independent groups t-test was performed in SPSS and revealed that there was a significant increase in number of fixations in an immersive experience when compared to a non-immersive experience, based on spatial presence self-location ratings, for diegetic games ($t(18)=2.191$, $p_{1\text{-tail}}=.021$).

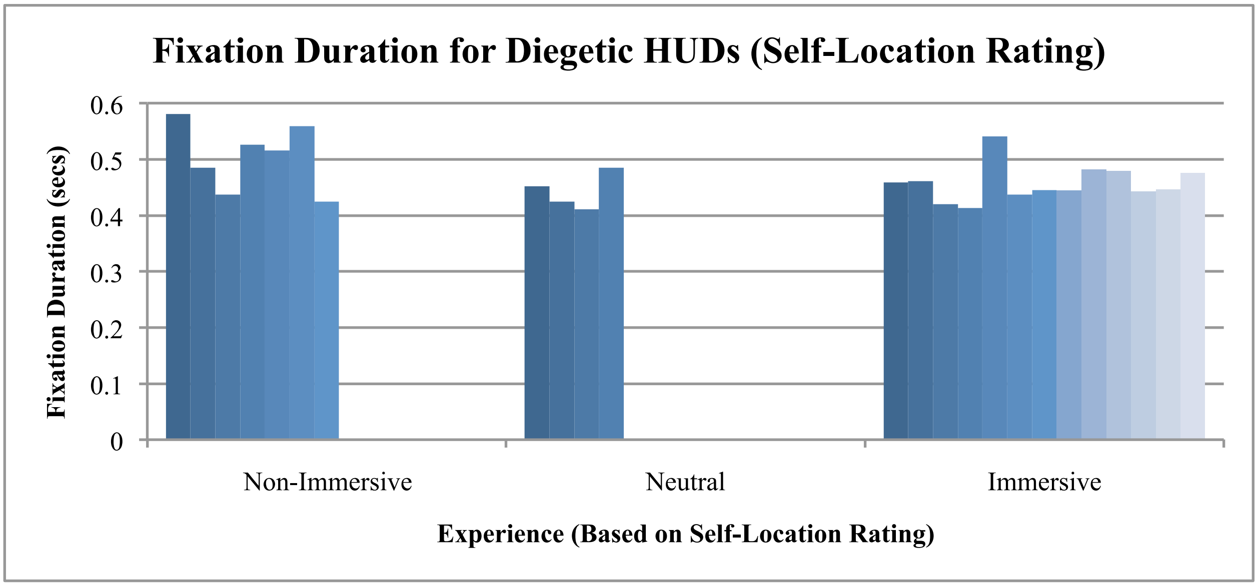

Figure 18. Average Fixation Duration for Diegetic HUDs (Self-Location Rating)

The fixation duration was also analyzed for the diegetic games, an immersive experience had an average fixation duration of .46 seconds (n=13, sd=.03s) and the non-immersive experience had a fixation duration of .50 seconds (n=13, sd=.06s). A significant difference was found between the two groups with the use of an independent groups t-test, showing that fixation duration was decreased in immersive experiences compared to a non-immersive experiences for diegetic games, based on spatial presence self-location ratings ($t(18)=-2.310$, $p_{1\text{-}tail}=.0165$).

The individual fixation frequency and fixation duration data are presented in Figure 19 and Figure 20, while Table 7 summarizes the average eye tracking data, for the non-diegetic games between the three groups, based on their MEC-SPQ rating for self-location.

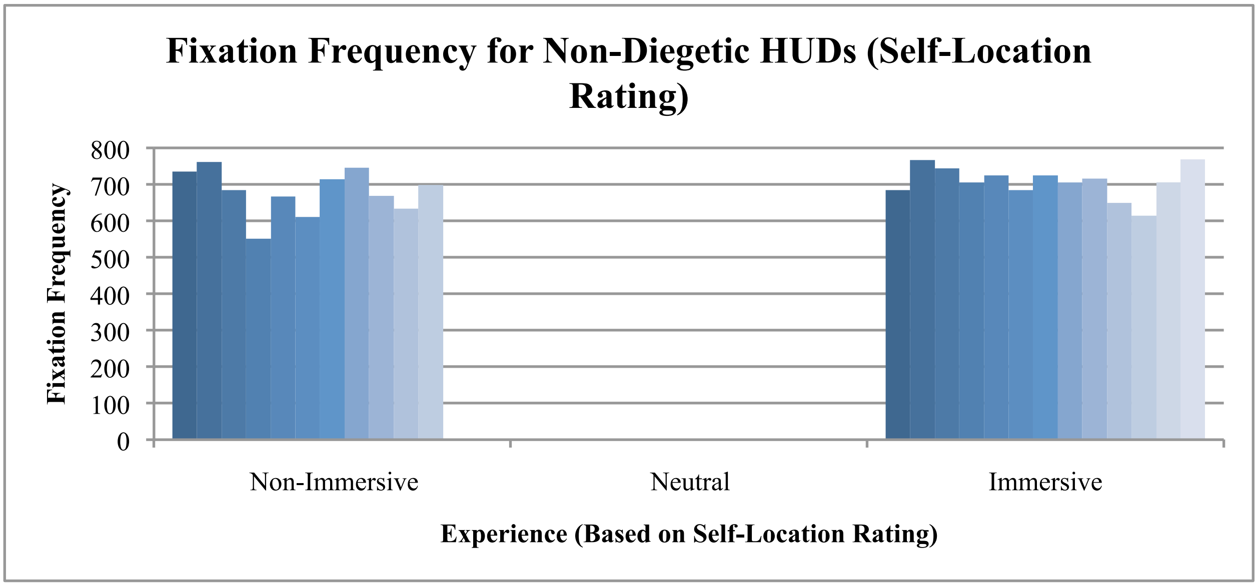

Figure 19. Average Fixation Frequency for Non-Diegetic HUDs (Self-Location Rating)

	Number of Participants	Average Spatial Presence Self-Location Rating	Average Fixation Frequency	Average Fixation Duration
Immersive	13	3.83 (.39)	707.54 (43.39)	.43s (.03s)
Neutral	0	-	-	-
Non-Immersive	11	2.34 (.38)	679.55 (62.88)	.45s (.05s)

Table 7. Eye Tracking Data for Non-Diegetic HUDs Based on Self-Location Ratings
Note. *p < .05

Table 7 presents the eye tracking data for the non-diegetic games in the study, based on the spatial presence self-location ratings from the participants. The average number of fixations in an immersive experience, for a non-diegetic HUD, was 707.54 fixations (n=13, sd=43.39), while the non-immersive group had an average of 679.55 fixations (n=11, sd=62.88). An independent groups t-test revealed that there was no significant increase in the number of fixations in an immersive experience against a non-immersive experience, based on the spatial presence self-location ratings, for non-diegetic games (t(22)=1.286, $p_{1\text{-tail}}$=.106) .

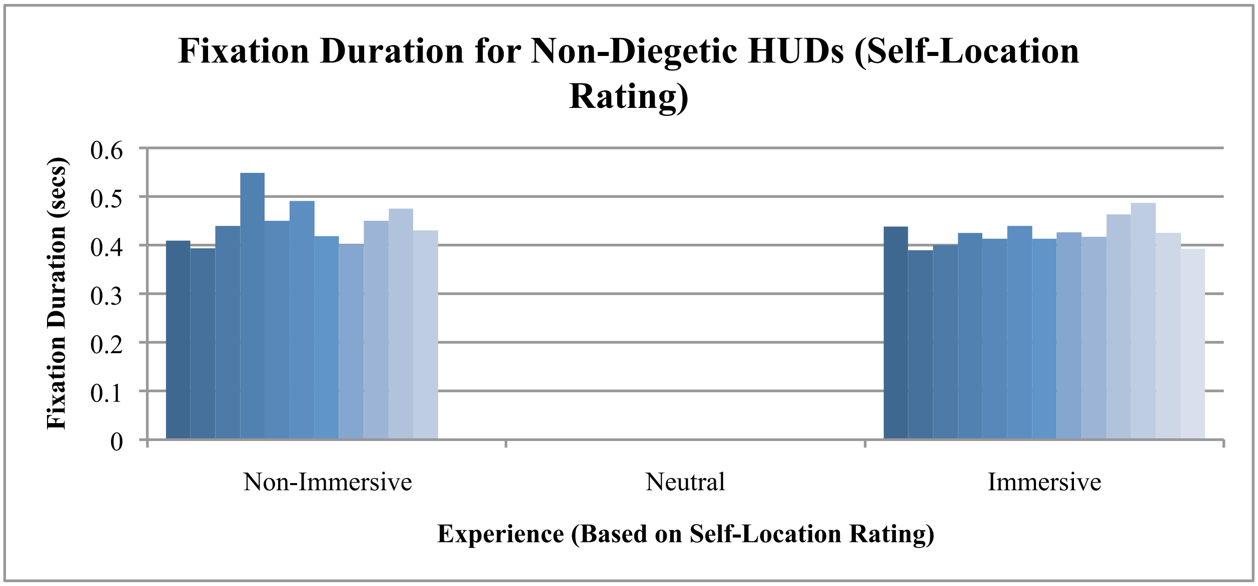

Figure 20. Average Fixation Duration for Non-Diegetic HUDs (Self-Location Rating)

The average fixation duration for an immersive experience was .43 seconds (n=13, sd=.03s) for a non-diegetic HUD, the average fixation duration was .45 seconds (n=11, sd=.05s) for the non-immersive experience. No significant decrease in fixation duration was found for the immersive experience in a non-diegetic game when an independent groups t-test was performed, based on spatial presence self-location ratings ($t(22)=-1.381$, $p_{1\text{-tail}}=.0905$).

Analysis of the eye tracking data among the diegetic games based on the spatial presence possible actions ratings from the participants can be seen in Table 8. The individual fixation frequency and fixation duration data between the three groups can be seen in Figure 21 and Figure 22.

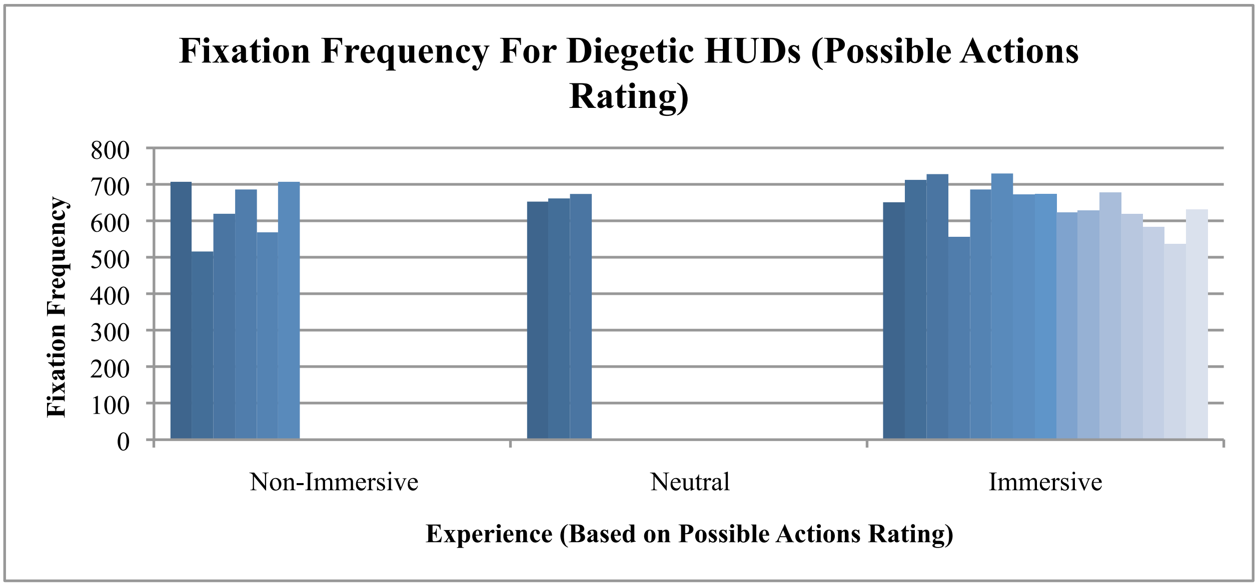

Figure 21. Average Fixation Frequency For Diegetic HUDs (Possible Actions Rating)

	Number of Participants	**Average Spatial Presence Possible Actions Rating**	**Average Fixation Frequency**	**Average Fixation Duration**
Immersive	15	3.97 (.42)	647.6 (58.45)	.47s (.04s)
Neutral	3	3 (0)	663.33 (11.06)	.45s (.01s)
Non-Immersive	6	2.46 (.10)	634.5 (79.95)	.48s (.06s)

Table 8. Eye Tracking Data for Diegetic HUDs Based on Possible Actions Ratings
Note. *p < .05

The average number of fixations in an immersive experience, for a diegetic HUD, was 647.6 fixations (n=15, sd=58.45). The non-immersive group had an average of 634.5 fixations (n=6, sd=79.95). An independent groups t-test was performed in SPSS and revealed that there was no significant increase in the number of fixations in an immersive experience when compared to a non-immersive experience, based on spatial presence possible actions ratings, for diegetic games ($t(19)=.418$, $p_{1\text{-tail}}=.34$).

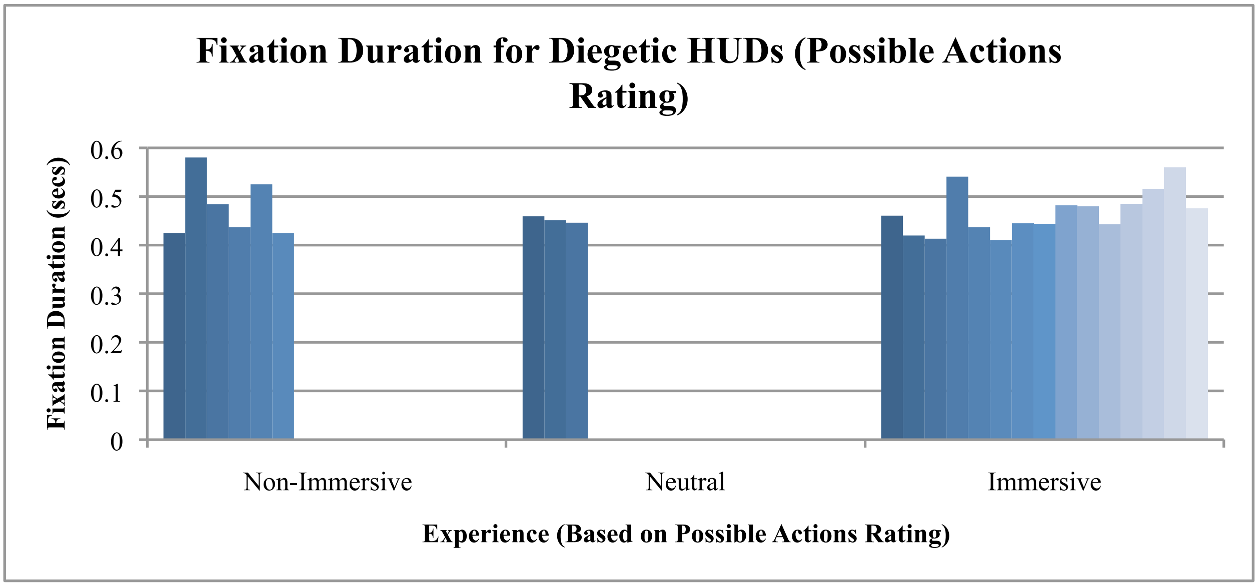

Figure 22. Average Fixation Duration for Diegetic HUDs (Possible Actions Rating)

The fixation duration for diegetic games had an average duration of .47 seconds (n=15, sd=.04s) for the immersive experience, while the non-immersive experience had an average duration of .48 seconds (n=16, sd=.06s). No significant difference was found between the two groups when an independent groups t-test was performed, thus showing that the fixation duration was not decreased in an immersive experience when compared to a non-immersive experience for diegetic games, based on their spatial presence possible actions ratings ($t(19)=-.509$, $p_{1\text{-tail}}=.3085$).

Table 9 presents the eye tracking data for the non-diegetic games, based on the spatial presence possible actions ratings from participants. The individual fixation frequency and fixation duration data are presented in Figure 23 and Figure 24 between the three groups for the non-diegetic games.

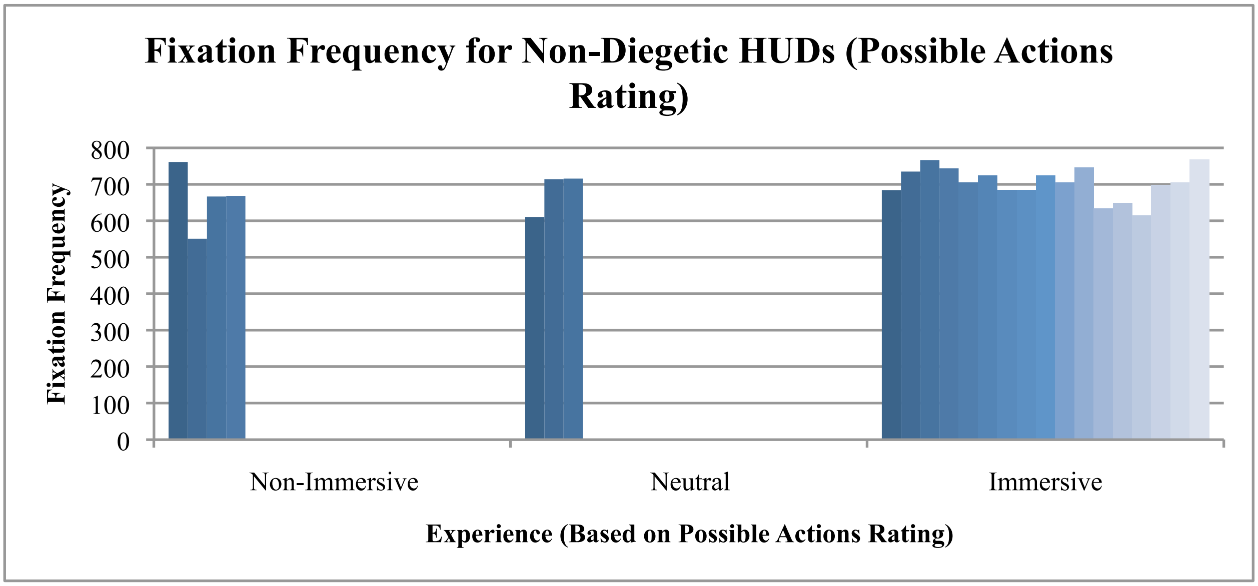

Figure 23. Average Fixation Frequency for Non-Diegetic HUDs (Possible Actions Rating)

	Number of Participants	Average Spatial Presence Possible Actions Rating	Average Fixation Frequency	Average Fixation Duration
Immersive	17	3.81 (.38)	704.76 (43.77)	.43s (.03s)
Neutral	3	3 (0)	680.67 (60.35)	.44s (.04s)
Non-Immersive	4	2.25 (.46)	662.5 (86.42)	.46s (.06s)

Table 9. Eye Tracking Data for Non-Diegetic HUDs Based on Possible Actions Ratings
Note. *p < .05

The average number of fixations in an immersive experience, for a non-diegetic HUD, was 704.76 fixations (n=17, sd=43.77), while the non-immersive group had an average of 662.5 fixations (n=4, sd=86.42). An independent groups t-test showed that there was no significant increase in the number of fixations in an immersive experience compared to a non-immersive experience, based on the spatial presence possible actions ratings, for non-diegetic games ($t(19)=1.439$, $p_{1\text{-tail}}=.083$).

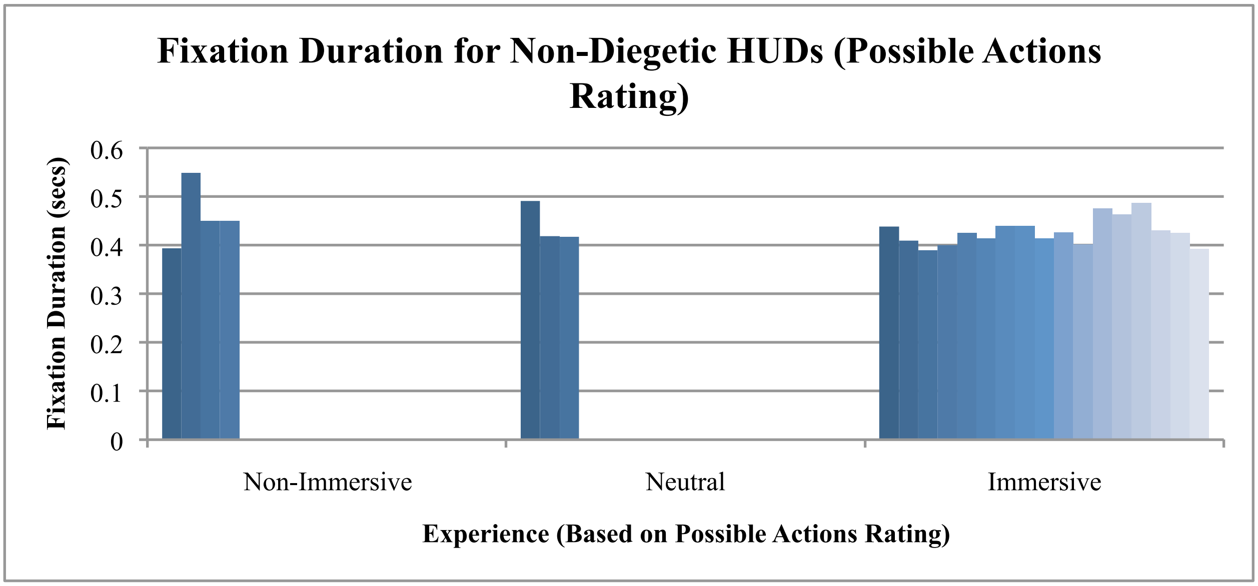

Figure 24. Average Fixation Duration for Non-Diegetic HUDs (Possible Actions Rating)

For non-diegetic HUDs, the average fixation duration for an immersive experience was .43 seconds (n=17, sd=.03s), and the average fixation duration was .46 seconds (n=4, sd=.06s) for a non-immersive experience. No significant decrease in fixation duration was found for the immersive experience in a non-diegetic game when an independent groups t-test was performed, based on spatial presence possible actions ratings ($t(19)=-1.652$, $p_{1\text{-tail}}=.0575$).

Discussion

Summary of Findings

The study suggests that there was a slight increase in both the feeling of self-location and possible actions in diegetic games when compared to non-diegetic games; however, there was no significant difference between the two types of games when analyzed for spatial immersion. Even though the study's focus was on spatial immersion based on the method of information presentation, many participants suggested other reasons on why they did not become immersed in specific games, for example, the graphics and storylines. So these attributes may have altered the ratings given by the participants during the study.

Previous studies have explained that the expectations of the player can affect their feeling of immersion (McMahan, 2003; Nunez, 2004). Due to the age group, many of these participants grew up with games that did not have diegetic heads-up displays. So this may account for the very minor differences in immersion between diegetic and non-diegetic games.

The research found significant differences when the self-location aspect of the MEC-SPQ was analyzed. For participants who played the diegetic games and felt that their location shifted to the game environment, their number of fixations increased and the fixation duration decreased. This was not significant for those who played the non-diegetic games. As for the aspect of possible actions, where a player has an increased feeling of interacting with the game environment's objects, no significant findings were discovered between diegetic and non-diegetic games in terms of eye movements.

Previous studies have shown the contrasting view for the eye tracking data. Immersive experiences were shown to have fewer fixations, with fixations that lasted a longer period of time (Jennett et al., 2008). This was not observed in this study, with neither the self-location nor the possible actions aspects of the questionnaire. Jennett et al. referenced findings from Styles (1997), which indicated when visual attention is increased, fixation frequency is decreased. Thus, Jennett et al.'s reason for their findings was that attention would be focused on visual components on the game, so the number of fixations will decrease.

An opposing argument can be used for this study as well, if a gamer is not immersed in their environment, then s/he must focus more attention on the virtual environment to understand the world, thus increasing their fixation duration. Longer fixation durations were shown to measure the difficulty of information interpretation (Jacob & Karn, 2003). Cooke (2006) mentioned that longer fixations implied that the user is spending more time trying to interpret and relate the interface component to the internalized representation. Thus non-immersed players may have had difficulty in interpreting the information and applying the meaning to the virtual world that they are now trying to associate themselves with. Overall, non-diegetic games did have a higher fixation count, with a shorter fixation duration when compared to diegetic games. The individuals' increase in fixations, and decrease in fixation duration, may suggest that information was easier to understand thus allowing them more time to observe and absorb other information in the game environment.

Upon completion of the experiment, various aspects of the methodology could have been modified to fix some errors in the study. All participants played each game for 25 minutes; however, each participant had different playing methods and skills. This ultimately made each participant complete their session at different locations of the game. This may have altered the ratings given to the MEC-SPQ since it evaluates the feeling someone had just experienced. A participant waiting on a loading screen would provide a different rating compared to a participant in the middle of an action sequence. The methodology should be revised to have specific segments of each game set prior to the study, so participants may complete the session on their own time, but each participant will end in the same location.

The study took place in a lab environment. This environment was bright and each participant had to sit at a specified distance from the television due to the eye tracker. The setup may have altered the participants' experiences, since the setting is very different from the typical gaming environment. This may have altered the immersion scores, thus providing this research with varying results. An alternative setup may have provided a different perspective to the research question.

Conclusion

Video games try various methods to bring the player into the game world. From realistic graphics to engrossing storylines, each aspect of the gaming experience affects the player differently. For this study, the focus was on the method of information presentation, specifically the difference between diegetic and non-diegetic heads-up displays. The data collected from the study show that when experiencing spatial immersion, although minor, there are not many significant differences between diegetic and non-diegetic interfaces. When collecting data, the participants' responses led us to discover interesting insight for their specific experiences.

Graphics and control of the game environment were other key factors affecting a player's feeling of immersion. These components however lead to other domains; as indicated earlier in the research, Thon (2008) mentions ludic and narrative immersion as experiences during gameplay. These dimensions focus on the level of challenge and depth of the story within a game. These were not the focus of the study, but participants brought them up as factors that affect their game experience. Heads-up displays were seen as important; designers must pay attention to the style and amount of information that is presented to the gamer.

We also brought to light the importance of a well-designed heads-up display. While some believe that a HUD does not decrease their feeling of immersion, a great majority of participants believe otherwise. Overall, many of the players believed that information should be presented in unique ways that fit the art direction of the game, while some believed that a minimal approach works best.

Eye movements also provided interesting information about these players' experiences. Researchers tend to apply eye tracking interpretations from other domains to video games, but the results from this study suggest that it may not be recommended. Jacob & Karn (2003) related eye tracking to difficulty in information interpretation, while Jennet et al. (2008) applied eye tracking directly to immersion in video games. This study ultimately discovered that eye tracking should not be directly applied to immersion itself, but rather to the difficulty in information interpretation based on the visual presentation. Non-immersive experiences caused players to focus more attention understanding the game, thus increasing fixation duration, which does affect the person's feeling of being relocated and immersed into the virtual world. Game designers must look into different methods to display information that is easier for a player to comprehend, allowing them to have an easier time to become spatially immersed in the game world.

Future Research

Future research should consider modifying the protocol to determine the impact on the results. Different age groups may also provide different insight in this study. A younger population may have a different response because the game designs they grew up with are different from older populations. Likewise with an older population, they may not be as familiar with the new "diegetic-like" designs recent games have taken, leading to different results.

Due to the difficulty of finding a purely diegetic and non-diegetic game, an alternative approach to the study may be to design one game, with two types of information presentation methods. This will solve the complication of different games affecting the player experience, due to dissimilar storylines or graphics. In addition, the game session may be modified to include an ending checkpoint in the game, rather than a strict ending time. This will allow players to end at the same point of the game, and the evaluation of spatial immersion will be based on the same last moments among all participants.

In order to analyze the eye tracking data, one researcher was available to study the data; if more researchers were available for the study a more in depth analysis may be possible. Using the eye tracking data, the fixation data may be examined to see how fixation frequency and duration are increased, or decreased, during a play session. This may unearth new findings on how eye patterns change as the game session progresses. Eye tracking data may also be collected with different software, to allow to this in depth analysis. The Mirametrix software did not allow for analysis of video, but rather still images. Different software will allow for a more automated and detailed analysis, rather than a manual frame-by-frame approach that this study exercised.

Upon further research, additional investigation of the participant's state of mind may have been beneficial for this specific type of study. Transportation theory is the level of when a person's beliefs may be altered by a certain narrative, in this case the game being played. This will help assist to what extent the participant felt consciously aware of being in the real world when playing. Transportation was shown to affect the enjoyment of the participant when reading a novel; this may then alter the level of spatial immersion of the gamer when playing a video game (Green, Brock, & Kaufman, 2004). This may be beneficial to incorporate into pre-test questionnaires prior to the study.

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Appendices

Appendix A

Research Question 2

Does the lack of a heads-up display significantly affect spatial immersion in a shooter video game in a non-diegetic video game?

To answer the second question the study will utilize one game using a non-diegetic presentation that can be turned on and off, participants will play for an allotted time based. A group of participants will play with the HUD turned on, while another group will play with the HUD disabled.

Similar to the first research question's hypothesis, expectations can affect a player's feeling of immersion (McMahan, 2003; Nunez, 2004). It is not common practice for an extremely non-diegetic game to absolutely lack a heads-up display (Wilson, 2006). Therefore, is it assumed there will be a significant difference between the experiences of user not utilizing a HUD.

Appendix B

IRB Form

R·I·T

Rochester Institute of Technology
INSTITUTIONAL REVIEW BOARD
585-475-5429 ~ www.research.rit.edu/hsro ~ sjrtlo@rit.edu

FORM A: Request for IRB Review of Research Involving Human Subjects

- **To be completed by the investigator** after reading the RIT Policy for the Protection of Human Subjects in Research, found in the *Institute Policies and Procedures Manual*, Section C5.0, and on the Office of Human Subjects Research website, http://www.rit.edu/research/hsro/process_geninfo.php.
- Submit an **electronic version** of the completed form **along with a signed hard copy** to **Sara Renna**, HSRO, Bldg 87, Suite 2400 sjrtlo@rit.edu . Location - 2nd Floor, Administrative Services Building/Innovation Center (Bldg #87), Suite 2400.

Project Title: Video Game HUDs: Information Presentation and Spatial Immersion		
Investigator's Name: James Babu	Investigator's Phone:	Investigator's Email: jxb5870@rit.edu
Investigator's College and Department: Golisano College of Computing and Information Sciences – Human Computer Interaction		
Project Start Date: April 2011	Date of IRB Request: April 2011	
If Student, Name of Faculty Supervisor: Dr. Evelyn Rozanski	Faculty's Phone:	Faculty's Email: eprics@rit.edu
If Not Employed or a Student at RIT, List Name, College & Dept. of RIT Collaborator: N/A	RIT Collaborator's Phone: N/A	RIT Collaborator's Email: N/A
Will this project be funded externally? ☐Yes ☒ No	Is the Investigator a student? ☒Yes ☐ No	
If yes, name of funding agency:		
Status of project: ☐ Submitted on	☐ Funding pending	☐ Funding confirmed
Do you have a personal financial relationship with the sponsor? ☐ Yes ☒ No If yes, please read RIT policy C4.0 – Conflict of Interest Policy Pertaining to Externally Funded Projects. Complete the **Investigator's Financial Disclosure Form** and attach it to this Form A. *All information will be kept confidential.*		

BY MY SIGNATURE BELOW, I ATTEST TO AN UNDERSTANDING OF AND AGREE TO FOLLOW ALL APPLICABLE RIT, SPONSOR, NEW YORK STATE, AND FEDERAL POLICIES AND LAWS RELATED TO CONDUCTING RESEARCH WITH HUMAN SUBJECTS. If significant changes in investigative procedures are needed during the course of this project, I agree to seek approval from the IRB prior to their implementation. I further agree to immediately report to the IRB any adverse incidents with respect to human subjects that occur in connection with this project.

Signature of Investigator Date

Signature of Faculty Advisor (for Student) or RIT Collaborator (for External Investigator) Date

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Signature of Department Chair or Supervisor Date

Complete the attached Research Protocol Outline and attach to this cover form with other required attachments.

Attachments required for all projects:

☒ Project Abstract

☒ Investigator Responsibilities and Informed Consent Training Certificate(s) from OHRP (see http://ohrp-ed.od.nih.gov/)

Attachments required where applicable:

☒ Informed Consent Materials

☐ Cover letter to subjects and/or parents or guardians

☒ Questionnaire or survey

☐ External site IRB approval

☐ Relevant Grant Application(s)

☐ Other

☐ Letter of Support from School Principal

Form A (continued)**: Research Protocol Outline**

- The RIT Institutional Review Board (IRB) categorizes Human Subjects Research into three Risk Types (Exempt, No Greater than Minimal Risk, and Greater than Minimal Risk, defined at the end of this form). The IRB makes the final determination of risk type.
- **Please complete this entire form (1 through 10 below). ENTER A RESPONSE FOR EVERY QUESTION.** If a question does not apply to your project, please enter "N/A". Leaving questions blank may result in the form being returned to you for completion before it is reviewed by the IRB.
- Underlined terms are defined at the end of this form.

FOR ALL PROJECTS, please complete 1-10 below.

1) **If you believe your project qualifies for Exemption, which exemption number(s) apply?**
   (Note: The IRB makes the final determination of Exemption)
   Three (3)

2) **Describe the research problem(s) your project addresses.**
   Research has shown that questionnaires and eye tracking can identify whether a person is immersed, or "into", a video game. Visual presentation of video game information will be analyzed to see if it significantly affects how immersed a player can get when playing a video game. Eye tracking data will also be collected to discover if there are patterns between those who are immersed when playing, to those who are not. The results should clarify if the visual presentation of video game information does affect the player's spatial immersion. Spatial immersion is the player's shift of attention from his or her real environment to the game spaces.

3) **Describe expected benefits to subjects and/or knowledge to be gained from your project.**
   Results would allow game designers to discover if a certain type of information presentation is crucial to improve the gamer experience.

4) **Describe the population sample for your project.**
   a) **How many subjects will participate in this project?**
      28 subjects
   b) **How will these subjects be identified and selected for participation?**
      Participants will be between the ages of 18 and 30. They will be selected through the use of an online screener, based on responses. This screener will be promoted via flyers, email, and word of mouth.
   c) **Describe the rationale for inclusion or exclusion of any subpopulation.**
      Participants must have good vision, without assistance or with the use of glasses or contacts, in order to be calibrated to the eye tracker. They must also be able to participate in the study without the assistance of an ASL interpreter because the participants' eyes must not leave the display area above the eye tracker during the duration of the study.
   d) **How will you recruit subjects?**
      A screener will be released to the public; participants will be filtered by their responses.
   e) **Describe any incentives for participation you plan to use.**
      All participants will be entered in a random drawing to win 1 of 2 available $50 Visa gift cards.

5) **Will you include any of the following vulnerable populations in your research?** (Check any that apply)

☐ Children ☐ Mentally Ill
☐ Prisoners ☐ Mentally Handicapped/Retarded
☐ Pregnant Women ☐ Fetuses

If any of these populations are to be included, please addresses the following:

a) **Rationale for selecting or excluding a specific population:**
N/A

b) **Description of the expertise of project personnel for dealing with vulnerable populations:**
N/A

c) **Description of the suitability of the facilities for the special needs of subjects:**
N/A

d) **Inclusion of sufficient numbers of subjects to generate meaningful data:**
N/A

6) **Describe the data collection process.**

a) **Will the data collected from human subjects be anonymous?** ☒ Yes ☐ No

b) **Will the data collected from human subjects be kept confidential?** ☒ Yes ☐ No

c) **Describe your procedures for ensuring anonymity and/or confidentiality:**
All participants will be named under a numerical naming convention. None of the participants will be referred to by name during the analysis, but rather by the Participant 1, Participant 2, etc.

d) **How much time is required of each subject?** 60 minutes

e) **If subjects are students, will their participation involve class time?** No class time is involved.

f) **What methods, instruments, techniques, and/or other sources of material will you use to gather data from human subjects?**
Eye tracking data will be collected with each participant. Responses to questionnaires to evaluate the level of immersion for each participant will also be collected. The eye tracking is noninvasive, and does not pose any risk to the participants.

7) **Will this research be conducted at another university or site other than RIT?** ☐ Yes ☒ No
If yes, describe location:

Note: If you will be conducting human subjects research at another university or college, you will also need to obtain IRB approval from that institution. **Attach a copy of that approval to this application.**

8) **Describe potential risks (beyond minimal risk) to subjects:**

a) **Are the risks physical, psychological, social, legal or other?**
No risks.

b) **Assess their likelihood and seriousness to subjects:**
No risks. The participant will be playing a video game for approximately 30 minutes, with the eye tracker located below the display.

c) **Discuss the potential benefits of the research to the population from which your subjects are drawn:**
Participants will be able to see how their eye movements vary when playing a video game.

d) Discuss why the risks to subjects are reasonable in relation to the anticipated benefits to subjects and others, or in relation to the importance of the knowledge to be gained as a result of the proposed research:

There are no risks. Playing video games will be common activity to the participants selected for the study. There is an eye tracking involved, it does not pose any risk to the participants.

e) Describe the planned procedures for protecting against or minimizing potential risks, including risks to confidentiality, and assess their likely effectiveness:

Each participant will be labeled using a numerical naming convention when collecting data. No sensitive information will be collected.

f) Where appropriate, describe plans for ensuring necessary medical or professional intervention in the event of adverse effects to the subjects:

There are no medical risks from the procedure that will be used in this study.

9) Will you be seeking informed consent? ☒ Yes ☐ No

If yes, describe:

a) What information will be provided to prospective subjects?

A description will be given within the informed consent form explaining the study. Some information will be explained only at the conclusion of the study.

b) What (if any) information will be concealed prior to participation, and why?

Participants will not be told they will be answering questions to evaluate their level of immersion, but rather just their experience. This will abstain participants from altering their views of their experience. They will also not be told that the eye tracking data will be viewed to see if patterns vary between those who have an immersive experience, to those who do not. This information will be disclosed at the conclusion of study to each participant.

c) How will you ensure consent is obtained without real or implied coercion?

All participants will be volunteers. They may leave at any time during the study; however the incentive will not be given till the conclusion of the study.

d) How will you obtain and document consent?

An informed content form will be utilized. Two copies will be signed by each participant, one for the participant and one for the experimenter.

e) Who will be obtaining consent? Provide names of specific individuals, where available, and detail the nature of their preparation and instructions for obtaining consent.

The experimenter.

f) Attach a copy of your consent materials (forms, protocol, script, etc.) to this application.

10) Please attach a copy of your project description or proposal abstract.

RIT IRB Risk Type Classification

Exempt

Research activities in which the only involvement of human subjects will be in one or more of the following six categories of **exemptions** are not covered by the regulations:

(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (a) research on regular and special education instructional strategies, or (b) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (a) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (b) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation. ***If the subjects are children, this exemption applies only to research involving educational tests or observations of public behavior when the investigator(s) do not participate in the activities being observed.*** [Children are defined as persons who have not attained the legal age for consent to treatments or procedures involved in the research, under the applicable law or jurisdiction in which the research will be conducted.]

(3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior that is not exempt under section (2) above, if the human subjects are elected or appointed public officials or candidates for public office; or federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

(5) Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (a) public benefit or service programs; (b) procedures for obtaining benefits or services under those programs; (c) possible changes in or alternatives to those programs or procedures; or (d) possible changes in methods or levels of payment for benefits or services under those programs.

(6) Taste and food quality evaluation and consumer acceptance studies, (a) if wholesome foods without additives are consumed or (b) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the US Department of Agriculture.

No Greater than Minimal Risk – The probability and magnitude of harm or discomfort anticipated in the research *is no greater than* those ordinarily encountered in daily life or in the performance of routine physical and psychological examinations or tests.

Greater than Minimal Risk – The probability and magnitude of harm or discomfort anticipated in the research *is greater than* those ordinarily encountered in daily life or in the performance of routine physical and psychological examinations or tests.

Human Subjects Research - Definitions

Anonymity – Anonymity offers the best insurance that disclosure of subjects' responses will not occur. Research data that is anonymous contains no information that would link the data to the individual who provided the information.

Confidentiality – Confidentiality refers to (a) identifiable data (some information about a person that would permit others to identify the specific person, such as a non-anonymous survey, notes or a videotape of the person) and (b) agreements about how those data are to be handled in keeping with respondents' interest in controlling the access of others to information about themselves. The two critical elements of this definition of confidentiality indicate the critical role of informed consent, which states how the researcher will control access to the data and secures the respondent's agreement to participate under these conditions.

Child (Definition of) **and Use of Children in Research -** Children are defined as persons who have not attained the legal age for consent to treatments or procedures involved in the research, under the applicable law or jurisdiction in which the research will be conducted. In New York State, a person age 18 is considered an adult and can provide consent without parental permission. However, some students at RIT are under age 18. To use children (individuals under the age of 18 years) in research, you must first obtain the permission of the parent(s) and then obtain **assent** from the child.

Human Subjects - The regulations define human subject as "a living individual about whom an investigator (whether professional or student) conducting research obtains (1) data through intervention or interaction with the individual, or (2) identifiable private information." *(1) If an activity involves obtaining information about a living person by manipulating that person or that person's environment, as might occur when a new instructional technique is tested, or by communicating or interacting with the individual, as occurs with surveys and interviews, the definition of human subject is met. (2) If an activity involves obtaining private information about a living person in such a way that the information can be linked to that individual (the identity of the subject is or may be readily determined by the investigator or associated with the information), the definition of human subject is met.* [Private information includes information about behavior that occurs in a context in which an individual can reasonably expect that no observation or recording is taking place, and information which has been provided for specific purposes by an individual and which the individual can reasonably expect will not be made public (for example, a school health record).]

Informed Consent – Informed consent is a process by which individuals learn about a study – the substantive issue investigated, participation demands (including time expenditure, types of activities), participant rights (voluntariness, confidentiality), risks, benefits, costs/compensation, contacts if further questions arise, etc. There are multiple **ways to convey these elements of consent**: by written document, oral presentation with script, oral presentation without script. In addition, there are various **ways to document consent**: written signature of the participant, written indication of participant's study identification number, oral recording of consent, oral consent documented by the investigator. In addition, sometimes it is important to obtain separate consent for the use of photographs or videotaped images. The different ways to obtain consent include:

(1) Written consent with written documentation by participant.
  (a) formal style (for study involving mothers and children)
  (b) informal style
  (c) formal style for at-risk population
(2) Written consent with written indication of participant's study identification number.
(3) Written consent without documentation (for no/minimal risk survey studies).
(4) Oral presentation with script with oral consent documented by the investigator.
(5) Oral presentation with script without documentation (includes contact card).

(6) Oral presentation without script without documentation (provides rationale for request for waiver of written documentation and indicates what will be said).
(7) Written consent with written documentation by participant for use of photos.

Population Sample

- Describe the proposed involvement of human subjects in your project.
- Describe the characteristics of the subject population, including their anticipated number, age range, and health status.
- Identify the criteria for inclusion or exclusion of any subpopulation.
- Explain the rationale for the involvement of special classes of subjects.

Research Activity - The ED Regulations for the Projection of Human Subjects, Title 34, Code of Federal Regulations, Part 97, define research as “a systematic investigation, including research, development, testing and evaluation, designed to develop or contribute to generalizable knowledge.” *If an activity follows a deliberate plan whose purpose is to develop or contribute to generalizable knowledge, such as an exploratory study of the collection of data to test a hypothesis, it is research.* Activities which meet this definition constitute research whether or not they are conducted or supported under a program which is considered research for other purposes. For example, some demonstration and service programs may include research activities.

Risks in Research – As with any activity, there is potential for harm in the social and behavioral sciences – from inconvenience or embarrassment to stigma or legal or economic consequences. Typically, however, in these sciences both the potential harms and the risks of them are minimal and not of the type routinely being assessed in biomedical research. Much of the risk relates to disclosure of the identity of human subjects or the information they provide; thus, considerable effort in these sciences is devoted to safeguarding subjects’ privacy and the confidentiality of the data they provide even when the information has no or minimal potential for harm.

Minimal risk means that the probability and magnitude of *harm* or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests. “Risk” refers to a probability that some harm will occur. “Harm” refers to a specific outcome(s) or event(s) – and can be inconvenience, physical, psychological, social, economic, or legal in nature. If human subjects are exposed to a degree of harm roughly equivalent to what one would expect in the course of daily life or in the course of routine tests and examinations, then “minimal risk” applies.

Sources of Materials

- Identify the sources of research material to be obtained from individually identifiable living human subjects in the form of specimens, records, or data.
- Indicate whether the material or data will be obtained specifically for research purposes or whether use will be made of existing specimens, records, or data.

Appendix C

Participant Screener Questionnaire

Thank you for your interest. The purpose for "Usability Study of Video Games" is to provide insight into various elements of the video game experience.

The survey should take approximately 5 minutes to complete. You will be contacted if you are selected for the second part of the study. The second part of the study will take place in Building 70 (Golisano) and take approximately an hour and a half. Once completed you will be entered into a raffle to win 1 of 3 $30 Visa Gift Cards.

1. What is your gender? *

   ○ Male

   ○ Female

2. What is your age? *

   ○ Under 18

   ○ 18-21

   ○ 22-25

   ○ 26-30

   ○ 31 or older

3. Were you enrolled as a student at RIT during the 2010-2011 school year? *

   ○ Yes

   ○ No

4. If yes, what area(s) was your field of study at the university?

☐ Arts

☐ Business and Finance

☐ Computing and Information Sciences

☐ Engineering

☐ Liberal Arts

☐ Math and Science

☐ Other ____________________

5. Do you require glasses in order to read a computer screen? *

○ Yes

○ No

6. Do you require contact lenses in order to read a computer screen? *

○ Yes

○ No

7. Do you have any other visual impairments? *

○ Yes

○ No

8. If yes, please explain in detail below:

9. Will you need a sign-language interpreter to facilitate communication during the study? *

○ Yes

○ No

Video Game Usage

1. Do you play console video games? *

○ Yes

○ No

2. If so, do you need assistance in using video game console controller?

○ Yes

○ No

3. What modern day consoles do you commonly play? *May choose multiple consoles*

☐ Microsoft Xbox 360

☐ Nintendo DS

☐ Nintendo Wii

☐ Sony PlayStation 3

☐ Sony PlayStation Portable

☐ Other ____________________

4. Approximately how many hours a week do you spend playing video games? *

○ Less than 1 Hour

○ 1-5 Hours

○ 6-10 Hours

○ 11-15 Hours

○ 16 or More Hours

5. What are your favorite genre games of video games? *May choose multiple genres* *

- ☐ Action
- ☐ Adventure
- ☐ First-Person Games
- ☐ Racing
- ☐ Role-Playing Games
- ☐ Simulation
- ☐ Sports
- ☐ Strategy
- ☐ Third-Person Shooter
- ☐ Other ____________________

6. Do you play, or are willing to play, thriller or horror games? (e.g. Resident Evil Series, Dead Space Series, Silent Hill Series, etc.) *

- ○ Yes
- ○ No

7. Do you play, or are willing to play, video games with a "Mature" rating? (e.g. Games that may include violence, foul language, gore, etc.) *

- ○ Yes
- ○ No

Study Availability

1. Will you be available to participate in the study during the summer, which will take place on the RIT campus? (e.g. June, July, August) *

- ○ Yes
- ○ No

2. If available during summer, which months are you able to participate in the study? *Choose all available months*

☐ June

☐ July

☐ August

3. Are you willing to have your voice, image, and computer screen recorded during the 1 hour session for analysis purposes only? Your information will be kept confidential. *

○ Yes

○ No

4. Please fill out your name in case you are selected for the study: *

5. Please provide your email address where you can be reached during the summer, in case you are selected for the study: *

Appendix D

Pre-Study Questionnaire

1. What is your gender?

   - ○ Male
   - ○ Female

2. What is your age?

3. Approximately how many hours a week do you spend playing console video games? *

   - ○ Less than 1 Hour
   - ○ 1-5 Hours
   - ○ 6-10 Hours
   - ○ 11-15 Hours
   - ○ 16-20 Hours
   - ○ 21 or More Hours

4. What are your favorite video game titles in the "shooter" genre? (First-Person, Third-Person, etc.)

Appendix E

Post-Task Questionnaire

MEC Presence questions (first 8 questions) were presented in random order.

1. I felt like I was actually there in the environment of the video game.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. It was as though my true location had shifted into the environment in the video game.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. I felt as though I was physically present in the environment of the video game.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. It seemed as though I actually took part in the action of the video game.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. I had the impression that I could be active in the environment of the video game.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. I felt like I could move around among the objects in the video game.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. The objects in the video game gave me the feeling that I could do things with them.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

8. It seemed to me that I could do whatever I wanted in the environment of the video game.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

9. I felt immersed in the environment when playing this video game.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

10. I had fun when playing this video game.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

11. Have you played this game before in the past? If so, how long ago did you play the game?
12. Do you believe the game presented status information (i.e. health, ammo count, etc.) in an effective manner? Why?
13. How many minutes do you believe it took for you to become familiar with the game controls?

Appendix F

Post-Study Questionnaire

1. Of the games that you played, which game do you believe presented status information (health, ammo, etc.) in a more effective manner? Why?
2. Which game made you feel more immersed and part of the game world? Why?
3. What attributes of a game do you believe affect your feeling of being part of the environment?
4. Do you believe a game's heads-up display (HUD) presentation affects your gaming experience? If so, why?

Appendix G

Experiment Script

Agenda

Thank you for your willingness to participate in this study to assist in assessing the user experience of playing a video game. This study will be comprised of seven parts:

- Overview
- Informed Consent
- Background Questions
- Playing the Games
- Post-Game Questions
- Follow-Up Questions
- Debriefing and Wrap-Up

Overview

The purpose of this study is to provide insight into various elements of the video game experience. You will play two different video games for 25 minutes each. At the conclusion of each game session you will answer a list of questions rating your experience. Your responses will provide a greater understanding of the gamer experience. During the session, a Mirametrix S1 Eye Tracker will be utilized to collect eye movement information.

I would like to stress that **the goal of the study is not to assess you or your abilities**, but rather, to evaluate the designs of the video games.

As a moderator I'll be taking notes and will be recording the video game footage from the game console. This data will be kept confidential and be used for analysis purposes only.

Your participation is completely voluntary, and you may discontinue your participation at any time. The study will last for approximately an hour and a half.

There will be an optional 5 minute break available after the first 25 minute play session. Do you have any questions so far?

Informed Consent

Before we begin, you'll need to read and sign this consent form. It summarizes and explains what I just discussed.

Background Questions

Please fill out this background questionnaire regarding your demographic information and video game usage.

Playing the Games

For this study, you will play two games. You will play the game in front of you first, and the second game will be presented after the first game session.

On the table in front of you is the instruction manual; you may reference the booklet prior to starting the game. Once you have started the game, please refrain from looking at the manual because the eye tracker will lose track of your eyes.

When you begin, you may choose any difficultly and please do not log into Xbox Live. During play, you may skip any cutscenes or in-game movies. Please do not save your game progress if you approach any save points. During both sessions, please play as if I am not in the room with you and keep your eyes on the TV.

After 25 minutes of gameplay, you will be asked to stop. Then you'll answer a questionnaire about your experience playing the game.

After you completed the questions, I will set up the second video game that you will play. Do you have any questions before we begin?

If you would like to read the manual, please do so now. If not, I will start the eye tracker calibration and game session.

Debriefing

I'd like to thank you for your participation in this research study to analyze a part of the gaming experience.

During this research, you were asked to play two different games and answer a set of questions regarding your experience. The purpose of this research is to discover if the heads up display (HUD) truly affects the feeling of spatial immersion during a play experience. Spatial immersion is the player's shift of attention from his or her real environment to the game spaces. In other words, the feeling of you being in the game environment, rather than being inside this lab.

The data and observations gathered from you today, combined with data and observations from other participants, will provide valuable insight on if a game's HUD affects spatial immersion based on the way the information is presented.

Thank you again for partaking in this study. Do you have any comments you would like to add?

Appendix H

Consent Form

PROJECT NAME – VIDEO GAME RESEARCH STUDY

RESEARCHER'S STATEMENT

You have been invited to partake in a thesis research study. The purpose of this consent form is to give you the information you will need to help you decide whether to participate in this study. Please read the form carefully. You may ask questions about the purpose of the study, what I will ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When I have answered all your questions, you can decide whether or not you want to participate in the study.

PURPOSE OF THE STUDY

The purpose of this study is to provide insight into various elements of the video game experience. You will play two specified video games for 25 minutes each. At the conclusion of each game session you will answer a list of questions rating your experience. Your responses will provide a greater understanding of the gamer experience. During the session, a Mirametrix S1 Eye Tracker will be utilized to collect eye movement information. The goal of the study is not to assess you or your abilities, but rather, to evaluate the designs of the video games.

RISKS

There are no physical risks to this research study. The eye tracker will only record your eye movements, which will not pose any risks.

BENEFITS

There are no immediate benefits to you. I hope that the results from the study provide valuable insight on how to design a better player experience for future video games. As a participant, you will gain the experience of being involved in a real research study.

COMPENSATION

At the completion of this study you will entered into a raffle to win one of three $30 Visa gift cards.

OTHER INFORMATION

Data in this study will be kept confidential. The collected data will be analyzed in an anonymous manner. This experiment will take approximately an hour and a half, and the video game footage from the game console will be recorded during this session for analysis purposes only. You may refuse to participate or may withdraw from the study at any time without penalty or loss of benefits to which you are otherwise entitled.

Printed name of researcher Signature Date

Subject's Statement

This study has been explained to me, and I have had the opportunity to ask questions. I volunteer to take part in this research. If I have questions later about the research, I can contact James Babu via email at jxb5870@rit.edu. If I have questions about my rights as a research subject, I can contact Heather Foti from RIT's Human Subjects Research Office by phone at (585) 475-7673 or via email at hmfsrs@rit.edu.

Printed name of subject	Signature	Date

Appendix I

Eye Tracking Data for Each Participant with MEC-SPQ Ratings

		Spatial Presence Rating		**Eye Tracking Data**	
Participant	**HUD**	**Self-Location**	**Possible Actions**	**Average Fixation Frequency**	**Average Fixation Duration**
1	*Metro 2033 (D)*	3.25	3	653	.459
	Bioshock (ND)	3.75	3.75	684	.439
2	*Dead Space (D)*	4	4.25	651	.461
	Resident Evil 5 (ND)	2.5	3.5	736	.409
3	*Metro 2033 (D)*	3.25	3.75	712	.420
	Bioshock (ND)	3.25	3.75	767	.390
4	*Metro 2033 (D)*	3	3	662	.452
	Resident Evil 5 (ND)	2.25	1.75	762	.394
5	*Metro 2033 (D)*	3.25	3.75	729	.413
	Bioshock (ND)	4.25	4	745	.401
6	*Metro 2033 (D)*	5	4.5	557	.541
	Resident Evil 5 (ND)	4	3.75	705	.425
7	*Dead Space (D)*	3	2.5	708	.425
	Resident Evil 5 (ND)	3.5	3.25	725	.414
8	*Metro 2033 (D)*	4	3.75	686	.437
	Bioshock (ND)	2.5	4.25	685	.440
9	*Dead Space (D)*	3	4.25	731	.411
	Resident Evil 5 (ND)	2.25	2.75	551	.549
10	*Metro 2033 (D)*	2.5	2.5	516	.581
	Resident Evil 5 (ND)	3.25	3.5	685	.440
11	*Metro 2033 (D)*	3.75	4	672	.445
	Resident Evil 5 (ND)	2.5	2.5	668	.451
12	*Dead Space (D)*	3.5	3.25	674	.444
	Resident Evil 5 (ND)	1.75	3	611	.491

13	*Metro 2033 (D)*	4	3.5	623	.482
	Bioshock (ND)	4.5	3.75	726	.413
14	*Metro 2033 (D)*	5	4.5	629	.479
	Resident Evil 5 (ND)	1.75	3	714	.419
15	*Metro 2033 (D)*	1.5	2.5	620	.485
	Bioshock (ND)	3.75	3.75	705	.427
16	*Metro 2033 (D)*	2.75	2.25	687	.437
	Resident Evil 5 (ND)	2.75	3.75	746	.402
17	*Dead Space (D)*	3.5	4	678	.443
	Resident Evil 5 (ND)	2.75	2	669	.450
18	*Dead Space (D)*	4.25	3	675	.446
	Bioshock (ND)	4	3	717	.418
19	*Dead Space (D)*	3	4.25	619	.485
	Bioshock (ND)	2	3.25	634	.475
20	*Dead Space (D)*	2.25	2.5	569	.526
	Resident Evil 5 (ND)	4.25	4.25	650	.463
21	*Dead Space (D)*	2.25	3.25	583	.516
	Bioshock (ND)	3.5	3.5	614	.487
22	*Dead Space (D)*	2	4	538	.559
	Bioshock (ND)	2.75	3.75	699	.431
23	*Dead Space (D)*	2.5	2.5	707	.425
	Bioshock (ND)	4	4.5	706	.426
24	*Dead Space (D)*	4.25	4.5	632	.476
	Bioshock (ND)	3.75	4.5	769	.392