EFFECTS OF DIEGETIC AND NON-DIEGETIC WAYFINDING ON PLAYER IMMERSION AND WAYFINDING EFFICIENCY

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Abstract

This study compares the effectiveness of wayfinding in video games using a diegetic and a non-diegetic navigation technique. Wayfinding is defined as the process of finding your way to a destination in the most efficient manner. The emergence of immersion and the difficulty we face when defining such a term due to its subjective nature makes it relatively hard to accurately measure such a variable.

The paper aims to study the relationship between Wayfinding Assistance Techniques (WATs), immersion, and navigational effectiveness. Participants were gathered and then divided into two groups. One group was tasked with navigating a maze assisted with a diegetic Wayfinding Assistance Technique and the other group had a non diegetic Wayfinding Assistance Technique. Both groups were timed throughout the duration of the maze. After completing the maze, participants were asked to fill out a questionnaire that aids with the assessment of immersion. The results were subjected to an Unpaired Two Sample T-test to determine their significance. Both Wayfinding Assistance Techniques presented no evident effect on player immersion and their efficiency in completing the maze.

The difficulty with measuring variables such as immersion and effectiveness play a vital role in research in this field due to their lack of certain definition and the importance of context when measuring them. The implementation of WATs does not help enhance immersion or increase navigational efficiency, however we establish that a case by case scenario is the most appropriate method when dealing with real life applications of WATs in video games or other scenarios.

1 INTRODUCTION

Every creature uses some form of wayfinding, whether intentional or unintentional. In the past, innate wayfinding assisted us in navigating the

globe and successfully establishing communities, which directly resulted in our survival as a species. Wayfinding is an efficient and natural process that is ingrained into every creature.

Wayfinding is defined as the process of finding your way to a destination in the most efficient manner possible. Humans have successfully completed this process by employing a variety of Wayfinding Assistance Techniques (WATs) such as compasses, celestial navigation, maps, and, more recently, global positioning systems (GPS) (Farr, Kleinschmidt, Yarlagadda, & Mengersen, 2012b).

With the popularity and widespread availability of expansive open world video games today, we have integrated wayfinding systems to facilitate in-game navigation and enhance user experiences. Diegetic WATs are often used in some video games to simulate an immersive experience.

A diegetic Wayfinding Assistance Technique (WAT) is a simulated environment element that directs a player to their destination. A player's conversation with a non playable character (NPC) which guides the player is an example of a diegetic WAT.

A non-diegetic element in a game is one that does not exist in the game world. It functions as an overlay that only the user sees. Mini maps are a common non-diegetic WAT in video games. These maps typically include a top-down view of the playable area, which the user can examine to determine the most efficient travel route.

Wayfinding systems can be evaluated in three ways (Ruddle & Lessels, 2006):

1 The task performance metric of the user,

2 A user's physical behavior, and

3 A user's non-physical behavior.

It is well known that users typically struggle with wayfinding in virtual environments and take longer to become familiar with the layout of virtual spaces than equivalent real-world spaces(Witmer, Bailey, Knerr, & Parsons, 1996). This is usually due to being immediately introduced into an unfamiliar environment and adjusting to any changes in hand-eye coordination (Rosenberg, Landsittel, & Averch, 2005). However, users with more video game experience tend to get familiar with virtual environments quickly and perform better when asked to navigate to a specific location (Bacim, Trombetta, Rieder, & Pinho, 2008).

The effectiveness of various WATs varies depending on the environment in which they are implemented. A mini map in a sailing game, for example, would be less efficient than a sextant for navigation. This is due to the fact that a mini map in such a situation would only provide an overview of

the empty ocean around you, whereas a sextant can help you find your latitude and longitude which are more helpful while one is at sea. Because of the extraneous variables that exist when one navigates through a specific area, accurately assessing WATs in virtual environments can be difficult. Some of the variables in the original metric, such as decision making, can be influenced by self-doubt and overthinking, resulting in an incorrect assessment of a WAT (Ruddle & Lessels, 2006).

Exploring the links between wayfinding and immersion in the context of video games can be critical to player retention and enjoyment. Since most video games try to retain their player base, it is critical that their wayfinding system is implemented in a way that is easy to use in order to maintain player immersion.

1.1 *Problem Statement and Research Questions*

In the experimental section of this study, participants were divided into two groups and each group was asked to navigate the same maze with two different WATs. One maze contained diegetic elements to help guide players towards the exits whereas the other maze contained a non-diegetic element in the form of a mini map to help players navigate. Both mazes contained secret walls that players could walk through. These walls were in the same position across both conditions. This study will focus on the first assessment metric: The task performance metric of the user (Ruddle & Lessels, 2006) in order to compare the navigational efficiency across the two mazes. The immersion assessment questionnaire (Jennett et al., 2008) will help us quantify player immersion to assist us with measuring immersion across the two different WATs. The findings of this study can be used to effectively design and implement WATs that do not interfere with player immersion while maintaining or improving navigational efficiency. To that end, the Research Question of this study is:

> *What is the difference between the effects of a diegetic and a non-diegetic wayfinding assistance technique on player navigational efficiency and immersion?*

I expect the results of the unpaired two sample t-tests to indicate that participants will spend longer in the non-diegetic maze (maze with map) due to allocating more time planning their path rather than making their way through the maze (Bacim et al., 2008). As for the diegetic maze (maze without map) I expect participants to encounter more overall secrets due to there being light indicators which highlight a secret wall along with pathways that lead to secret walls.

As for immersion between the two mazes, I expect the diegetic maze to produce higher levels of immersion which will be measured via an immersion questionnaire (Jennett et al., 2008).

1.2 *Findings*

The findings of the t-tests revealed that there was no difference between the two WATs in regards to player efficiency and immersion across both groups of participants. Both mazes took approximately the same amount of time to complete: The diegetic map took participants and average of 43.25 seconds to navigate whereas the non diegetic map had participants taking 42.7 seconds on average.

There may have been no evident differences between the two WATs due to the type of participants I had as part of my study. 90% of the participants had indicated that they had a fair amount of experience with video games. Since this was the case, most participants had their own schemas (Nisbet, 2016) regarding wayfinding which could have led to no significant differences between the WATs.

This study was also conducted online via a voice communications application so the participants were in their home environment which could have led to some extraneous variables such as noise and interference which could be considered distracting. This study also utilized a maze as the virtual environment. Mazes generally do not encourage players to explore their surroundings, they incite players to reach the end and escape the maze as soon as they can.

These aforementioned factors may have influenced the results of this study to some extent. In a more controlled environment we could eliminate such extraneous elements and with more access to computational resources and time one could design a game that truly encourages exploration. These changes to the current version of the study could provide us with more insights into this subject.

These results let us allocate more resources towards enhancing player immersion and providing players with satisfactory and efficient way finding systems in the long run. Each type of game will benefit more from a certain WAT than another; implementation of WATs should still be considered on a case by case basis as there is no true "one size fits all".

2 RELATED WORK

2.1 *Research context*

While most WAT related research is centered around the use of WATs in rehabilitation programs which aid people who suffer from cognitive disorders by using RFID chips for wayfinding (Chang, Chen, Chou, & Wang, 2008), this paper focuses on their use in video games. Almost every video game employs some form of wayfinding to assist the player in reaching their destination. Games must aim to strike a balance between fluency and efficiency. It is counterproductive for the player to spend their time traversing the world when they could instead be exploring or completing quests; this will lead to lower player retention in the long run (Caroux, Isbister, Le Bigot, & Vibert, 2015). In order to create an experience that a player will want to revisit in the future, level designers must find the most appropriate WAT for their environment and create levels/environments that are fun and navigable.

2.2 *Defining Wayfinding*

Initially Farr, Kleinschmidt, Yarlagadda, and Mengersen (2012a) defined wayfinding as "the process of identifying a current location and knowing how to get to a desired destination as quickly and effortlessly as possible". When defining the wayfinding process, the familiarity of the scene is irrelevant

Later on Lynch (2015) defined wayfinding as the consistent use and organization of sensory cues from the external environment. It evolved into the concept of spatial orientation before being defined as wayfinding. Wayfinding is now known as the process of moving through space to reach a specific destination (Farr et al., 2012b).

Wayfinding was quickly recognized as an innate and cognitive function that happens subconsciously given that people had unique identifiers about their environments (Park & Evans, 2018). This process was also linked to emotion, as wayfinding performance was heavily dependent on a person's emotional state (Laurier, Brown, & Hayden, 2012). Environmental factors also have an impact on the wayfinding process, shifting it from a logical to an emotional and animalistic one.

Wayfinding appears to be described as a complex and evolving concept with no true origin, as it is present in every aspect of our lives, conscious or subconscious. Each study on what wayfinding is has chosen to focus on different features and approaches to wayfinding, which helps us slowly stitch together a larger picture.

2.3 *Types of Wayfinding*

While wayfinding is a cognitive process which requires feature recognition, location memorization and schemas (J. C. Xia, Arrowsmith, Jackson, & Cartwright, 2008) it can be facilitated via a multitude of methods. People have the same initial reaction when presented with a new environment, be it virtual or physical. In both cases, people will first scan the scenario and attempt to establish self orientation before deciding on an appropriate route to take (D. Gibson, 2009).

Since this study focuses on the effects of wayfinding in virtual worlds, we can divide wayfinding into two categories: Diegetic and Non-Diegetic wayfinding. Diegetic wayfinding utilizes elements that are a part of the virtual world to help the player navigate. Making use of sound and wind cues to nudge a player along a pathway is an example of diegetic wayfinding.

Figure 1: This image depicts the game Ori and the Blind Forest

Ori and the Blind Forest is a game famously known for utilizing environmental features such as spikes and lights along with music to guide the player towards their goal.

Non-Diegetic wayfinding provides the user with a wayfinding method that exists independent of the game world. Having a mini map available at all times is one common example of a non-diegetic WAT.

Figure 2: This image depicts the game Fortnite

In Figure 2 we notice a mini map on the top right of the image. This provides the user with all the relevant player while not being accessible by the character in game.

2.4 *Differentiating Locomotion from Wayfinding*

Dalton, Hölscher, and Montello (2019) established the distinction between locomotion and wayfinding under the umbrella term navigation. Wayfinding necessitates a person knowing where to go and how to get there on purpose, whereas locomotion refers to successful real-time navigation without injuring oneself. Dalton et al. (2019) also identified additional fundamental aspects of wayfinding. When it comes to navigation, being oriented is essential. In order to define wayfinding, partial orientation is also acceptable. Disorientation during wayfinding is also considered common as long as it is brief; however, even minor periods of disorientation can cause anxiety, tardiness, and frustration, all of which can lead to skewed analyses of WATs and their efficiency (Dalton et al., 2019).

Prior research into diegetic wayfinding cues in virtual spaces determined that individuals have a baseline set of expectations shaped by previous experiences (Nisbet, 2016). When navigating new environments, they rely on these expectations and schemas. In order to maintain immersion, good game design requires that people be able to recognize interactable objects with ease.

Maintaining visual communication with a player throughout the game's experience is also essential for efficient navigation (Nisbet, 2016). Games should have to establish certain consistent rules in order to not disorient the player. For example, if a game has a stone brick wall that cannot be

breached through by the player then this must remain consistent throughout the game. If a player is respawned (resurrected) every time they encounter water this means that water is deadly towards the player. These examples are part of the game's visual language, which communicates to a player the bounds of exploration.

2.5 *Significance and Application of WATs*

Bacim et al. (2008) conducted another study that emphasized the importance of WATs in complex and unfamiliar environments. They discovered that users who had a WAT spent significantly less time and traveled significantly less distance than those who did not have a WAT. Bacim et al. (2008) also emphasized the drawbacks of certain WATs; for example, the mini map scenario resulted in users spending more time planning their route and did not encourage exploration. Furthermore, as a potential future study, a link between immersion and WATs was discussed. We could argue that because this study exposed participants to new situations and environments, they spent a lot of time planning their next move when given a mini map.

A study conducted by J. Xia, Packer, and Dong (2009) focused on tourists and their ability to find their way around based on individual differences such as age, gender, and type of travel group. This study was intriguing because it focused on individuals in an unfamiliar environment, and the findings confirmed that familiarity with the environment led to the most efficient and coordinated wayfinding. The findings of this study directly support the claims made by Bacim et al. (2008) and help generalize this claim, increasing its reliability.

The Gibsonian (Heft, 1996) perspective emphasized interaction as a key factor in wayfinding; scenarios with higher interaction resulted in better schemas that aid people in achieving successful navigation. E. J. Gibson (1969) claimed that wayfinding from an ecological standpoint involved movement through the perception of temporally structured visual information; this was later considered the Gibsonian perspective. Bacim et al. (2008)'s maze did not allow for any kind of interaction. One could argue that if their multi-level maze had interactable surfaces, it would lead to better navigational strategies. However, the schemas that a participant would create and implement would be useful only in environments that take a long time to navigate. Interactable surfaces are more common in long-term games that aim to keep users engaged than in environments that take only a few minutes to navigate.

Another study by Kataoka (2005) suggested that the frame of reference is important when navigating. Bacim et al. (2008) gave participants a maze-like hallway and a mini map to use as a frame of reference, which naturally

leads to participants attempting to expand their frame by studying the map and planning their move.

2.6 *Wayfinding and Immersion*

Brown and Cairns (2004) defined immersion as a state of ultimate interaction with any form of stimulus. In particular, it was defined as the highest level of engagement an individual could attain while interacting with a stimulus. This definition of immersion is extremely important in the context of video games partly due to the importance placed on it by game reviewers and journalists. This is however subjective and the true intensity of immersion differs from person to person. For the remainder of this paper I will be relying on this definition of immersion to justify my decisions and solutions. This definition is the most acceptable simply due to the fact that it was developed within the context of video games which also happens to be sub context of this paper.

The interaction between wayfinding and immersion has been studied before, however there are multiple contradictory findings which will be discussed that make truly defining and measuring immersion a challenging task.

We can argue that Bacim et al. (2008) omitted a few key aspects of wayfinding, which could have led to the results they obtained. Interactable surfaces, an improved frame of reference, mazes that do not cause disorientation, and performance testing based on familiarity could have all contributed to an experience that could have resulted in improved immersion and more efficient wayfinding. It's also worth mentioning the metrics proposed by Ruddle and Lessels (2006); implementing user behavior tracking and comprehending user thought processes may aid in understanding how immersion and wayfinding work on an individual level.

However, Li and Giudice (2013) conducted a study with participants in two different maps with two different objectives and discovered that immersion did not improve navigation in any significant way. Their findings indicated that immersive virtual environments are not required, reducing equipment costs and technical complexity for future experiments. This could be due to environmental over stimulation. The greater the complexity of the environment, the more time a user spends learning about it and the less immersed they are. This also introduces the notion that map familiarity and gameplay fluency may be important factors in increasing immersion.

It is clear that considerable effort was expended in first defining wayfinding and then attempting to find the most efficient WAT. In video games, WATs must be efficient and not disrupt player immersion and

vice versa. This study will consider previous research into WATs and attempt to identify any relation they may have to immersion and wayfinding efficiency.

3 METHOD

In this study we decided to investigate the effects non-diegetic and diegetic WATs have on way finding efficiency and player immersion.

Two identical mazes were created in the Unity (Haas, 2014) game engine to help study the aforementioned relationships. Both mazes shared the same layout however one maze featured a non-diegetic wayfinding technique in the form of a mini map on the top right corner of the user's screen (Figure 3). The other maze featured diegetic WATs and had trodden pathways that, if followed, would lead players directly to the exit (Figure 4). This maze also had lights highlighting any secret doors (Figure 5).

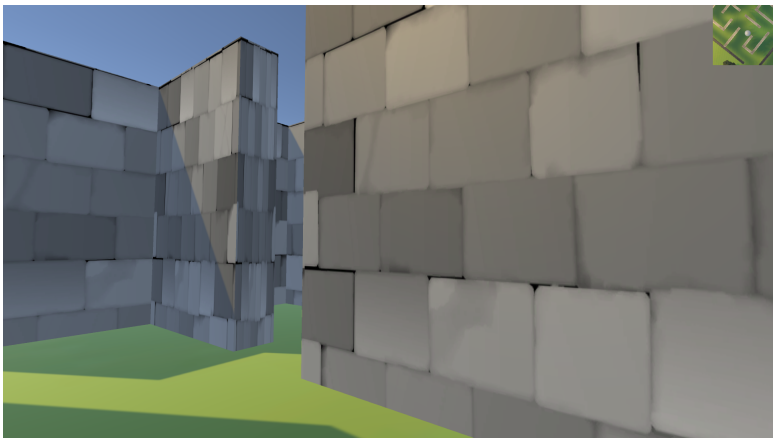

Figure 3: Non diegetic maze

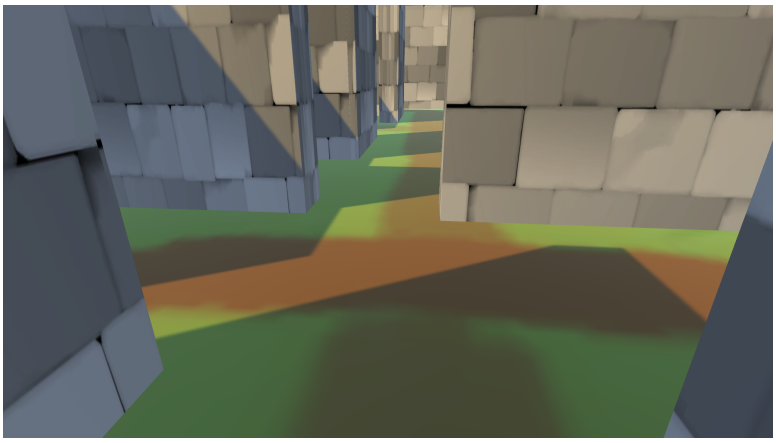

Figure 4: Trodden pathways in the diegetic maze

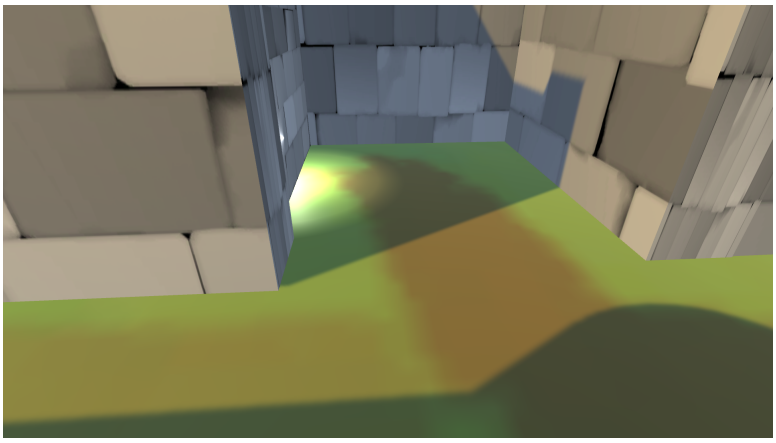

Figure 5: Lights highlighting the secrets in the diegetic maze

Both the diegetic and non diegetic maze had four hidden walkways in the walls. These hidden walkways were in the same location on both versions on the maze in order to maintain some form of consistency.

The maze was inspired by Bacim et al. (2008)'s multi-level virtual environment, which was designed to evaluate WATs in a similar scenario. Along with the first metric of evaluating WATs proposed by Ruddle and Lessels (2006), I will be able to accurately test the effectiveness of my WATs against the mazes.

3.1 *Pilot Studies*

In order to ensure that my maze and variation of WATs were the appropriate tools to carry out this study I conducted a Pilot study consisting of four participants. Initially, I decided not to inform participants about the secrets

in the maze. Surprisingly, none of the four participants encountered any of the secrets on their first run through the maze. They were unaware of the fact that there were secrets situated in the mazes. Therefore, the decision was made to inform the participants that the maze does indeed have a few secret walls that they can walk through scattered around.

After a second pilot study, where participants were informed about the secrets in the maze, 3 out of the 4 participants managed to find one secret.

While the sample size was small (N = 8) for my pilot studies it demonstrated that participants do not initially assume that they are able to walk through walls, which is consistent with the schemas proposed by J. C. Xia et al. (2008). That is why I decided to inform participants about the existence of secrets in the walls.

3.2 *Software and Materials*

Both variations of the maze were created using the Unity (Haas, 2014) game engine using free assets from the Unity Asset Store. Any custom textures were designed in Paint3D. In order to help enhance user immersion I decided to add some trees and lightning to the mazes. The maze was kept relatively simple as to not overload the user with too much information . Too much information presented to a user at once can lead to nausea, frustration and disorientation (Dalton et al., 2019).

Two questionnaires were used in this study. One questionnaire was a general demographic questionnaire to collect some initial data on my participants. The other questionnaire designed by Jennett et al. (2008) helped me measure and quantify immersion levels.

Google Forms was used to help facilitate the process of collecting information. Since the entire experiment was conducted online, we decided to use Discord (Discord Inc., n.d.) which is a popular voice chat application. Other forms that were used were an informed consent form and another document containing instructions for the game. All the questionnaires were the same for participants across both conditions.

Statistical data was collected via Google Sheets and the statistical analysis was conducted in R (R Core Team, 2021) through the RStudio IDE (RStudio Team, 2015).

3.3 *Participants*

Participants (N = 25) for my study were chosen via chair referral sampling and were randomly divided into two groups. 13 participants were assigned to the non diegetic map and the remaining 12 were assigned to the diegetic

map. The mean age of my participants was 20.32 and there were 20 males, 4 females and 1 participant chose not to answer.

3.4 *Measures*

The WATs will be the variables that I will be adjusting between maze versions. The dependent variables are the time taken to complete the maze and the immersion score. Maze A has diegetic WATs in the form of brown pathways and lights on the secret walls, whereas Maze B only has a mini map on the top right of the game screen. With these variations, I intend to assess user immersion through a questionnaire (Jennett et al., 2008) and WAT efficiency through time spent completing the maze.

3.5 *Procedure*

The entire experiment was carried out online. Participants were asked to join a voice call for the duration of the experiment. The participants were given the informed consent form with a summary of the experiment and were given the opportunity to ask me any questions they may have had. After the initial consent form, they were asked to fill in the general demographic form. Then they were given the game instructions and had to download the game files. I requested that the participants share their screen while playing the game so that I could keep track of the time they took to make their way through the maze and the number of secrets they encountered. I recorded the taken per participant via a stopwatch on my laptop. I muted myself while they made their way through the maze in order to avoid causing any sort of distractions. After completing the maze participants were asked to fill in the immersion questionnaire and then they were debriefed regarding the experiment. Some participants wanted to try the maze again to try and find more secrets in the maze. The entire procedure took around 7 - 10 minutes per participant.

3.6 *Pre-processing and Evaluating the Data*

In order to run any form of statistical analysis on the data from the immersion questionnaire I had to convert the data into an ordinal scale. This was done by converting the scale of the answers into a 1-5 scale with 1 being "strongly disagree" and 5 being "strongly agree". Since there were a total of 18 questions which would help me measure immersion the highest immersion score one could acquire would be $18 \cdot 5 = 90$.

Since I plan on running the unpaired two samples test I must ensure that the two samples are independent of each other, test for equal variances and a normal distribution. I chose to run an unpaired two sample t-test because the variances I found were equal in all cases.

A Shapiro test was run on the time taken by participants across the two conditions; diegetic and non diegetic. The p values for the diegetic and non diegetic samples were p = 0.5 and p = 0.6 respectively. This means that we can assume normal distribution since the p values are greater than 0.05. Then a variance test using F-test was conducted for the time dataset which returned a p value of p = 0.34. Since this is greater than p = 0.05 which means there is no significant difference between variances in both groups. The time dataset has passed both the prerequisites for the unpaired two sample t-test and we can now run the t-test.

The same process was followed by taking the total immersion score per participant over both the groups. In the Shapiro test the immersion score for the no map group was p = 0.72 and the immersion score for the map group was p = 0.72. Since this is greater than p = 0.05 we can assume normal distribution. As for the variance test; the p value was p = 0.79 over both the groups. The immersion scores across both map and no-map groups has passed both the prerequisites for the the unpaired two sample t-test and can now be processed.

Two edits were made regarding the general demographic questionnaire in order to simplify data processing. One participant answered 'cis-male' and another answered 'he/him' when they were asked to include their gender. These were change to 'Male' so as to not create any unexpected outliers during the data processing.

4 RESULTS

This study's unpaired two samples t-test segment was conducted using R (R Core Team, 2021). There were two analyses performed: one analysis tested the immersion score over the two mazes and the other tested the time taken over the two mazes.

The following graphs illustrate the data post-processing:

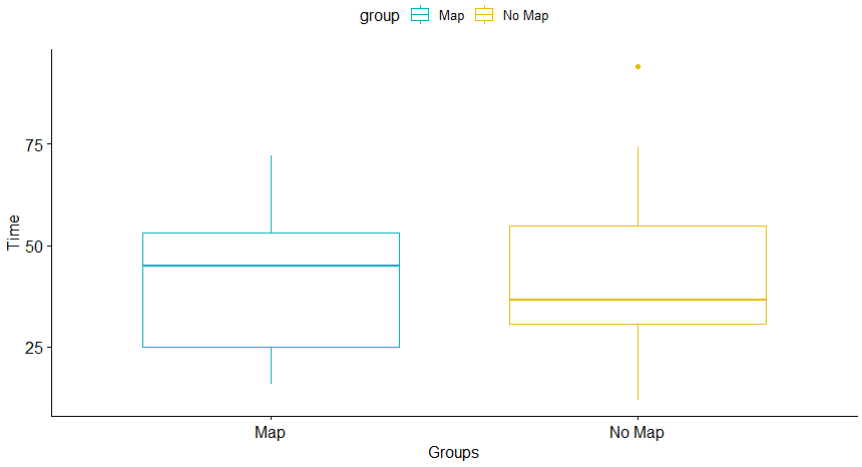

Figure 6: Boxplots of the amount of time spent in the maze per group

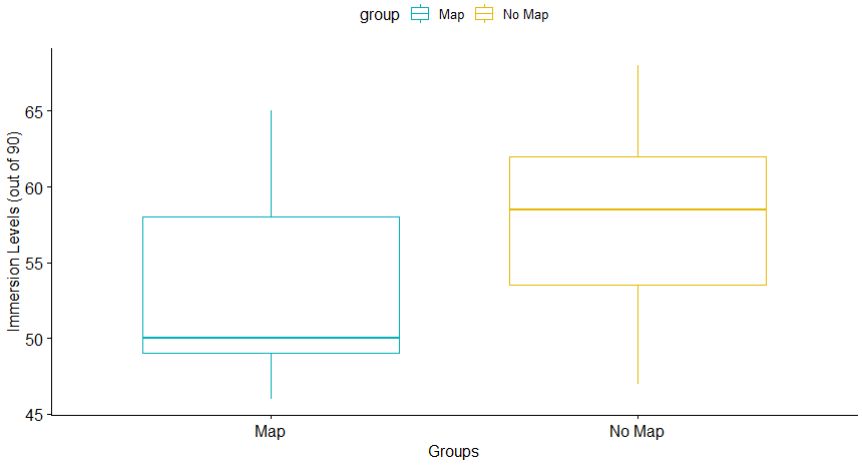

Figure 7: Boxplots of immersion per group

When evaluated against time taken, the 13 participants in the non diegetic group (M = 42.69, SD = 17.9) compared to the 12 participants in the diegetic group (M = 43.25, SD = 23.7) demonstrated no significant differences t(23)= -0.066 , p = 0.947.

When evaluated against immersion scores, the 13 participants in the non diegetic group (M = 53.07, SD = 5.96) compared to the 12 participants in the diegetic group (M = 57.3, SD = 6.7) demonstrated no significant differences t(23)= -1.68 , p = 0.106.

Therefore we can conclude that the presence of a non diegetic or a diegetic wayfinding assistance techniques do not influence the amount

of time a player takes to complete the maze or the levels of immersion a player experiences.

5 DISCUSSION

The primary goal of this paper was to investigate the effects a non diegetic and a diegetic wayfinding assistance technique on player wayfinding efficiency and immersion. However, a general overview of the results suggests that no such discernible effect exists. We can safely conclude that the Wayfinding Assistance Techniques I employed did not have any significant effect on my variables.

These results were rather unexpected because prior studies (Bacim et al., 2008) indicated that different WATs can have a significant impact on time spent in a maze because users spend time assessing and planning their next move. Bacim et al. (2008) also claimed that mini maps as a WAT will persuade users to spend more time planning moves rather than executing them. From my results, we notice that the diegetic group took longer on average to make their way through the maze. However, since the difference between both conditions is less than 1 second we can claim that my results are not conclusive due to the sample size being extremely small (N = 25).

Since my p values did not reach the required alpha levels ($p = 0.947$ for time and $p = 0.106$ for immersion levels) my findings are more in line with those of Li and Giudice (2013). From my analysis we can conclude that there is no significant relationship between WATs and immersion within the scope of my study while Li and Giudice (2013) claimed that immersion did not improve wayfinding efficiency. Li and Giudice (2013) also claimed that elaborate game designs and computational systems are unnecessary when assessing WATs. This is in opposition to the metrics proposed by Ruddle and Lessels (2006). The second and third metrics regarding a user's physical and non-physical behavior requires a significant amount of computational load. My research utilized the first metric which assess the the task performance metric of the user by keeping track of the time taken to complete a navigational task.

While the focus of my study wasn't on enhancing user immersion the overall mean immersion scores were rather surprising given the overall quality of the maze. The non diegetic and diegetic groups reported a mean immersion score of 53.07/90 and 57.3/90 respectively. The maze designed for the purpose of this research lacked polish and attention to detail. It is surprising that users still happened to find the maze immersive which is in line with Li and Giudice (2013). The computational load of the game was minimal, the second and third metrics proposed by Ruddle and Lessels

(2006) were not met and yet users indicated an above average immersion score on both diegetic and non diegetic mazes. These findings indicate that it is extremely difficult to measure immersion as it is subjective (Brown & Cairns, 2004). This further reinforces the fact that measuring the effect other variables have on immersion is a difficult and subjective process, especially when navigation and immersion are words that have no universally agreed upon meaning (Darken & Peterson, 2002).

My study initially aimed to replicate the study carried out Bacim et al. (2008), they utilized more advanced metrics such as travel speed to calculate the effectiveness of WATs which I could not replicate due to equipment constraints. Bacim et al. (2008) wholly implemented the first WAT assessment metric suggested by Ruddle and Lessels (2006) rather than just components which would make their results more valid.

Since people who have little to no experience with virtual environments tend to take longer to acquaint themselves (Bacim et al., 2008), I decided to keep my maze relatively simple. This included basic colors and objects users would expect to encounter in a maze (a brick wall, grassy grounds and trees) so that the user does not get overwhelmed. If a user gets overwhelmed in a virtual scenario they tend to get nauseous, dizzy and frustrated. All of which result in reduced wayfinding capabilities (Dalton et al., 2019).

I initially planned on investigating if there exists a relationship between WATs and the number of secrets one would encounter in a maze. However, after conducting a shapiro test I concluded that the results were not normal and therefore a t test could not be carried out. In the diegetic group, 8 distinct users encountered secret walls whereas in the non diegetic group we had 3 distinct users encounter secrets. This could suggest that people are more likely to explore the playable area if given cues in the forms of lights emanating and pathways leading them to secrets. However, since my results are limited due to a small sample size and overly evident lights in the diegetic map we cannot claim that this is always true. During debriefing some participants from the diegetic group claimed to have noticed the lights from the walls and they assumed that these were graphical errors rather than a diegetic cue. This could be solved by spending more time making secrets according to the schemas of people.

Despite the fact that my research produced insignificant results we can use these results as a guideline on what not to do if someone decides to replicate this particular study. A major issue with my study was the lack of a varied and large group of participants. Since WATs are best implemented on a case by case basis they are also best tested either on a case by case basis or on a given demographic for a more economical solution. One would also have to find and rely on a definition of immersion and standardize it

across their groups because as we have seen earlier, immersion is extremely subjective Brown and Cairns (2004).

In the context of video games and how my research can be applied to them; it is safe to say that it is of utmost importance to design wayfinding techniques on a case by case basis. We have see games such as Ori and the blind forest and Hollow Knight (Horn, 2019) masterfully utilize diegetic elements such as sound and the environment to tell a story and guide the players to their end goals while we also have games such as dark souls which provide users with a massive playable zone and yet manage to successfully implement diegetic elements alongside their non diegetic elements (Zhao, n.d.). Certain video game genres are forced to utilize one or two WATs simply because it is the most efficient. For example, a first person shooter will always have a mini map on screen for the user. Genres like these cannot afford to deviate from these norms due to schemas that old and new players have formed about these games (Moura & Bartram, 2014). Players also tend to start a game with a task in mind rather than just explore which could explain why utilizing a maze for my study was not the most appropriate tool. People inherently have a schema to make their way through and solve mazes (Moura & Bartram, 2014).

Measuring true wayfinding efficiency and immersion would require a lot of computational load and one would have to adhere strictly to all the metrics proposed by Ruddle and Lessels (2006) in order to effectively draw relationships between these terms and establish relationships. Wayfinding is also expanding into Virtual Reality (VR) Moura and Bartram (2014) and it still cannot be completely defined due to contextual usage of major terms such as immersion and efficiency. The computational load required to track every single aforementioned metrics would itself be a rather impressive feat. This field is still relatively new and every study into this topic could help advance our understanding.

6 CONCLUSION

Defining wayfinding has been a tedious process with many authors defining it within the context of their own research. Farr et al. (2012b) finally standardized the definition for wayfinding by describing it as a process of making our way to a certain destination in an efficient manner. Establishing the differences between wayfinding, navigation and locomotion has left us with a fair amount of definitions to work with. Recently we've noticed the same trend when attempting to define immersion. Previous research into immersion is extremely scattered and in different domains such as virtual reality, game design and UI design to name a few (Brown & Cairns, 2004). This inconsistency within the field of wayfinding makes it relatively

difficult to conduct studies, validate and compare our own results (Nilsson, Nordahl, & Serafin, 2016). Context is of utmost important when conducting a study on terms with variable definitions. The definition provided by Brown and Cairns (2004) describes immersion as a powerful experience in gaming where one feels like they are part of the game. This is the definition that the rest of the paper utilizes when immersion is mentioned.

This paper set out to investigate the effect between non diegetic and diegetic Wayfinding assistance techniques (WATs) have on navigational efficiency and immersion levels. Navigational efficiency is measured by follow the first WAT metric proposed by Ruddle and Lessels (2006) which takes into account the task performance metric of the user in terms of time taken to successfully navigate and immersion levels are measured by a questionnaire on immersion curated by Jennett et al. (2008).

The experiment was carried out with 25 participants who were divided into two groups. One group navigated their way through a diegetic maze and the other navigated their way through a non diegetic maze. Both groups were timed in order to help measure the effectiveness of wayfinding. After making their way through the maze, both groups were handed out the same immersion questionnaire in order to gauge their immersion levels.

The results of the experiment indicated that there was no relationship between Wayfinding Assistance Techniques, wayfinding efficiency and immersion levels since the p values did not reach the required alpha levels. While there might be many factors that may have led to this outcome, the small sample size and the variety of participants seem to be a major factor. This is due to the extremely subjective nature of immersion and the computational demands of advanced efficiency tracking.

The case by case nature of implementation of WATs in real life scenarios such as hospitals Chang et al. (2008) and in video games Moura and Bartram (2014) make this an extremely challenging task that one truly cannot generalize a solution to the implementation of WATs. Some genres of video games are essentially locked into the type of WATs they can utilize which further limits expansion and research into potential newer techniques. Wayfinding has been around for thousands of years and almost every living creature is capable of utilizing wayfinding to some extent (Golledge, 2003), we use wayfinding principles when designing our cities and we are efficient partly due to intelligent wayfinding systems.

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