Narrative Engagement in Interactive Cinematic VR Experiences

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Abstract

This research is an exploratory work focused on investigating narrative engagement in cinematic virtual reality experiences. VR has the potential to create immersive engaging stories. We are yet, however, to formally identify a way to measure or create engagement expressly for cinematic virtual reality. Therefore, through this investigation, we theorised and created and analytical framework for narrative engagement. This framework (VRNEF) assesses narrative engagement in cinematic VR, as well as assists in its creation through practical design guidelines. The work was evaluated through the creation a of implementation of the VRNEF and the results of which are presented in this thesis.

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List of Publications

Clarke, Lynda; Kelomees, Raivo (2022). [re|dis]connection: Interactive Storytelling Art. Carnegie Mellon University, pp. 141-156. https://doi.org/10.1184/R1/21565380.v1

Wolfe, A., Louchart, S. and Loranger, B. (2022) 'The Impacts of Design Elements in Interactive Storytelling in VR on Emotion, Mood, and Self-reflection'. *ICIDS 2022.* Springer Science and Business Media Deutschland GmbH, 13762 LNCS, pp. 616–633. doi: 10.1007/978-3-031-22298-6_40.

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Awards

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Official Selection Raindance Film Festival 2023 *Isle*
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SGSAH (Scottish Graduate School for Arts and Humanities) Research Showcase 2022 *Aonar*
Glasgow Game Talks 2022 *Aonar*
CTSG (Creative Tech Scotland Gathering) 2023 *Aonar*
Aesthetica Film Festival 2023 *The Journey*
Raindance Film Festival 2023 *Isle*
XReview interview 2023 *The Journey*
AniFilm Festival 2024 *Isle*
SGSAH *(*Scottish Graduate School for Arts and Humanities)10th Anniversary Showcase 2024

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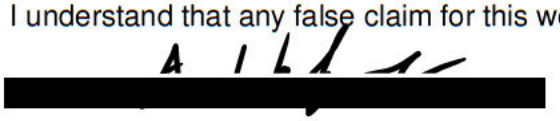

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Definitions and Abbreviations

3D	Three dimensional
Ambient Sound	Sound surrounding the player with consistent volume and pitch not originating from a particular source
Backwards (reverse) Scoring	Numerical scoring scale runs in the opposite direction, where strongly disagree equals 5
Diegesis	Narrative or a plot
Discourse	The structure of a narrative's transmission as well as its manifestation
Exploratory	One of 4 strategies for interactivity. Users' actions do not influence the plot
External	One of 4 strategies for interactivity. User is outside virtual world with no concrete persona
IDN	Interactive Digital Narrative
Internal	One of 4 strategies for interactivity. User is inside virtual world with a persona
Forward Scoring	Numerical scoring scale runs in the forward direction, where strongly agree equals 5
Fourth Wall	Conceptual barrier between any fictional work and the viewer/reader
Immersion	User's engagement with VR that results with being in a flow state. VR immersion mainly depends on sensory immersion
IPQ	IGroup Presence Questionnaire
Manifestation	How the narrative is transmitted, i.e., video, orally, written etc.
NPC	Non-player Character
Ontological	One of 4 strategies for interactivity. Users' actions can influence the plot
PEP	Player Engagement Process—framework created to assess engagement based on the desire to continue
Spatial sound	Sound surrounding the player with variable volume and pitch depending on the players' location and physical orientation towards the origin of the source.
Transportability	Ease and frequency of experiencing transportation
VR	Virtual Reality
VRNEF	Virtual Reality Narrative Engagement Framework

1 Introduction

1.1 Rationale

This research is an exploratory work focused on investigating narrative engagement in cinematic virtual reality (VR) experiences. Although narrative engagement and its implementations have been well documented in film, games and other media, this knowledge is limited in the subject of VR. A method to measure or create this engagement expressly for virtual reality is yet to be determined. Therefore, through this investigation, we theorised and created and analytical framework for narrative engagement. This framework assesses narrative engagement in cinematic VR, as well as assists in its creation through practical design guidelines. This framework will support a growing body of knowledge and understanding in the development and directing of cinematic virtual reality outputs.

For the context of this research, cinematic VR encompasses immersive storytelling applications with fixed or predetermined stories that have a cinematic quality. Cinematic quality can be considered as “VR with media fidelity approaches found in feature film” (Mateer, 2017).

This does not include the category of games or game-like experiences nor the category of 360 films with no interactivity. To clarify, it is a not task-based, or task led experience. Instead, it has limited interactivity and is focused on storytelling using a set of design and psychological criteria and the technology that VR inherently provides. Limited interactivity in this context refers to the use of local agency (having an impact on the scene), rather than global agency (having an impact on the story’s outcome).

1.1.1 Evolution of Storytelling

Storytelling is an intrinsic human characteristic. It serves to entertain, communicate, and pass down information from generation to generation (Hennebury, 2020). However, how people have shared their stories has changed drastically over time.

Storytelling originated with visual stories, such as cave drawings, before shifting to oral traditions, where stories are passed down from generation to generation verbally. Later, with the rise of written language, stories began to form narratives in a written form, such as plays, letters, and books etc. for centuries. As technology has become more advanced, there has been a return to visual stories, though the other traditional formats are still prevalent (Mendosa, 2015). For example, with the invention of the camera, stories eventually became films. Likewise, with the creation of gaming platforms, stories were integrated and played a greater role in games.

While storytelling itself is not new, digital storytelling is still in its infancy relative to what are considered more traditional storytelling forms. The earliest recorded cave painting dates from over 64,000 years ago in Maltravieso cave, Cáceres, Spain (Hoffman et al., 2018). The Epic of Gilgamesh, regarded as the oldest story ever written, is over 4,000 years old (Mark, 2022). Auguste and Louis Lumière showed the first fictional film in 1895, called *L’Arroseur Arrosé* (Pruitt, 2014). More recently with the rise of digital games, Colossal Cave Adventure was one of the first of its kind regarding digital storytelling (interactive fiction) to appear, albeit in a digital text form, in 1976.

Delving further into digital media, digital storytelling has enabled novel forms of creativity and flexibility that can span distance, time, and language barriers. Within this form of storytelling lies the concept of creating interactive digital narratives (*IDN*s), the history and definition of which are discussed in further detail in **Sections 2.2.1** and **2.2.2**. The more traditional forms of storytelling, such as oral or written books, generally regard the listener or reader as an observer who exists outside of the story. *IDN*s, however, allow the user to become a part of the story, interact with it, change how they experience it, and possibly change the

course of the story altogether. Interactive narratives are the next step in the evolution of storytelling, and this work will contribute to that growth.

1.1.2 Immersive Storytelling in Virtual Reality

The technology of virtual reality offers the features of *immersion* and *presence*. Artificial environments in VR become immersive as they replace the users' real-world surroundings convincingly enough that the user is able to suspend disbelief and fully engage with the created environment. To clarify, they are able to immerse themselves into an artificial realm, losing awareness of the “outside” world (Bolkholt, 2017). *Presence* in VR is defined as one’s sense of being in the virtual world (Schubert, Friedmann, and Regenbrecht, 2001; Biocca, 2014; Slater, Usoh and Steed, 1994.) Both of these features have the potential in enhance storytelling in VR. One example of this is that of *Turning Forest* (2017), a VR fairytale story utilising VR’s technological ability of 3D sound (spatialisation). The use of the audio spatialisation created an immersive environment for the users to get lost in, as well as enhancing their sense of presence within the experience.

However, the creation guidelines of virtual reality stories are unclear and undefined, unlike those of games and film. There are no clear guidelines, tools, or a specific pipeline for creating stories in VR experiences. Therefore, it can be challenging to create stories in VR that keep the user engaged. Nevertheless, due to the immersive capability and technological abilities of virtual reality, it has the potential to create more engaging content than games and film can provide.

This research focuses on cinematic storytelling experiences in virtual reality. In this context, cinematic refers to the film-like quality of an application i.e., relating to the visual and aesthetic qualities of the experience. Therefore, these storytelling experiences are expressed in this cinematic way, with the addition of interactivity and immersion provided by virtual reality. As such, there are very few applications in this category. The majority of applications available to the public centre around games or non-interactive 360 videos. Therefore, this niche category is focused on the meaningful expression of engaging narratives.

1.2 Overall Research Aim and Individual Research Objectives

1.2.1 Aim

The aim of this research is to explore the opportunities of interactive cinematic VR experiences with the goal of developing a framework for creating and monitoring narrative engagement. In theory, this novel framework will be able to effectively assist creators and researchers in producing engaging stories in VR, as well as providing a way to measure engagement of the narratives created.

In addition, this work will allow to further define and understand the nature of storytelling and narrative engagement in VR by defining storytelling in cinematic virtual experiences, defining narrative engagement in these experiences, and examining how narrative engagement can be measured within them. Therefore, our research question is: Can a reliable narrative engagement evaluation framework be designed for cinematic virtual reality experiences?

1.2.2 Objective

In order to conduct this investigation, this work focuses on the following objectives:

- Understand IDN and immersive VR contexts (O1)
- Investigate engagement measures towards narratives (O2)
- Creation of Narrative engaging VR experiences (O3)
- Create and validate usability of narrative engagement scale (O4)
- Establish guidelines for creating narrative engagement in VR based on design elements (O5)

- Apply principles towards the design of VR experiences and their evaluations (O6)

The first and second objectives (O1, O2) centre on reviewing current literature on storytelling and narrative engagement in virtual and conventional environments to identify concepts and elements that contribute to narrative engagement and their practices.

The third objective (O3) involves the creation of two cinematic VR experiences to use as artefacts for this research (a pilot and a final experience).

The fourth and fifth objectives (O4) (O5) involve creating a new two-part narrative engagement framework. The first part (O4) is a measurement scale based on the research mentioned above. The scale is then tested for reliability and validity. The second part, (O5) encompasses the creation of the engagement scale guidelines that will work in tandem with the measurement scale.

The final objective (O6) entails the creation of a new VR experience based on the guidelines created in (O5). This experience is then tested with the new measurement scale, resulting in the guidelines and measurement scale being evaluated as a combined framework.

1.3 Outline of Dissertation

This dissertation consists of eight chapters. The second chapter provides a theoretical background for the remaining chapters. The third chapter introduces the methodology used for the study and the fourth chapter focuses on the design and evaluation of the pilot project from research gathered in **Chapter 2**. The fifth chapter reports the creation of the VRNEF (Virtual Reality Narrative Engagement Framework) and its evaluation. The sixth chapter involves the creation of the final VR experience. The seventh chapter provides the results and analysis from the final study conducted as outlined in **Chapters 3** and **6**. Finally, the concluding chapter discusses all findings and as well as limitations and recommendations for future work. **See Figure 1-1**

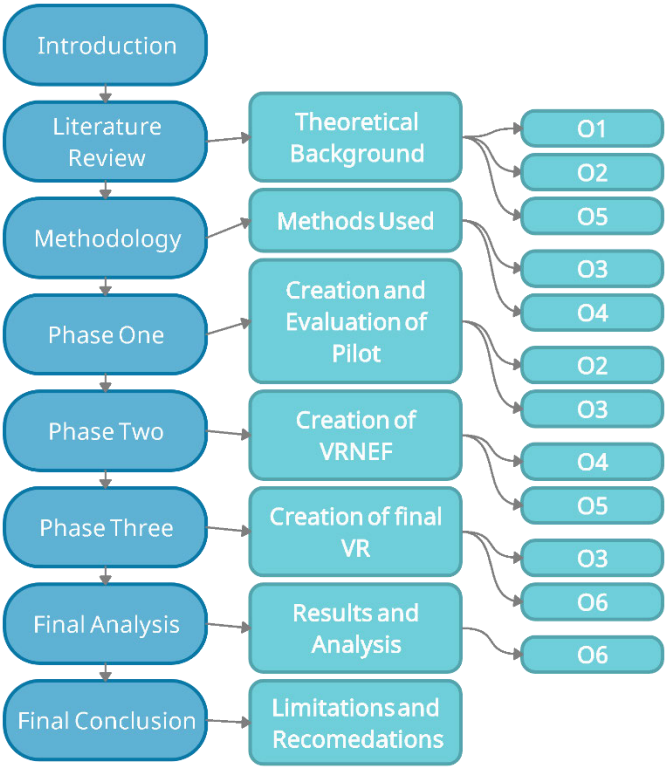


Figure 1-1 Outline and objectives of Dissertation.
(Original image created by Austin Wolfe)

Chapter 2: Literature Review. Through this literature review, a brief history of *IDN*s and a definition of narrative engagement contextualised to VR is produced (O1), elements and criteria for creating engaging stories are identified to formulate guidelines (O5), a critical analysis of relevant studies is conducted, and possible engagement measurement tools are defined (O2).

Chapter 3: Methodology. This chapter presents the intended methodology proposed for this study. This study is adopting a positivist stance on the objectivist epistemological view while implementing a convergent mixed methods approach, gathering data that is both qualitative and quantitative. This research is divided into three main phases: *Phase One* (the pilot); *Phase Two* (VRNEF scale and guidelines); and *Phase Three* (the final). Each phase is discussed in terms of the content produced, the studies that will be carried out, and how they are evaluated (O3) (O4).

Chapter 4: *Phase One*: Pilot. In this chapter, the creation of the pilot VR experience as well as the methods used to collect and analyse data. This creation of pilot study and measurements used to analyse it will address (O2) and (O3).

Chapter 5: *Phase Two*: VRNEF Creation. This chapter addresses the creation of the initial VRNEF (O4); and the creation of the VRNEF guidelines(O5). In addition, it reports the results and recommendations following a confirmatory factor analysis on the measurement scale to test for reliability and validity (O4).

Chapter 6: *Phase Three*: Final Study. This chapter centres on the creation of the final VR experience (O3). Furthermore, the final study conducts a secondary reliability and validity test on the VRNEF scale, as well as tests the VRNEF guidelines in tandem with the scale (O6).

Chapter 7: Final Analysis. In this chapter, the result from the final project (*Phase Three*) is evaluated. This is assessed based on both qualitative and quantitative data, as well as reviewed on its reliability and validity for a second time (O6).

Chapter 8: Final Conclusion. Chapter 8 concludes the dissertation with a discussion of the most significant findings, as well as the limitations for each of the project phases. Additionally, it discusses what the VRNEF could potentially mean for the design of narrative VR experiences and recommendations for future exploration.

For consideration, previous publications of contributions towards this research have been included in **Appendix: K**.

1.4 Contribution to Knowledge

The significance of this research is that it will further knowledge in the understanding of narrative engagement in cinematic virtual reality. Furthermore, the resulting novel framework will help to establish reliable and effective design practices for VR cinematic experiences. This investigation will also substantially contribute to ongoing discussions on narrative engagement in Interactive digital narratives.

The work will provide researchers and practitioners with practical tools towards the design and assessment of the effectiveness of audience narrative engagement in VR.

2 Literature Review

2.1 Introduction

This literature review explores the opportunities for storytelling in VR, towards understanding narrative engagement in interactive cinematic VR experiences. The objectives of this review will be to define the concepts of storytelling, interactive digital narratives, interactivity, and narrative engagement. This will assist in the identification of specific elements of storytelling that contribute to narrative engagement and help to evaluate studies conducted on narrative engagement with various media and their measurement practices.

The first section, **2.2**, provides a brief history of interactive digital narratives. Additionally, it delivers a definition of storytelling and draws a comparison with digital storytelling and interactive narratives. This is intended to first understand how these concepts are connected, work together, and build on each other. Then we discuss how the interactivity of *IDN* affects storytelling in VR, with the intention of highlighting potential advantages or disadvantages of this method.

Section 2.3 focuses on narrative engagement. This includes the definition of narrative engagement in the context of this study and its value. The definition of narrative engagement gives an insight into its diverse facets for a well-rounded understanding of the concept.

Section 2.4 discusses the use of storytelling structures within *IDN*, their incompatibility and alternatives. In addition, this section also investigates the creation of engaging stories and their story elements. These factors of an engaging story highlight specific criteria that can be applied to increase or create engagement, ensuring that the story does not fail to engage.

Section 2.5 discusses and reflects upon existing narrative engagement studies in various medias. These are games, 360 videos, video and audio, written, and VR. These studies will provide insights into potential tools for measuring engagement and emphasise other key aspects that researchers found crucial in creating narrative engagement in their media.

To summarise, through this literature review, a brief history of *IDN*s and a definition of narrative engagement contextualised to VR is produced. Moreover, elements and criteria for creating engaging stories are established. Additionally, this review includes a critical analysis of relevant studies, and the definition of potential engagement measurement tools.

2.2 Storytelling and Interactivity

2.2.1 Brief History of Interactive Digital Narratives

Interactive digital narratives can and have taken on numerous forms over time. According to Koenitz, IDNs have three main trajectories: text-based, cinematic/performative, and ludic/experimental (Koenitz *et al.*, 2015)

The first trajectory is text-based *IDN*'s, which originated in the 1960s. The first iteration of this was a program called *Elisa*. *Elisa* was developed as an early AI (artificial intelligence) that responded to a user's text-based input by replying with pattern matching (Weisenbaum, 1966). Although *Elisa* was not developed as entertainment software, but rather as a therapy tool, it paved the way for further development for text-based *IDN*s with the creation of interactive fiction. In 1976, another text-based *IDN* involving interactive fiction appeared, called *Adventure*. This narrative allowed users to explore a digital world through text. For instance, the user would be presented with written scenery, such as "you are in the forest". The user can then input which direction they would like to go, such as "north". As the story progresses, the digital world changes depending on where the user had chosen to explore (Crowther, 1976). Text-based *IDN*s further

progressed with the formation of hypertext. Hypertext IDNs involved authors creating a story in segments on a screen (*lexias*) connected by hypertext. The users could move through the story by selecting the hypertext links, leading to other story parts. It also allowed them to return to previous segments, which sometimes changed upon revisitation, provided that the user gained more insights through the other *lexias*. While one of the earliest hypertext *IDN*s was created in 1987 titled *Afternoon, A story*, (Joyce, 1991; Koenitz *et al.*, 2015), many content creators and storytellers still use them today, by employing programs such as Twine. See **Figure 2-1**

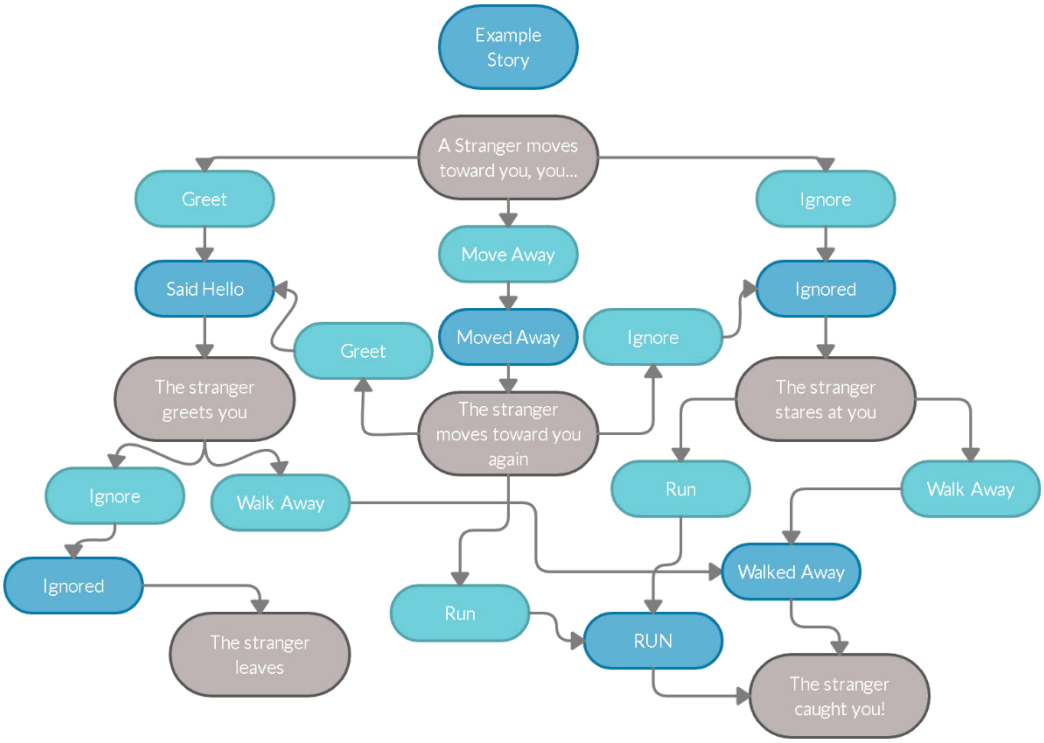


Figure 2-1 Example story main with Twine.
This story illustrates how users can revisit sections of the story and choose different paths. The blue represents the lexia and the teal represents the actions a user may take. (Original image created by Austin Wolfe)

The next trajectory is the cinematic/performative *IDN*s (Koenitz *et al.*, 2015). In 1967, Radús Činčera created the experiment *Kinoautomat* (Kinoautomat,1967). The *Kinoautomat* involved playing a movie that was paused at several points during its viewing to ask the audience to make a decision. Depending on the answer, the projectionist exchanged the lens cap between two synchronised film projectors, changing how the audience experienced the story (Naimark, 1998). This marked one of the earliest examples of cinematic *IDN*s by the use of the film projector. The evolution of technology from film projectors to laserdiscs, cable TV, and DVDs also led to an evolution in cinematic *IDN*s. Regarding TV, Oliver Hirschbiegel created *Murderous Decision* in 1991, a crime story broadcast simultaneously on two TV channels, both presenting the same story from the perspective of a different character. The audience could interact with the story by simply switching between the channels with a remote control (Weiberg, 2002). Although this *IDN* was fairly simple in design, as film evolved further, cinematic *IDN*s became more complex. Consider the example of *Bandersnatch*, an interactive Netflix TV series (Netflix, 2018).

Cinematic *IDN*s are still utilised today, often in modern video streaming services such as Netflix. Netflix's *Black Mirror: Bandersnatch* (Netflix, 2018) is a cerebral thriller about a game developer who is creating an interactive game on a SX Spectrum computer for a company called Tuckersoft. The film allows the user to make choices at critical parts of the film, shaping and defining the story's outcome. The story itself has five distinct endings. However, *Bandersnatch* goes a step further by creating a secret ending that the user must uncover. A certain series of choices can lead the user to an alternate ending that plays a sound clip. That sound clip can be played through a SX Spectrum computer emulator (from the film), which creates a

QR code. The QR code can then be scanned, taking the user to a previously hidden page on a website for the software company Tuckersoft. There, the user can download a version of one of the games created in the film, provided they have a SX Spectrum emulator to play it on. This example transverses over multiple medias to give the user more interactivity, as well as freedom on how they want to experience the story (Netflix, 2018).

The final category of *IDN*s is the ludic/experimental. This category includes storytelling through video games, virtual reality, and other and experimental narratives. Growing from the earlier text-based *IDN*s, video games added graphic elements to their narrative experiences. Take into consideration the Monkey Island series (LucasArts, 1990–2010). Although the first iterations were simplistic visually, this series is a notable example of blending narratives with game elements. The gameplay requires the user to solve seemingly nonsensical puzzles to move the story along, using humour as a catalyst for engagement. By doing so, it was able to maintain a balance between puzzle solving and narrative development. Later video game examples expanded into open world experiences, like the Dragonage series (BioWare, 2009-2014). These games portray a third person perspective in an exploratory highly detailed world. As the story progresses, the player can acquire companions to assist them throughout their travel. Depending on the players' actions, the companions can gain or lose affection for the player. Gaining affection leads to other potential stories that provide more background about the companions, creating a para-social interaction. Likewise, the players' actions also influence the gameplay of the story as well as the overall outcome. At the end of the game, credits roll, revealing the consequences of the players' actions and how they affected the world and the people in it.

Another notable example is the open world game titled *The Last of Us. The Last of Us* (Naughty Dog, 2013) received numerous accolades for its storytelling and gameplay experience. This post-apocalyptic game is visually stunning, and the story is so well defined and implemented, it almost forces an emotional connection with the player to the main characters. This emotional connection helps give the narrative depth and creates an immersive experience, allowing the player to identify with the characters and their actions. Optional dialogue responses from the player change the development of the main characters emotional relationship to one another, thus also impacting the relationship between the player and those characters.

Interactive Digital Narratives have evolved remarkably since *Elisa* and *Adventure*. Works like *Black Mirror: Bandersnatch* and *The Last of Us*, are evidence of an established and growing field. As indicated, IDNs span multiple medias and technologies, and have varying degrees of narrative engagement. To further explore this narrative engagement, it is essential to next examine the definitions and importance of storytelling and interactive digital narratives.

2.2.2 Definition of Storytelling and Interactive Digital Narratives

Broadly speaking, storytelling is the act of telling and writing stories. It is an ancient art form that can teach morality: punishing immoral behaviour and rewarding the good (Storr, 2019, p. 2). It can also offer a method for sharing cultural identity, knowledge, discovering beliefs, strengthening social ties, and bringing joy. It can even inspire people to do noble deeds or reveal their dark secrets (Richardson *et al.*, 2018).

According to Austin and Chatman (1979), storytelling encompasses both the *story* and the *discourse*. The story itself comprises events, existences, actions, happenings, characters and environments, essentially all content. Whereas the *discourse* is how the story is transmitted. The discourse constitutes the *structure* of this transmission, and the *manifestation* of it, i.e., verbal, written, cinematic etc. See **Figure 2-2**.

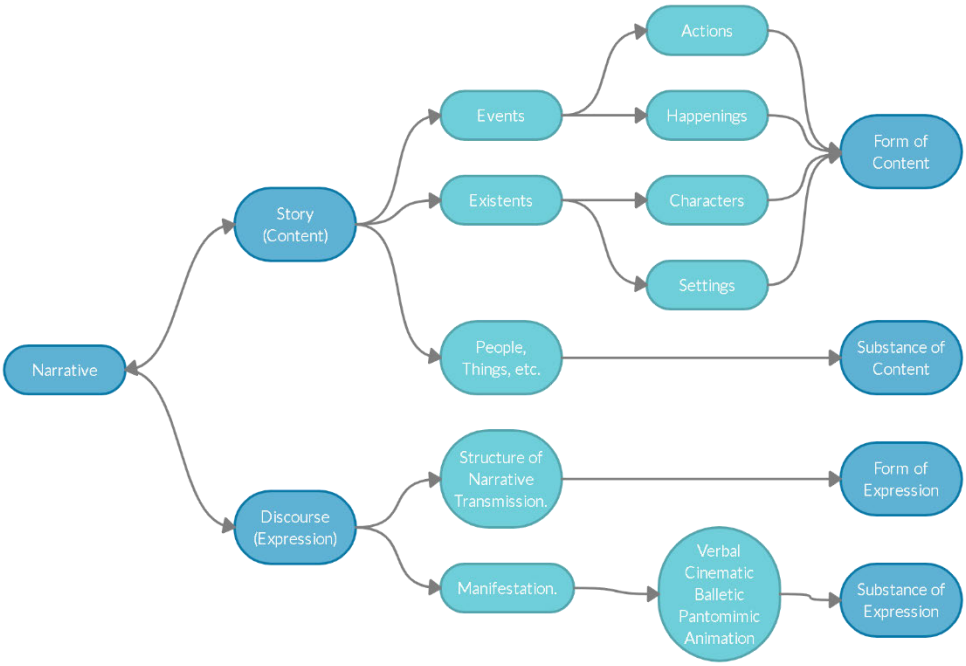


Figure 2-2 Austin/Chatman Discourse and Manifestation
(Austin and Chatman, 1979. Image is original representation, modified for aesthetic purposes.)

Digital storytelling progresses a step further; the *manifestation* of its *discourse* uses digital technology and media. Digital storytelling, however, is a vast field that incorporates content for video games, interactive cinema, virtual reality, augmented reality, and more (Miller, 2020, p.4).

Building on digital storytelling, Interactive Digital Narratives (*IDN*) adds the element of interactivity. The *IDN* is a form of digital interactive experience in which users can create or influence dramatic storylines through actions, by assuming the role of a character in a virtual world, interacting with NPCs (non-player characters), or by directly manipulating the fictional world state. In short, the player has the ability to be the character in the story, not just the observer (Riedl and Bulitko, 2013).

IDN connects artistic vision and technology. At its core, its task is to make the fourth wall permeable; to enter the narrative, to participate and experience the story. *IDN* can dissolve the division between active creator and passive audience, and create a new triadic relationship between creator, dynamic narrative artefact, and participant. Interactivity, therefore, can have a direct impact on storytelling itself, particularly in VR (Koenitz *et al.*, 2015, p. 1).

2.2.3 Interactivity and Affect in Storytelling in VR

Interactivity can be considered as a type of play. According to Ryan (2009) the combination of storytelling and interactivity is generally seen in two forms: the narrative game and the playable story. In a narrative game, story enhances gameplay, whereas in a playable story, the gameplay produces the story.

Regardless of the experience being considered a “narrative game” or “playable story”, interactivity in digital applications, such as virtual reality, can put people in a remarkable position to influence the outcome of the story through their own efforts. This distinguishes them, as the creation of actions with consequences has the potential to create emotional possibilities; emotions that are usually not evoked by traditional story-based entertainment. For example, the ability to evoke guilt or pride is unique to digital narratives and games. Readers or film watchers may be emotionally attached to the characters, but they are unlikely to feel personal responsibility or pride for the protagonist (Isbister, 2018, p. 9). Along with creating emotional possibilities, interactivity can also affect the storyline.

Traditional story-based entertainment, such as in books or films, is almost always linear, with one event following one another in a somewhat straight line. When digital interactive works contain a story line, it can break this mould and allow the story to become non-linear, with the user being able to change the course of the story (Miller, 2020, p. 19). Additionally, digital stories through the use of interactivity often break the *fourth wall*, as users can communicate and interact with the characters in the story. This interactivity can be multi-sensorial, include elements of play and exploration, and use multiple media avenues to help create the story (Miller, 2020, p. 24). So how is this employed in VR?

According to Ryan (2002, pp. 595-596), interactivity can be employed for VR by four strategic forms: In the first form, *internal*, users are inside the fictional world, either by identifying with the avatar or by viewing the virtual world from a first-person perspective. Conversely, in the *external* form, users are outside the virtual environment, playing the role of someone who can control the virtual world. Thus, *internal* interactivity will result in the user's personification, whereas *external* interactivity does not require a concrete persona (Ryan, 2002, pp. 595-596).

With the *exploratory* form, users can navigate, alter their perspective, or examine objects to learn about the virtual world. However, their actions do not alter the plot and have no impact on the story's outcome. Comparatively, the *ontological* form allows users' decisions to influence the story into different outcomes or paths. These pairings of strategies can be cross classified to have different interactive narrative possibilities. For instance, interactivity could be paired as *internal/exploratory* or *internal/ontological* etc. (Ryan, 2002, pp. 595-596). See **Figure 2-3**.

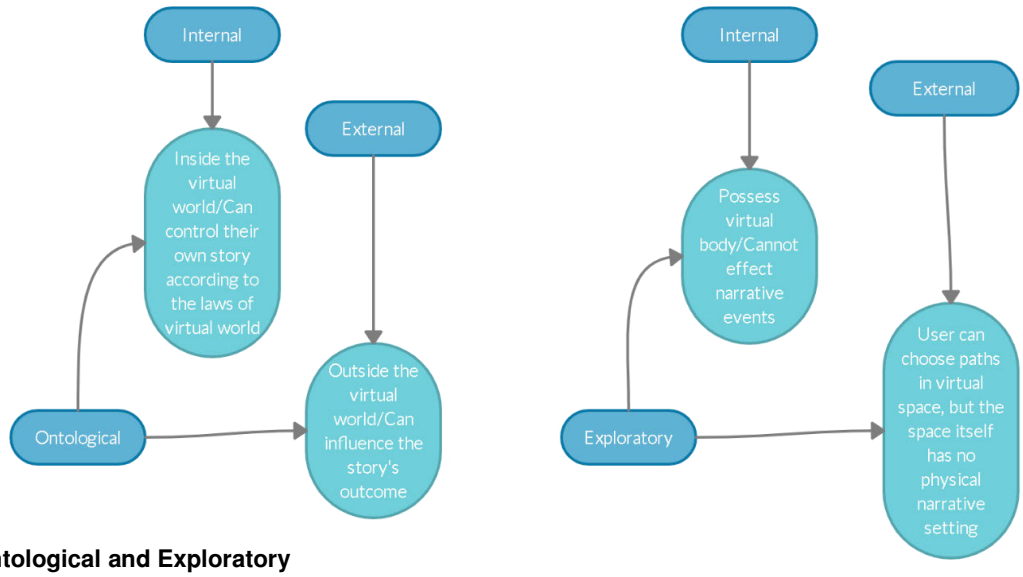


Figure 2-3 Ontological and Exploratory pairings with Internal/External Factors
(Ryan, 2002, pp. 595-596. Image is original representation, modified for aesthetic purposes.)

2.3 Narrative Engagement

2.3.1 Definition of Narrative Engagement

On the surface, narrative engagement can be described as being engrossed in the world of a story and temporarily losing awareness of self and real-world surroundings. On a deeper level, narrative engagement is a multifaceted concept. For example, in Schoenau-Fog 's (2011a) research, he defined narrative engagement as the *continuation desire* (discussed further in **Section 2.5.2.2**); possessing the desire to continue to experience. Additionally, other facets of narrative engagement include:

- *Transportation*--the process of becoming fully engaged in a story (Green, Brock, and Kaufman, 2004)

- *Identification*-- a mechanism through which the audience experience reception and interpretation as if the events were happening to them (Cohen, 2001)
- *Presence*--the user feeling that they are in the story world (Schubert, Friedmann, and Regenbrecht, 2001; Biocca, 2014; Slater, Usoh and Steed, 1994)
- *Flow*-- these ease in which a user arrives at a pleasant optimal performance (Csikszentmihalyi, 1997)
- *Enjoyment*--based on the concept of *flow*; enjoyment is the product of attaining optimal flow. (Sweetser and Wyeth, 2005)

Furthermore, Busselle and Bilandzic (2008) identified four dimensions of narrative engagement:

- *narrative understanding*--the ease in comprehension of the story.
- *attentional focus*—concept that one should not be aware that one is distracted.
- *emotional engagement*--feeling for or with the characters.
- *narrative presence*—sensation that one has left the actual world and entered the story. (Busselle and Bilandzic, 2008; Roth, 2016)

Based on the above listed research, visually, narrative engagement appears like a web of concepts. **See Figure 2-4**.

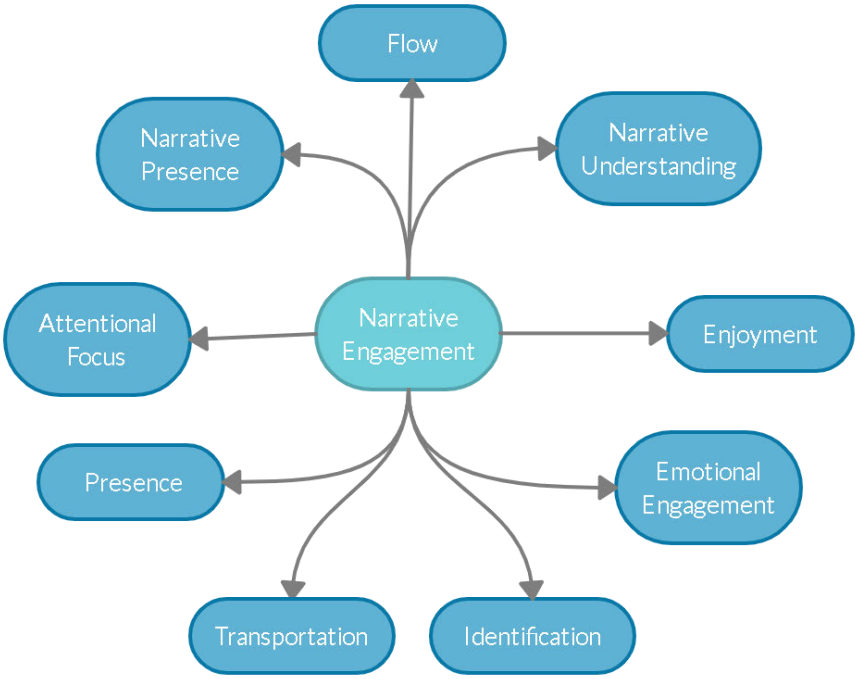


Figure 2-4 Facets of Narrative Engagement
(Original image created by Austin Wolfe)

Understanding these facets and dimensions of narrative engagement is crucial, as they can be adapted and applied to a story as a tool for measuring its engagement. However, before measuring that engagement, it is necessary to define what makes a story engaging.

2.3.2 Significance of Narrative Engagement in VR

As mentioned in **Section 2.2.2**, storytelling can be used as a method for teaching morality, sharing cultural identity, knowledge, discovering beliefs, and strengthening social ties. Additionally, other studies have shown that narratives can actually influence beliefs (Green and Brock, 2000; Appel and Richter, 2007) and attitudes (Lee and Leets, 2004).

The concept of *transportation* (Green and Brock, 2000) mentioned in the previous section, proposes that the more someone is transported into a narrative world, the more the story will influence their beliefs. According to their model, *transportation* is a mental process in which attention, emotion, and imagery are focused on events occurring in the narrative. The model postulates that stories can change beliefs due to vivid imagery because it makes narrative events appear like real experience. Additionally, as a consequence, the cognitive mechanisms that allow for a critical evaluation of the story are partly neutralised, opening the door for persuasive effects (Appel and Richter, 2007).

In a study focused on persuasive storytelling on online hate groups and racism, Lee and Leets (2004) found that high narratives (involving a plot and characters) with implicit or vague messages were found more persuasive initially than low-narratives (without meaning) and explicit messages. Moreover, the neutral parties (persons neither initially agreeing nor disagreeing) were the most easily swayed in their attitudes.

Furthermore, the presence of characters in a story can affect message processing through identification (Cohen, 2001). *Identification* is a mechanism through which the audience experience reception and interpretation as if the events were happening to them. When the receiver of the story identifies with a character, they lose self-awareness and become fully merged with the feelings, perspective, motivation, and experiences of that character. Therefore, when *identification* occurs, persuasion becomes more likely (Cohen, 2001).

Green and Brock's (2000) suggestion that imagery in narratives can persuade was originally postulated on literature. In VR, the imagery is no longer textualized or up to the reader to imagine. Instead, the imagery can become the users' reality through the creation of a virtual world. A world that the user not only can see and hear, but also interact with. This is especially significant in VR, as although other digital medias like videogames also have virtual worlds, virtual worlds in VR physically transport the user. The significance of this imagery of the virtual world is explored further in **Section 2.4.3**. A further study on how VR could potentially change participants' beliefs via *transportation*, noted that VR participants recorded higher transportation rates than those who watched a playthrough on the monitor of the same content. Additionally, the VR participants identified highly with the main character due to its first-person perspective (Raffel, 2018). This may suggest that in virtual reality, the potential for *transportation* and *identification* may be amplified.

2.4 Interactive Digital Narrative Design

The design of IDN's requires looking through a multifaceted lens at various factors that can make a story engaging. Firstly, digital story structures are examined and their appropriateness for IDNs' and virtual reality. Secondly, the concepts of change, control, curiosity, and suspense are introduced along with their potential towards influencing story structures. Finally, *aesthetic value* is also discussed in relation to its narrative value and influence on the experience of cinematic VR.

2.4.1 Digital Storytelling Structures, Interactive Digital Narratives, and VR

Story structures form patterns that allow the viewer to create meaning from the experience. Koenitz *et al*. (2018, pp. 107-120) sheds light on the exploration of storytelling structures and their application for digital interactive narratives. Through their research, they considered widely accepted narrative structures, such as the dramatic arc of Aristotelian poetry and the Hero's Journey (Campbell, 1991). Aristotle's Poetics involves a well-shaped plot with a beginning-middle-end structure, in which the narrative increases in intensity to the climax and approaches an end parallel to the tone of its beginning. The Hero's Journey traces its protagonist's story roughly through a predetermined set of stages: introduction of the hero's world; a call to adventure; meeting with guide; the crossing of the threshold; the ultimate ordeal; and the reward gained and return home (Koenitz, 2018, pp. 107-120).

In non-interactive forms, these structures generally account for about half of the content (Koenitz, 2018, pp. 107-120). However, in digital applications such as games and VR, the user can spend a large amount of their time in this story structure. Because of this change, it violates the rules of these models, resulting in the narrative being deficient. Furthermore, Koenitz (2018, pp. 107-120) postulated that the Hero's Journey was inadequate for IDN as it shields creators to non-Western forms of narratives and prevents the opportunity to conceive radically different aesthetic experiences. Additionally, the Hero's Journey structure is dependent on the journey of the protagonist and their call to adventure, following a set of events where the choices have already been chosen. This is particularly problematic in VR experiences, where the user is actively the camera/first person view, i.e., they usually are the protagonist. The nature of the technology of VR gives the user the will to act or to not act. Users are therefore no longer carried by the story structure and are driven by their own will. If the story structure is strictly followed, the user loses their power of acting. Conversely, if the power of acting is given to the user, this story structure breaks down as it can no longer follow a sequence of events due to the users will. However, Koenitz (2018, pp. 107-120) offers some alternatives to the hero's journey to combat the shortcomings and inadequacy of these structures: *Aetiological Oral Narratives; Gangan Comics; Sīra Narratives;* and *Epiphanic Structure* (Koenitz, 2018, pp. 107-120).

A*etiological oral narrations* are stories that explain the origin of certain phenomena while communicating traditions and concise histories. *Gangan Comics* is based on adaptations of Indian mythology in comics, in which the solution to one conflict also immediately causes the next conflict. The *Sira narrative* structure has a central hub from which assorted smaller episodic journey narratives depart and return, which are in the larger frame of a community's survival and eventual demise. The *epiphanic structure* is a cycle of conflict designed to create a moment of epiphany that causes the player to understand the events of the narrative in a different light and then explores the narrative from the beginning again to discover the consequences of this revelation. (Koenitz, 2018, pp. 107-120) These alternative story structures may have the ability to be better adapted to interactive stories than the previously mentioned dramatic arc and hero's journey, as VR is less likely to violate the rules of the structures when applied in digital media.

Another alternative storytelling structure that may be better suited to virtual reality and other IDNs is Propp's morphology of folklore (Propp, 1928). Based on his analysis of over 100 Russian folktales, Propp identified five categories of elements that define the construction of a complete story. These are:

- Functions of dramatis personae
- Conjunctive elements (ex. a voice calling)
- Motivations (reasons and aims of personages)
- Forms of appearance of dramatis personae (how the functions appear)
- Attributive elements (accessories, i.e., a house or garment)

The dramatis personae comprised 31 fixed consecutive functions in a syntagmatic structure (Propp, 1928):

Table 2-1 Propp Functions of Dramatis Personae

Absentation (someone leaves or dies)	**Branding** (hero is marked)
Interdiction (the hero is warned against an action)	**Victory** (villain is defeated)
Violation of interdiction (warning is violated)	**Liquidation** (issues are resolved)
Reconnaissance (villain tries to attain information)	**Return** (hero travels home)
Delivery (villain succeeds)	**Pursuit** (hero is pursued)
Trickery (attempt to deceive victim)	**Rescue** (hero is saved)
Complicity (victim is fooled)	**Unrecognised arrival** (hero is unrecognised)

Villainy/**Lacking** (villain harms, or item is lacking)	**Unfounded claims** (a false hero presents claims)
Mediation (attention of hero is gained)	**Difficult task** (a trial is proposed)
Beginning counteraction (hero considers actions)	**Solution** (hero accomplishes task)
Departure (hero leave home)	**Recognition** (hero is recognised)
First function of the donor (encounters helper)	**Exposure** (false hero is exposed)
Hero's reaction (hero responds to donor)	**Transfiguration** (hero gains new appearance)
Receipt of magical agent (acquires magical agent)	**Punishment** (villain suffers consequences)
Guidance (led to a location)	**Wedding** (hero marries or is rewarded in other ways)
Struggle (hero and villain struggle)	

Most functions have a list of potential choices to fulfil its meaning. For instance, the first function of *absentation* can have one of three possibilities: someone leaves (older generation); someone dies; or someone leaves (younger generation). In this way, a storyteller can choose from a list of viable actions under each function to build a story. The result creates a web of connections between the functions. Propp further explored these connections by examining the functions in depth. The figure below illustrates the possible connections between the function *first function of the donor*, and *receipt of magical agent*. The purpose of the *first function of the donor* is to prepare the hero for the receipt of the magical agent. This model shows there are nine available actions for this function. The donor can test the hero or interrogate them (*test/interrogation*), the donor is either dying or deceased and makes a request (*dying person*); the donor is a prisoner pleading for mercy or freedom (*mercy and freedom*), there is a dispute to be settled (*division*), other requests (*other*), a hostile tries to kill or fight the hero (*annihilate/skirmish*), or the hero is presented with the magical item to make an exchange (*exchange*). See **Figure 2-5**.

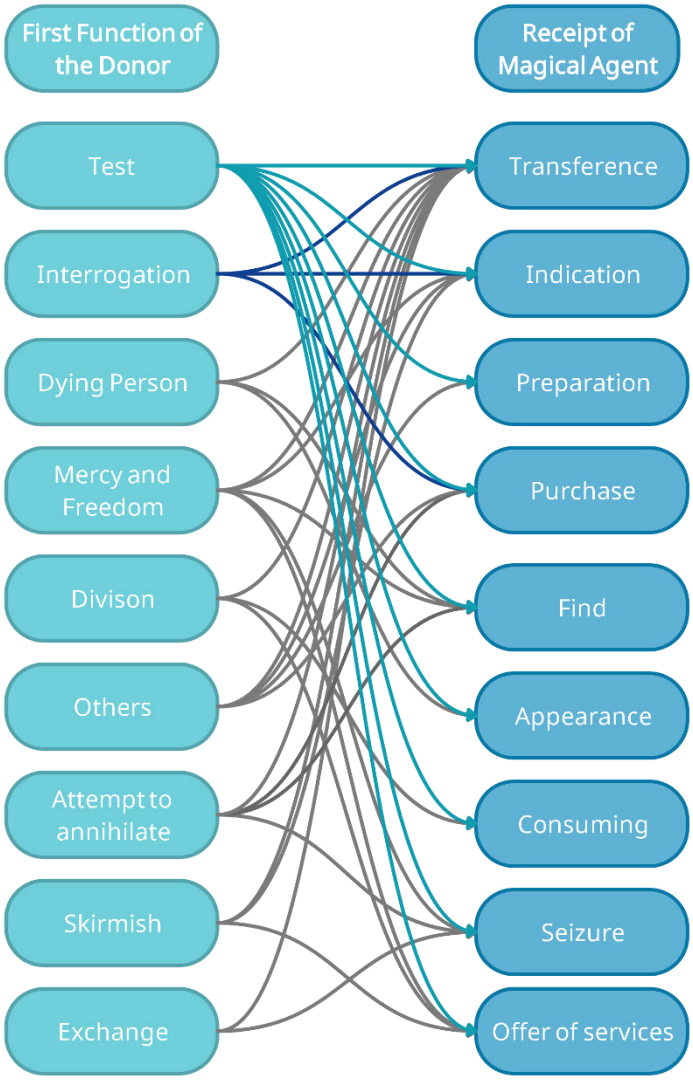


Figure 2-5 Connections of Functions
(Propp, 1928. Original image created by Austin Wolfe)

As shown above, if the hero is *tested*, there are nine other corresponding actions on how the receipt of the magical agent is attained. However, if the hero is *interrogated*, there are only three options: *transference* (the item is received as a reward); *indication* (the item is pointed out); or *purchase* (the hero buys the item) (Propp, 1928). Using the connective properties of this morphology, this story structure may prove invaluable to content creators and storytellers, as it allows them to *engineer* a story.

Bucher (2017) takes a simpler approach for virtual reality, asserting that the story structure can be based on the basic three act structure of Aristotle: a beginning, middle, and end. He offers all stories should start with an inciting incident that drives the rest of the story, proposing the following examples:

- **The Magical Opportunity**-An unexpected magical opportunity or gifting after an established setting of either monotonous or difficult life of the character.
- **The Test**-A major challenge is forced on the protagonist to have the life they want. The test often after some major component of the protagonist's identity has been taken away or threatened.
- **An Enemy Arises**- the life of the protagonist is thrown into chaos by the arrival of an unexpected force, they must choose to confront them or lose what is important to them.
- **The Missing Piece**- a missing piece of the protagonist's life is introduced (usually a person). Unfortunately, the "missing piece" is reluctant to fill that hole initially and must be persuaded or won over.

Whilst narrative structures are an inherent part of storytelling, the contexts and motivating drives that form the body of a narrative also need to be considered. The next section focused on concepts of storytelling that are used to create engaging stories.

2.4.2 Designing an Engaging Story

The following sections discuss specific factors and concepts that impact the engagement in stories. These concepts will be revisited throughout the research and ultimately utilised within the final VRNEF creation discussed in **Section 5**.

2.4.2.1 Change, Control, and Curiosity

“Many stories begin with a moment of unexpected change” (Storr, 2019, p. 11). According to Hood (2012), change is endlessly fascinating to the brain, as almost every perception of the brain is based on the recognition of change. Perception systems simply do not work unless there is change. The brain tends to be quiet in a natural state, but when it detects changes, neuroactivity increases (Hood, 2012).

Building on this, Storr (2019, p. 12) asserts that the main task of the brain is to control everything and everyone around it by its perception of reality. Brains must perceive the physical environment and the people in it in order to control them. Since the brain in seeking control, it is constantly on the lookout for unexpected events or change, and unexpected change makes the brain curious. Masterful storytellers exploit this psychology by creating moments of unexpected change at the very start of a story. This change is the first arousal of curiosity, and curiosity is the first thing people should experience when they engage with a story (Storr, 2019, pp. 12-15). Therefore, change is a crucial element when creating any engaging story and is necessary to lead to curiosity.

The brain is naturally curious. It is especially inquiring when presented with a partial set of information that it realises is incomplete. It has a natural tendency to fill in the gaps, which means there is a positive relationship between curiosity and knowledge. The more curious it is, the greater the thirst for knowledge (Loewenstein, 1994). A thirst for knowledge can keep the brain engaged in the story as it is actively seeking the outcome. However, this must be done with care. If the brain is too confident about what it knows or is too confused, the engagement fails. So, a compelling story needs a certain amount of curiosity to work. See **Figure 2-6**.

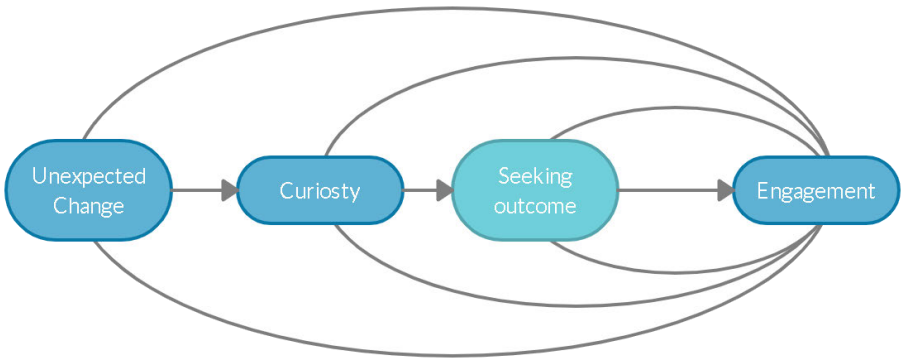


Figure 2-6 The influence of change and curiosity on engagement
(Loewenstein, 1994. Original image created by Austin Wolfe)

Similarly, Brewer and Lichtenstein (1982), had corresponding insights. Curiosity is not only an integral part of storytelling but can also be a driving force as a structure of story events. Regarding their structural affect theory, a curiosity event structure must contain a significant event early in the sequence, comparable to Storr's (2019, p.12) "unexpected change." In a curiosity discourse structure, the significant event is omitted

from the discourse, but the experiencer is given enough information to know that the event is missing. This lets them become curious about the withheld information. The curiosity is resolved by providing enough information in the later parts of the discourse for the omitted significant event to be reconstructed (Brewer and Lichtenstein, 1982). However, both Storr's and Brewers' curiosity assessments were based on more traditional storytelling, such as written and oral applications, not digital environments.

To *et al*. (2016) offered insight on the concept of curiosity in a digital environment and implementation of employing it. Their research defined curiosity as one's inclination toward uncertainty and willingness to balance between the known and unknown. In their research, they defined types of curiosity and levels of uncertainty in games, to encourage game designers to use *curiosity types* in moments of uncertainty, thus assisting in balancing the knowledge gap (To *et al*., 2016).

There are five key types of curiosity: *perceptual/attention* to something new, *manipulatory*, curiosity about *complex/ambiguous, conceptual/active* information seeking, and *adjustive-reactive.* For example, *perceptual* and *adjustive-reactive* curiosity can effectively combat the frustration of players with difficult puzzles or tasks, to keep the game engaging and not frustrating. Additionally, *conceptual curiosity* can be brought about by conceptual shifts when there are new expectations or a sudden moral dilemma (To *et al*., 2016). See **Figure 2-7** for examples of curiosity types.

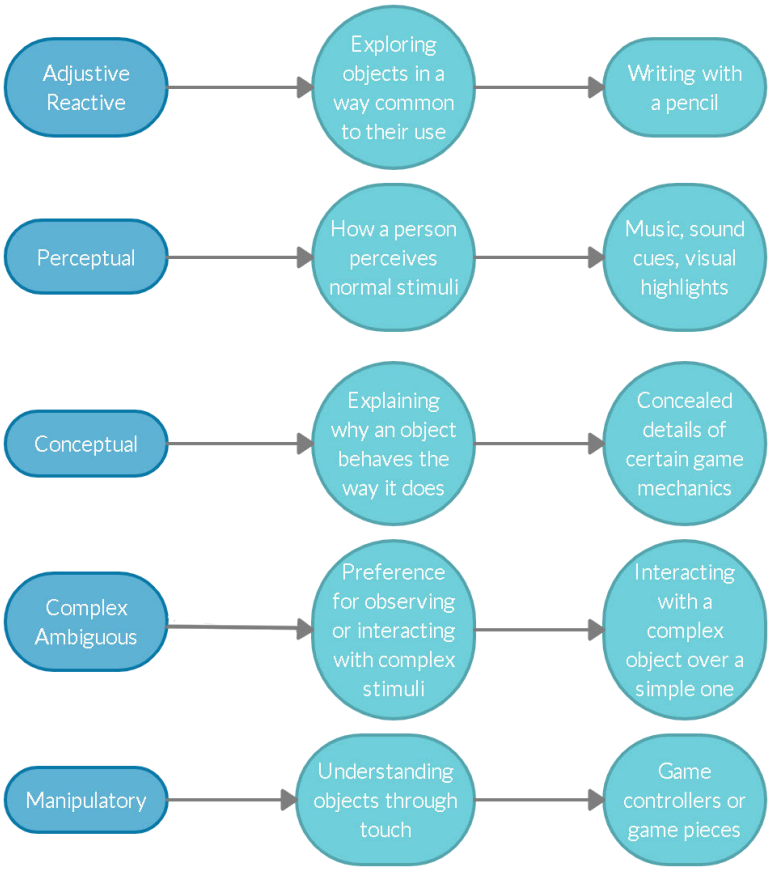


Figure 2-7 Curiosity types and examples
(To *et al*., 2016. Image is original representation, modified for aesthetic purposes.)

Using a *curiosity type* as mentioned above, may prove an invaluable way of adding interest and engagement into digital storylines as they allow the creator to conceptualise gameplay around balancing the known and the unknown.

2.4.2.2 Suspense

In literature, suspense is a device that authors used to keep the interest of their readers alive throughout the story. The purpose of using this in literature is to make readers more concerned about the characters, to form a sympathetic connection with them, and thus to keep them engaged in the narrative. Suspense can range from moments of terror and fear to moments of tension. With regards to this research, suspense is examined through the lens of creating tension in a story. This is closely aligned with curiosity, as the unexpected change and seeking of outcome both can create moments of tension. Likewise, as Storr (2019, p.12) mentioned, the brain seeks control, and lack of control creates moments of suspense (tension) due to uncertainty and instability (Lenhe and Koelsch, 2015). Thus, curiosity and suspense are intertwined. This is not to say necessarily they depend on one another, but rather they can have some measure of influence on each other.

In addition to curiosity, Brewer and Lichtenstein (1928) identified a suspense story structure to enhance engagement in stories. A suspense structure must contain an initiating event. This event then leads to significant consequences (good or bad). In this structure, the initiating event occurs early in the discourse. It must also contain an outcome event, which will resolve the suspense when presented. See **Figure 2-8.**

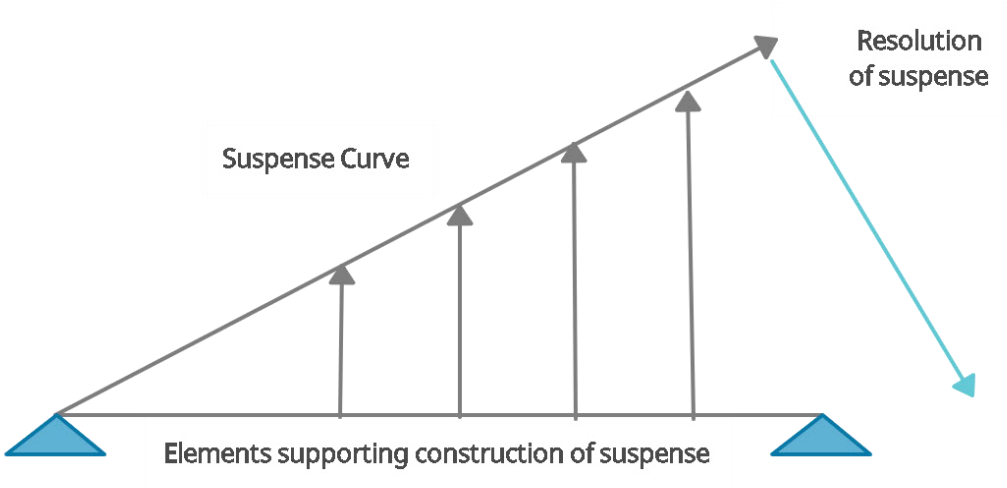


Figure 2-8 Suspense Effect Structure
(Brewer and Lichtenstein, 1928. Image is original representation, modified for aesthetic purposes.)

Using this structure, Smith (2000) created a narrative model for suspense, asserting that there are four types of suspense: *vicarious*, *direct*, *shared*, and *composite*. *Vicarious* suspense is when the spectator knows more than the character. *Direct* suspense is where the spectator experiences suspense alone, rather than through an emotional bond with a character. *Shared* suspense is when the spectator and character(s) share a similar emotional response to the tension. Suspense becomes a *composite* when direct suspense is synchronised with *vicarious* and *shared* suspense.

According to Keith Bound (2016), his five-year empirical study regarding electrodermal activity as a response to suspense, found that shorter film clips of *vicarious* and *direct* suspense produced a higher frequency of anxiety responses than the longer film clips of *shared* and *composite* suspense. This prompted the claim that *vicarious* and *direct* suspense are best suited for shorter narratives, as *shared* and *composite* suspense may take longer to develop within the narrative. This is notable, as likely VR experiences are shorter than a typical film length, leading to the conclusion that *direct* or *vicarious* suspense types may be better suited for the media.

2.4.2.3 Lighting up the Suspense

For practical application of suspense and curiosity, the use of light can be considered. Since these concepts are intertwined, lighting in scenes becomes particularly useful. Lighting can be used by combining curiosity and suspense affect structures. One way this can be accomplished is by concealing, delaying, or revealing story information through light. Using low-key lighting, for example, draws viewers' attention to potential hidden dangers lurking in the darkness and shadows (Eitsen, 2010). The dark can increase the fears of viewers by playing on their imagination of what they cannot see, and by building expectations or / and assumptions about what dangers hide in the dark. In addition, the illumination of a bright light can also elicit suspense to reveal story information, either creating an anxiety response, or playing to the viewers' curiosity (Bound, 2016).

To illustrate this, consider directional lighting. Directional lighting, such as a flashlight or beam of light, creates a strong contrast between bright white and dark shadows. This can be used to deliberately conceal or delay story elements, or to highlight objects or key characters (Bound, 2016). Along with the ability of creating suspense, lighting is also linked to the art and aesthetic discussed in the next section.

2.4.3 *Aesthetic value* and Art

Unlike traditional storytelling, digital media is in a unique position to add visual aesthetics to increase narrative engagement. Aesthetics is a branch of philosophy that involves the nature of beauty and art, as well as the creation and appreciation of attractiveness. Aesthetics in digital media is often related to visuals and audio. In gameplay, it can also incorporate other sensory phenomena like haptics (touch or vibrations) or the embodiment of a character. Embodiment can be described as feeling that a body is "theirs", and that it moves to the users' intentions (Kilteni, Groten, and Slater, 2012). Aesthetics may also relate to the physical appearance of characters or landscape imagery. Additionally, aesthetic content can relate to the personal background and previous experiences of the recipient. For example, the depiction of a scene in a film can remind the viewer of feelings that resonate with the mood of the recipient, and thus invoke congruent feelings in the viewer (Cupchik, 1995).

> Aesthetic experience occurs when we find that something is pleasing to us by virtue of its form. Such an object stimulates us in the sense that it provokes and incites a feeling response, but it does so in a way that goes beyond merely being pleasing to the eye (Kirkpatrick, 2007).

Since aesthetics plays a role in evoking emotions and how the user experiences the story, it is a crucial element in narrative engagement for digital applications, especially in virtual reality, as the user is surrounded by the aesthetic content of the virtual world.

The creation of an aesthetic experience can be implemented by using a visual style. Visual style can have a significant effect on the general user experience. A visual style can contain many design elements that work together to create a coherent whole that is more than its parts (Garver, Adamo-Villani and Dib, 2018). Along with traditional art, these elements can be used to visualise digital media such as games and animated film. Arnheim, (1954, p.10-444) defines these elements as:

- *Balance* - how elements work in unison
- *Shape* - the contour that represents an object.
- *Form* - the visual representation that shapes define.
- *Growth* - the personal progression of a style and artist
- *Space* - arrangement of elements
- *Light* - shadows and highlights (light intensity and direction)
- *Colour* - the colours describing an element.
- *Movement* - the direction that an eye is led to follow.
- *Tension* - contrasting elements that evoke uneasiness.
- *Expression* the personal representation of an element. See **Figure 2-9**.

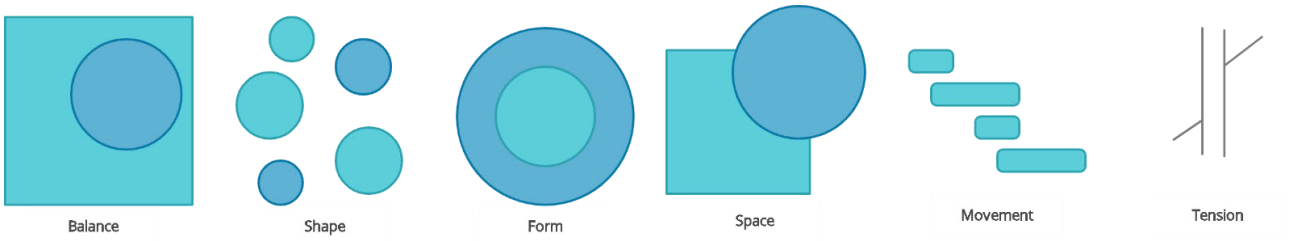


Figure 2-9 Examples of Arnheim's visual elements of art.
(Arnheim, 1954, p. 10-444. Original image created by Austin Wolfe.)

Conversely, Pentak and Lauer (2015, pp. 27) defined the elements of design as:

- Unity - the combination of other elements as a whole
- Emphasis - an element, or groups of elements that overpower the others, creating a point of focus.
- Proportion/Scale - the relationship between the sizes of elements in art in relation to other elements within the same piece
- Balance - a state where elements do not overwhelm each other.
- Rhythm - the repetition of the same elements to create movement.
- Line - the distance between two points
- Shape - elements in 2D space that are either geometric or organic.
- Texture - the physical feeling or visual feel
- Space - the area that contains the art.
- Movement - the path or direction an eye is led.
- Value - light and dark, and their contrast
- Colour - defined by hue, intensity, and value.

Note that the elements of *movement*, *shape*, and *colour* are consistent for both views, while other elements are further split up or termed differently, such as *balance* and *tension* being categorised as *unity*, *emphasis*, *proportion*, and *balance*. **See Figure 2-10**.

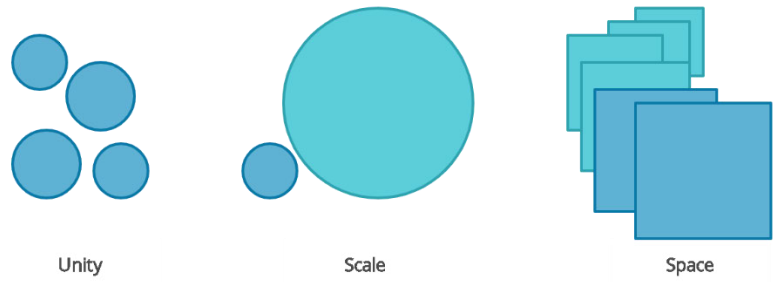


Figure 2-10 Pentak and Lauer elements of Design Examples
(Pentak and Lauer, 2015, pp. 27. Original image created by Austin Wolfe.)

As visually demonstrated above, primarily these design elements were created for use in 2D art applications. However, the core concepts can still be applied to 3D virtual environments. In addition to these design elements, colour is also of importance in the visual style. In interactive designs, for example, colour can help memorisation, recall, and recognition. Additionally, colours affect people physiologically. Certain colours have been associated with increased blood pressure, increased metabolism and eye strain. Colours also influence emotions and moods (Karr, 2013). See example the below.

Green **Blue**

- Brings equilibrium and relaxation, feelings of comfort.
- Helps to breathe deeper and slower.
- Suggests nature, peace, well-being.
- Represents environmental friendliness
- Lowers blood pressure, has a cooling and soothing effect.
- Deep blue is associated with calm, restful nights.
- Inspires mental control, clarity, and creativity.
- An overuse of dark blue can be depressing

Adapting these design principles and colour theory in a visual style may prove an effective method for contributing to the *aesthetic value* of a VR storytelling application.

2.4.3.1 Creating Engaging Characters

In digital stories, visual style can also be employed for character creation. Solarkski (2017, p.13) suggested that digital medias, like traditional medias, are based on the same design principles as mentioned in the previous section and serve a secondary purpose of creating *aesthetic value* as applications in visual narratives. Furthermore, that a better understanding of these aesthetics will lead to richer virtual experiences. He proposed the use of traditional artistic techniques involving the psychology of shapes (Arnheim, 1954; Pentak and Lauer, 2015, pp. 27-255) and lines of movement to facilitate applying this into a virtual world. The psychology of shapes is simplified into three categories:

- Circle: innocence, youth, energy, femininity
- Square: maturity, stability, balance, stubbornness
- Triangle: aggression, masculinity, force

Psychologically, people associate with these shapes and their corresponding concepts due to real-life experience and the sense of touch. Through touch, people visually assess the characteristics of objects based on experience (angular = sharp = harmful). These shapes may be a feasible option to practically design the character as well as their pose. "Characters should also adopt poses to communicate their changing emotional and physical state". The same principle can be applied to the movement of the character. Lines of movement communicate a variety of emotions, ranging from delicate and dynamic (curved lines); slow and peaceful (straight uprights and horizontals); and aggressive (angular). In designing a character's movements, these lines can be chosen to complement the emotions the users are supposed to experience (Solarski, 2017, p. 13). See **Figure 2-11**.

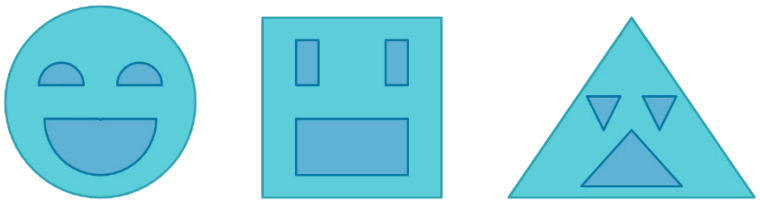


Figure 2-11 Solarski Character Shapes
(Solarski, 2017, p. 13. Image is original representation, modified for aesthetic purposes.)

Along with the physical shape of characters, characters in stories need flaws, personality, and a sense of identity. Flaws help define characters and help others to empathise and become emotionally invested in their struggle (Storr, 2019, p. 69). In terms of personality, the *Five Factor Model* (FFM) has been often used in psychology to categorise people's personalities. This categorisation can likely be applied to character development as well. The *Five Factor Model* (McCrae, Gaines and Wellington, 2012) in psychology suggests that the personality of people and characters is assessed across five domains*: neuroticism, extroversion, openness, agreeableness*, and *conscientiousness.* For example, if someone is high in *openness,* they are likely to be curious, artistic, emotional, imaginative, and liberal (McCrae, Gaines and Wellington, 2012; Isbister, 2006, pp. 23-40). See **Figure 2-12**.

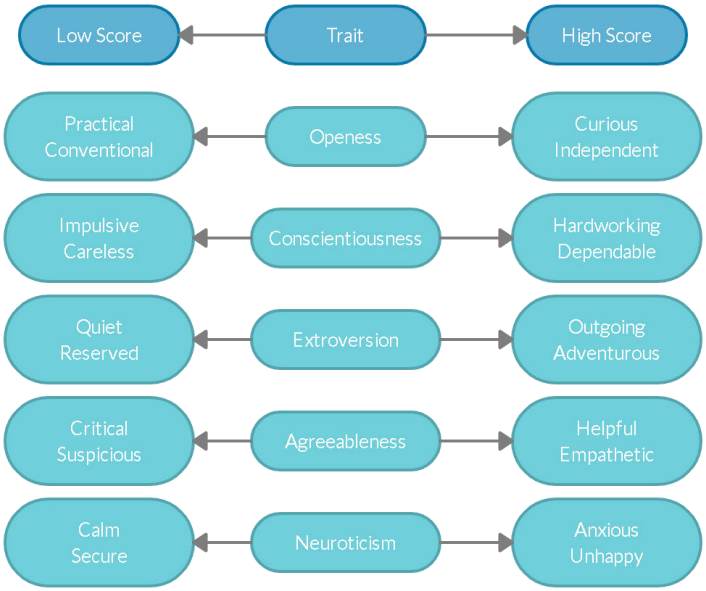


Figure 2-12 Five Factor Model
(McCrae, Gaines and Wellington, 2012. Image is original representation, modified for aesthetic purposes.)

Applying such a model to a potential character will not only help to develop the character's personality, but ultimately will aid in guiding the storyline later. In addition to characters requiring a personality, they also need a sense of identity.

The identity (who they are) of a character can be observed by their fashion, belongings, or other items. For instance, an introvert would prefer muted tones in their wardrobe, whereas as an extrovert would prefer bright colours (Gosling, 2008, pp.12-19). It is, therefore, possible to design a character based on what or how they have chosen to portray their identity. Aligned with this is the concept of *behavioural residue*, residue of actions from the character that indicate things about their lives. This could be inconsequential objects such as stacked pizza boxes in a corner, or crumped pieces of paper, but they give insight into the personality of the character (Gosling, 2008, pp.12-19). Developing the character in this way, allows for a greater potential of the user to identify and sympathise with them, both through their visual appearance and actions. An emotionally engaging character can heighten user empathy and keep them engaged in the story experience. Equally important, if not more so for virtual reality applications, is the creation of an engaging story-world.

2.4.3.2 Creating an Engaging Story-world

The story-world is the world in which the character inhabits, i.e., their reality. In the gaming world, the term environmental storytelling is often used in relation to the story-world and refers to the art of arranging a careful selection of the objects available in a game world so that they suggest a story to the player who sees them.

> Environmental storytelling creates the preconditions for an immersive narrative experience in at least one of four ways: spatial stories can evoke pre-existing narrative associations; they can provide a staging ground where narrative events are enacted; they may embed narrative information within their mise-en-scene; or they provide resources for emergent narratives (Jenkins, 2004, p. 124).

An engaging story-world can also become the reality of the user/viewer. The story-world constitutes environment objects that serve as narrative obstacles and constraints, either acting in harmony or in opposition to the other characters. People can react emotionally to characters based solely on their shape

and animation, but it is only when the characters are seen in an environment that a narrative emerges. Environments can also be represented by shapes as well as the characters as mentioned in the previous section. A character within a story-world can create a dissonance or a harmony (Solarski, 2017, p. 16). **See Figure 2-13.**

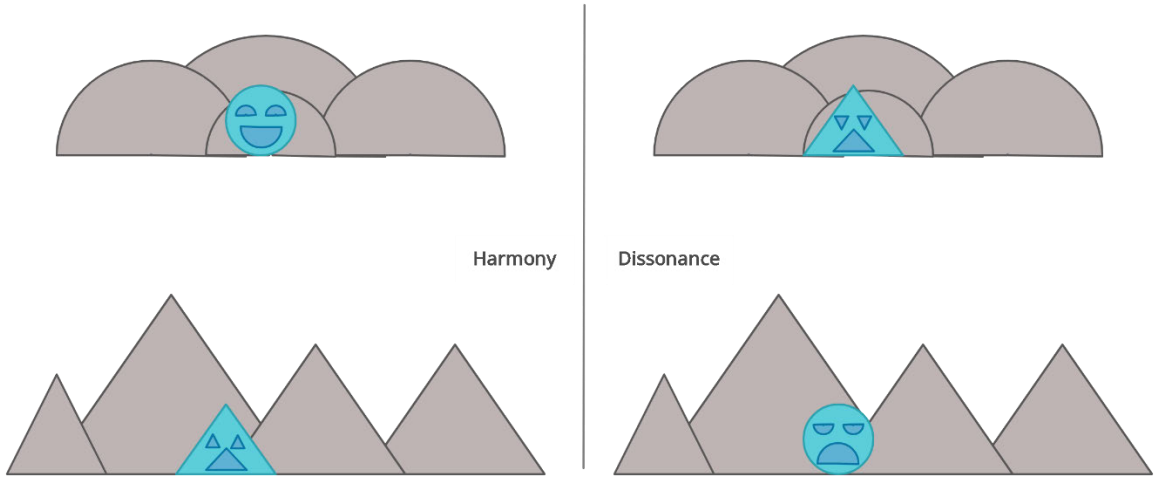


Figure 2-13 Solarski Environment Shapes
(Solarski, 2017, p. 16. Image is original representation, modified for aesthetic purposes.)

As noted in the above illustration, there is a sense of dissonance when the character and story-world shapes are in contrast, and a harmony when they are visually similar. A circular character appears threatened when placed in an angular environment, while a triangular character appears the threat in a rounded environment. Creating this contrast is (circle vs triangle) an essential component of storytelling, as it can spark conflict and action within the narrative, as well as emotional conflict within the audience. In this way, the story-world can be used in conjunction with the character to alter the mood or emotions within the story structure. Especially within VR, if users are able to virtually exist within differently shaped environments throughout the story, it will give them the ability to experience a wide range of emotions and moods that reflect the narrative.

Another key aspect of an engaging story-world is its ability to capture the attention of the user/viewer. As the perception of reality is inherently flawed (Storr, 2019, p.13), the brain is discriminating on what it focuses on. People are attracted not only to change but also to decidedly noticeable details. These details may be items that people find meaningful in some way, and that the meaning plays a dominant role in guiding attention in scenes of stories. In Henderson and Hayes' (2017) study, meaning maps were developed to predict the distribution of attention through image salience and meaning. Participants were asked to rate the meaning of patches of images based on how informative or recognisable it was. Through a combination of this rating and eye tracking, it was found that when the relationship between meaning and salience was controlled, only meaning indicated a variance of attention. Thus, indicating that meaning was a driving force in attention (Henderson and Hayes, 2017). Understanding the meaning behind certain details could then offer an opportunity to create and keep attention in a story-world. In practice, this may be an object that is mentioned or important to the storyline in some fashion. If the item is interactable, upon interaction, it may also add additional story content, such as audio or visual displays. This would not only keep the attention of the user but reward them by revealing more of the story.

By utilising these artist techniques and psychological practices regarding characters and story-world, the *aesthetic value* of a story may be increased. If there is an increase of this value, then there is an increase of narrative engagement with the application. Due to the nature of virtual reality and being able to be present in the virtual world, VR storytelling experiences have the potential to greatly exploit *aesthetic value* as a means of creating engagement.

2.4.4 Final Notes Concerning Interactive Digital Narrative Design

As discussed, there are multiple factors to be considered in the design of engaging stories for interactive digital narratives like VR. To review, story structures such as the hero's journey (Campbell, 1991) and Propp's morphology (1928) were discussed and assessed on their appropriateness for VR storytelling. Additionally, the concepts of change, control, curiosity, and suspense were defined, how these play a role in impacting the story structure, and their use in practical applications. Finally, the psychology of art and aesthetics were discussed, and provisions presented on how to utilise these theories to create engaging characters and story-worlds within virtual reality. These are important to note as they will be revisited throughout this research.

2.5 Assessing and Monitoring Narrative Engagement

The following sections present existing studies conducted on measuring and exploring narrative engagement for a range of media. Firstly, related works ranging from digital games to written works are examined, and the methods used to evaluate or create engagement. Next, specific explorations into narrative engagement for virtual reality are presented. Finally, further VR research conducted on measuring narrative engagement is examined.

2.5.1 Related Works

In the subsequent sections, existing research concerning games, 360 videos, video and audio, and written media are presented. Note that not all studies are specifically relevant to VR, however they are important to acknowledge as they do surround narrative engagement and engagement in general, and on this front may provide valuable insight that could be applied to virtual reality. Performative art is not considered in the related works or in the scope of this research. Performance art is generally created through the actions of the performer or by the participants in the audience, and can be live, scripted, or spontaneous. As the majority of storytelling VR experiences are single player and not live, this is too large for the scope of this research. Additionally, as the context of this research concerns specifically cinematic VR storytelling, the role of the user is more of an observer role with limited interaction, while performance art is centred around the performer/s and influencing the story. Therefore, related works are limited to narrative engagement for individuals experiencing pre created content in the media listed.

2.5.1.1 Digital Games

Concerning digital games, engagement follows a process. According to Schoenau-Fog (2011b), who created the player engagement process (*PEP*) for games, engagement is based on a single aspect: the *continuation desire*. This framework includes the following steps:

- Players can be motivated to start playing either for game-related reasons or for personal reasons.
- When a player starts playing, either the game sets an objective (extrinsic), or the player sets a self-defined objective (intrinsic).
- The objectives trigger activities which the player performs.
- An engaged player can have the desire to continue activities as long as the goal is not achieved in order to experience the achievement of the activity.
- Players can experience affect (positive or negative) as the result of performing an activity.
- If the affect is experienced as positive, player engagement can be sustained, and a new cycle can begin with new objectives.

Even with the creation of this framework, Schoenau-Fog (2011b) acknowledged the difficultly of measuring this engagement in digital games as it is multifaceted. Instead, he suggested that measuring *disengagement* may be a viable alternative. An example of this would be to record when users stop playing

or look away from the game. Additionally, although Schoenau-Fog's *PEP* research primarily focused on general engagement in games, and not specifically narratively, it is important to note, as it can be assumed his engagement process can be adapted and repurposed as a guide for narrative engagement as well (Schoenau-Fog, 2011b).

2.5.1.2 360 Videos

360 videos are videos that can be experienced using a VR headset or phone, where the video surrounds the user but with no interactivity. One study examined the current methods filmmakers employed to tell stories in VR 360 films and assessed whether users were able to follow the narrative. The content was gathered from five professional filmmakers for this research. Using 20 participants, they recorded the user's head orientation while looking at the experience. During and after the experiment, participants were asked to answer general and video-related questions, which were then compared with the director's editing (which contained the intended cues and outlines for the story). The methods investigated in this study contained directional cues to draw the attention of their users: sound, environment, and movement / action (Fearghail *et al.*, 2018).

The results indicate that visual discomfort and disorientation of the viewer reduce the immersive quality of the film and cause difficulties gaining a full understanding of the narrative (Fearghail *et al.*, 2018). Furthermore, it was found using traditional cinematographic directions seemed to work well to attract users' attention, but that they needed to be better adapted to a spatial environment (Fearghail *et al.*, 2018).

Regarding how the data was collected, Schoenau-Fog (2011a) mentioned in his research, that the interruption of the experience to ask questions can likely break the engagement in the narrative. Therefore, questions during the experience may not be the best course of action. However, the method used of recording head orientation may be a viable option for recording unobtrusive data.

Similarly, Nielsen *et al.* (2016) examined two methods in another 360-narrative video: one in which the virtual body was in the region of interest, and the other in which the viewer's attention was drawn to the region of interest by a firefly. The research found viewers preferred the firefly method of directing attention, and that forcing the viewer's attention by orienting the virtual body increased visual discomfort. (Nielsen *et al.* 2016) This method of a diegetic direction, then, would seem a workable option for directing the user to certain important plot points and avoid user discomfort, as mentioned by Fearghail *et al.* (2018).

Regarding presence, narrative engagement, and empathy, Bindman *et al.* (2018) compared the use of high-immersion technology (VR) to low-immersion (smartphone) for narrative engagement when viewing a 360 animated video. Participants were randomly assigned to high or low immersion conditions and completed a compassion scale before the study. Participants viewed the film with headphones and either an Oculus Rift or Samsung Galaxy 6, depending on the condition assigned. Before the screening, the viewer was not given additional information about their role in the film. In the 2D version (mobile phone), a rabbit assists the viewer, and it is implied that the viewer is also a rabbit. In the 3D version (headset), the viewer had the ability to look down at their 'body' and see their bunny body. The interaction was through implication via other rabbits' behaviour and responses, there was no actual viewer interaction within the film (Bindman *et al.*, 2018). After completion of the film, participants completed the Presence Questionnaire (Slater, Usoh, and Steed, 1994) and *Narrative Engagement Scale* (Busselle and Bilandzic, 2009) as well as an interview on their perception of the role in the narrative.

Concerning presence, users reported significantly higher presence in VR compared to the smart phone. Furthermore, VR participants who perceived themselves as a character in the story reported more empathy than those who believed they were observers. Interestingly, the perception of role did not have a significant impact of perceived presence but did have an expected impact on narrative engagement. "This finding implies that one's feeling of presence in a virtual environment (where you are) is independent of one's role (who you are)."

To clarify, since the 3D version allowed the user to view their rabbit body, this provided the user with a sense of embodiment. Due to this embodiment, they were able to perceive themselves as the character thus reporting more empathy than those who felt that they were observers. This indicates that having a sense of embodiment not only increased empathy, but narrative engagement as well. Although the exact same film was used for both the 2D and the 3D versions the simple ability to be able to see their body, was able to change the user's understanding of their role in the environment.

Bindman indicated practical considerations for increasing the perception of role: the strong use of narrative techniques to get viewers understand their role and feel a part of the story; that creators should further consider using visual and aural clues; and that people should understand their role in an immersive story (Bindman *et al.*, 2018).

2.5.1.3 Video and Audio

Diving into the comparisons of media and its effect on narrative engagement, one study investigated to what extent the medium of a story influences the conscious and unconscious engagement with the narrative. Sensors were placed on participants' wrists to measure physiological responses to the content, as well as having the participants use self-report measures regarding their involvement in the material. Participants then were given either videos to watch, or auditory stories to listen to (Richardson *et al.*, 2018).

Participants reported a greater involvement in watching videos compared to listening to auditory scenes, but stronger physiological reactions were recorded for auditory stories. They demonstrated higher and more variable heart rates, greater electrodermal activity, and higher body temperatures when presented with auditory content.

They concluded that the physiological evidence suggested stories in an auditory format were more cognitively and emotionally engaging. They also postulated that this may be because listening is a more active process of co-creation.

In their study, the use of auditory narration had a higher level of engagement than that of a video. In this respect, one could assume that adding auditory narration to scenes in a digital environment contributes to integrating the user into the narrative but should not be used as a sole source of engagement (Richardson *et al.*, 2018).

2.5.1.4 Written

Based on the theory of Structural Affect developed by Brewer and Lichtenstein (1982), Hoeken and Sinkeldam (2014) carried out a study on the effects of curiosity, suspense and surprise on narrative engagement. The theory of Structural Affect states that different affective reactions can be generated by manipulating the order in which a story's events are narrated (i.e., flash forwards / backwards). Four hypotheses were presented: If the story's outcome is unknown, it will be more appreciated when it is known (H1); when the story's outcome is unknown, certain passages will receive more attention (H2); If the story contains a surprise, it will be more appreciated (H3); and If the story contains a surprise, the previous events will be remembered better (H4). Using a story from a professional author, participants were randomly assigned one of four versions of the story. The story was presented a sentence at a time on a computer screen and the sentences could not be reviewed or reread. The researchers used various methods to assess their research. They used a manipulation of the Likert scale to find feelings of suspense and surprise, and with another Likert scale, tested for appreciation of the story to determine the importance of knowing the outcome. Additionally, by using a pretest, they measured participants' attention to different paragraphs and utilised twenty comprehension questions to measure the memory of the events before the surprising event. Regarding the first hypothesis (H1), the knowledge of the results seemed to have little or

no impact on appreciation but found that curiosity and suspense are both effective tools for engagement. The second hypothesis (H2) was inconclusive, and the third hypothesis (H3) found surprises were indeed appreciated by the audience. In addition, hypothesis four (H4) suggested that surprises are likely to increase understanding and comprehension of the story through the recall of events (Hoeken and Sinkeldam, 2014).

This study was based on a written story. However, the concepts of suspense, surprise and curiosity can be applied to digital technologies and, by extension, to VR, as a viable means to engage the user in the story (Hoeken and Sinkeldam, 2014).

2.5.2 Final Notes Concerning Related Works

These narrative studies provide potential guides for measuring narrative engagement through head tracking, and self-report measures such as the *presence* questionnaire (Slater, Usoh and Steed, 1994) and *Narrative Engagement Scale* (Busselle and Bilandzic, 2009). They also help identify important key factors of engagement such as the previously mentioned concept of curiosity, as well as suspense and surprise, audio, and diegetic direction.

2.5.3 Narrative Engagement and VR

Some current explorations for narrative engagement in VR include the use of *flow*, tension, emotion, and interactivity. This section introduces these concepts along with research that examined their practical application for impacting narrative engagement.

A unique feature of stories in digital applications is the potential for *flow*. This is the ease with which users arrive at a pleasant, optimal performance. There are eight factors for optimal flow (Csikszentmihalyi, 1997):

- A challenge activity requiring skill.
- A merging of acting and awareness.
- Clear goals
- Direct immediate feedback
- Concentration on the task at hand
- A sense of control
- A loss of self-consciousness
- An altered sense of time

This can be visualised as a channel between the anxiety and boredom of the user. See **Figure 2-14**.

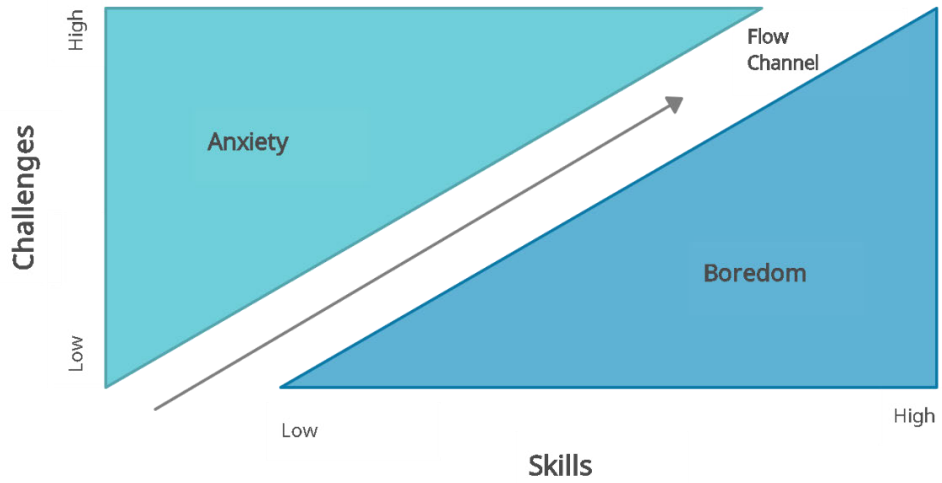


Figure 2-14 Flow Factor Scale
(Csikszentmihalyi, 1997. Image is original representation, modified for aesthetic purposes.)

If the user is given too little ability in a potential flow factor, such as a challenge that requires skill, it can lead to frustration. Likewise, if the challenge is too simple, it can lead to apathy and thus, disengagement (Isbister, 2018, p. 5). This concept can more easily be seen in gameplay, and although some of the factors, such as an “altered sense of time” may be easier to achieve in VR, flow may not be a suitable concept for storytelling in VR as it focuses so heavily on gameplay. It is important to acknowledge in general however, as a guideline to avoid both anxiety and boredom within the experience.

In addition to *flow*, tension may serve as an important tool in engaging users in digital stories. One such tool is employing a "ticking clock". This can mean that the protagonist is given a specific or a limited amount of time to complete an objective, or there will be consequences. This is easily noticeable in popular fairy tales, such as Cinderella, which must be at home before midnight (Miller, 2020, pp. 104-105). Moreover, increasing tension in can assist in building a foundation for emotional connection or *transportation* (Sak, 2018).

As mentioned earlier in **Section 2.2.3**, emotion can play a key role in interactive applications such as VR, by creating emotional possibilities. A method of evoking emotion can be made through *NPC*s (non-player character). One study illustrated the use of an *NPC* with four different postures and verbal cues. These were: consistent dominant postures and cues; consistent submissive postures and cues; dominant posture with submissive cues; or submissive posture with dominant cues. The participants then made choices based on what postures and cues they were presented with, in order to evaluate how they could be influenced by the *NPC*'s emotional state. It was concluded that those who interacted with mixed signals were less influenced by the *NPC* (Isbister, 2006, pp. 23-40, Isbister, 1998). This gives NPCs in digital stories a significant role in evoking emotions. Users can not only use their avatars to experience the game but also interact emotionally with *NPC*s.

Additionally, motion and movement can affect emotion. This applies to both the user, and the other characters in the story, and both will influence that emotion. Using VR, the user has the ability to use their entire body in the experience in which they are immersed. Consider the following example of *Deep*.

On the Oculus Rift, developer Owen Harris created the experience *Deep*. A VR headset with custom belt like controllers measured the diaphragm as it expands and contracts. This initially was built to assist persons with anxiety issues in a game-based setting. In an interview with Christos Reid, a mental health spokesperson who participated in the experience, recalled that the experience was particularly moving. "I was trying to watch the game, but I had tears at the bottom of the Oculus headset because it calmed me down more than anything ever has in my entire life" (Donnelly, 2015).

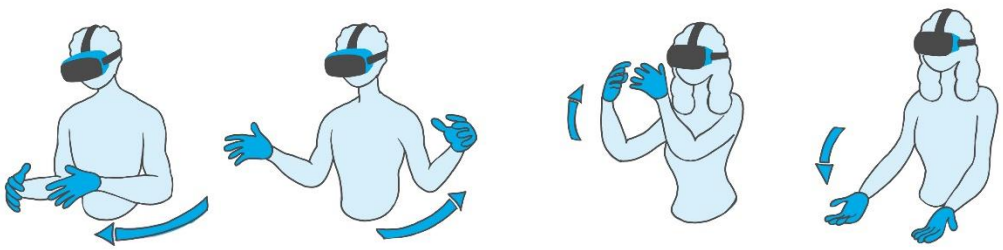


Figure 2-15 Physical movements of “Deep” during diaphragm beathing exercises.
Left: use of horizontal hand movement to sync breath. Right: use of vertical hand movements to sync breath.
(*Deep* diagram from the application. Image is original representation, modified for aesthetic purposes.)

It can be surmised then that the ability to use the entire body in digital technology experiences, particularly in VR, allows designers to access different emotions that may be inaccessible during controller-based ones (Isbister, 2018, pp. 81).

With regards to interactivity, there are many different avenues that can be employed in a digital story. One such avenue is *stimulus and response*. This may be implemented with something such as an auditory cue, or a highlighted item (*stimulus*), causing the user to react and engage (*response*). *Navigation and control* give the user the ability to move freely around and gives the user control over objects. Finally, there is *communication*, as in the ability to communicate with others in the scene. Although this is often used verbally, it is not exclusive. Using these elements allows the user to explore the virtual environment and participate in the narrative (Miller, 2020, pp. 82-83).

2.5.4 Further Narrative Engagement Studies Specific to VR

As mentioned in **Section 2.5.1**, Schoenau-Fog (2011b) asserts that a fundamental requirement of "any interactive experience is the desire to continue the experience". Utilising his *PEP* framework, a study was conducted to investigate engagement in interactive narratives by focusing on the *continuation desire*. His findings suggested engaged users were motivated to begin the experience and continue it. In the end, he concluded that the desire for continuation could be a prerequisite for experiencing the other factors of engagement, such as presence and *flow*, since the user first had to have the desire to begin and continue the experience, making it an essential step in narrative engagement (Schoenau-Fog, 2011b).

This revelation was discovered by administering his Engagement Sample Questionnaire (ESQ). This used 7-point Likert scale and open-ended questions concerning the objective of continuation. The questionnaire assessed the following categories:

- Objectives, (extrinsic objectives or intrinsic objectives)
- Activities (interfacing, socialising, solving, sensing, experiencing the story and characters, exploring, experimenting, creating, or destroying)
- Accomplishment (by advancement, achievement, or completion)
- Affect (positive: enjoyment and pleasure; negative: frustration and boredom; and absorption: flow and immersion) (Schoenau-Fog, 2011b)

In this research, the use of the *ESQ* proved to be an effective measurement tool because of its ability to gauge engagement even when the user was presented with non-pleasurable content in VR.

Another virtual reality study investigated sound. Bhide, Goins and Giegel (2019) used the concept of spatial sound and audio cues to enhance immersion and presence in the virtual world. Their research highlighted the usefulness of spatial sound, analysed, and established the potential of spatial sound as a powerful storytelling tool in a virtual game environment designed for virtual reality. They proposed that, in a well-designed environment, appropriate visual and audio cues may be embedded in the game space to evoke emotional response, construct the underlying narrative, and contribute to presence and immersion while still preserving game interactivity. For this study, a VR game called “charlotte” was adapted by removing all game object interactions and by enriching the soundscape exclusively. Three sound cue categories were used: a door sound (open/close); in place triggers intended to evoke fear when the user overlaps, and far placed triggers intended to influence the players’ direction. Three tests were conducted: mixed audio, ambient sound, and spatial sound. All participants were given a post-experiment questionnaire measuring engagement, engrossment, participation, and immersion (Bhide, Goins and Giegel, 2019).

All the participants are equally engaged with the environment irrespective of the sound condition. Consistently, no significant differences between mixed audio and spatial audio tests were recorded. However, significant differences between spatial and ambient tests, and mixed and ambient tests in all categories, were noticeable. Therefore, it is concluded that using either spatial or mixed audio would provide a more immersive and engaging experience in VR (Bhide, Goins and Giegel, 2019).

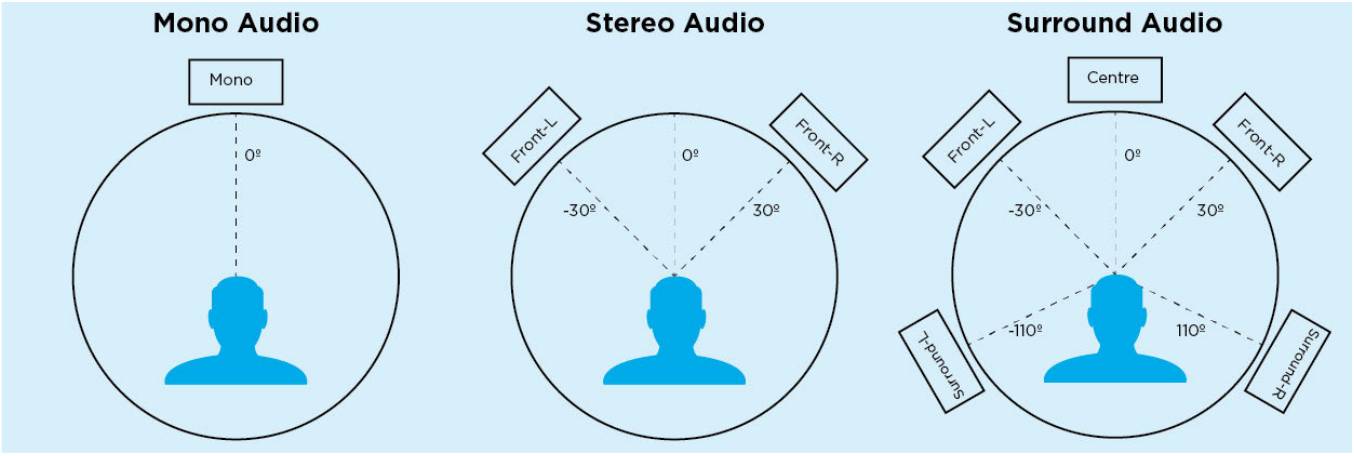


Figure 2-16 Audio directional differences between Mono, Stereo, and Surround sound.
(Venema, 2021. Image is original representation, modified for aesthetic purposes.)

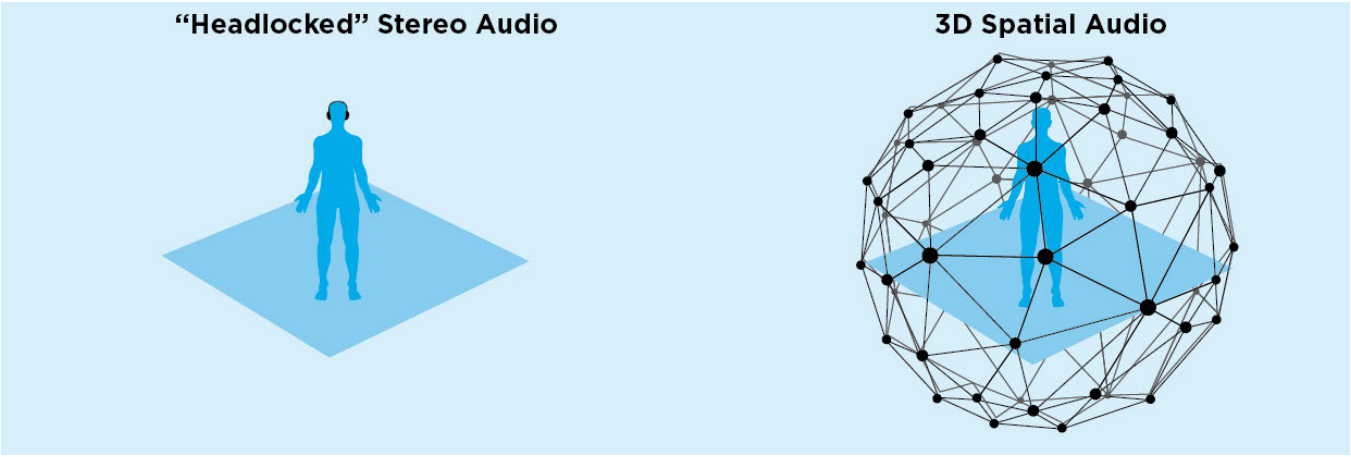


Figure 2-17 Sound variations in VR. Use of stereo sound vs 3D spatial sound.
(Venema, 2021. Image is original representation, modified for aesthetic purposes.)

Another possibility of measuring engagement in VR is through capturing emotions and immersion. This study examined the methods of capturing emotions during an interactive story and the concept of *diegesis*. *Diegesis* defines the boundary between the story world and the real world. This was conducted through a comparison of emotion capture in a diegetic versus non-diegetic space and how this can affect its accuracy. A study was performed based on these two methods using self-reporting methods in the form of choices the player would make throughout the interactive experience. The results showed that the diegetic (*DEC*) approach led to a better story experience, but non-diegetic (*NDEC*) led to the players' emotion being captured more accurately. They attributed this to the fact that, while the *NDEC* method explicitly asks for player emotion via simple emotion words, the *DEC* method blurs the story world and the real world in terms of player emotions (Brown *et al.*, 2020). See **Figure 2-18**.

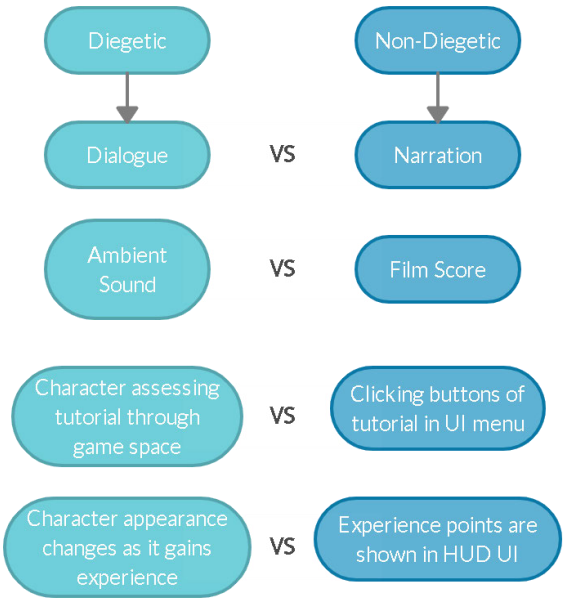


Figure 2-18 Examples of Diegetic Non-Diegetic factors
(Brown *et al.*, 2020. Image is original representation, modified for aesthetic purposes.)

In terms of virtual reality, it would appear that a diegetic approach would not only be better suited for the media, but also would lead to a better story experience.

2.6 Conclusion

Through this literature review, we provided a brief history of *IDN*s and defined seminal concepts of storytelling and interactive digital narratives. Additionally, we reflected on the multi-faceted concepts of narrative engagement, namely, the *continuation desire, transportation, identification, presence, flow* and *enjoyment*; as well as Busselle and Bilandzic's (2009) model for narrative engagement: *Narrative understanding; Attention Focus; Narrative presence; Emotional engagement.* Furthermore, we introduced engaging elements were introduced as potential influencers of engagement in stories. These were the ideas of *change, control, curiosity, suspense, and aesthetic value.* Finally, we critically reviewed engagement studies and established potential measurement tools including head and eye tracking and self-report measures such as the *Presence Questionnaire* and *Narrative Engagement Scale* (Busselle and Bilandzic, 2009). We also discussed the potential use of sound, diegetic direction, flow, and tension and their importance to impacting engagement.

Moving forward, conclusions from our review offer a range of potential implementations for creating and sustaining narrative engagement in VR, as well as providing pointers on how to evaluate narrative engagement. For the purposes of this research, concepts and elements from these literary findings have been chosen for discussion in the following section based on their potential to offer reliable measures and observations. See **Figure 2-19**.

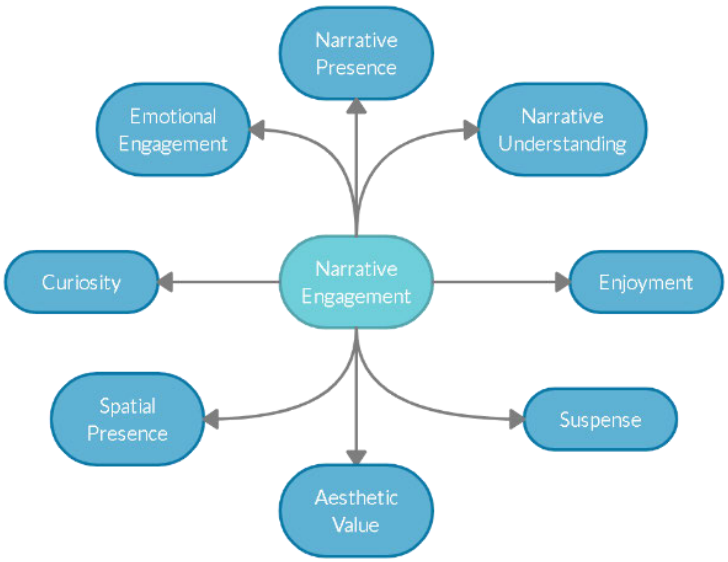


Figure 2-19 Summarised Narrative Engagement Concepts
(Original image created by Austin Wolfe)

To clarify, these constructs relate to narrative engagement for VR storytelling experiences that have a cinematic quality with predetermined stories. Although there may be some existing works that qualify under this definition (*The Crow, Wolves in the Walls, Song of the Sea*), they may not include all of these elements of narrative engagement. Therefore, these concepts are the basis on which the VRNEF is created. Using these elements, measurement tools and practical guidelines are designed and discussed in further detail in **Section 5**.

3 Methodology

3.1 Introduction

As highlighted in the literature review (**Section 2**), this research is focused on exploring the opportunities presented by storytelling and narrative engagement in interactive cinematic virtual reality experiences. The exploration of these opportunities involves identifying concepts of narrative engagement and storytelling elements in the context of VR applications.

To review, the context of the research is:
Investigating the opportunities and boundaries of storytelling in VR towards the aim of developing a framework for creating and monitoring engagement in interactive cinematic VR experiences. In addition, three sub questions are considered:

- What is storytelling in a cinematic virtual experience?
- What is narrative engagement in a virtual experience?
- How can narrative engagement be measured in a virtual experience?

In order to answer these questions, the study completes the following expanded objectives:

- Review current literature in storytelling and narrative engagement in virtual and traditional environments to identify concepts and elements that contribute to narrative engagement. (O1, O2)
- Design and prototype a virtual experience based on the information elements and concepts identified by the literature review. (O3)
- Evaluate the experience via the use of standardised self-reporting measures and observational data. This is accomplished by employing a mixed method approach, as the data gathered will be both quantitative and qualitative in nature. (O2)
- Create a new two-part narrative engagement framework. The first part (O4) is a measurement scale that is then tested for reliability and validity. The second part, (O5) encompasses the creation of the engagement scale guidelines that will work in tandem with the measurement scale.
- Apply principles towards the design of a new VR experience based on the guidelines created (O5) and their evaluations (O6)

In this section, an explanation on why this approach was selected and where the research is situated within the research context is provided. Additionally, the project phases are discussed, and reliability and validity practices are introduced.

3.2 Selecting a Methodology

The literature review from the previous section highlighted several elements in the exploration of narrative engagement. To recapitulate, these were the *continuation desire* (Schoenau-Fog, 2011a), *transportation* (Green, Brock and Kaufman 2004)*, identification* (Cohen, 2001)*, presence* (Biocca, 2014)*, flow* (Csikssentmihalyi, 1997), *and enjoyment* (Sweetser and Wyeth, 2005); as well as Busselle and Bilandzic's (2009) model for narrative engagement: *Narrative understanding; Attention Focus; Narrative presence; Emotional engagement.* Additionally, the ideas of *change* (Storr, 2019, p. 11), *control* (Storr, 2019, p. 12)*, curiosity* (Loewenstein 1994, To *et al.* 2016)*, characters* (McCrae, Gaines and Wellington, 2012; Isbister, 2006, pp. 23-40)*, suspense* (Hoeken and Sinkeldam, 2014)*, ignition point* (Storr, 2019, p. 108)*,* and *story-world* (Henderson and Hayes, 2017).

As shown in **Figure 2-19** in the previous section, the following factors were prioritised for this study.

Table 3-1 Prioritised Concepts and Elements

Narrative Engagement Concepts	Engaging Storytelling Elements
Narrative understanding	*Aesthetic value*
Narrative presence	• *Story-world*
Spatial presence	• *Characters*
Emotional engagement	• *Emotion*
Enjoyment	*Suspense*
	Curiosity

These are the concepts and elements that will be created in the virtual reality experiences (O3, O5) and evaluated through this methodology. These are evaluated through questionnaires and observations, using a mixed method approach on the stance of positivism on the objectivist epistemological view.

3.2.1 Positioning of the Research

Objectivism is the view that "things exist as meaningful entities independently of consciousness and experience, that they have truth and meaning residing in them as objects" (Crotty, 1998, p. 14-26). This research is positioned on this paradigm as it is assumed that the reality of this study is a concrete structure and that it is waiting to be discovered and understood. This is beneficial, as objectivist research can provide the reliability of consistent results and external validity to apply the results to other contexts. Objective epistemology informs the stance of positivism, which adheres to the view that the research findings of a study are observable and quantifiable. To clarify, this epistemology and theoretical perspective means that the researcher will objectively gather and uncover the facts that exist in the data. (Crotty, 1998, p. 14-26) In contrast, constructionist research posits that there is no objective truth, and that meaning is not discovered but rather constructed through subjective interpretation. This would be ill suited for this study as it would not be quantifiable and would not allow for the results to be applied to other contexts (Crotty, 1998, p. 14-26).

This position of the research is regarding the creation of the framework to create and monitor narrative engagement for virtual reality (VRNEF). To clarify, in **Section 2.6**, this research objectively defines the constructs that make up narrative engagement, as well as the elements that make up those constructs (objectivism). In doing so, these elements and constructs become observable and quantifiable (positivism).

In addition to being able to gather quantifiable data, some qualitative data will also need to be gathered, as it will strengthen the final results. For this reason, the methodology chosen for this research is the mixed methods approach.

3.2.2 Mixed Methods

The mixed methods approach involves the collection of both qualitative (open-ended) and quantitative (closed-ended) data in response to research questions. The methods involved in this practice can include data collection, data analysis, and interpretation of that data (Creswell, 2018, p.14-17).

As the data sought in the research is both qualitative and quantitative, mixed methods is an appropriate choice because of its strength of drawing on both qualitative and quantitative research and minimising the limitations of both approaches. It is also a useful strategy in order to have a more complete understanding of the research questions by comparing different perspectives drawn from quantitative and qualitative data and explaining quantitative results with a qualitative follow-up data collection and analysis.

For this study, the use of the convergent mixed methods design is employed. This is a single-phase approach, where both the qualitative and quantitative data are collected separately, analysed, and then

compared. This is the most appropriate approach, as it allows for the collection of the data roughly at the same time (Creswell, 2018, p.14-17). **See Figure 3-1**.

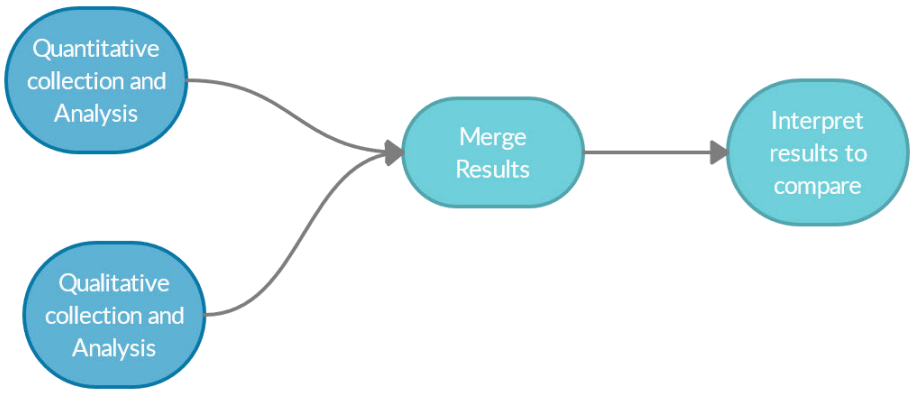


Figure 3-1 Convergent Mixed
(Original image created by Austin Wolfe)

The qualitative data will be gathered through observation, and the quantitative will be gathered through self-reporting measures. There are various advantages to observational data, especially for virtual reality. Foremost, the researcher can record information as it occurs, which increases accuracy. Another advantage is unusual or unexpected aspects may be noticed during observations which may not have been recorded otherwise. Likewise, self-reporting measures are of equal importance as the data gathered can be quantified, thus allowing it to be applied in other contexts. Using self-reporting measures is considered standard in many VR studies.

Limitations of this methodology can include the need for extensive data collection, the time-intensive nature of analysing both qualitative and quantitative data, and the requirement for the researcher to be familiar with both quantitative and qualitative forms of research (Creswell, 2018, p.14-17). This also extends to the necessity of learning or being knowledgeable about specific data gathering and analyses programs, such as SPSS AMOS, STATA, and MAXQDA. Moreover, the use of self-reporting measures and observational data gather also have limitations, and these are discussed in further detail in **Section 4.**

3.3 Project Phases

This research is divided into three main phases. In the following sections, each phase is discussed in terms of the content produced, the studies that will be carried out, and the way in which they are evaluated.

3.3.1 *Phase One*

Phase One begins the creation of a cinematic virtual reality experience. This experience is created based on the findings in **Section 2** regarding storytelling elements, concepts, and criteria for creating engaging stories. After the VR experience is built, a study is conducted on the experience. The study is evaluated with the standardised questionnaires on narrative engagement and VR applications explored in **Section 2**. In addition, observational data is collected during the study and coded for analysis. Lastly, the data reported is assessed and analysed.

3.3.2 *Phase Two*

Phase Two will then begin the creation of the VRNEF (Virtual Reality Narrative Engagement Framework). This framework encompasses both a measurement scale, and guidelines for implementing narrative engagement. The development of the measurement scale is dependent upon the analysis conducted on

the standardised questionnaires used in *Phase One*. Likewise, the guidelines are dependent upon the concepts and elements of narrative engagement identified in **Section 2** and how they can be implemented. The constructs for the VRNEF are created from each of these concepts defined for narrative engagement.

Firstly, the measurement scale is constructed. Upon the completion of the scale, a study is conducted using the VR experience created in *Phase One* and the new VRNEF. This study is to test the reliability and validity of the scale (discussed in **Section 3.4**). Depending on the results of the testing, the scale is then modified and adjusted. Finally, the guidelines of the framework are created. These guidelines will directly correlate with the scale and will provide solutions to constructs that fail, or negatively impact the overall narrative engagement.

3.3.3 *Phase Three*

The final and third phase is ultimately a combination of the first two. With the initial VRNEF completed, a new VR experience is developed based on the analysis of the pilot and the VRNEF guidelines. This experience will then be tested with the final VRNEF.

The final study is then evaluated with both the VRNEF and observational data. Additionally, a second reliability and validity test is conducted, which is then followed by the quantitative and qualitative data recorded being assessed and analysed. See **Figure 3-2.**

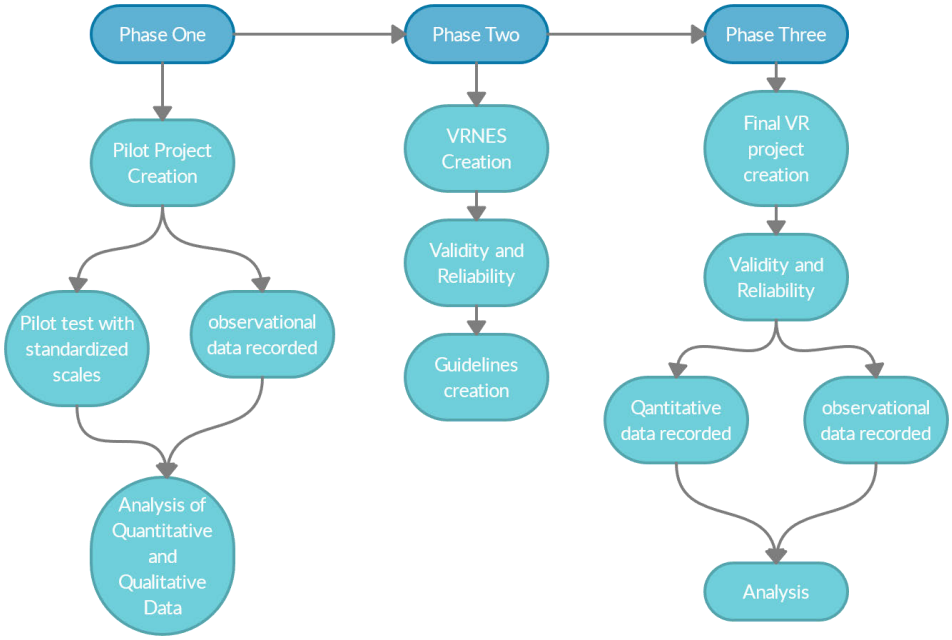


Figure 3-2 Project Phases
(Original image created by Austin Wolfe)

3.3.4 Ethical Methods

Regarding the phases of the project, some ethical considerations were taken into account. This was in part due to the necessity of the first study being conducted within a participant's homes while being observed by the researcher, and due to the additional protocols in place for Covid-19 at the time of the second and third studies. Initial ethical approval was given in 2021 regarding the first study in *Phase One*. As the experiment was carried out in participants homes without the researcher physically present, it was given a medium risk score with a low likelihood. The mitigation of which, was to screen participants using inclusion and exclusion criteria, i.e., participants needed to be physically able to participate, have an appropriate physical space to move in (free of obstacles) and have normal or corrected vision and hearing. In addition to this they were given health and safety details for using the VR equipment as well as what

was to be expected or not expected for the individual application. They were also advised on what to do in case of any adverse effect. This was provided both in document form and verbally relayed to each participant before conduction of the study. These documents can be viewed in **Appendices: A** and **B**. Although observation data was collected, no video or audio recordings were made of the participants to protect individual privacy and anonymity. This data was only recorded by hand. Further ethical approval was given in 2022 for the remaining two studies. These had the same mitigations requested as before, with an additional risk assessment for in-person studies due to Covid-19 risks. As the participants would be sharing equipment, only double vaccinated participants were allowed within the study environments. Moreover, additional time between participants was implemented, with a minimum of one hour in between to allow for thorough sanitation of all equipment before use. Ethical approval was provided in compliance with the GSA Research Ethics Policy and Code of Practice.

The participants recruited for these studies were over the age of 18 and able to give consent for participation, with the right to withdraw that consent at any time. Potential users were recruited through calls to participation though the Glasgow School of Art, the University of Glasgow, and events where work was showcased, such as ICIDS (International Conference of Interactive Digital Storytelling) 2021, SGSAH (Scottish Graduate School for Arts and Humanities) Research Showcase 2022 and the Glasgow Game Talks 2022.

All participant identities were anonymised on the questionnaires to avoid bias and prioritise confidentiality. Participants were required to have normal or corrected vision for the experience and were asked before beginning whether or not they were prone to motion sickness. They were then advised about the potential of VR programs causing motion sickness and asked to give verbal acknowledgement of this information before continuing. Participants did not receive any payment or credit for their collaboration and were all volunteers.

3.4 Reliability and Validity

As part of the VRNEF requires the creation of a questionnaire to measure the multi-faceted concept of narrative engagement, it is important to test the questionnaire for both reliability and validity. This ensures that the scale is measuring what it intends to measure, and it is doing so consistently. To illustrate, you can visualise this as shooting at a target, and consistently hitting the bullseye. See **Figure 3-3.**

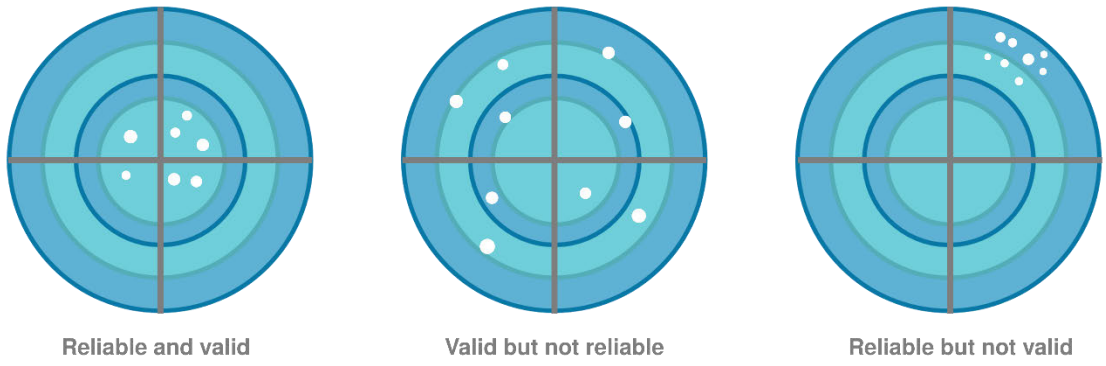


Figure 3-3 Comparison of reliability and validity
(Original image created by Austin Wolfe)

As noted in **Figure 3-2**, the second and third phase includes the conduction of a study to measure these concepts. The following sections will define reliability and validity in the context of this project as well as the methods used for each concept.

3.4.1 Reliability

Reliability refers to the consistency in the results of the measurements and its ability to measure consistently. A scale must be reliable in order for it to also be valid (Brinkman, 2009). To test the reliability of the VRNEF scale portion of the narrative engagement framework, the method chosen to be employed is the use of Cronbach's α. This α, created by Lee Cronbach in 1951, (Cronbach, 1951) is used to measure the internal consistency of a scale, with the measurement expressed as any number between 0 and 1. The internal consistency is the extent to which all the items of the scale measure the same concept or construct, as well as providing the amount of measurement error. The equation for the Cronbach's α can be represented as:

$$\alpha_{st} = \frac{N \cdot \bar{r}}{1 + (N - 1) \cdot \bar{r}}$$

In the equation, N represents the number of items, and r is the average correlation between those items. Criteria for good reliability using Cronbach's α, is at least 0.5 (regarded as satisfactory) or 0.7 or above (regarded as good) (Hinton, McMurray, and Brownlow, 2004).

Limitations of the Cronbach's α can lead to untrustworthy results if used improperly. The value of the α can be affected by the length of the scale; if the scale is too short, the α is reduced. Likewise, to increase the α, more items testing the same concept can be added. In addition, the α can be used to confirm whether a sample of items is unidimensional (Tavakol and Dennick, 2011). As this scale is multi-dimensional with multiple concepts/constructs, reporting an α on the entire scale may inflate the value of the α. Therefore, the α will be calculated per concept/construct rather than for the entire scale to ensure its proper use. It is important to note that the α alone will not determine full reliability of the scale and must be used in conjunction the analyses discussed in the following section regarding validity.

3.4.2 Validity

There are several types of validity regarding validating a scale. For the purposes of this research, the concept of *construct* validity will be tested. *Construct* validity can be used to determine how well the scale measures what it is theoretically intending to measure. The method chosen to evaluate the construct validity is through factor analysis. There are two types of factor analysis, exploratory and confirmatory.

The exploratory factor analysis (EFA) may be used to explore patterns in the data set. It helps the researcher to identify items that may not empirically belong or do belong in the intended construct. In short, it helps to determine the construct structure. However, since the constructs have already been structured with their items assigned to them, (based on research provided from **Section 2**) the EFA may prove redundant. Therefore, for this scale, the confirmatory factor analysis will be employed. The confirmatory factor analysis (CFA) is used to confirm the stated theoretical model of the scale created. To clarify, it tests if the data collected supports the hypothesised model. Since the theoretical constructs of the scale are well understood and supported through other research in a similar context, this is the most appropriate course of action. Through this, the researcher can then specify the relationship between the item and the construct and use CFA to confirm the hypothesised number of constructs, the relationship between the constructs, and the relationship between the constructs and the items. See **Figure 3-4** for an example of a CFA that shows the relationship between the constructs of narrative engagement.

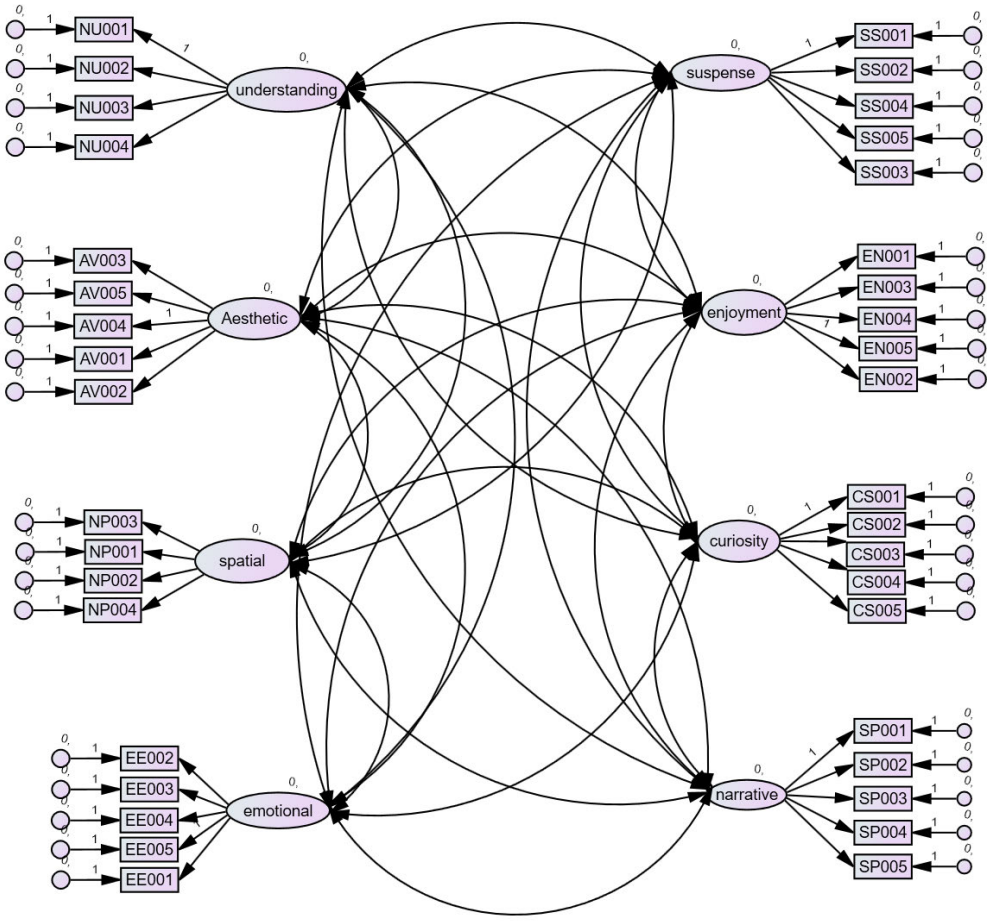


Figure 3-4 Diagram for CFA
(Original image created by Austin Wolfe)

An estimator is needed to perform the CFA. The estimator is a statistical method for extracting the variance from the data. Since this scale is on a 5-point Likert scale, the maximum-likelihood estimation with robust standard errors (MLR) is chosen as the estimator. The MLR works best on scales that have 5 or more response options. Once chosen, the CFA is performed using SPSS AMOS and STATA.

It is important to note that when conducting a CFA, larger sample sizes are typically better, as they increase statistical power and improve accuracy, usually around 100-200 participants. Ideally, the number of participants used should be a ratio of 2 to 3 participants per item in each construct (Gagne and Hancock, 2006). This would mean that at a minimum, the initial VRNEF should have a participant count of 76 as it had 38 items. Likewise, the final VRNEF should have a participant count of 96 as it had 48 items. However, due to the current pandemic climate and time constraints, this sample size was difficult to attain. For the first validity study of the VRNEF, 32 participants were used. For the final validity study 62 participants were used.

3.5 Summary of Methodology

In conclusion, this study is adopting a positivist stance on the objectivist epistemological view, as it will objectively gather facts and provide reliable data. It will accomplish this by implementing a convergent mixed methods approach, gathering data that is both qualitative and quantitative in nature. The qualitative data will be in the form of observation during the study, and the quantitative will be in the form of a post questionnaire. Both will be analysed separately and then combined. This process will be discussed in greater detail in **Section 5**.

Moreover, the study will conduct a validity and reliability test of the VRNEF. This will be accomplished by the calculation of Cronbach's α, and a confirmatory factor analysis (CFA). The Cronbach's α and CFA will both contribute to reliability, and the CFA will provide construct validity by using a maximum-likelihood estimator.

4 Phase One: Pilot

In the following sections, the creation of the pilot virtual reality experience is discussed. This experience is used in the conduction of two studies. The first study is conducted using standardised reporting methods identified from **Section 2**. The second study is examined using the created VRNEF from **Section 5**. This section covers the first study, its data collection, results, and analysis. The second study is discussed in further detail in **Section 5** as it is dependent upon the results of the first.

The importance of the pilot study is to create a base line VR experience, one that is not created with the VRNEF guidelines, and is evaluated based on standardised measurement scales identified in **Section 2**. This is to assess which questionnaires are relevant to or can be adapted to fit the media of cinematic VR in relation to effectively measuring narrative engagement. Additionally, the outcome of the assessments will help to identify which concepts and elements of narrative engagement are of greater importance.

4.1 Project Creation for Pilot Study

The VR experience created for this study was made based on the recommendations and findings in the literature review from **Section 2**. This comprised three main stages: the *Script*, the *Assets,* and *Interactivity and immersion*.

The *Script*:

As mentioned in **Section 2.3.3**, Koenitz (2018, pp. 107-120) stated that traditional western story tropes might be ill-suited to virtual reality, due to the inevitability that the model of the story line would break because of the technological nature of VR. With this in mind, a more general outline was chosen for the script. Using a modified version of Blake Snyder's (2005) Beat Sheet as a guide, an initial script was sketched out (see **Appendix: C** for full storyline) and was loosely based on an accumulation of varied Scottish folklore books for content (See **Appendix: J** for resources). This beat sheet was chosen as it is less restrictive than the western story tropes and allows for more variance without breaking the rules of the story's structure. See **Figure 4-1**.

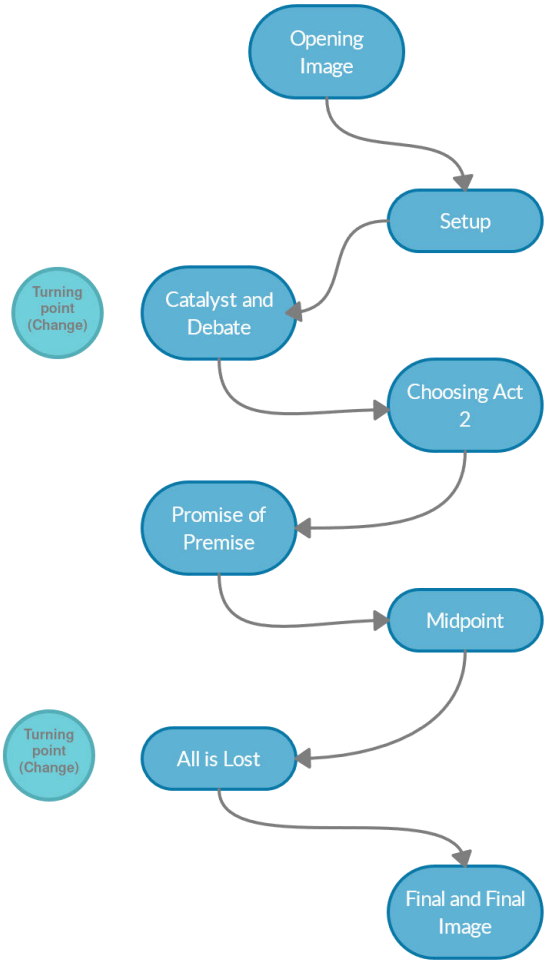


Figure 4-1 Modified Beat Sheet from Blake Snyder
(Snyder, 2005. Image is original representation, modified for aesthetic purposes.)

This script created a starting point, allowing for the concepts from the literature review to be implemented. As previously discussed in **Section 2.3.2.1**, where the concept of *change* (Storr, 2019, p. 11-12) was introduced. *Change* therefore was woven into the script early on to assist with engaging the user from the beginning during the *catalyst and debate,* as illustrated in **Figure 4-1**. It was again employed towards the end, in *all is lost*, as a final turning point. As Richardson *et al*. (2018) postulated that listening was an active process in co-creation, the script was written to be narrated, filling in details that were not present in the world, as well as leaving out details that were.

The *Assets*: The assets for the project encompassed the concepts of *characters*, *story-world,* and *curiosity*.

For the character creation recall the suggestions from **Section 2.4.3.1**: the *Five Factor Model* (FFM) and *behavioural residue* (Gosling, 2008, pp.12-19). First, the characters were given a personality based on the FFM (McCrae, Gaines, and Wellington 2012). On this scale, the main character (lighthouse keeper) was given high scores for *openness*, *conscientiousness,* and *agreeableness*, with low scores for *extroversion* and *neuroticism*. This meant that the character's personality was curious, dependable, reserved, empathetic, and calm. This created a blueprint for how the character would look and act. Therefore, the character was able to be designed based on these personality traits. To clarify, this informed the characters physical appearance, such as particular colours he wore, as well as the animations, such as the way he walked and moved. See **Figure 4-2**.

Figure 4-2 Main Character (lighthouse keeper)
(Original image created by Austin Wolfe)

Second, to emphasise the personality and identity of the character, other assets were created as *behavioural residue* (Gosling, 2008, pp.12-19). An example of such assets were items like a smoking pipe, picture frames, maps, and wine bottles that gave small indications about the character's life, many of which were interactive. See **Figure 4-3**.

Figure 4-3 Behavioural Residue
(Original image created by Austin Wolfe)

Next, the story-world was then created based on the character's attributes and persona. The world itself was constructed on an island, with the scenes occurring in various locations around it. This was done so

that when scene changes occurred, it would lessen the amount of time it took for the user to reorient themselves in the world, since they could see all the other places they had previously been. To bring the story-world to life, animal and plant life was added through other assets such as birds, rabbits, sea creatures, grasses, and trees. Some of these played multi-purposed roles, contributing not only to the story world and persona of the character but were also employed as certain *curiosity types* (To *et al*., 2016) and *diegetic* devices (Fearghail *et al*., 2018; Brown *et al*., 2020). An example of this is a recurring bird in the experience. The user first meets it in the menu, and then again in the first scene where it can be interacted with. It is then placed throughout various other scenes to help direct the focus and attention of the player much like the firefly in Fearghail *et al*.'s (2018) study as mentioned in **Section 2**. See **Figure 4-4** of an example of the placement. Curiosity played a dual role in both the *assets* and the *interactivity* stages.

Figure 4-4 Example map diegetic placement.
(Original image created by Austin Wolfe)

Interactivity and *immersion*: Recall from **Section 2.2.3** that interactivity can be considered as a type of play (Ryan, 2009). This is considered in two forms: the narrative game, and the playable story. This application in considered to be a playable story as the gameplay produces the story. Additionally, it utilises an exploratory/internal approach (Ryan, 2002, pp. 595-596). This means that the users can navigate and examine objects, but their actions do not alter the plot and have no impact on the story's outcome (exploratory). In addition, the experience in is a first-person perspective, and in a position to identify with their avatar (internal). It is also important to note that interactivity was limited to local agency (impact with the scene) and not global agency (impact on the outcome of story). Global agency would not be suitable for cinematic VR storytelling as the author needed to retain authorial control to properly employ and measure the concepts and elements that influence narrative engagement.

In **Section 2.3.2.1,** To *et al*. (2016) discussed the possibilities of utilising *curiosity types* into digital narratives: *manipulatory, complex/ambiguous, perceptual, conceptual*, and *adjustive/reactive*. For the creation of the experience, four out of five types were employed. *Manipulatory* was introduced simply by the use of the controller in the experience, with the ability to grab, hold, or throw items. *Complex/ambiguous*

was utilised by making complex objects to interact with. Some of these included objects such as birds or rabbits that were animated and provided haptic feedback when touched. Others were in the form of picture frames that highlighted or changed their image when handled. *Perceptual* was implemented through music, sound cues from various objects, and visual highlights. And *adjustive reactive* constituted the items that were simpler and had a common use, such as a violin that the user could play. *Conceptual* was left out, simply due to the difficulty of executing it within the narrative.

Along with this, the use of music, audio cues, and highlights were used to focus and gain the user's attention and increase immersion. In particular, both ambient and spatial sound were used throughout the VR experience, as suggested by Bhide, Goins and Giegel (2019). The music and narration were ambient with no discernible source. The spatial sound encompassed everything else. This included elements like waves crashing, bird calls, wind, thunder, rain, and whale calls. Each sound had an individual attenuation radius (the falloff of the source) utilising a natural sound function (See **Figure 4-6**) and employed binaural spatialisation. This meant that the sound changed and shifted based on the user's physical orientation towards the sound. These overlapped with each other to create a more natural and immersive environment. See **Figure 4-5** for an example of spatial sound locations and their fall offs.

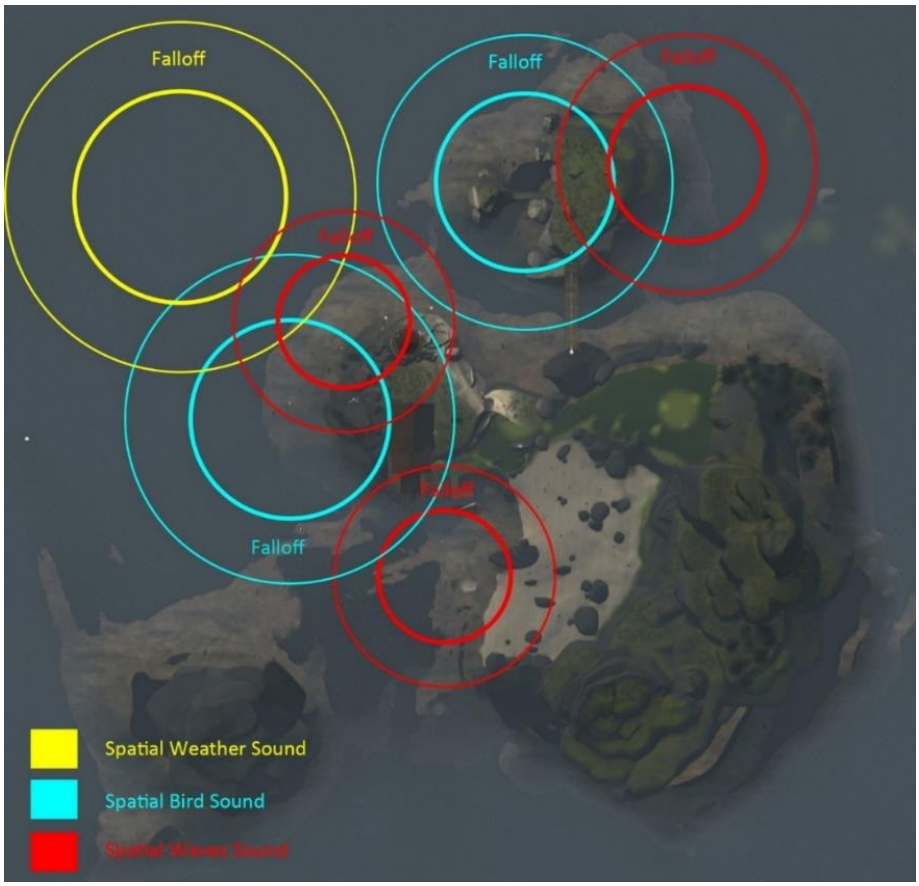


Figure 4-5 Example map of spatial sounds
(Original image created by Austin Wolfe)

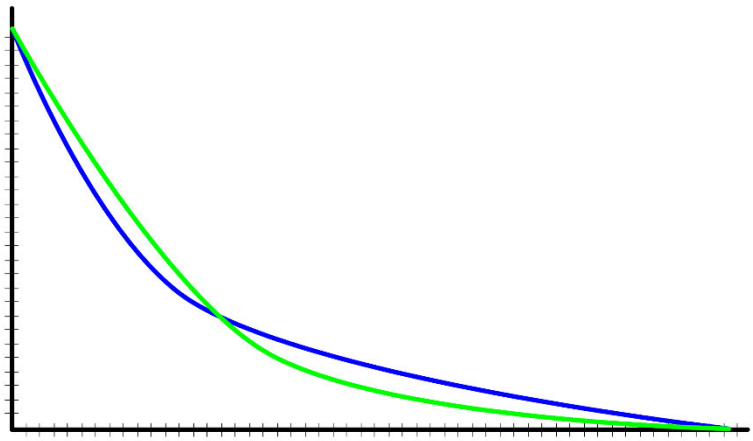


Figure 4-6 Natural sound function.
This is the rate of attenuation over distance. This models a naturalistic falloff behaviour that is closer to matching reality. (Original image created by Austin Wolfe)

In addition to the spatial and ambient sounds, other interactivity was built into various other assets. As mentioned earlier with regards to curiosity, some picture frames changed and were highlighted when held, other objects could be collected and thrown or placed down by the user such as vegetables and wine bottles. This auditory, visual, and physical interactivity added to the overall immersive feeling of the experience.

The script, assets, and interactions took approximately six months to complete, with the majority of that time spend on the assets. To breakdown, approximately four months were spent on the asset creation, and 1.5 months on the interactions, and .5 months on the script. Although a definitive number cannot be provided, its estimated that 80 to 100 assets were created during this time. With the script, assets and interactions completed, the pilot experience was finalised and built, ready for the conduction of the first study.

4.1.1 Data Collection for Pilot Study

Upon completion of the VR experience, the questionnaires and observation methods were then created based on the suggested use from the literature review in **Section 2**. The following sections will describe the self-reporting measures employed, the observational methods, and ethical considerations for both approaches as well as their limitations.

4.1.1.1 Self-Reporting Measures

As narrative engagement is a multifaceted concept, several questionnaires can be employed for a well-rounded scope in the context on interactive storytelling VR experiences. For this research, the questionnaires used were based on the concepts discussed in the previous sections and the literature review. These are:

- Narrative understanding (NES)
- Attention focus (NES)
- Narrative presence (NES)
- Emotional engagement (NES)
- Suspense
- Curiosity
- Flow
- Presence
- Enjoyment

- Aesthetic pleasantness

For consistency, all scales were measured on a 5-point Likert scale using a combination of forward scoring **(F)** and backwards scoring **(B)**, as denoted on the following scales. Forward scoring has numerical values attached to the anchors in a forward direction, with *fully agree* = 5, and *fully disagree* = 1. Backwards (reverse) scoring has numerical values attached to anchors in the opposite direction, with *fully disagree* = 5 and *fully agree* =1. The use of both scoring methods was standard for the questionnaires and was not altered. Some questionnaires were shortened based on the recommendations of other researchers. The shortened versions were chosen over the full scales, as it lessened the amount of time the participants spent self-reporting.

4.1.1.2 Narrative Engagement Scale

Busselle and Bilandzic's (2008) research interpreted four factors for narrative engagement while developing their *Narrative Engagement Scale* (NES). As mentioned previously, these were *narrative understanding*, *attentional focus*, *emotional engagement*, and *narrative presence.* Although it was not developed specifically for VR, it has been a widely used model in research and other VR studies (Bindman *et al*., 2018; Richardson *et al*., 2018; Schoenau-Fog, 2011a), as well as having a Cronbach's α of over .80. For these reasons, it can potentially be adapted for use in interactive VR stories. The NES consists of 12 questions on a 7-point Likert scale and was adapted to a 5-point scale for consistency across all questionnaires. The Likert scale was denoted with the anchors: *fully agree, somewhat agree, not sure, somewhat disagree,* and *fully disagree*. The scale included the following:

Narrative Engagement Scale Questions (NES)
Narrative understanding
1. At points, I had a hard time making sense of what was going on in the experience. ***(B)***
2. My understanding of the characters is unclear. ***(B)***
3. I had a hard time recognising the thread of the story. ***(B)***

Attentional focus
1. I found my mind wandering while the during the story experience. ***(B)***
2. While in the virtual world I found myself thinking about other things. ***(B)***
3. I had a hard time keeping my mind on the story. ***(B)***

Narrative presence
1. During the experience, my body was in the room, but my mind was inside the world created by the story. **(F)**
2. The experience created a new world, and then that world suddenly disappeared when the application ended. **(F)**
3. At times during the experience, the story world was closer to me than the real world. **(F)**

Emotional engagement
1. The story affected me emotionally. **(F)**
2. During the experience, when a main character succeeded, I felt happy, and when they suffered in some way, I felt sad. **(F)**
3. I felt sympathy for some of the characters in the story. **(F)**

4.1.1.3 Suspense Scale

Measuring suspense in interactive storytelling is a somewhat novel idea. Knobloch, S. *et al.* (2004) developed a three-item scale for suspense rating media content in terms of being thrilling, gripping, and exciting. Other scales used to measure suspense are context specific (Hartmann, Stuke and Daschmann, 2008), but neither of these are in the context of interactive narratives. Based on these studies and his own research, Roth (2016) postulated that the measurement of suspense of interactive narratives should be based on the emotional involvement in the story's outcome. He therefore constructed 10 items to capture suspense based on emotional investment in the story specifically in the context of interactive narratives.

This scale was later shortened to four items, based on the items with the highest item-total correlations. The Likert scale was denoted with the anchors: *fully agree, somewhat agree, not sure, somewhat disagree,* and *fully disagree*. The scale included the following:

Suspense evoked by Interactive Storytelling environments scale (SS)

1. At some moments I was anxious to find out what would happen next **(F)**
2. Sometimes I was worried about how the story would develop. **(F)**
3. Some moments were rather suspenseful. **(F)**
4. I found myself wishing for a particular story outcome. **(F)**

4.1.1.4 Curiosity Scale

Spielberger *et al*. (1979) determined curiosity as a state, *thus the State-Trait Curiosity Inventory* (STCI) was developed to measure the intensity of curiosity as a transitory emotional state (Spielberger *et al*., 1979; Spielberger, Peters and Frain, 1981). The STCI includes 10 items on a 4-point scale asking participants to report how they feel at a particular moment. This was adapted to a 5-point Likert for consistency throughout the other questionnaires, and "in the moment" was rephrased to "during the experience". Additionally, the 10 items were adapted into three based on the recommendations of Roth (2016). The Likert scale was denoted with the anchors: *fully agree, somewhat agree, not sure, somewhat disagree,* and *fully disagree*. The scale included the following:

Curiosity scale (CS)

During the experience I felt…..

1. Curious **(F)**
2. Interested **(F)**
3. Inquisitive **(F)**

4.1.1.5 Flow Scale

As stated in **Section 2.5**, Csikszentmihalyi (1998) proposed eight factors for optimal flow: challenge activity; merging of acting and awareness; clear goals; direct immediate feedback**;** concentration; a sense of control; loss of self-consciousness; and an altered sense of time. Based on this model, Jackson and Eklund (2002) developed the Flow State Scale (FSS). Initially, this scale was a 36-item list, and later paired it down to 9 items to allow for usage in a wider range of studies. Each item chosen reflected one of the nine higher order factors from the original scale (Jackson, Martin and Eklund, 2008). Findings from the shorter list revealed that it provided a good representation of the long version with high reliability. Roth (2016) further adapted the scale into five items based on the highest item-total correlations through their research. The Likert scale was denoted with the anchors: *fully agree, somewhat agree, not sure, somewhat disagree,* and *fully disagree*. The scale included the following:

Flow Scale (FFS-2)

During the experience. . .

1. . . . I felt competent enough to meet the demands of the situation **(F)**
2. . . . I acted spontaneously and automatically without having to think **(F)**
3. . . . I had a strong sense of what I wanted to do **(F)**
4. . . . I had a good idea while I was performing about how well I was doing **(F)**
5. . . . I was completely focused on the task at hand **(F)**

4.1.1.6 Presence Scale

There are currently a few standardised presence questionnaires in circulation for VR applications (SUS (Slater, Usoh and Steed, 1994), IPQ (Schubert, Friedmann and Regenbrecht, 2001), WS (Witmer and Singer, 2005), therefore, research on these scales was accessed to find the most suitable one for this

study. Schwind *et al*. (2019) conducted a study on the efficacy of these questionnaires and ultimately recommended the IPQ (Igroup presence questionnaire), as it provided the highest reliability within a reasonable timeframe. The IPQ is a 14-item list, on a 5-point Likert scale. The items consist of 4 categories: *General*, *Spatial presence* (the sense of being physically present in VR), *Involvement* (measuring the attention devoted to the experience) and *Experienced Realism* (measuring the subjective experience of realism. Based on these categories, the scale was shorted to contain one item from each category. The Likert scale was denoted with the anchors: *fully agree, somewhat agree, not sure, somewhat disagree,* and *fully disagree*. The scale included the following:

Presence Scale (IPQ) Short Scale

1. In the experience I had a sense of "being there" (G) **(F)**
2. I felt present in the virtual space (SP) **(F)**
3. The virtual world seemed more realistic than the real world (ER) **(F)**
4. I was not aware of my real environment (INV) **(F)**

4.1.1.7 Enjoyment Scale

The measuring of *enjoyment* has proved somewhat problematic. According to Roth (2016), while the concepts of *enjoyment* have been used in media research (such as amusement, sense of achievement etc.) (Vorderer, Klimmt and Ritterfeld, 2004a), there is no study available that has attempted to measure it directly. Sweetser and Wyeth (2005) agreed, stating "there is no method to assess player enjoyment in games", and based their measurement of enjoyment on the concept of flow. Since there was already a separate *flow scale*, Roth (2016) ultimately created a simple short scale consisting of two questions. The Likert scale was denoted with the anchors: *fully agree, somewhat agree, not sure, somewhat disagree,* and *fully disagree*. The scale included the following:

Enjoyment Scale (ES)

The experience. . .

1. . . . was entertaining **(F)**
2. . . . was enjoyable **(F)**

4.1.1.8 Aesthetic Pleasantness Scale

Aesthetic pleasantness in media is often related to the visuals and audio. Aesthetic evaluations may relate to the physical appearance of characters or landscape imagery. Additionally, aesthetic content can relate to the personal background and previous experiences of the recipient. For instance, the depiction of a scene in a movie, can remind the viewer of feelings that resonate with the recipient's mood, thus evoking congruent feelings (Cupchik, 1995). Thus, in the context, it is applied to encompass the elements of *story-world, characters,* and *emotion.* For this study, the following questionnaire was used to access aesthetic pleasantness on a 5-point Likert scale (Rowold, 2008; Cupchik and Laszlo, 1994; Roth, 2016). The Likert scale was denoted with the anchors: *fully agree, somewhat agree, not sure, somewhat disagree,* and *fully disagree*. The scale included the following:

Aesthetic Pleasantness Scale (APS)

The experience. . .

1. . . . made me think **(F)**
2. . . . made me think about my personal situation **(F)**
3. . . . told me something about life **(F)**
4. . . . was inspiring **(F)**
5. . . . moved me like a piece of art **(F)**

4.1.1.9 Self-Reporting Limitations

Self-reporting measures to reflect on past experiences can be somewhat limited, as it can be hindered by such things as selective memory, mixing memories of other events or exaggeration. However, there is still validity in the use of these methods, as these limitations can be reduced. One such reduction, is the use of standardised questionnaires as they can be backed with research and a high Cronbach α, increasing their validity. Additionally, wording of the questions was kept to the specific standard to avoid confusion or vagueness, with the exception of changing the phrase of "in the moment" to "during the experience" across all scales for consistency. Finally, all questionnaires were administered immediately following the completion of the experience to lessen any potential forgetfulness or exaggeration from the participants.

4.1.1.10 Observation Limitations

Limitations of observational data can include the researcher being seen as intrusive. According to Schoenau-Fog (2011a), the interruption of the experience to conduct survey or interviews can lead to a disruption of the flow, and thus lead to disengagement. To mitigate this, the observational data recorded was non-invasive; participants were not asked questions during the experience. Another limitation of this observation was that of the setting of the study. As the observations were made over online video, the view of the participants was limited, and as a result, the researcher was unable to see the full participant at times during the experience.

4.1.1.11 Observation

Observational data for the study was recorded during the experience by the researcher in a nonparticipant role. The data recorded is in a semi-structured format using pre-defined events. The participants were aware that they were being observed, and aware that the researcher would not participate in the experience. The participates were also able to provide open-ended comments after the completion of the post questionnaire. An observational protocol was created for use during the observations. This included the current scene, time, and a record of events. For each scene, the time was recorded whenever the user engaged an activity. See **Table 4-1**.

Table 4-1 Example of Observation Protocol for Scene 2

Scene	Time	Description of Events
2	1:10 1:25 1:40	Interaction with bird Following gaze of character Interaction with character

Observation was carried out via online streaming video (Zoom), with the participant sharing their PC screen. This allowed the researcher to view both the participant and their camera view during the experience. During this study, it was not possible to have in person participants due to restrictions from the global pandemic. The raw data of the observations is discussed further in **Section 4.3**, where it is be coded, analysed, and quantified to be combined with the self-reporting measures.

4.2 Experiment and Results of Pilot

After the project was completed and the data collection protocol in place, 10 participants over the age of 18 were recruited to take part in the experiment. Participants were from varying backgrounds, ethnicities, and genders, and all had some prior experience with VR. The data collection was then divided into two main stages: *observation and reflection*.

Observation stage. Once the participants had their headset on, they started the program and observations were made and recorded throughout their experience. This encompassed the qualitative data.

Reflection stage. After the completion of the VR experience, participants were invited to complete a set of self-reporting questionnaires. The *Narrative Engagement Scale* (NES); the *Suspense Scale* (SS); *Curiosity Scale* (CS); *Flow Scale* (FSS-2); *Presence scale* (IPQ), *Enjoyment Scale (ES*), and *Aesthetic Pleasantness* (APS). This data comprised the quantitative data.

After completion of the data collection, the data analysis consists of three substages: *Analyse Quantitative*, *Analyse Qualitative*, and *Mixed Methods*. First, the quantitative results were analysed in terms of statistical results. Second, the qualitative database is analysed by coding the data and collapsing the codes into broad themes. The final phase is the mixed methods analysis, which consists of integrating the two databases. The integration of this data takes a data transformation approach. This means that after the qualitative data has been coded into themes, they are counted and grouped, to form quantitative measures. The following sections will discuss the results of the quantitative and qualitative data. See **Figure 4-7**.

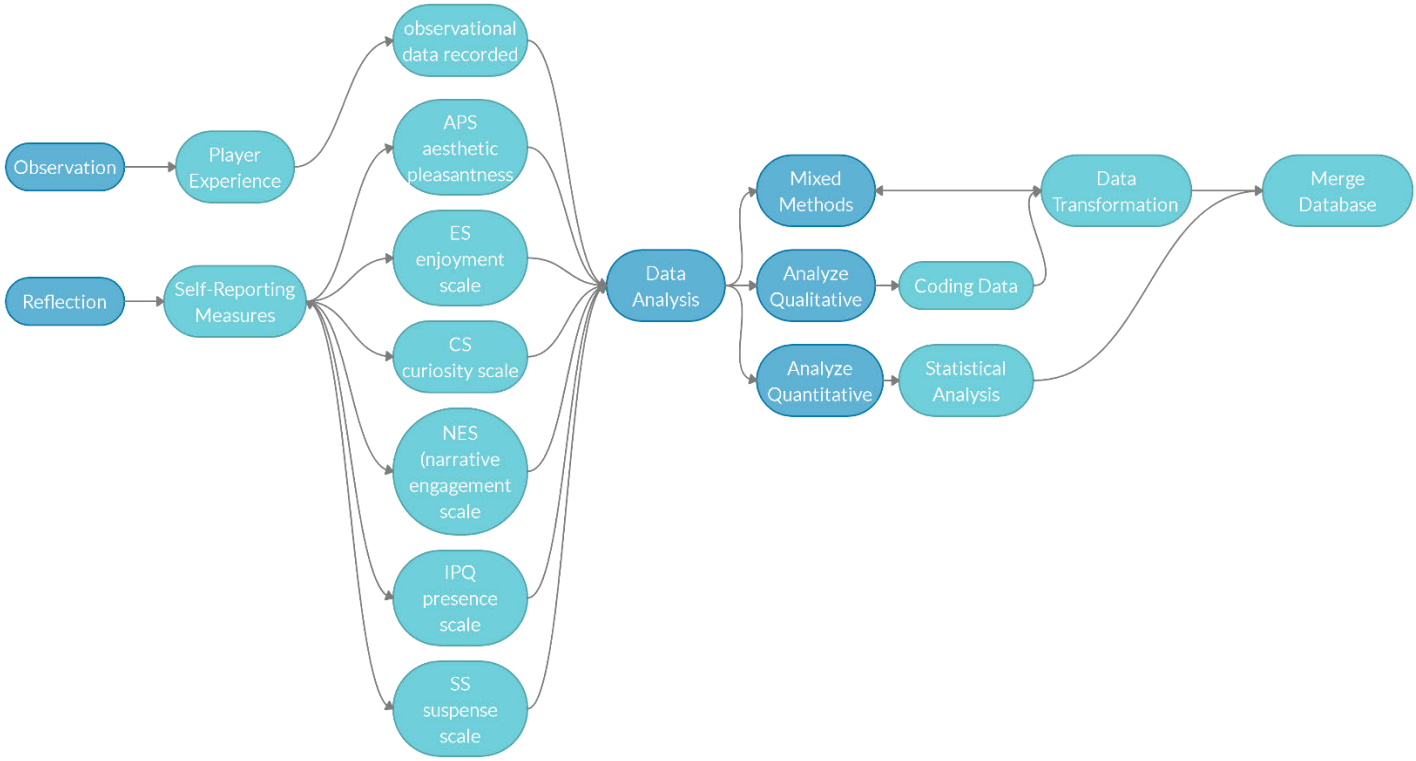


Figure 4-7 Stages and substages of Analysis
(Original image created by Austin Wolfe)

4.2.1 Presentation of Quantitative Data

To summarise from **Section 4.1.1** all quantitative data was measured on a 5-point Likert scale using a combination of forward and backwards scoring. In this section, the mean and standard deviation are provided for each of the scales. The mean (M) is made up from the average of the value of the responses. The standard deviation (SD) is the measure of the amount of variation of the recorded values. The full record of data may be seen in **Appendix: E**.

Firstly, the NES results are presented. In the literature review, Busselle and Bilandzic (2008) had identified four factors for narrative engagement. These were:

- *narrative understanding*--the ease in comprehension of the story.
- *attentional focus*—concept that one should not be aware that one is distracted.
- *emotional engagement*--feeling for or with the characters.

- *narrative presence*—sensation that one has left the actual world and entered the story.

Consequently, the *NES* (Narrative Engagement Scale) was considered by these individual factors primarily. *Narrative understanding* recorded both the highest mean at 4.83 (M), and lowest standard deviation at 0.37 (SD). Likewise, *Emotional engagement* and *Narrative presence* also recorded high values with low deviations. *Attentional focus* saw the lowest data with at mean of 3.60 (M), and the highest variation at 1.57 (SD) (See **Table 4-2** and **Figure 4-8**).

Table 4-2 Narrative Engagement Scale Data

	Narrative understanding	***Attentional Focus***	***Narrative presence***	***Emotional engagement***
NES (Narrative Engagement Scale)	M = 4.83 SD = 0.37	M = 3.60 SD = 1.57	M = 4.33 SD = 0.82	M = 4.50 SD = 0.76

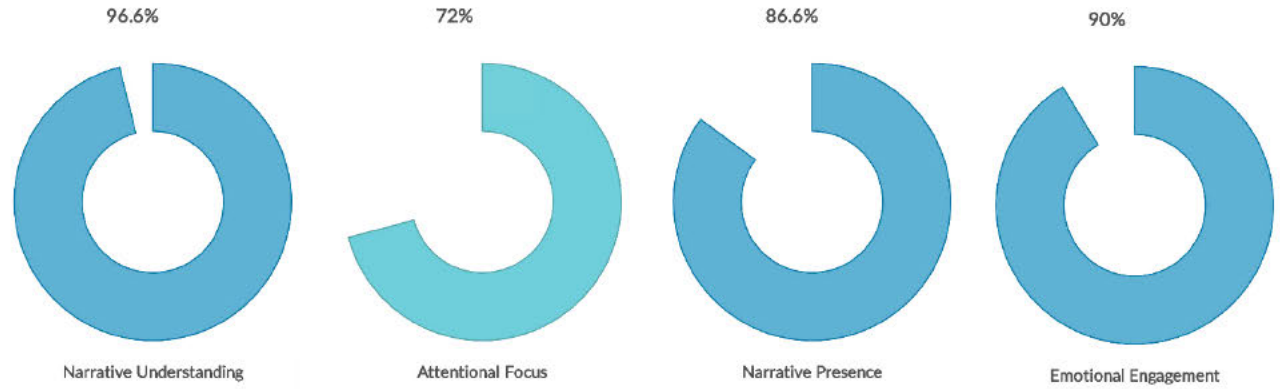


Figure 4-8 NES Graph
The above figure provides a visual representation of the total recorded score divided by the maximum score that could have been achieved on each scale. (Original image created by Austin Wolfe)

Along with the individual factors, the *NES* was combined with the remaining scales for further analysis. Combined, the overall *NES* was recorded with a mean of 4.32 (M)and the second lowest standard deviation of 0.45 (SD). The *ES* (Enjoyment Scale) recorded the highest at 4.75 (M), and lowest deviation at 0.43. It is also important to note that the lowest scoring scales were the *SS* (Suspense Scale) at 3.35 (M), with a fairly large deviation at 1.23 (SD), as well at the *FFS-2* (Flow Scale) at 3.64 (M). Although scoring fairly high comparatively, the *IPQ* (Presence scale) all showed a larger deviation at 1.25 (SD). These results and fluctuations in data will be discussed further in **Section 4.3** during the analysis of the pilot (See **Table 4-3** and **Figure 4-9**).

Table 4-3 Combined Assessment Data

NES Combined (Narrative Engagement Scale)	M = 4.32 SD = 0.45
SS (Suspense scale)	M = 3.35 SD = 1.23
CS (Curiosity Scale)	M = 4.63 SD = 0.60
FFS-2 (Flow Scale)	M = 3.64 SD = 1.07
IPQ (Presence Scale)	M = 3.92 SD = 1.25

ES (Enjoyment Scale)	M = 4.75 SD = 0.43
APS (Aesthetic Pleasantness Scale)	M = 4.43 SD = 0.83

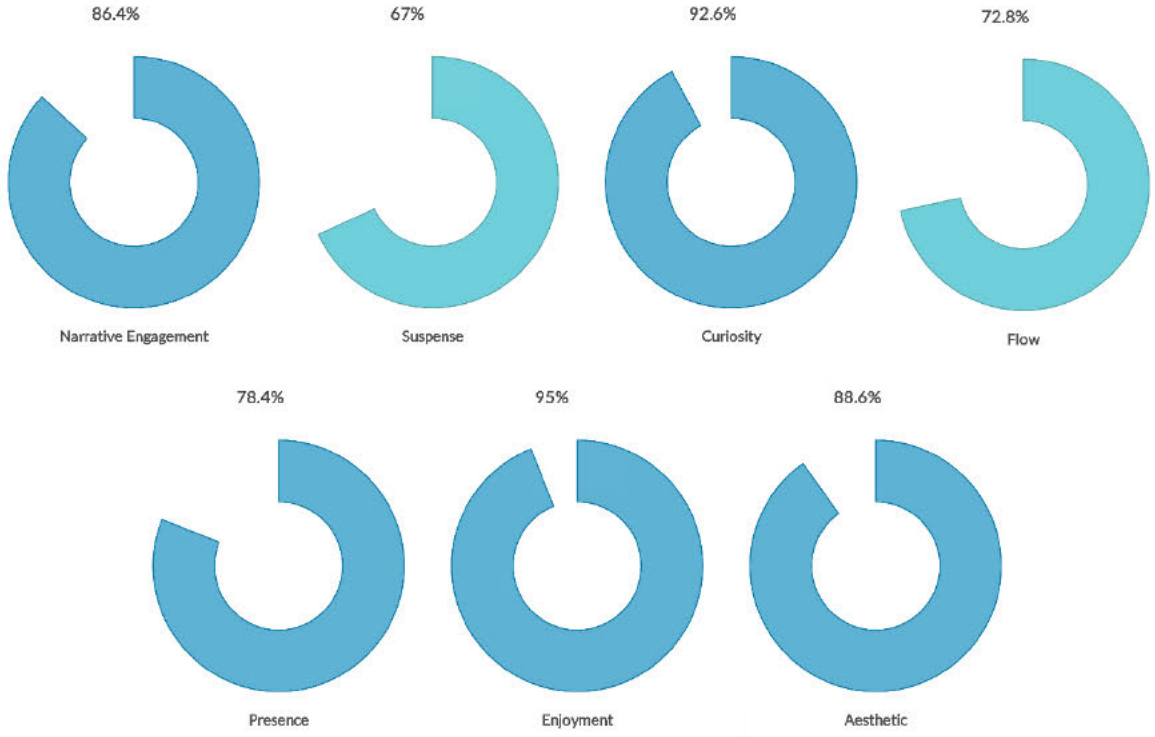


Figure 4-9 Combined Assessment Graph
The above figure provides a visual representation of the total recorded score divided by the maximum score that could have been achieved on each scale. (Original image created by Austin Wolfe)

4.2.2 Presentation of Qualitative Data

Qualitative data for this study was gathered via observation during the VR experience. The data was hand recorded, then transcribed into documents and coded into similar themes. This data was coded into the following themes:

- Focus on Characters
- Interaction with Character
- Follow character gaze.
- Interact with shell (*meaningful item/diegetic*)
- Focus on crow (*diegetic item*)
- Aesthetic focus(*environment*)
- Aesthetic focus (*Life*)
- Interaction with other objects

Table 4-4 indicates the percentage of participants for which each code appears. **Table 4-5** shows the frequency of each code per participant. The coding was recorded and calculated via the program MAXQDA.

Table 4-4 Codes at a glance (Percentages)

Codes	Percentage of participants	Number or participants
Focus on Characters	100%	10/10
Interaction with Character	100%	10/10
Follow Character gaze	90%	9/10
Interact with Shell (*Meaningful Item/diegetic*)	100%	10/10
Focus on Crow (*Diegetic*)	100%	10/10
Aesthetic focus (*Environment*)	100%	10/10
Aesthetic focus (*Life*)	100%	10/10
Interaction with other objects	80%	8/10

Table 4-5 Codes at a glance (Frequency per participant)

Code System	10	9	8	7	6	5	4	3	2	1	SUM
Interact with other objects	1	1	5	7	1	2		11	3		31
Aesthetic Focus (Life)	4	5	9	8	5	7	8	4	3	3	56
Aesthetic focus (Environment)	7	5	7	2	4	3	7	3	3	4	45
Focus on Crow (Diegetic)	2	1	1	3	1	3	3	1	2	2	19
Interact with Shell (Meaningfull Item)	2	2	2	1	2	1	1	2	4	1	18
Follow Character Gaze	2	1	6	2	1	1	2		2	1	18
Interact with Character	1	1	1	1	1	1	1	4	1	1	13
Focus on Characters	15	11	14	11	10	16	13	11	10	9	120

As **Table 4-4** demonstrates, the majority of the codes appeared for each participant with the exception of *follow character gaze*, which was reported at 90 percent, and *interaction with other objects* which was reported at 80 percent.

It is important to note that while **Table 4-5** reveals the frequencies of the codes per participant, and their totals, the totals are not necessarily an indication of priority of one code over another, as each code holds a different purpose. For this reason, each code will be evaluated and analysed independently. Additionally, **Figure 4-10** shows another visual example of a single case model of these frequencies for one participant.

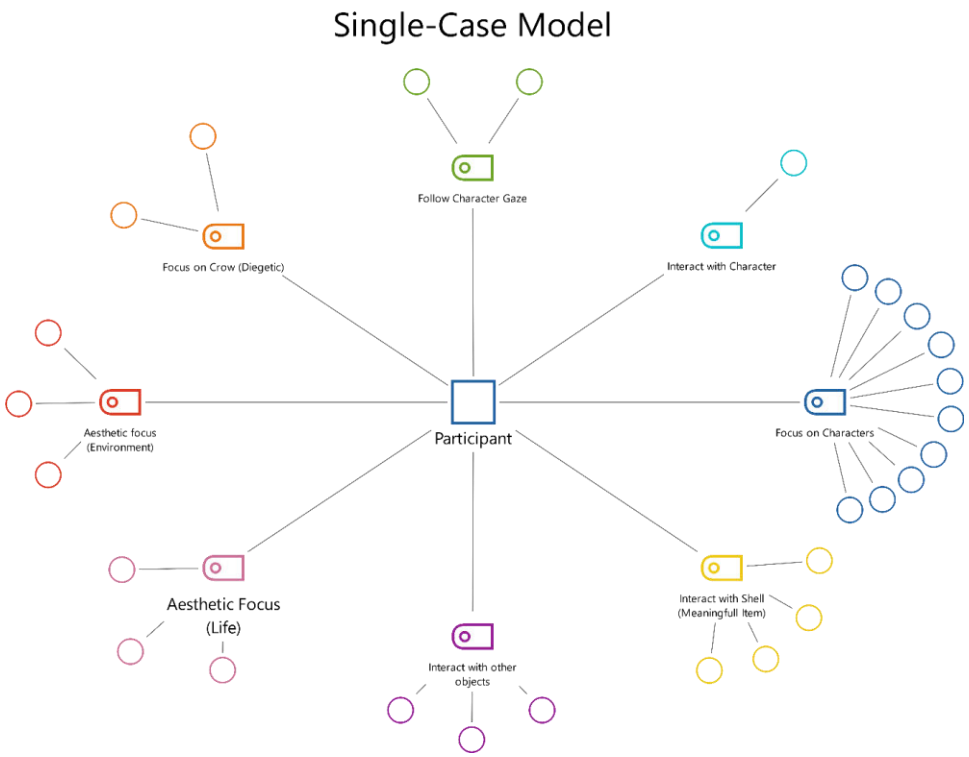


Figure 4-10 Single Case Model
(Original image created by Austin Wolfe)

Firstly, both the *Focus on Crow (Diegetic)* code and *Interact with shell (meaningful)* code had a max amount of four possible occurrences within the experience. With this in mind, *Focus on Crow (Diegetic)* revealed the following:

- 30 percent of participants focused on the object 75 percent of the maximum allowance. (3/10)
- 30 percent of participants focused on the object 50 percent of the maximum allowance. (3/10)
- 40 percent of participants focused on the object 25 percent of the maximum allowance. (4/10)

Whereas *Interact with shell (meaningful)* showed:

- 10 percent of participants interacted with the object 100 percent of the maximum allowance. (1/10)
- 50 percent of participants interacted with the object 50 percent of the maximum allowance. (5/10)
- 40 percent of participants interacted with the object 25 percent of the maximum allowance. (4/10)

As an example, for clarity, the first set of numbers translates to three out of a total of ten participants triggered the *Focus on Crow* code three times out of a total of four possible occurrences.

Conversely, *focus on characters, Aesthetic focus (life)* and *aesthetic focus(environment)* did not have a set number of occurrences. Therefore, their frequencies and totals are of some importance at 120, 56, and 45 respectively. Likewise, *Interact with character* did not have a set number of occurrences, but is only recorded a total of 13 times. However, it is important to note that all participants attempted interaction with the character at least once, and that single interaction occurred at the same point during the story. This is analysed in further detail in **Section 4.3**. *Interact with other objects* is wildly varied as far as frequencies go and holds a larger standard deviation of 3.37 (SD). The final code is the *follow character's gaze*, which held an average of 2 per participant with a deviation of 1.8 (SD). With both sets of data presented, the following section will explore a deeper analysis of each data set.

4.3 Pilot Analysis

The following sections are comprised of a separate quantitative and qualitative analysis, a summary of the combined data collected, limitations, and future recommendations.

4.3.1 Quantitative Analysis

The quantitative analysis focused on the efficacy and usefulness of the standardised questionnaires used during the study. First, consider the Narrative Engagement Scale (*NES*) (Busselle and Bilandzic 2008). Recall from **Section 2.3.1**, that the *NES* consisted of 4 separate subcategories:

- *narrative understanding*
- *attentional focus*
- *emotional engagement*
- *narrative presence*

The data from this scale demonstrated high averages and low deviations for all categories save for one, *attentional focus*. Although the mean was above average, 3.60 (M), the deviation was high at 1.57 (SD). As stated in **Section 4.1.1.2**, the following statements were used for this subcategory:

1. I found my mind wandering while the during the story experience.
2. While in the virtual world I found myself thinking about other things.
3. I had a hard time keeping my mind on the story.

As demonstrated, these statements primarily focus on the mind: paying attention and not wandering from the subject. The discrepancy for this large deviation of the subcategory can be narrowed into two potential factors. The first possibility is the differences of cognitive capabilities and personalities of each participant. It is possible that some individuals may have more difficulty in narrowing their focus on one thing at a time. For example, for someone who has a natural inclination to have a "wandering mind" or someone that has a cognitive difficulty such as an attention deficit disorder, it is reasonable that they would have the same inclination or difficulty in virtual reality. As no baseline was gathered before the experience on each participant's attention level or capabilities, it is difficult to have clarity on the efficacy of this category. Additionally, the other possibility for the large deviation is the manner in which the study needed to be performed. Since observations needed to be completed via video chat and on varying hardware, some individuals experienced technical issues, like stuttering during the experience. This may have been a potential factor in breaking the focus of a participant. However, since the averages in the other subcategories were high with low deviations and overall, the entire scale had a higher average of 4.32 (M), this subcategory may not hold as much weight at the others, and either may not be needed, or may need to be modified to eliminate potential discrepancies.

Likewise, the presence scale (*IPQ*) (Schubert, Friedmann and Regenbrecht, 2001) indicated a similar trend. Although the average was above an acceptable range at 3.92 (M), like the *attentional focus*, it too suffered a high deviation of 1.25 (SD). Also, like *attentional focus*, it is likely that this large deviation was also a product of technical issues. Recall that the four statements used for this scale were:

1. In the experience I had a sense of "being there"
2. I felt present in the virtual space.
3. The virtual world seemed more realistic than the real world.
4. I was not aware of my real environment.

These statements are based on the physical presence the participant perceives in VR, and the lack of awareness of their real environment. As mentioned previously, one of the technical issues experienced by some participants was stuttering. This was likely due to participants using varying headsets and graphics

cards, as well as having to live stream the experience. Regardless of cause, this would have an impact the user's perception of presence as it breaks the sense of "being there". Additionally, as the observations were conducted in the participants' homes, they had varying physical space in which to move. As this experience initially was created to allow the participant to move around in a large space, various participants had less room in which to explore; ultimately running out of room and thus become "aware" of their real environment's limitations. To lower the deviations in these scores, these environmental variables must be eliminated.

The suspense scale (*SS*) demonstrated both a lower average of 3.35 (M) and a high deviation of 1.23 (SD). As mentioned in **Section 4.1.1.3** this scale was created by Roth (2016) in response to a lack of a suspense scale for interactive digital narratives. These statements were:

1. At some moments I was anxious to find out what would happen next.
2. Sometimes I was worried about how the story would develop.
3. Some moments were rather suspenseful.
4. I found myself wishing for a particular story outcome.

The high deviation of the scale may indicate that the scale may need to be modified further, or that there is a discrepancy in the actual wording of the scale. It is possible that some individuals may perceive the concept of suspense differently than others. Additionally, the use of the words "worry" and "anxious" may be a cause for confusion. Therefore, further research needs to be completed to access the efficacy of this scale. However, the lower average of the scale indicates a problem with the project itself. The story and the project did not contain clear moments of suspense, and therefore it may have been difficult to identify them. As suspense is an important factor and is closely linked with the concept of curiosity (Hoeken and Sinkeldam, 2014), clearer moments of suspense need to be implemented in the project and storyline.

The flow scale (*FFS-2*) revealed an average of 3.64 and a deviation of 1.07 (SD). To review, the concept of flow by Csikszentmihalyi (1997) is these ease in which a user arrives at a pleasant optimal performance. Flow comprises eight specific factors: challenge activity; merging of acting and awareness; clear goals; direct immediate feedback; concentration; a sense of control; loss of subconsciousness; and altered sense of time. As indicated in **Section 4.1.1.5** the flow scale used the following statements:

1. . . . I felt competent enough to meet the demands of the situation.
2. . . . I acted spontaneously and automatically without having to think.
3. . . . I had a strong sense of what I wanted to do.
4. . . . I had a good idea while I was performing about how well I was doing.
5. . . . I was completely focused on the task at hand.

From this perspective, the scale coincides with the eight factors quite well. However, the larger deviation and lower average indicate problems. In past studies, the flow scale was generally used for game-based interactive digital applications (Isbister, 2006, 2018), as the factors for flow were easier to implement and measure. As this project was a cinematic experience with a linear storyline, there wasn't sufficient opportunities to create flow based on all of these factors. There was no direct instruction or clear task given during the experience for the user to be focused on, nor was there any gauge on which the user could evaluate their own performance. While participants were able to accurately report such statements as "I acted spontaneously and automatically without having to think", the task orientated statements had the largest variation in answers. This is because there was no clear task, and there was no clear task because the participants' actions were unable to affect the storyline in a linear story. This would indicate that either the flow scale is ill suited to cinematic experiences with linear stories, that it needs to be heavily modified to fit this genre, or that the project needs to find a better way to apply this scale without sacrificing its structure.

The curiosity scale (*CS*) performed well, with an average of 4.63 (M) the low deviation of 0.60 (SD). However, it is important to note that the scale only had three statements that were simplified from the original 10. So, while it is an indication that the project did create curiosity and was able to accurately measure it, it might be pertinent to use the full-scale to get a more accurate view of the curiosity factors in the experience. Additionally, since *curious types* (To *et al*., 2016) were used in the project, expanding this scale to target those specific types may also prove beneficial to fine tune the results.

The enjoyment scale (*ES*) had the highest average of 4.75 (M) and the lowest deviation of 0.43 (SD). Like the *SS*, Roth (2016) created the scale in response to the lack of one. Although it only consists of two statements, they were relatively simple, and the participants were able to answer them clearly and accurately. While it would be prudent to continue research to expand the scale, it was effective in relation to this project. This is because, in conjunction with the scale, enjoyment was also able to be observed during the experience. This enjoyment was observed objectively by the researcher in the form of participants smiling, chuckling, laughing, and even some dancing.

The aesthetic pleasantness scale (*APS*) had an average of 4.43 (M) with a deviation of 0.80 (SD). As **Section 2.5** stated, this scale encompassed the elements of *story-world*, *characters*, and *emotion*. The high average and low deviation indicate that aesthetic pleasantness overall may play a more important role in narrative engagement than initially thought. To explain this assumption, this scale can be directly compared to the qualitative findings discussed in the next section.

4.3.2 Qualitative Analysis

First, consider the following codes: *Aesthetic focus (life), aesthetic focus(environment*), and *focus on character*. The aesthetic focus (*life*) was coded as such to include the focusing on organic elements within the experience. These included objects such as wildlife, trees, grass, etc. *Aesthetic focus (environment)* included the items such as the sky, the waves, and the weather. Combined, these elements make up the *story-world,* and part of the emotional element as stated in the aesthetic pleasantness scale. As mentioned in the previous section both codes had high frequencies throughout the experience, 56 and 45 respectively, with a combined total of 101. Additionally, *focus on the character* (which also makes up the *character* element of the *APS*) also had high frequencies with a total of 120. This implies that focusing on the aesthetics of the story-world is nearly as important as focusing on the characters in story. As all of these codes are also part of the *APS*, this further indicates the importance of aesthetic pleasantness overall. Consider that the frequency of these codes combined equals to 221, whereas the rest of the codes combine equals to 99, and the overall total of frequencies is 320. Based on the number of frequencies for this study, participants spent nearly 70 percent of their time focusing on the aesthetics (*character* and *story-world*).

Another indication of its significance is that of verbal feedback received after completion of the story. Upon completion of the experience, each participant was asked which scenes they had an emotional connection to. With the exception of one outlier, all the other participants named the same two scenes having affected them the most. The first scene identified (**Figure 4-11**), involved the participant standing on the edge of a lighthouse at night with Northern lights in the sky, and the lights reflecting on the ocean water.

Figure 4-11 First Identified scene by participants.
(Original image created by Austin Wolfe)

The second scene identified, involved the user being immersed in the ocean, physically flowing through the water, and elements and ocean creatures becoming bioluminescent **(Figure 4-12)**. Both of these scenes had very strong visual attributes attached to them, which would lead to the possibility of investigating their visual attributes further.

Figure 4-12 Second scene identified by
(Original image created by Austin Wolfe)

Additionally, the one participant that chose a different scene, chose a scene involving the characters gardening together (**Figure 4-13**). The participant gave the following reason for this choice: “I used to garden with my partner, and I can’t be with her right now”. The participant further stated that this scene made them feel “nostalgic”. This coincides with Cupchik (1995), from **Section 4.1.1.8**, who postulated that aesthetic content could relate to the personal background and previous experiences of the recipient, thereby evoking congruent feelings in the participant.

Figure 4-13 Outlier scene identified by
(Original image created by Austin Wolfe)

The next data code to analyse is the *interact with shell (meaningful)*. This code was attached to the specific interaction with an object (shell) during the experience. This object was the only object directly referenced in the experience’s narration. Furthermore, it was also used as a physical representation for a “moment of unexpected change” (Storr, 2019, p. 11) and as an ignition point for the story (Storr, 2019, p. 108). It was for these reasons that the shell was deemed a *meaningful item* (Henderson and Hayes, 2017) as meaning

plays a dominant role in guiding attention in scenes of stories. As mentioned in **Section 4.2.2**, 100 percent of participants triggered this code. It is interesting to note that although some participants interacted with the shell more than once, all participants interacted with the shell at the same moment the story. This moment happened at the very end of the story when the character interacts with the participant. Conversely, the *interact with other objects* code had a more varied response. When comparing the two, while *interact with shell (meaningful)* had a higher deviation of 0.87 (SD), *interact with other objects* had a much larger variation of 3.37 (M). This variation may be attributed to a few things. Firstly, this may connect directly to the sense of flow stated in **Section 4.3.1** as there was no clear direction, instruction, or task given to the participant at any time. Thus, the participant may have been unsure about what they could or should interact with. The exception of this, of course, being the shell, as this was directly used in the story. Personalities differences also may have influenced this variation, as some individuals may be more inclined to be tactile and want to touch and explore things while others may be of a timid nature. Although these items were used as *curiosity types* (To *et al*., 2016) and *behavioural residue* (Gosling 2008, pp.12-19), it is unclear if they had any true bearing on the narrative engagement of the story as a whole and may need to be assessed individually. However, it can be postulated that the interaction with the shell had a more consistent response because it was a part of the story thus giving it more meaning, whereas the other objects were not. This may imply the that interactive objects require more meaning or purpose to the story in order to have consistent interaction and engagement.

Like the *Interact with shell* code*,* the *interact with character* code was largely initiated at the very end of the story at the same time for all participants. To clarify, in the final scene the character turns to the participant and gestures for them to come to them and sit down, where the interactable shell is also located. The significance of this is that although the participant had multiple opportunities to interact with the character, 90 percent of them only did so at the end when the character interacted with them first. This may signify that for a user to engage with a non-player character (NPC), the NPC must first engage with them.

Focus on crow and *follow character's gaze* were both diegetic devices within the experience to gain the attention of the participant and engage them. The crow was purposely made as a focusing diegetic device, while the gaze of the character was an accidental addition. The crow was first introduced in the first scene where the participant could interact with it, and it would appear throughout other scenes using a sound cue to direct the focus of the participant. This proved to be a semi-accurate way to direct focus, as all participants were able to focus on the crow at one point or another. However, the results were not very consistent, which may be because the crow is not a part of the story and holds no other significance.

The *following character's gaze* code was accidental, as it was a product of the character's natural personality. To explain, the code was initiated whenever the character would point while looking at something, looked out to sea, or was otherwise searching for something. The participant would then follow the gaze and direction of the character. This signifies engagement and connection to the character as well as curiosity, as the user is trying to physically look where the NPC is looking. While the frequencies of this are varied, it appears to add to the engagement of the story, as it is a more natural occurrence than a random appearance of a bird. If purposely controlled, it may prove a more effective device in gaining a keeping attention on the story. See **Appendix: C** for story script.

4.3.3 Summary of Research Data

To summarise the quantitative data, the narrative engagement scale worked moderately well, however the subcategory of attentional focus must either be eliminated or modified to better adapt to cinematic VR experiences and eliminate possible discrepancies due to different cognitive abilities. The flow scale may also not be well suited to certain VR cinematic experiences that follow a linear storyline, as users do not have a specific task assigned to them or have the ability to influence the outcome of the story. The alternative to this is that the gameplay itself would have to change in order to adapt to the concept of flow. The curiosity scale worked successfully and with a reasonable degree of accuracy but was relatively

simplistic. Further evaluation and research are needed to develop a more in-depth scale regarding narrative engagement. This also applies to the scale of suspense, with the addition of requiring further development and research on the relationship between curiosity and suspense, as well as to the practical implementation of opportunities to create suspense within the experience.

Regarding qualitative data, aesthetic pleasantness appears to play a significant role in narrative focus, and therefore needs to be expanded and further explored in depth. Additionally, interactive items may need to hold more meaning for them to be interacted with consistently. Using a diegetic item to focus the attention of the user is potentially an effective way to assist with engagement, but the focus needs to be more purposeful. Finally, meaningful interactions with NPC characters may be dependent on the NPC character that initiates interaction first, but the user is more likely to engage in mirroring the behaviour of the NPC i.e., looking where they are looking.

Overall, aesthetic pleasantness seems to be the strongest component, as it is reflected well in both the quantitative and qualitative data, with the scale correlating to *Aesthetic focus (life), aesthetic focus(environment*), and *focus on character*. It could also be argued that the combined narrative engagement scale (NES) also correlated to those same codes (with the addition of *follow character's gaze*) as it involved emotional engagement and focus. Finally, the curiosity scale (CS) seemed directly linked to the interaction codes. Even though the frequencies of the interaction codes were lower, the CS scored quite well with a high mean and low deviation. This may indicate that curiosity also holds more weight than some of the other elements.

4.4 Limitations

Limitations of the pilot study were largely due to technology issues. Since the study had to take place via the Internet and in the participants' homes, many variables were introduced. The first of these being hardware, as participants not only had varying headsets, (Oculus Rift, RiftS, Quest, Quest2) they also had varying graphics cards and CPUs. To clarify, each headset has a different maximum resolution and FPS (frame rate per second), and different graphics cards and CPUs that can process these resolutions and frames more or less effectively than others. This can lead to problems, such as stuttering in frames or longer delays between scenes, which have the potential to affect the presence and engagement of the user within the experience. The observation itself encountered technology issues as it was streamed via Soom. This caused some lagging problems with participants who had weaker Wi-Fi connections, making it difficult to accurately timestamp events during the observation.

In addition, participants had different sizes in the physical space in which they performed the experience. As the application was meant to be room scale with an area of movement of a minimum of 6ft x 6ft, some participants had less room. This meant that participants were unable to reach or explore certain places. This was evident during observation, as some participants would try to reach for an object or walk somewhere and were unable to do so due to physical constraints. This too increased the potential of breaking presence and engagement.

The final limitations are regarding the sample size. As this study was conducted via internet, participants needed to have access to their own headsets and VR compatible PCs. This greatly reduced the potential number of participants to only those who had a specific brand of headset. Additionally, although there was nearly double the number of people who expressed interest in the study, only half followed through. This is likely due to the observational requirement needed over Zoom, which some participants were unwilling to do or uncomfortable with. A small sample size is problematic as in increases the bias and lacks the statistical power to find significant effects in an overall population.

4.5 Recommendations

The first recommendations for the final project are regarding the study itself. Firstly, is the need for a larger sample size. A larger sample size would give a more accurate representation of populous and eliminate many deviations in quantitative and qualitative data while increasing its validity. Additionally, the study needs to be performed in a more controlled environment. This means the environment needs to use the same hardware, headset, the same graphics card, and have the same room scale. It is also inadvisable to conduct such an experiment online as it introduces other technical issues, as discussed in **Section 4.4**, such as stuttering or prolonged delays, as well as the inability to accurately see the entirety of the participant's body during observation.

Furthermore, the final project needs to have more opportunities for suspense, and more research should be explored on other suspense scales, creating suspense, and its definition. This was lacking in both the research and project, and as it is linked with curiosity (Hoeken and Sinkeldam, 2014), and as curiosity largely impacts narrative engagement (To *et al.*, 2016; Storr, 2019, p. 11; Loewenstein, 1994), it would be beneficial to have a more in depth understanding of it. Along with suspense, the curiosity scale would also benefit from more exploration into its assessment, concepts, and the relationship of curiosity to narrative engagement as a whole. This would provide a well-rounded data set, increasing accuracy and validity. Finally, additional research should be conducted on the importance of aesthetics in cinematic VR experiences, and aesthetic scale needs to be modified and expanded based upon those recommendations.

The use of the flow scale is probably not appropriate for cinematic VR experience with the linear storyline, therefore it either needs to be eliminated from the narrative engagement measurement or heavily modified to better fit with the genre. Likewise, the attentional focus aspect of the narrative engagement scale also either needs to be eliminated or heavily modified to eliminate discrepancies based upon potential cognitive differences, capabilities or personalities.

Once these concepts have been better explored, and the scales modified to reflect the research and genre, they can then be combined into a narrative engagement scale specifically for interactive cinematic VR. This may then become a new standard scale for this genre. Moreover, the final project created will need to reflect this by implementing the changes noted above, as well as the additional research explored. An outline of the project may then be able to be used as a guideline in conjunction with the final narrative engagement scale.

5 Phase Two: VRNEF Creation

The Virtual Reality Narrative Engagement Framework (VRNEF) creation consists of two parts: the measurement (scale), and the guidelines. The VRNEF is created from the analysis and recommendations from the study conducted in *Phase One* in **Section 4**. In **Section 5.1**, the creation of the measurement and results of the reliability and validity of the measurement scale is discussed. Additionally, following the results, the modifications that were made which produced the final measurement scale are considered. **Section 5.2** will explore the development of the guidelines, their modifications, and finalised adjustments. Finally, **Section 5.3** will provide final thoughts regarding the VRNEF creation.

5.1 VRNEF Measurement

The following sections outline the initial VRNEF measurement scale, the results and analysis of the first reliability and validity test, and the modifications made to the scale following the analysis.

5.1.1 Initial VRNEF Measurement

As shown in **Figure 2-7**, in **Section 2**, the concepts defined for narrative engagement are *narrative understanding*, *narrative presence*, *spatial presence*, *emotional engagement*, *suspense*, *curiosity*, *enjoyment*, and *aesthetic value*. These concepts are used to make up the constructs of the VRNEF measurement scale. For consistency, all scales are measured on a 5-point Likert scale using forward scoring. Each construct has numerical values attached to the anchors in a forward direction, with *fully agree* = 5, and *fully disagree* = 1.

As reported in **Section 4.2.1** and the analysis in **Section 4.3.1**, the NES (Busselle and Bilandzic, 2008) concepts of *narrative understanding* and *emotional engagement* were assessed. Both reported high means at 4.83 (M) and 4.50 (M) respectively, and low standard deviations at 0.37 (SD) and 0.76 (SD) respectively. As both concepts fared well during *Phase One*, the constructs of *narrative understanding* and *emotional engagement* were adapted from the original (NES) to fit the VRNEF. In considering *narrative understanding*, the original scale had a backwards scoring method, therefore the statements were modified to fit a forward scoring model. In addition, another variable was added to the construct for better accuracy. The new construct of *narrative understanding* thus became:

- NU001 At moments in the story, it was easy to make sense of what was going on in the experience.
- NU002 My understanding of the characters is clear.
- NU003 The plot of the story was easy to recognise.
- NU004 I was able to understand the story.

Emotional engagement was likewise adapted, but with the addition of two more variables. Kuijpers' *et al*. (2014) research centred around the development of a scale for story absorption. Within it, they included the concept of *emotional engagement*. Similar to Busselle and Bilandzic's (2008) definition of *emotional engagement*, Kuijpers *et al*. (2014) described it as feeling "for or with the characters" in the story. However, their scale expanded that definition, including nine variables. Based on their expansion, two more variables were adapted to the construct based on high factor loadings (EE005, EE004). This new construct included the following:

- EE001 The story affected me emotionally.
- EE002 I felt how the character/s were feeling in the story.
- EE003 I felt sympathy for some of the character/s in the story.
- EE004 I felt connected to the character/s in the story.
- EE005 I felt for what happened in the story.

The concept of presence was divided into two constructs: *spatial presence* and *narrative presence*. For this research, *spatial presence* is defined at the participants' presence in the visual space, while *narrative presence* is the participants' involvement in the story.

To review, presence was measured in *Phase One* via the IPQ (Schubert, Friedmann, and Regenbrecht 2001). Although it performed with a decent mean of 3.92 (M) the standard deviation was less than desirable at 1.25 (SD). As mentioned in **Section 4.3.1**, this deviation may have been caused due to technical errors during the execution of the study. Nevertheless, since the IPQ fared well in other studies (Schwind *et al*., 2019) the decision was made to include some of its variables into the structure based on their high item correlations. In addition to this, Vorderer *et al*. (2004b) suggested that action was just as important as location when assessing *spatial presence*. Their model postulated that *spatial presence* also depends on what a person could "do". Therefore, two variables concerning action were included into the construct. Subsequently, as discussed in **Section 2.5.2.2**, Bhide, Goins and Giegel's (2019) research suggested that spatial audio contributed to presence and immersion in virtual spaces. Consequently, an additional variable was added concerning ambient sounds. The resulting construct became the following:

- SP001 I felt physically present in the virtual world.
- SP002 In the experience I had a sense of being there.
- SP003 I felt like I could move around the environment (action)
- SP004 I felt that I could interact with objects in the virtual environment (action)
- SP005 In the experience I had a sense of being there due to the ambient sounds around me.

As mentioned above, for this framework, *narrative presence* entails the concept of involvement in the story. This was designed as a way to differentiate between being physically present and being mentally present within the narrative. This is in line with Schubert, Friedmann, and Regenbrecht (2001) who proposed that presence is made of both spatial presence and involvement (or psychological immersion). Thus, the *narrative presence* construct was formulated and modified from the IPQ's dimension of involvement.

- NP001 During the experience, my mind was inside the world created by the story.
- NP002 I was not aware of my real environment.
- NP003 I was completely captivated by the virtual world.
- NP004 During the experience, I felt involved in the story.

The curiosity construct was created in part based on the scale in *Phase One*, the Melbourne Curiosity Inventory (Naylor 1981), and the concept of curiosity types (To *et al*., 2016). From *Phase One*, the word "interested" was carried over to fit into the construct (CS001). The Melbourne Curiosity Inventory (MCI) is a self-reported measurement of an individual's curiosity. This scale distinguishes between being in the state of curiosity and having the trait of curiosity. For this research, the state of curiosity was considered. Higher factor loadings of variables were examined in evaluating the scale, thus the terms "exploring", and "intrigue" were adapted for the VRNES. This became "exploring the environment" and "know how the story would end".

As mentioned in **Section 2.4.3.1**, the use of curiosity types may be a valuable way to add curiosity elements to digital story lines. To evaluate this, two variables were added based on the curiosity types of perceptual (CS004) and manipulatory (CS005). The construct for curiosity can be regarded as:

- CS001 I felt interested in the story.
- CS002 I wanted to know how the story would end.
- CS003 I was interested in exploring the environment.
- CS004 I paid more attention to highlighted elements/objects.
- CS005 I was interested in the objects I could interact with

The enjoyment construct was adapted from the IMI (Ryan and Deci, 2000) and Vorderer, Klimmt and Ritterfeld (2004a) conceptual model of enjoyment. The IMI was created to target a participant's subjective experience during an activity. Among other concepts, it assesses the participants' interest or enjoyment of that task. All items on the subscales have had a factor loading of at least .6, and the scale has strong support for validity (McAuley, Duncan and Tammen, 1987). Three variables were adapted from this scale for the VRNEF, utilising the terms "enjoyable", "interesting", and "attention". Vorderer, Klimmt and Ritterfeld (2004a) suggested that enjoyment was the core of entertainment and had prerequisites that needed to be met by the media product. These prerequisites included the technology used, the design, the content, and the aesthetics. Thus, two variables were added to target these prerequisites in a broad sense. Additionally, Csikszentmihalyi (1997) suggested that one criterion needed to create enjoyment was users having a sense of control over their actions. This combined construct on enjoyment can be seen below.

- EN001 During the experience I felt moments of enjoyment.
- EN002 During the experience I felt great interest in the story.
- EN003 I would describe this experience as enjoyable (IMI)
- EN004 This experience held my attention well (IMI)
- EN005 In would describe this experience as interesting. (IMI)
- EN006 I felt a sense of control over my actions.

As discussed in **Section 2.4.4**, *aesthetic value* encompasses emotion (personal experiences), imagery and design elements, such as visual or audio components. As this is a multifaceted concept by itself, variables were added to encompass these values. The *aesthetic value* construct was compiled based on the review in **Section 2**, the analysis of the aesthetic pleasantness scale in **Section 4.3**, and an aesthetic pleasure design scale (Blijlevens *et al.*, 2017).

Based on the aforementioned definition, one variable targeted visuals. Another two variables regarding emotional reactions were gleaned from the original scale of aesthetic pleasantness used in *Phase One*. The final two variables were constructed from the aesthetic pleasure design scale (Blijlevens *et al.*, 2017). This scale included the concepts of aesthetic pleasure, typicality, novelty, unity and variety. Two variables were chosen from this scale due to their high factor loadings to encompass the design aspect of *aesthetic value*. Therefore, the resulting construct of *aesthetic value* can be seen below.

- AV001 The experience was visually interesting.
- AV002 Some moments/imagery in the story reminded me of a personal experience.
- AV003 The experience was aesthetically pleasing.
- AV004 The experience was rich in different elements.
- AV005 The visual experience was unique.

The final construct of the VRNEF measurement scale is suspense. Recall in **Section 2.4.3.2**, in regard to this research, suspense is viewed through the lens of tension. In addition, Lenhe and Koelsch (2015) speculated that moments of suspense could occur due to uncertainty or instability. Furthermore, Bound (2016) suggested that the cognitive state of anticipation is an important component of suspense and can influence how individuals comprehend stories. These keywords (tension, uncertainty, and anticipation) were used as variables for the construct of suspense. Two more variables were added that expanded these definitions for accuracy of results.

- SS001 At moments in the story, I was eager to find out what would happen next.
- SS002 Some moments were rather suspenseful.
- SS003 At moments in the story, the outcome seemed uncertain.
- SS004 At moments in the story, I experienced anticipation.

- SS005 At moments in the story, I experienced tension.

5.1.2 Results of Initial Validity and Reliability Study

The following sections will address the reported results for the initial reliability and validity study of the VRNEF measurement scale. These results are calculated through the use of Cronbach's α and a confirmatory factor analysis of the constructs.

For this study, 32 participants were recruited to take part, using the same VR experience created in *Phase One*. These participants had not taken part in the previous study, and the study was conducted in person, using consistent hardware in a predetermined space, as suggested by the recommendations from **Section 4.5**. See **Appendix: G** for CFA data.

5.1.2.1 Cronbach's α

As mentioned in **Section 3.4.1**, Cronbach's α is used in conjunction with the CFA to measure reliability. It accomplishes this by measuring the internal consistency of a scale, with the measurement expressed as any number between 0 and 1.

Table 5-1 Initial Cronbach's A In 2nd Phase

Construct	Cronbach's α	Number of Items
Narrative understanding	.750	4
Narrative presence	.610	4
Spatial presence	.559	5
Emotional engagement	.858	5
Suspense	.873	5
Curiosity	.266	5
Enjoyment	.723	5
Aesthetic value	.233	5

Initial values of the Cronbach's α ranged from the lowest at .233 (*Aesthetic value*) to the highest at .873 (*Suspense*). According to Hinton, McMurray, and Brownlow, (2004) an acceptable value for reliability is .5, with good reliability at .7. Under this model, the concepts on *Enjoyment*, *Suspense*, *Emotional engagement*, and *Narrative understanding* all rated as having good reliability. The concepts of *Narrative presence* and *Spatial presence* are rated with acceptable reliability, while the concepts of *Aesthetic value* and *Curiosity* are rated as having unacceptable reliability. However, after the CFA was completed, the final values of Cronbach's α changed due to adjustments to the constructs that were needed to perform the CFA.

Table 5-2 Adjusted Cronbach's α In 2nd Phase.

Construct	Cronbach's α	Number of Items
Narrative understanding	.750	4
Presence	.810	4
Emotional engagement	.858	5
Suspense	.873	5
Curiosity Story	.863	2
Curiosity Environment	.463	3
Enjoyment	.867	4
Aesthetic value	.730	3

As noted in **Table 5-2**, *Curiosity* was divided into two (*Curiosity environment, Curiosity story*), and *Spatial* and *Narrative presence* were combined, as well as some variables changing. This put the final αs all above .7 with the exception of *Curiosity Environment*, which still rated at an unacceptable value of .433. It is important to note that due to the reduction of some of the variables, the final values of the Cronbach's α may be inflated. For this reason, the α does not establish reliability alone, but needs to be assessed in conjunction with the confirmatory factor analysis (CFA).

5.1.2.2 Confirmatory Factor Analysis

The calculation of the CFA was run in two programs, SPSS AMOS and STATA. This is due to the nature of the data gathered, to account for discrepancies. The CFA in SPSS AMOS runs under the assumption that the errors involved in the data are independently and identically distributed, following normal probability distribution with zero mean and unknown variance. However, the data collected for this study violates this, as it is non-normal and asymmetrical. This means most participants had similar responses on the scale, with little deviation. As this study tested validity, not model fit, it was unclear the effect this would have on the resulting data. For this reason, the CFA was also run in STATA using Satorra-Bentler adjustments to account for this issue and compare the results for better accuracy (Satorra and Bentler, 2010). Satorra-Bentler adjustments can better calculate a CFA when non-normal and asymmetrical data is involved.

In a Confirmatory Factor Analysis both convergent and discriminant validity are assessed. These examine the extent to which measures of a latent variable shared their variance and how they are different from others. Convergent validity is the degree of confidence we have that a trait is well measured by its indicators. Discriminant validity is the degree to which measures of different traits are unrelated. These are reported and assessed by the Average Variance Extracted (AVE) and Composite Reliability (CR). CR is a less biased estimate of reliability than Cronbach's α, with an acceptable value of .7 and above. AVE measures the level of variance captured by a construct versus the level due to measurement error. Values above 0.7 are considered very good, whereas the level of 0.5 is acceptable.

In both programs, the CFA does not run properly so the model was adapted for a better fit by the restructure of two constructs as noted in **Table 5-2**, **5-3**, and **5-4**. To run the CFA, two variables were removed from the *Aesthetic value* construct, three variables removed from the *Spatial presence* construct, two from *Narrative presence*, and one from *Curiosity*. The removal of these was due to poor factor loadings. Moreover, *Spatial* and *Narrative presence* were combined, as they had higher correlations, and *Curiosity* was divided into two, as they appeared to measure two types of curiosity: *story* and *environment*.

According to SPSS AMOS, all constructs had a CR above .7, with the highest rating at .902 for *Suspense*, and the lowest at .714 for *Curiosity of environment*. Additionally, all constructs are rated above .5 with AVE, with *Curiosity of story* rating the highest at .760, and *Aesthetic value* with the lowest at .520.

Table 5-3 SPSS AMOS Validity Values

Construct	CR	AVE
Narrative understanding	.812	.596
Presence	.820	.536
Emotional engagement	.856	.569
Suspense	.902	.697
Curiosity	.863	.760
Curiosity Environment	.714	.561
Enjoyment	.842	.588
Aesthetic value	.757	.520

STATA reported a change in some values. While all constructs are still reported above .7 for CR, Enjoyment was indicated the highest at .903, and *Aesthetic value* the lowest at .754. Again, all constructs reported above .5 on the AVE scale. Enjoyment was recorded with the highest AVE at .705, and *Narrative understanding* the lowest at .504, barely higher than *Aesthetic value* at .509.

Table 5-4 STATA Validity Values

Construct	CR	AVE
Narrative understanding	.805	.582
Presence	.818	.535
Emotional engagement	.861	.560
Suspense	.890	.625
Curiosity	.851	.693
Curiosity Environment	.720	.552
Enjoyment	.904	.705
Aesthetic value	.754	.509

It should be considered that the values recorded from the CFA may have a degree of inaccuracy due to the small sample size of the study. Recall from **Section 3.4**, that the suggested participant count for this reliability and validity study was 76, and only 32 participants were recruited.

5.1.3 Reliability and Validity Study Analysis

The results of the initial reliability and validity test show some promising values, as well as a few concerning ones. As mentioned in **Section 5.1.2** these were reported by using the Cronbach's α, CR and AVE. The VRNEF measurement scale shows high values of composite reliability (CR) across all constructs in both programs used. It also shows a high Cronbach's α across all constructs, with the exception of curiosity environment. As both values determine the reliability of the data, with the CR being less biased than the α, it would appear that the modified VRNEF is acceptably reliable. Moreover, all constructs scored above .5 on the AVE, which is the minimum value required. Since the AVE and CR help to determine construct validity, it can also be assumed that the data is also valid.

However, as .5 is the acceptable range, some constructs were barely past that amount. In particular, *Aesthetic value*, which scores between .509 and.520 on both programs. During the CFA process two variables were removed from *Aesthetic value* due to poor factor loadings, which enabled the calculation of the analysis. This does not necessarily mean that those variables don't fit the construct, but rather that they need to be reassessed and reworded, with the goal of refitting them back into the construct. Additionally, as the AVE is just over the acceptable line, the construct as a whole requires reassessment. This is not completely surprising as *aesthetic value* itself is a multi-faceted concept.

Likewise, the *curiosity* construct also proved troublesome. Although only one variable was removed, it was necessary to split the construct into two. This is not ideal for the constructs, as they ended up with only two variables each. Having only two variables in a construct can create inflation with the Cronbach's α, as well as other mathematical errors in the statistical analysis. Therefore, the construct of *curiosity* also must be revised and reconstructed. Since the curiosity construct visually appears to be measuring two separate aspects of curiosity, and has relatively high factor loadings within them, the split in the constructs should remain, but with more variables added.

Furthermore, the *presence* constructs (spatial and narrative) had a total of five variables removed and were eventually combined. Although the combined construct fared well with the Cronbach's α, CR, and AVE, this is also not an ideal solution. It is assumed that the constructs worked better together due to the

questions being too similar in nature, without enough variance to be distinctive. Therefore, these constructs also must be reviewed and amended.

To review, according to the Cronbach's α and the CFA, the modified VRNEF is considered to have good reliability and acceptable validity. However, as the study was performed with a limited sample size and modifications needed to be made to the scale, there is room for inaccuracy and bias. Additionally, a single study does not necessarily confirm reliability and validity data. Therefore, reliability and validity are tested again in the final study in **Section 6.2**, utilising a larger sample size, and reconstructing the problematic constructs of *Aesthetic value*, *Curiosity*, and *Presence*.

5.1.4 Modifications of VRNEF Measurement following CFA

After the calculation of the initial Cronbach's α and CFA of the measurement scale, some of the constructs and variables needed to be modified to prove reliability and validity. These included the concepts of *Aesthetic value*, *Curiosity*, *Spatial presence*, and *Narrative presence*. These modifications are then tested again during *Phase Three* of the research.

As noted in **Section 4.1.1.8**, the original scale for *Aesthetic value* had the following questions:

- AV001 The experience was visually interesting.
- AV002 Some moments/imagery in the story reminded me of a personal experience.
- AV003 The experience was aesthetically pleasing.
- AV004 The experience was rich in different elements.
- AV005 The visual experience was unique.

During the CFA, AV001 and AV002 were removed due to poor factor loadings. Therefore, these variables needed to be reassessed, and the construct rebuilt. Further research was conducted to assess and rebuild the *Aesthetic value* construct. To do so, aesthetic design, pleasantness, and aesthetic emotions were re-examined.

According to Khalighy *et al*. (2014) on measuring aesthetic design, aesthetics is divided into two categories: beauty and attractiveness. Beauty is then split further into contrast, proposition, and pureness, while attractiveness is split into novelty and appropriateness. In this context, beauty is a constant phenomenon not affected by external stimulus, while attractiveness is variable and can change over time. Conversely, under the Blijlevens *et al*. (2017) five factor model, aesthetics consists of five categories: pleasure, typicality, novelty, unity, and variety. The category of pleasure contains the elements of beauty and attractiveness together, instead of in opposing constructs. Additionally, the concepts of beauty, attractiveness, and novelty play important roles in measuring aesthetics, and are often used as defining words in studies surrounding aesthetics (Khalighy *et al*., 2014; Blijlevens *et al*., 2017; Schindler *et al*., 2017). Therefore, the terms beautiful (AV007) and attractive (AV001) were added, as they appeared to be the most used in the research conducted and had high factor loadings at .917 and .936 respectively on the five-factor model (Blijlevens *et al*., 2017). The word visually from AV005 was removed, while leaving "unique" in place. Unique is used instead of the word novel, as it may be easier for participants to define.

Additionally, Schindler *et al*. (2017) postulated that some negative or unpleasant emotions may have a place in creating *aesthetic value*. According to their research, people experienced greater nostalgia when presented with aesthetic stimuli when in a negative mood. Moreover, a tragic story touched more people after being exposed to stimuli that made them think about their own mortality. Schindler *et al*. (2017) suggested that the "feeling of being moved" may be able to capture some of these unpleasant emotions, without explicitly stating that they are negative on the scale, as this would change how the scale is scored. To clarify, the words "being moved" may be used to encompass feelings of nostalgia, melancholy, or even sadness. For this reason, the original AV002 was replaced with the simpler statement of AV006, stating that the experience was "moving". Finally, AV002, the experience was "inspiring", was added in, as it had

been used in the pilot study in *Phase One* with some success, and to increase the number of variables in the construct to increase accuracy (Rowold, 2008; Cupchik and Laszlo, 1994; Roth, 2016).

With these changes, the overall construct of *Aesthetic value* was revised to the following:

- AV001 The experience was visually attractive.
- AV002 The experience was inspiring.
- AV003 The experience was aesthetically pleasing.
- AV004 The experience was rich in different elements.
- AV005 The experience was unique.
- AV006 The experience was moving.
- AV007 The experience was beautiful.

* * *

In considering the *curiosity* construct, the modifications made were more extensive. To review, the original *curiosity* construct listed the following statements:

- CS001 I felt interested in the story.
- CS002 I wanted to know how the story would end.
- CS003 I was interested in exploring the environment.
- CS004 I paid more attention to highlighted elements/objects (types)
- CS005 I was interested in the objects I could interact with (types)

During the calculation of the CFA, CS005 was removed due to a poor factor loading, and CS001 and CS002 formed one construct, while CS003 and CS004 formed the other. While the newly formed constructs had good overall reliability and validity, more variables needed to be added to improve accuracy of the measurements. The first construct of curiosity was based upon the story. Hoeken's (2000) research studied the inter-connectivity of suspense, curiosity, and surprise, as well as their relationship. Their research found that both curiosity and suspense influence the appreciation of the story. This would infer that a higher appreciation of a story might equal a higher value in curiosity. Based on this concept, CS001 through CS005 were revised to target the appreciation of the story through curiosity. This led to the following changes:

- CS001 I found the story interesting.
- CS002 I felt interested in how the story would end.
- CS003 I found the story stimulating.
- CS004 I felt focused on the story.
- CS005 I found the story surprising.

The second construct created targeted curiosity in the environment. As two of the variables in the construct were directed towards curiosity types (To *et al*. 2016), this concept was expanded to include variables aimed at interactions that evoked curiosity using all five curiosity types. To review, these were: perceptual/attention to something new (P), manipulatory (M), curiosity about complex/ambiguous (C), conceptual/active information seeking (C/A), and adjustive-reactive (A/R). Following this model, *curiosity environment* was reconstructed as:

- CE001 I was interested in exploring the environment (A/R)
- CE002 I was interested in the main characters (C/A)
- CE003 I was interested in the objects around me (M/P)
- CE004 I was interested in how I could affect the virtual world (C)

* * *

The final change to the VRNES measurement scale was the spatial and *narrative presence* constructs. To review, the constructs consisted of the following:

- NP001 During the experience, my mind was inside the world created by the story.
- NP002 I was not aware of my real environment.
- NP003 I was completely captivated by the virtual world.
- NP004 During the experience, I felt involved in the story.

- SP001 I felt physically present in the virtual world.
- SP002 In the experience I had a sense of being there.
- SP003 I felt like I could move around the environment.
- SP004 I felt that I could interact with objects in the virtual environment.
- SP005 In the experience I had a sense of being there due to the ambient sounds around me.

During the CFA, SP002, SP003, SP005, NP002 and NP004 were removed, with the remainder of the questions being combined under one construct. As this is not an ideal solution, the constructs were separated again, and the variables were more clearly defined.

In the case of *spatial presence*, Vorderer *et al* (2004b) gave some clearer insight into defining *spatial presence*. They categorised *spatial presence* as including both location and action. Using their model, which is situated on a 4-item Likert scale, variables were extracted based on a Cronbach's α of .8 or more. This fit the original construct, as the items not removed during the CFA were SP001 (location) and SP004 (action). Therefore, these were expanded to include two additional variables each, representing location and action respectively. Thus, the modified *spatial presence* construct became:

- SP001 I felt physically present in the virtual world (L)
- SP002 I felt like the objects in the environment surrounded me (L)
- SP003 I felt like I was actually there in the virtual environment (L)
- SP004 I felt like I could interact with objects in the virtual environment (A)
- SP005 I felt like I could move around the environment (A)
- SP006 I felt like I could have some effect on things in the environment (A)

Narrative presence proved more problematic. Upon further review, the construct of *narrative presence* appeared to share some similarities with *transportation* (Green and Brock, 2004). Transportation is defined as absorption into a story, and is comprised of imagery, affect, and attentional focus. Based on this theory, Appel *et al*. (2015) developed a short form scale for transportation broken into four subjects: Cognitive, general, emotional, and imaginative. However, translating this scale to an adaptation for digital media is challenging, as most of the *transportation* elements surround mental imagery. This is not suited for a media such as virtual reality that relies heavily on visual elements. For this reason, *transportation* was not chosen to be a part of the VRNEF measurement from the start. Unfortunately, the original construct appeared to be leaning toward transportation elements (NP002, NP004), making *narrative presence* difficult to separate from *spatial presence* in a digital scene. To remedy this, the construct was rebuilt to resemble the original definition of *narrative presence* more closely: involvement (Schubert, Friedmann, and Regenbrecht, 2001). Therefore, the adjusted narrative presence construct consisted of the following:

- NP001 I was unaware of time in the virtual world.
- NP002 I felt involved in the story.
- NP003 I was unaware of the physical world outside the experience.
- NP004 I found it easy to keep my mind on the story.
- NP005 I was completely captivated by the story.

After these adjustments were made to the VRNEF measurement scale, the entire scale was tested again for reliability and validity in **Section 6.2**. It is important to note that following the final reliability and validity analysis, a few more minor modifications were needed. Therefore, see **Appendix: F** for the final version of VRNEF scale.

5.2 VRNEF Guidelines

The guidelines of the VRNEF are built in direct correlation to the measurement scale. The guidelines aim to provide solutions to any of the concepts of narrative engagement that fail or otherwise hinder effective engagement in the storytelling experience. In short, it provides a way to practically apply tools and concepts to a cinematic VR experience while pinpointing where the application is failing. It is important to note that these solutions are not finite and serve as suggestions for developers and researchers alike. In the following sections, each concept is discussed as to how it can possibly be applied in virtual reality to create or improve narrative engagement. In addition, each concept has a threshold mean (which is derived from the scale) that denotes at which point the narrative engagement is failing, and therefore needs further analysis and/or adjustment. These thresholds are set based on the maximum score available for each construct with the direct weight of the Likert scale. For example, if each construct has a maximum score of 5, a score of 2.5 would be considered neutral; 2.4 would be considered to be in the negative; and 2.6 would be considered as positive. It is important to note that if a construct fails completely; it does not necessarily mean that the experience is failing at narrative engagement, provided that the overall threshold for the entire scale is <25 as this is slightly more than half of the total possible points of 45.

In summary, the concepts of narrative engagement are *narrative understanding*, *narrative presence*, *spatial presence*, *emotional engagement*, *suspense*, *curiosity of story*, *curiosity of environment*, *enjoyment*, and *aesthetic value*. See **Appendix: F** for the final version of the VRNEF guidelines.

5.2.1 Narrative Understanding

Regarding this research, *narrative understanding* is the comprehension and ease of its conception of the story within the experience. This concept relies on the storyline of the narrative experience. Thus, choosing and applying a narrative structure is crucial for the enforcement of this concept. Narrative structures can be used as blueprints for the plot, and they also form patterns that allow the receiver to create meaning from the experience. Additionally, a narrative structure will create a more cohesive story, connecting all of the storytelling elements. This helps prevent confusion or the possibility of the participant becoming lost in the plot. Therefore, the implementation of a narrative structure would directly impact narrative understanding.

In **Section 2.4.1**, some possible story structures were provided that could be better adapted to storytelling in virtual reality. Therefore, the suggestion for this concept is to make use of the following structures within a cinematic VR experience:

- Aetiological oral narratives, Gangan Comics, Sira narratives, epiphanic structure (Koenitz *et al.*, 2018, pp. 107-120)
- Propp's morphology of folklore (Propp, 1928)
- Three-act structure of Aristotle that starts with an inciting incident (Bucher, 2017).

Choosing one of these structures may help to alleviate any conceivable breakdown of the story that may confuse the user, as the structures tend to have more lenient literary rules. The threshold for *narrative understanding* is a mean of 2.6 or greater for a positive effect on narrative engagement.

5.2.2 Narrative Presence

As mentioned in **Section 4.1.1.2**, *Narrative Presence* is defined as the participant's involvement in the story. This is the concept of being mentally present within the narrative. Two suggestions are considered to create the participant's involvement in the story. The first is the ability of the story to persuade users through the events of the story structure. The more persuasive the story, the greater the possibility for the participant to stay involved in the narrative. Research by Dahlstrom (2012) suggested that events that are part of the cause-and-effect structure of the story are more persuasive than other main story elements. Cause-and-effect is a series or chain of events/actions that progress the direction of the narrative. For example, a character is motivated to achieve a goal; they go on a mission to reach it; which then leads to other characters helping or preventing this achievement.

The second suggestion for creating narrative presence is the concept of character connection. This is not to be confused with emotionally connecting with the character but rather how the person can relate to the character or the character's situation.

One way to create this connection is to remind users of experiences in their own lives that relate to those in the narrative. Reminding can create a link between story content and the user's past personal or media-based experiences. Individuals were more involved in a story when the story brought to mind events from the users' real lives (Strange and Leung, 1999). The threshold for *Narrative Presence* is a mean of 2.6 or greater for a positive effect on narrative engagement.

5.2.3 Spatial Presence

Spatial presence is comprised of *location* and *action*. *Location* is the classic definition of “being there”, and *action* is the possible actions that the participant can perform in the virtual space (Vorderer *et al*., 2004). Therefore, the suggestions for creating spatial presence are divided into those two groups, so that they directly correlate with each statement within the VRNEF measurement scale.

SP001, SP002, and SP003, are all associated with *Spatial presence location*. This may be improved by the use of minimaps, waypoint navigation and landmarks. Minimaps may be attached to controllers within the environment and display the participant’s relative position. This means that the minimap moves with the player but does not rotate, as it maintains the same orientation as the landscape. Waypoints may allow participants to move quickly from specifically marked locations. Additionally, landmarks are an inexpensive way to orient the participant, and if given meaning within the environment, can prove to be an effective tool for improving spatial presence (Kotlarek, Lin and Ma, 2018).

SP004, SP005, and SP006 correlate to *Spatial presence action*. *Action* is centred around interactivity. Interactivity within an IDN can be physical, cerebral, and emotional. Physical interactivity concerns the senses: sight, hearing, touch etc. Cerebral interactions include such things as a strategy. Emotional interactions include empathising and identifying with a character (Designing Interactivity into Game Play, 2019). As this construct is dedicated to presence, interactivity for this concept is centred around the physical, in particular, what the user can touch and how they can move within the environment. Therefore, the interactivity for this construct needs to contain the ability to pick up, move, or interact with objects in some way; allow the physical movement of the user through the virtual space; and allow the interactive items to have some effect on the environment or story.

The threshold for *spatial presence is* a mean of 2.6 or greater for a positive effect on narrative engagement. In addition, although the contrast is a combined calculation, as it is split into *location* and *action*, it should be easy to identify which part of spatial presence is effective and which is ineffective within the construct as well.

5.2.4 Emotional Engagement

The creation of *emotional engagement* entails that the use of specific design elements and psychology are intertwined. Firstly, consider the Lazarus Theory of Cognition (Folkman *et al.*, 1986). This theory states that emotions have intentionality and that a person's cognition determines their significance and force. To create an emotional response, the following steps are followed in order:

- A stimulus is introduced.
- The individual creates a cognitive appraisal of the stimulus.
- An emotional response is produced based on the cognitive appraisal.
- A physiological response is formed based on the emotional response.

While the creator or researcher has little control over the last three steps, they do have more control over the stimulus. The practical application of this stimulus in VR requires certain design elements. In this research context, this application is focused on colour, audio, and character development.

As stated in **Section 2.4.4**, colours affect people physiologically and can influence emotions and moods (Karr, 2013). Additionally, colours may have multiple emotions tied to them and can vary depending on personal and cultural background.

For the simplicity of this guideline and in the context of this research, colours are matched based on Ekman's (2016) seven basic emotions (and their colour associations) and the psychology of achromatic and chromatic colours (Wilms and Oberfeld, 2018). For example, the emotion of enjoyment is tied to the saturated colours of orange and yellow. See **Table 5-5**.

Table 5-5 Ekman's basic emotions and their associated colours

Ekman's Emotions	Associated Colours
Fear	*Purples*
Anger	*Saturated Reds*
Disgust	*Yellow-Greens*
Enjoyment	*Saturated yellows and oranges, light blues*
Surprise	*Medium saturated blue-greens*
Contempt	*Red-orange*
Sadness	*Desaturated blues*

In addition to colour, the use of audio will assist in creating emotional engagement. As mentioned in **Section 2.5.2.2**, the ability of virtual reality to utilise spatial sound can be a valuable tool in eliciting emotions, such as triggering moments of fear (Bhide, Goins and Geigel, 2019). Additionally, the use of music may also be of use.

Using the Musical Mood Induction Procedure (MMIP), Västfjäll (2001) explained that a slow tempo produces seriousness, sadness, anxiety and even serenity. Conversely, a higher tempo can evoke humour, happiness, or excitement. Low pitches tend to evoke seriousness, sadness, and fear, while medium and higher pitches evoke serenity, humour, happiness, and excitement (Balkwill, and Thompson, 1999; Juslin and Sloboda, 2001; Jacquet, 2014). These principles were also applied using Ekman's (2016) emotions, and therefore the suggestion for music is as follows:

Table 5-6 Ekman's basic emotions and their associated music

Ekman's Emotions	Pitch	Tempo
Fear	*Low to medium*	*Medium to fast*
Anger	*Medium*	*Fast*
Disgust	*Low*	*Slow*
Enjoyment	*High*	*Fast*

Surprise	*Medium to high*	*Medium to fast*
Contempt	*Medium*	*Slow to medium*
Sadness	*Low*	*Slow*

The final tool for emotional engagement is character development. This correlates to both the design and personality of the character. As mentioned in **Section 2.4.4.1**, the overall shape of the character plays a role in eliciting an emotional response. This is by the psychological assumption that people inherently view angular objects as potentially threatening and rounded objects as friendly. Along with the designing the shape of the character, crafting the personality is also important, as it allows the user to empathise and emotionally connect to the characters. The suggestion for this creation is the use of the FFM. To review, the Five Factor Model (FFM) suggests that the personality of people and characters is assessed across five domains: neuroticism, extroversion, openness, agreeableness, and conscientiousness (McCrae, Gaines and Wellington, 2012; Isbister, 2006, pp. 23-40). Therefore, the creation of a personality based on the FFM can be observed in the following example:

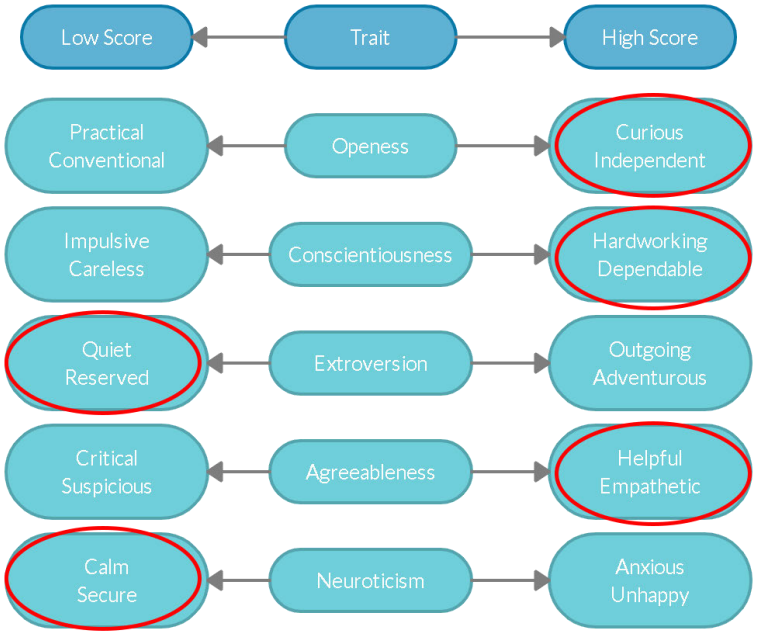


Figure 5-1 Five Factor Model with example choices
(McCrae, Gaines and Wellington, 2012. Image is original representation, modified for aesthetic purposes and to indicate chosen values.)

Note that the red circle indicates a chosen personality trait. Any combination may be made provided that only one trait is chosen per domain. Utilising these suggestions may help to improve emotional engagement within the narrative engagement structure. The threshold for *Emotional Engagement* is a mean of 2.6 or greater for a positive effect on narrative engagement.

5.2.5 Suspense

Suspense focuses on the use of the suspense effect structure and lighting. To review, the suspense effect structure must contain an initiating event that leads to significant consequences. This event must happen early within the discourse, and there must be a resolution of the suspense (Brewer and Lichtenstein, 1928). Within this structure, four types of suspense can be enacted: vicarious, direct, shared, and composite (Smith, 2000). For virtual reality, the suggestion is to implement either or both, direct and vicarious suspense, as VR tends to have shorter narratives (Bound, 2016). Both direct and vicarious suspense is focused on the participants and how they perceive the situation, rather than the participant's relationship with the other characters. Hence, the VRNEF measurement scale questions are participant targeted.

Additionally, the other possible practical tool for creating suspense is the use of light within the experience. For example, using low-key lighting draws viewers' attention to potential hidden dangers (Eitsen, 2010). Furthermore, directional lighting can be used to deliberately conceal or delay story elements, highlight objects or key characters, or can be used to reveal story information (Bound, 2016).

To clarify, if the suspense fails within the narrative, the use of direct or vicarious suspense may not be employed effectively; there may be a lack of a suspense effect structure; or the lighting may be creating the wrong atmosphere to cultivate suspense. The threshold for *Suspense* is a mean of 2.6 or greater for a positive effect on narrative engagement.

5.2.6 Curiosity of Story

The construct of *Curiosity Story* correlates to the curiosity event structure, as mentioned in **Section 2.4.3.1**. The curiosity event structure states that it must contain a significant event early within the story. However, the significant event is omitted from the story, and the participant is given just enough information to know that the event is missing. The curiosity is resolved when enough information is provided later in the story for the participant to reconstruct the event (Brewer and Lichtenstein,1982). This reinforces the findings from Hoeken's (2000) research that curiosity influences the appreciation of the story. However, the curiosity event structure does not necessarily negate the suspense event structure from **Section 5.2.5.** Both structures may exist within the story as these concepts are interconnected. The threshold for *Curiosity Story* is a mean of 2.6 or greater for a positive effect on narrative engagement.

5.2.7 Curiosity of Environment

The *Curiosity of the Environment* is based upon the use and application of curiosity types. Curiosity types include adjustive reactive, complex/ambiguous, manipulatory, conceptual, and perceptual (To *et al*., 2016). Each of these types was targeted by the questions on the VRNEF measurement scale, and therefore gives the ability to analyse them individually to target which are working and which are not. Therefore, the guidelines for this construct are directly linked to each statement on the measurement scale. It is important to note that it is not required that all five curiosity types are implemented, provided that the total mean of the construct is over the threshold mark as stated at the end of this section.

CE001 relates to the adjustive/reactive type. This is engaged when participants explore the functions of objects in a way that is common to that object. This depends on two things: the participant's expectations of the environment and the participant's ability to perceive the environment. Curiosity is created when the participant must probe the environment to understand how ordinary objects behave in it.

CE002 relates to the complex/Ambiguous type. This involves a participant's preference to interact with something complex over something simple. To create this specific curiosity type, it is suggested to have some interactable objects that are variable or have multiple uses and purposes within the experience (To *et al*., 2016).

CE003 correlates to the manipulatory curiosity type. This can be observed in the desire of participants to touch and interact with game objects in the virtual world. An application of manipulatory curiosity may involve the physical manipulation of objects to advance in the experience, solve puzzles, learn, or simply to play. This may be the easiest type to execute in virtual reality, as VR by design, allows participants to interact physically with objects in a virtual world. Additionally, this can also be associated with perceptual curiosity. Perceptual curiosity can be achieved by providing music, sound, visual highlights in the environment, and haptic feedback. Creating a situation that provokes perceptual curiosity can be accomplished by making participants aware of a knowledge gap through the introduction of novel stimuli.

CE004 is connected to the conceptual. This type refers to active information seeking. To utilise this type, an information gap must be created within the experience. This allows the players to investigate or uncover information, stories, mechanics, or other aspects that will keep them engaged in the experience.

The threshold for *Curiosity Environment* differs from the other constructs. As long as at least one curiosity type is scoring high, this construct has a mean of 1.8 or greater for a positive effect on narrative engagement. This is because not all curiosity types need to be used, and the construct is weighted to account for this. However, in the event that the construct meets the threshold of 1.8, but the responses are more symmetrical (with none targeting a high score of a specific type), this would be seen as a failure unless the mean reaches 2.6 overall for the construct.

5.2.8 Enjoyment

As previously discussed from **Section 2.3.1**, Sweetser and Wyeth (2005) noted that enjoyment resulted from reaching optimal flow. They further suggested certain criteria for creating enjoyment targeted at the gaming genre. While most of these criteria do not apply to cinematic experiences as these experiences are not task-based, there are a few that can be adapted to virtual reality. These criteria are the concepts of *control* and *immersion*.

The criterion for *control* is that the user should have a sense of control: over their movements and interaction; have a sense of impact on the virtual world; and be able to engage with the experience the way that they want to (not simply following planned instructions). VR is well suited to this, as the technology allows for physical movement within the world and the ability to let the user do what they want to, thus giving greater autonomy to the user. Regarding *immersion*, users should "experience deep but effortless involvement" (Sweetser and Wyeth, 2005). This means that users should become less aware of their surroundings, less self-aware and less worried about everyday life or self and experience an altered sense of time. Again, VR is well suited for this by the very nature of the technology to override the perception of the user's world. As VR naturally has the ability to enhance enjoyment through these avenues, how can enjoyment be created or improved?

Bilandzic and Busselle (2011) explored how enjoyment is created or enhanced in cinema. This is the concept that *transportability*, *external realism*, and *narrative realism* all are predictors for enjoyment. *Transportability* is a self-reported measure from the user on their ease and frequency of experiencing transportation i.e., a predisposition to losing awareness in the world around them (Green, Brock and Kaufman, 2004). *Narrative* and *external realism* facilitate the narrative experience. *Narrative realism* requires consistency in the story, i.e., the character's motivations and goals. *External realism* requires consistency in the real world, meaning that divergence from the actual world needs to be backed by story-world logic. For instance, the presence of sorcerers in the *Lord of the Rings* series is explained by a story-world logic that allows magic. If these divergences are not explained, it prompts the user's critical thoughts, which disrupts them from the narrative experience. These concepts can directly influence enjoyment or transportation, identification, and immersion. Through this, Bilandzic and Busselle (2011) were able to map how these concepts have a positive influence on enjoyment based on genre. See **Figures 5-2, 5-3,5-4,** and **5-5.**

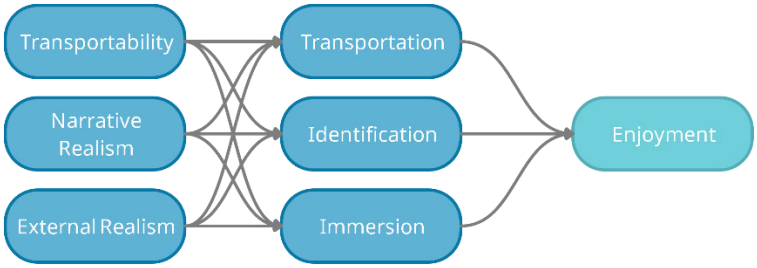


Figure 5-2 Original relationship for transportability.
(Bilandzic and Buselle, 2011. Image is original representation, modified for aesthetic purposes.)

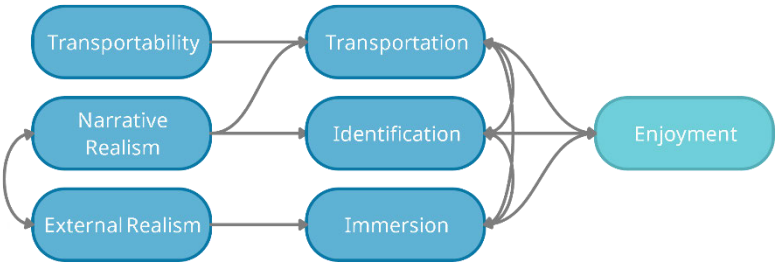


Figure 5-3 Romantic comedy relationship for transportability.
(Bilandzic and Buselle, 2011. Image is original representation, modified for aesthetic purposes.)

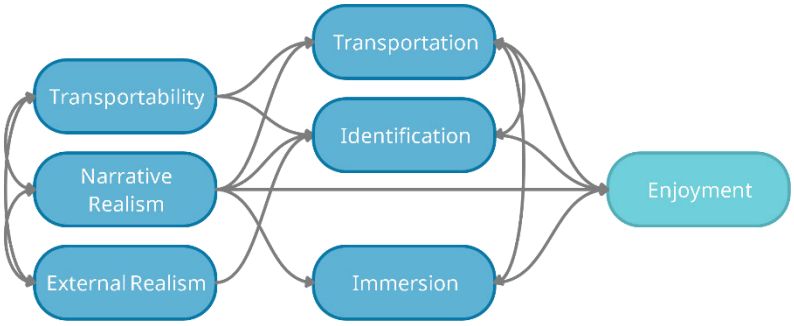


Figure 5-4 Sci-Fi and fantasy relationship for transportability.
(Bilandzic and Buselle, 2011. Image is original representation, modified for aesthetic purposes.)

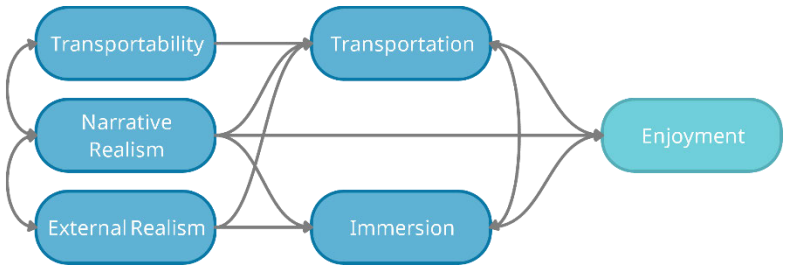


Figure 5-5 Thriller relationship for transportability.
(Bilandzic and Buselle, 2011. Image is original representation, modified for aesthetic purposes.)

Thus, these mappings can be applied in a practical way, by choosing a specific map for a chosen genre. Following the routes, one could ensure that the concepts of *transportability*, *narrative realism*, and *external realism* are appropriately linked to the correct ideas of immersion, identification, and transportation (Cohen, 2001; Green, Brock, and Kaufman, 2004). As a result, this will ultimately improve enjoyment within a story. The threshold for *Enjoyment* is a mean of 2.6 or greater for a positive effect on narrative engagement.

5.2.9 Aesthetic value

Implementing *aesthetic value* is arguably the most important guideline for this framework, as it ties in multiple elements from the other constructs, as well as additional design criteria. As discussed in **Section 2.4.4**, *aesthetic value* for virtual reality encompasses emotion (personal experiences), imagery, and design elements, such as visual or audio components and haptics. As such, there are numerous avenues to take for the creation of this within a VR experience. For this context, there are three practical suggestions: introducing a visual style of characters and story-world; implementing meaningful items in the story-world; and the integration of haptic feedback.

The first suggestion is the use of a visual style, as mentioned in **Section 2.4.4.** This is when design elements work together to create a coherent whole that is more than its individual parts (Garver, Adamo-Villani and Dib, 2018). While the choice of visual style is ultimately up to the creator/researcher, it must

follow proper design rules. This framework includes colour, shape, light, form, movement, and scale (Arnheim, 1954; Pentak and Lauer, 2015).

Regarding colour, its properties include hue (pure colour), intensity (amount of saturation), and value (lightness and darkness of colour). To recall, colours can affect people psychologically, influencing emotions and moods (Karr, 2013; Pentak and Lauer, 2015). However, the usage of the correct colour to affect emotions or moods is tricky. This is because different cultures can have different associations with colours, and the individual can have different associations then the norm. It is possible that one could choose colours based upon their target audience and their association with those colours. However, this may not be a plausible solution, as most VR experiences are available worldwide, and it would be impossible to satisfy this criteria for every culture. Instead, the focus will be on colour theory, and how not to use colour, as this is more universally accepted in the art world.

Colour theory begins with the knowledge that colour cannot exist without light and is therefore closely linked with light. How the colour is perceived by the user is reliant on how the environment is lit. That said, colour theory is based on the traditional colour wheel. **See Figure 5-6.**

Figure 5-6 Colour Wheel
(Original image created by Austin Wolfe)

The primary colours are red, blue, and yellow, any combination of which will result in secondary colours: orange, green and purple. Any combination of secondary colours with primary colours will result is tertiary colours: red-orange, yellow-green, etc. Utilising how these colours work together, creates harmonies. These are visual pairings that are pleasing to the eye, adding to the *aesthetic value*. For example, complementary colours (colours opposite each other on the wheel), create high contrast, but also high tension and, if overused will appear too jarring. Analogous harmonies (colours next to each other on the wheel) create serene environments and are often found in nature, being very pleasing to the eye. Thus, these harmonies can be used in the creation of the storyworld and characters in the VR experience to affect how the experience is perceived and felt by the user. Particularly in regard to characters, their personalities can also be solidified by the colours chosen for them to wear. As mentioned in **Section 2.4.3.1**, an introvert might wear muted tones, and an extrovert might prefer bright colours (Gosling, 2008, pp.12-19). Therefore, depending on what personality traits were given to them from the FFM mentioned in **Section 5.2.4**, those traits would potentially determine the characters coloured wardrobe.

In addition to colour theory, there are a few rules on improper use. Overuse of colour creates clutter and confusion. Overusing certain colours can affect the environment, i.e., an overuse of dark blue can be depressing. Conversely, the under-use of colour results in users lacking interest in the experience (Karr, 2013; Pentak and Lauer, 2015). Therefore, it is necessary to be discerning when using colour to find a proper balance.

Moreover, recall from **Section 2.4.3**, that shape and form are imperative for the visual style. Shape is the contour of something, and form is the visual representation of that shape (Pentak and Lauer, 2015). These are broken into two categories: circular and angular. This applies to both the characters and story-world. For characters, a circular shape/form is often linked to something innocent, safe, or comforting. Angular shapes are often linked to aggression, force, or fear (Solarski, 2017, p. 13). This also applies to the environments. A character with rounder and softer features in a round and softer environment creates a harmony. Whereas that same character in an angular environment creates dissonance, and the environment is seen as a threat. By changing the shapes in the experience, this can be a great advantage, as it quickly can create or dissipate tension, and will alter the perception of the user as well as their emotional involvement.

Notice that the visual style elements of shape and colour both play a role in *aesthetic value* as well as emotional engagement as mentioned in **Section 5.2.4**. Therefore, there is a relationship between emotional engagement and *aesthetic value*, and it would be expected to see similar scoring results in these two constructs.

Next, consider meaningful items. Implementation of meaningful items is not only crucial to *aesthetic value* but also to the story itself. They assist in creating an emotional connection between the user and the characters by increasing connections to the users' own personal experiences. As mentioned in **Section 2.2**, an engaging story-world has the ability to capture the attention of the user/viewer because people are attracted to noticeable details that they find meaningful. In practice, this may be an object that is mentioned or is essential to the storyline. If the item is interactable, upon interaction, it may also add additional story content, such as audio or visual displays. Meaningful items are also connected to the curiosity types mentioned in **Section 2.4.3.1**, as they will most likely be adjustive reactive (exploring objects in a way common to their use), complex ambiguous (interacting with complex items over simpler ones), or manipulatory items (understanding the objects through touch). Therefore, it is expected to see a correlation between the *curiosity environment* construct, and the *aesthetic value* construct.

Another essential element to creating *aesthetic value* is with haptics. Haptics is feedback or vibrations through the technology used by digital media. This ability is unique to the technology and well-suited for the medium of virtual reality. As mentioned in **Section 2.4.3**, aesthetics also relates to the embodiment of the individual in the scene. For *aesthetic value*, haptics is vital as it allows for incorporating further sensory inputs, which leads to a more profound sense of embodiment of the individual in the virtual space. According to Wang (2019), haptic feedback is "indispensable" for enhancing the VR experience, and Richard (2021) stated that there is a "significant superiority of force feedback over no haptic feedback regarding embodiment". Additionally, specifically regarding haptics' aesthetics, it is uniquely qualified for evoking cognitive and emotional reactions (Carbon and Jakesch, 2013).

The hardware to apply haptics is the decision of the creator, as haptic feedback has various forms, including feedback through the VR controllers, VR gloves, arm haptics, full body haptics, and even mouth haptics. Haptics can go beyond vibrations and also include perceived physics in the virtual world. For example, when attempting to collect and interactable item, it may have a different weight compared to another, and will therefore be more difficult to pick up, perhaps requiring two hands instead of one. Adding this type of feedback to the hardware assists in creating a deeper sense of embodiment within the virtual story-world.

Incorporating a visual style, meaningful items, and haptic feedback, all contribute to the aesthetic of the VR experience, and thus, will increase its value. Again, the threshold for *Aesthetic Value* is a mean of 2.6 or greater for a positive effect on narrative engagement.

5.3 VRNEF Conclusion and Final Thoughts

To summarise, the Virtual Reality Narrative Engagement Framework (VRNEF) creation consists of two parts: the measurement scale and the guidelines. The scale was created based on the results of the *Phase One* study, the research examined from **Section 2**, and additional research provided in **Section 5.1**. Upon its completion, the measurement scale was tested for reliability and validity by utilising the Cronbach's α and a confirmatory factor analysis (CFA). Finally, the guidelines portion was created which was determined by the measurement scale, the research examined from **Section 2**, and additional the research provided in **Section 5.2**.

The VRNEF consists of nine constructs: *narrative understanding*, *narrative presence*, *spatial presence*, *emotional engagement*, *suspense*, *curiosity of story*, *curiosity of environment*, *enjoyment*, and *aesthetic value*. These constructs appear in both the measurement scale and the guidelines, and with the exception of *curiosity environment*, all have a threshold mean of 2.6 to be considered as having a positive effect on narrative engagement. By using this framework, creators and researchers will be able to assess VR experiences with the measurement scale, while the guidelines will provide possible solutions to any construct that fails to meet the threshold. Additionally, the entire VRNEF measurement scale has a total threshold of 25. The threshold value was determined by the number of constructs within the scale. Each construct has a max score of 5, and as there are a total of nine constructs, the maximum score that can be obtained is 45. Essentially, the experience must get a high score on at least five constructs (25) to be considered as having acceptable narrative engagement. A score of 30 is considered good, a score of 35 is considered great, and 40-45 is considered excellent. Therefore, even if one construct fails, as long as the overall scale meets the threshold, the VR experience can still be considered as having good narrative engagement. The complete VRNEF framework may be viewed in **Appendix: F**.

6 Phase Three: Final Study

The following sections provide an overview of the final study. The first section, **6.1**, outlines how the final project was created by utilising the nine constructs from the VRNEF. **Section 6.2** presents the results of the final study that was conducted on the aforementioned project, including a second reliability and validity test, as well as the results from the VRNEF scale itself. Finally, **Section 6.3** provides insight for ethical consideration of the study.

6.1 Project Creation for Final Study

A final virtual reality experience was designed to use for the final study of this research. This experience was created based on the guidelines created **in Section 5.2.** Each section describes how the project was developed to meet the criteria of each proposed construct. It is important to note that although the constructs are presented in a linear fashion in this section, the project was not created linearly. Instead, the creation was more organic, with many of the constructs being addressed at the same time.

6.1.1 Creating Narrative Understanding

As previously mentioned from **Section 5.2.1** that *narrative understanding* relies on choosing and applying a narrative structure. For the creation of the final project, the VR application was again based on Scottish Folklore for consistency. The narrative structure chosen was a modified version of Propp's morphology (Propp, 1928). Using this structure, the story was broken down into a "formula", which became the building blocks of the story. In short, the structure consisted of the following functions in order: *Interdiction*; *Absentation*; *Interdiction Violated*; *Villainy*; *Lack*; *Mediation*; *Departure*; *First Function of the Donor*; *Hero's Reaction*; *Magical Agent*; *Transference*; *Struggle*; *Victory*; *liquidation*; *Hero Returns*; *and Solution.* **See Figure 6-1.**

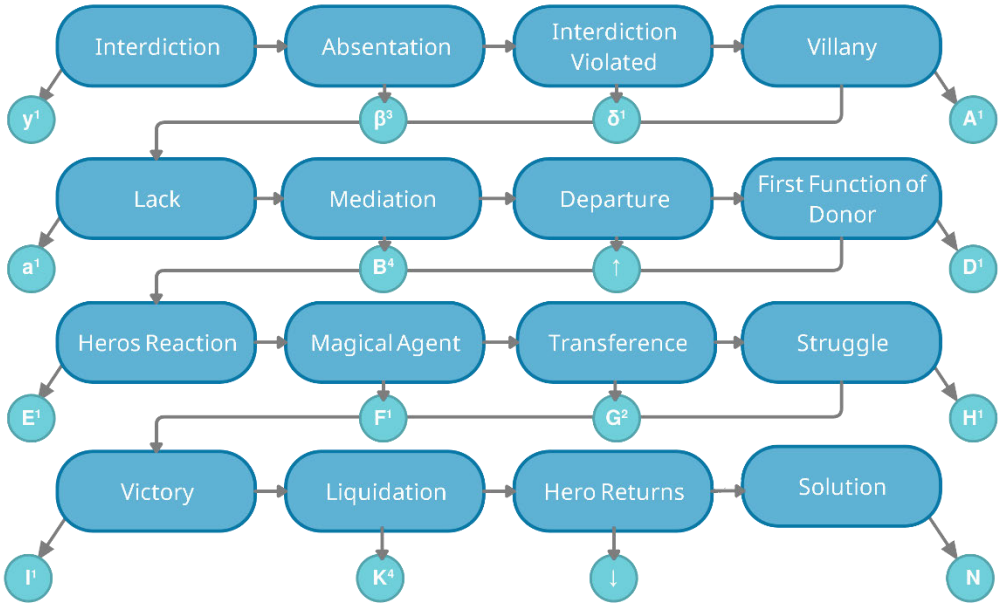


Figure 6-1 Propp's Morphology formula of functions
(Propp. 1928. Original image created by Austin Wolfe)

Note that each function has a corresponding designation value, such as y^1, that indicates which specific action is used per subject. Recall that each function has a possible list of actions as noted in **Section 2.4** and **Figure 2-5**. Choosing an action per function creates a formula for the overall story structure. Therefore, the written formula for this specific story structure can be written as the following:

Figure 6-2 Written formula of functions.

Using Propp's (1928) morphological outline, this formula translates to the following:

- *Interdiction*--An action forbidding something is addressed to the characters.
- *Absentation*--Members of a younger generation absent themselves.
- *Interdiction Violated*--The forbidden action is broken.
- *Villainy*--The villain causes harm to a member of the family by way of abduction.
- *Lack*--The family member lacks something (the abducted family member).
- *Mediation*--The protagonist goes in search for the family member but has not been asked to do so.
- *Departure*--The protagonist leaves home.
- *First Function of the Donor*--The protagonist is tested.
- *Heros reaction*--The protagonist withstands the test.
- *Magical Agent*--A magical agent(s) is directly transferred to the protagonist.
- *Transference*--The protagonist travels through land or on water.
- *Struggle*--The protagonist and villain meet and fight in an open field.
- *Victory*--The villain is defeated.
- *Liquidation*--The object of the quest (abducted family member) is obtained as a direct result of the preceding actions.
- *Hero Returns*-- The protagonist returns home.
- *Solution*--The task is resolved.

This outline acted as a blueprint upon which the entirety of the story was built. This enabled specific details to be filled in that matched each function and their actions. The details of which can be viewed in the full script in **Appendix: H**.

It is important to note, that while at first glance Propp's morphology (1928) may look similar to that of the hero's journey (Campbell, 1991), there are some key differences. Recall that from **Section 2.4.1**, the hero's journey follows a predetermined set of stages, and a reason that is can be problematic in VR is due to its strict story structure surrounding the protagonist. It is often difficult for the user to be the protagonist in VR as the user has active control over the camera and can act upon their own will (interacting or moving where the like). As they can act upon their will, it can be challenging to make them follow a strict formula such as the hero's journey without losing that will. Therefore, this structure breaks down early on, as hero's journey depends on a call to adventure and the protagonist must refuse that call. If the user is made to refuse the call, they are no longer acting on their own will. Thus, if the user is the protagonist, either the structure fails, or the user loses autonomy. However, Propp's morphology has several possible options instead of a call to adventure and provides more leeway regardless of the user being the protagonist. For example, the story does not solely revolve around the protagonist or hero and provides numerous choices. This not only allows for more complex structures, but also enables the creator to craft a story specific to their VR application. As noted in **Figure 2-5** in **Section 2.4.1,** when considering the function *first function of the donor*, if the hero is *tested*, there are nine possible corresponding actions, if they are *interrogated*, there are three actions, and so on. Therefore, if an option in the structure doesn't work for the experience, another option can be chosen that is better suited. For these reasons, this modified version of Propp's morphology was chosen, as it allowed the user to not be in the position of protagonist, while still allowing them their own actionable will.

6.1.2 Creating Narrative Presence

As mentioned in **Section 4.1.1.2**, *Narrative presence* is the participant's involvement in the story. This is the concept of being mentally present within the narrative. The suggestions for applying this concept from **Section 5.2.2**, are to persuade the user through the event of the story, and to create character connection. Therefore, persuasion was created through events that were part of a cause-and-effect structure (Dahlstrom, 2012). This directly worked in tandem with the structure created from the previous section using Propp's morphology (Propp, 1928). In a specific example, the sister of the main character was abducted (i.e., *lack*). As a result, the character was motivated to find his sister (i.e., *mediation*). He went on a journey (i.e., *departure*) and sought the help of other characters (i.e., *first function of the donor*). See **Figure 6-3**.

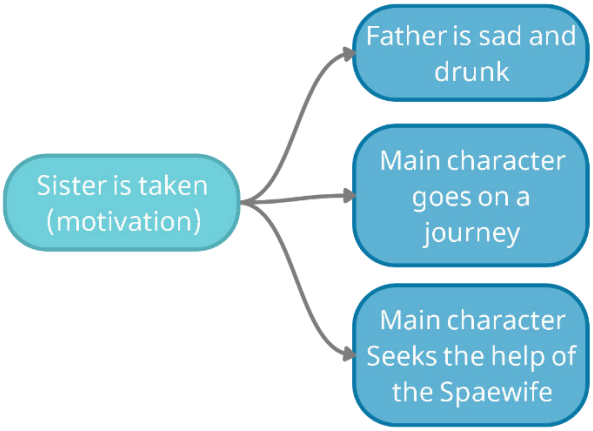


Figure 6-3 Cause-and-effect structure example.
(Original image created by Austin Wolfe)

Along with persuasion, to create *narrative presence*, character connection needed to be enforced. This is how the person can relate to the character or the character's situation. This can prove challenging, as it can be difficult to predict how a user may connect with a character due to their own personal backgrounds and experiences. Therefore, in terms of practical application, opportunities were created in order to provide the possibility of this connection. For example, some opportunities provided concerned the notion of loss. Within the story, this was the loss of both a parent and a sibling, with the surviving parent suffering from depression and alcoholism. Furthermore, the surviving sibling takes responsibility and attempts to solve the parent's problems. Creating multiple opportunities such as these increases the possibility of creating a character connection as they can create a link between story content and the user's past personal experiences. Both these concepts assisted in creating a feeling of involvement in the story for the participant.

6.1.3 Creating Spatial Presence

Spatial presence is comprised of *location* and *action* (Vorderer *et al.*, 2004). For this context, recall that *location* is sense of "being there" while *action* is the range of possible actions within the environment. *Spatial presence location* was created with the use of landmarks/markers. One such marker was that of a recurring bird throughout the locations which orients the user on where to face within the environment using both visual and audio cues. This bird was different from the one created in *Phase One*, as it was more accessible to the user, visually prominent, and was a part of the story as the spaewife's companion. In addition, a glowing marker was used within the scenes to assist the user with returning to the initial starting location of the environment. This was extremely beneficial as it allowed the user to reorient themselves if they physically wandered too far. Therefore, assistance from an outside force was unnecessary, lessening the possibility of users losing spatial presence within the virtual environment.

Spatial presence action is centred around interactivity. As with the pilot study, the user has local agency and an exploratory/internal approach is employed regarding interactivity. This interactivity can be physical, emotional, and cerebral (Designing Interactivity into Game Play, 2019). Physical interactivity was created

through touch with a number of interactable items such as butterflies, birds, and fish. These interactable items moved away if the user's proximity to them became too close. Additionally, visual interactivity was employed through other environmental elements like reduced visibility such as fog and darkness in particular scenes. The user had the option to light up areas with a handheld lantern. Finally, the user was able to physically move their bodies throughout the space as far as the headset would allow them to. This allowed them to access areas and items that were not immediately within their reach. See **Figures 6-4** and **6-5**.

Figure 6-4 Interactable butterflies
(Original image created by Austin Wolfe)

Figure 6-5 Interactable lantern
(Original image created by Austin Wolfe)

Emotional interactions were utilised as these include empathising and identifying with a character. Moreover, they are tied to the character connection aspect of *narrative presence*. An example of this is an interactive item of a stuffed toy. This toy belongs to the missing child in the story and can later be seen being held by the weeping father. This allows for an emotional connection and interaction with the characters as the user can see the connection of the item between the characters, and thus, possibly empathise with the father's pain. This particular item also played the role of a *meaningful item* as discussed in **Section 2.2** and **5.2.9**. See **Figure 6-6**.

Figure 6-6 Meaningful item (toy)
(Original image created by Austin Wolfe)

It is important to note that cerebral interactions were not implemented in this experience as they include such things as strategy, and strategies would most likely be experience in more game like applications.

6.1.4 Creating Emotional Engagement

The creation of *emotional engagement* for the final project was based on the Lazarus Theory of Cognition. Furthermore, *emotional engagement* also included the implementation of colour and music psychology using Ekman's emotions (2016), and character development based on the Five Factor Model (FFM) (McCrae, Gaines and Wellington, 2012). First, consider the Lazarus Theory of Cognition (Folkman *et al.*, 1986).

- A stimulus is introduced.
- The individual creates a cognitive appraisal of the stimulus.
- An emotional response is produced based on the cognitive appraisal.
- A physiological response is formed based on the emotional response.

Multiple stimuli were introduced throughout the experience to evoke emotional responses. Some of these were in the form of virtual physical objects the user could interact with. Others came in the form of visual or auditory cues. For example, as night falls during a particular forest scene, the happy ambient bird song is replaced with various piercing owl hoots, fox screams, and rustling noises.

As stated in **Section 2.4.4**, colours affect people physiologically and can influence emotions and moods (Karr, 2013). For this project, colours for particular scenes, objects, and characters were chosen based on Ekman's basic emotions (2016). These colours were adjusted to reflect any emotional changes throughout the story. For instance, based on the recommendations of **Section 5.2.4**, the feeling of enjoyment was simulated by applying yellows, oranges, and light blues in the opening scene of the experience. See **Figure 6-7**.

Figure 6-7 Opening Scene
(Original image created by Austin Wolfe)

Likewise, audio for each scene depended on the use of the Musical Mood Induction Procedure (MMIP) (Västfjäll, 2001). This procedure also corresponded with the same emotional markers as the colours and was based on the research discussed in **Section 5.2.4** (Balkwill, and Thompson, 1999; Juslin and Sloboda, 2001; Jacquet, 2014). With this in mind, consider again the opening scene referenced in the above **Figure 6-7**. Since this scene was targeting enjoyment, the ambient music has a higher pitch associated with it. Therefore, for this scene, the colour and audio work together to help create emotional engagement by stimulating that feeling of enjoyment.

Lastly, the characters for the VR experience were designed and developed based on the FFM (McCrae, Gaines and Wellington, 2012). For this story, there were four total human characters, and one non-human character. The humans consisted of two children (Alastair and Fia), their father, and a spaewife or witch. The non-human character was a kelpie, a shapeshifting creature from Scottish folklore. First, consider Alastair. On this model, this character was developed as practical and conventional; hardworking and dependable; outgoing and adventurous; helpful and empathetic; and calm and secure. This informed how he would look, act, move, and otherwise behave within the experience. For instance, because of being hardworking and dependable, he was animated to complete strenuous tasks, such as assisting his father on their farm. Additionally, since he was outgoing and adventurous, the story also involved him journeying throughout the experience and encountering various obstacles along the way. See **Figure 6-8**.

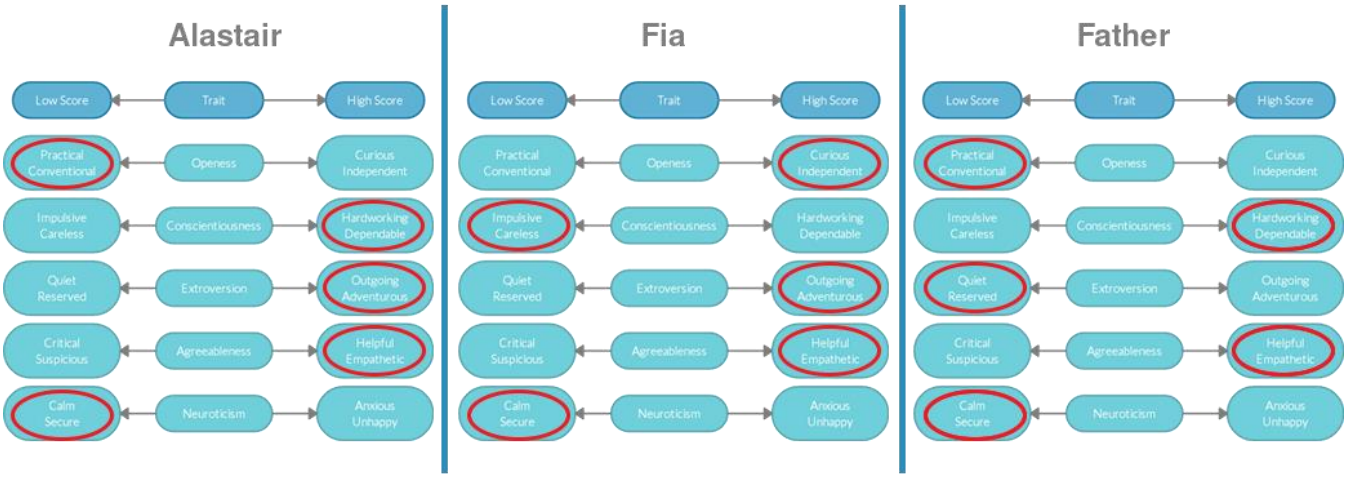


Figure 6-8 FFM for three main characters

(McCrae, Gaines and Wellington, 2012. Image is original representation, modified for aesthetic purposes and to indicate chosen values.)

By developing the FFM for all the characters, it helped to inform their entire personalities as well as their outward appearances. Therefore, in a practical sense, it was extremely beneficial in the modelling, texturing, and animating processes for each character as well as their individual behavioural responses within the story.

6.1.5 Creating Suspense

Suspense focuses on the use of the suspense effect structure (Brewer and Lichtenstein, 1928) and lighting (Bound, 2016). To review, the suspense effect structure must contain an initiating event that leads to significant consequences. Within this structure, four types of suspense can be enacted: vicarious, direct, shared, and composite (Smith, 2000). As this is experience is for virtual reality, both direct and vicarious suspense was utilised as per the suggestion from **Section 5.2.5.**

As discussed in previous sections, vicarious suspense is when the spectator knows more than the character. Direct suspense is where the spectator experiences suspense alone. For this project, vicarious suspense was implemented largely through the narration, as the narration provided some foreshadowing of events to come, such as warnings or admonishments. Direct suspense was implemented in a number of ways, such as specific music with foreboding tones, use of light to conceal or reveal items and areas, compositing the scenes in particular ways to confine or obscure characters and the user, and even the use of silence. An example of this can be seen in **Figure 6-9** below.

Figure 6-9 Underwater lair
(Original image created by Austin Wolfe)

In this scene, audio was reduced to a low rumble of an underwater sound and the user and characters were confined. Additionally, the lighting and visibility was low, so the lantern at the bow of the boat created tension (Lenhe and Koelsch, 2015) in the atmosphere at it slowly revealed the path ahead.

Concerning light in other scenes, additional suspense was created by using an interactable lantern in some of the darker environments. This allowed the user to pick up the light and shine it into the dark spaces, using it to reveal previously hidden objects from view. These are just a few of the examples employed within the experience, but even these few greatly added to the overall suspenseful feel of the application.

6.1.6 Creating Curiosity of Story

The construct of *Curiosity Story* correlates to the curiosity event structure, as mentioned in **Section 2.4.3.1**. The curiosity event structure states that it must contain a significant event early within the story and that the experiencer is given enough information to know that the event is missing, which sparks curiosity.

This particular story focused more heavily on suspense over curiosity and therefore relied on the suspense effect event structure as its main composition. However, the curiosity structure was still utilised. This was applied as a secondary optional story. Notably in the story, the family consists of a single parent. The mystery of the missing parent is the curiosity event, or the “omitted information”. Therefore, meaningful items were created throughout the story. When interacted with, visual written information appeared to the user, giving more information about the missing parent. See **Figure 6-10**.

Figure 6-10 Example of optional story content
(Original image created by Austin Wolfe)

Employing these optional items throughout the experience assisted in satisfying the curiosity of participants. It is important to note that not all users were expected to interact with the objects. Nevertheless, they were vital to add as some users are naturally more curious than others, and therefore, they can be useful to provide the opportunities for that satisfaction.

6.1.7 Creating Curiosity of Environment

The *Curiosity of the Environment* construct is based upon the use and application of curiosity types. Curiosity types include adjustive reactive, complex/ambiguous, manipulatory, conceptual, and perceptual (To *et al.*, 2016).

Adjustive/reactive types refers to exploring objects in a way that is common to their use. For this project, these were objects such as a lantern that lit up, as well as a bow and arrow that the user could shoot a target with. Perceptual refers to how the user perceives stimuli. This was employed by the use of music, sound cues, and visual highlights. For example, within the story there is a wisp (glowing ball with a trail) that creates an audio and visual cue for the user to follow. See **Figure 6-11**.

Figure 6-11 Example of perpetual curiosity
(Original image created by Austin Wolfe)

The conceptual types were not used in this experience as there were no hidden or concealed game mechanics to uncover. Conceptual items usually involve the explanation of why an object behaves the way it does, and this did not seem to fit within this particular story creation. Likewise, complex/ambiguous was also omitted, as there were no overly complex objects that were interactable within the application.

Manipulatory curiosity was used solely through the use of the physical VR controllers used for the experience. Although their usage was simplified to only needing to push one button in order to pick up an object, simply touching certain buttons animated individual fingers, giving the appearance of a more natural looking hand that was form fitting or “physics based” around objects. Furthermore, objects that were interactable and certain environmental items also provided varying degrees of haptic feedback as suggested from **Section 5.2.9**. For instance, while in the boat as seen in **Figure 6-9** above, the sides of the boat would vibrate if the user touched them.

6.1.8 Creating Enjoyment

As noted from **Section 2.3.1**, Sweetser and Wyeth (2005) noted that enjoyment relied on certain criteria. These are the concepts of *control* and *immersion*. *Control* means the user should have a sense of control over their movements and interaction, have a sense of impact on the virtual world, and be able to engage with the experience the way that they want to. In this aspect, control was created within the environment by the user having the ability of physical movement. The experience was designed so that the user could physically move about the space, instead of staying in a stationary position. Moreover, the user was given a sense of impact on the world through interactions with the environment. This again included interactions such as the butterflies and birds flying away from the user as mentioned in **Section 6.1.3**. Moreover, although the user was guided to an extent (by visual and auditory cues), the user ultimately had control over where they chose to look, and what they chose to interact with. This again gave more autonomy to the user.

In regard to the *immersion* criteria of enjoyment, users should become less aware of their surroundings, less self-aware and less worried about everyday life or self and experience an altered sense of time (Sweetser and Wyeth, 2005). For the practical application of this, the sci-fi and fantasy relationship for transportability was applied as suggested by Bilandzic and Busselle (2011). **See Figure 6-12**.

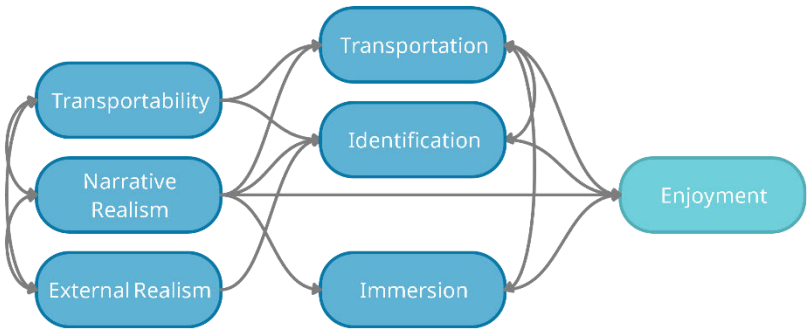


Figure 6-12 Sci-Fi and fantasy relationship for transportability.
(Bilandzic and Busselle, 2011. Image is original representation, modified for aesthetic purposes.)

Using this model, *narrative realism* has a positive effect on transportation, identification, and immersion. *External realism* only has a positive effect on identification, and transportability has a positive effect on transportation and identification. Recall that, *narrative realism* includes aspects such as consistent motivations of goals from the characters. *External realism* requires that the story be backed by story world logic. Therefore, since in this model *external realism* only has a positive effect on identification, the story needed to be consistent with actual world experiences or expectations from the point of view of the user. An example of this, is that the magical antagonist of the story was explained by story world logic via the narration. Had it not been, it would have prompted critical thoughts and disrupted the narrative experience.

The takeaway from this, is that in order to create enjoyment from this experience, *narrative realism* needed to be consistent over all aspects of the transportability model, and *external realism* needed to be consistent with the point of view of the user.

6.1.9 Creating Aesthetic value

As discussed in **Section 2.4.4**, *aesthetic value* regarding virtual reality encompasses emotion (i.e., personal experiences), imagery, and design elements, such as visual or audio components, embodiment and haptics. From the VRNEF guidelines, there were three practical suggestions: introducing a visual style of characters and story-world; implementing meaningful items in the story-world; and integration of haptic feedback.

Regarding visual style, colours and shapes were chosen with care for both environments and characters. Colours were chosen to simulate moods employing the use of colour harmonies as suggested in **Section 5.2.9**. For example, analogous colours were chosen to create serene environments. Conversely, complementary colours were selected to create contrast and tension on items and objects of interest. Regarding the characters, depending on the FFM determined for each character, the colour of their wardrobes was constructed based on the observations of Gosling (2008, pp.12-19). Under this model, Fia adopted a brighter wardrobe, as she was deemed as adventurous, impulsive, and independent. Whereas, Alastair had a muted wardrobe as he was calm and practical. Additionally, during scenes where Alastair needed to be more adventurous, he donned a brightly coloured blue scarf. See **Figures 6-13** and **6-14**.

Figure 6-13 Colour of wardrobes for characters
(Original image created by Austin Wolfe)

Figure 6-14 Character's blue scarf during adventurous scenes
(Original image created by Austin Wolfe)

Likewise, shape was implemented in a similar way. The shapes of the child characters were designed with rounder features, indicating innocence. In contrast, the antagonist (the Kelpie) had angular features which indicated danger (Solarski, 2017, p. 13). See **Figure 6-15**. Furthermore, as mentioned in **Section 2.4.3.2**, the placing of round or angular characters in round or angular environments creates either a harmony or a dissonance (Solarski, 2017, p. 12-17). This theory was also utilised in particular scenes. For instance, the antagonist, an angular character, was often placed in a rounded environment to emphasise the dissonance in the story.

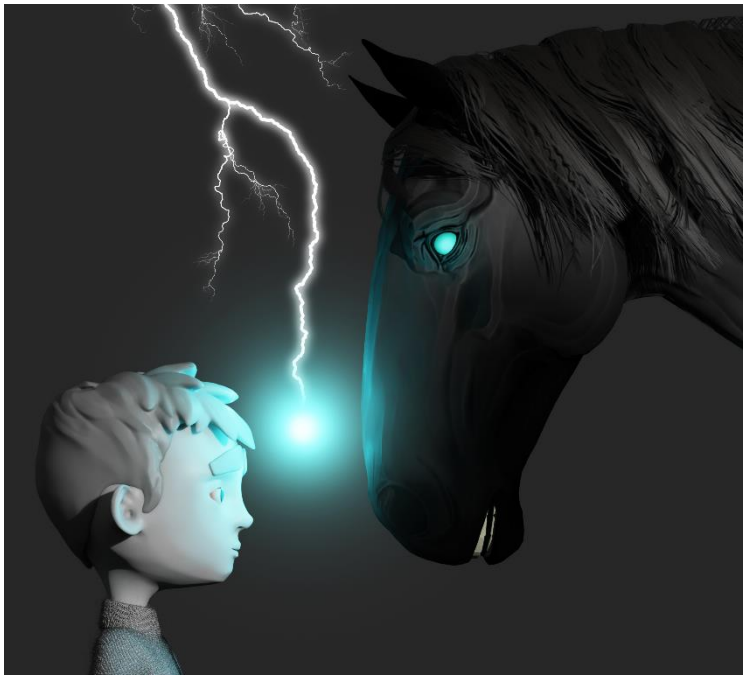


Figure 6-15 Contrast of soft features vs angular
(Original image created by Austin Wolfe)

As well as shape and colour, audio was strategically used throughout the experience by implementing VR's technological ability of sound spatialisation. This was particularly crucial in scenes that needed to portray more suspense. For instance, as mentioned in **Section 6.1.5**, during a forest scene, night falls, with a drastic audio change. Sounds of owls, trees creaking, twigs snapping, and a wolf howling surround the user, changing in volume and attenuation as the user moves. Likewise, in the following scene, the hoofbeats of the kelpie (antagonist) are heard from far away, long before any visual, and gradually increase in volume and reverb as the antagonist grows closer to the user. These examples help to perpetuate suspense and tension within each scene, therefore increasing the emotional response and adding to the *aesthetic value*.

Next, we reflect on the use of meaningful items. Meaningful interactable items were created throughout the story that the user could choose to interact with. Many of these items gave the user more story content when picked up, by displaying text that followed the user's gaze as mentioned in **Section 6.1.7**. For example, in the first scene, the user stands next to a cairn with illegible markings. When interacted with, the inscription on the cairn can be read, introducing the unseen character of the mother. See **Figure 6-10**. Another example is a picture frame of the children, which when interacted with, displays a written warning by their mother. Although these things do not change the story's outcome, they provide underlying information that the user would not receive without interaction, and thus it enhances the experience and creates a deeper emotional connection.

Finally haptic feedback (vibrations in the controllers) was applied throughout the experience. As mentioned in **Section 5.2.7**, haptics and lead to a more profound sense of embodiment (Wang, 2019; Richard, 2021; Carbon and Jakesch, 2013). All interactable pickable items had haptic feedback, which was individualised in frequency and amplitude depending on the item. Moreover, other haptic feedback was applied to other environmental objects that could not be picked up to assist in deeper immersion. For example, as mentioned in **Section 6.1.7**, in one scene the user is centred within a boat. If the user touches the railings of the boat, haptic feedback is given. This is useful, as it is common nature to lean, or rest one's hands on the railings of things in the real world. However, in a virtual world, doing so lacks physical solidity. Therefore, adding haptic feedback of such things in the environment gives the user more physicality in the virtual world and improves their immersion within it. Additionally, to further increase embodiment, physics

were included within the world as well. Items were given different weights depending on their materials and given different sound effects if dropped or thrown on different surfaces. Some objects were heavier than others and required more effort to pick up. Likewise, the material and shape of the item changed how the object reacted when dropped, i.e., whether it rolled or bounced. For instance, if a user picked up and dropped the metal compass, it not only had a perceived weight based on its materials, but it also made a metallic sound when dropped.

To summarise, the use of a visual style, audio, meaningful items, and haptic feedback all contributed to the concept of *aesthetic value*. This construct took the most amount of time to implement as it covered most of the asset creation and animation of the experience. However, recall that the analysis from **Section 4.3** regarding the *Phase One* study suggested that aesthetics may play a much larger role in narrative engagement than the other constructs, as it is intertwined with many of them. Therefore, it would be reasonable to assume that this construct would require the most amount of time and attention.

6.2 Results of Final Study

After the creation of the VR experience and ensuring that all constructs from the VRNEF were addressed in terms of creating narrative engagement, the project was packaged and ready to be applied to the final study.

The following sections will address the reported results for *Phase Three*. These results encompass the means (M) and standard deviations (SD) of each construct, the overall mean and standard deviation, and the overall score of the final VR application. Moreover, the observational data is presented and coded into themes. Lastly, results are presented from a final reliability and validity factor analysis. For this study, 62 participants over the age of 18 were invited to take part. It is important to note that the target participant amount of 96 was not reached and could potentially impact the significance of the final calculations. Therefore, the accuracy of the results presented here would benefit from a further 35 participants at a later date.

6.2.1 Presentation of Quantitative Data for Final Study

Considering that the VRNEF scale is recorded on a Likert scale ranging from 1-5, a mean and standard deviation was recorded for each concept as well as a combined calculation for the total scale. The final VR application recorded a high mean across all concepts, with the highest mean at 4.89 (M) for *Narrative Understanding*, and the lowest at 4.31 (M) for *Spatial Presence*. Furthermore, the lowest standard deviation was also recorded for *Narrative understanding* at 0.18 (SD) and the highest was recorded fort *Emotional Engagement* at 0.66 (SD). Overall, the VRNEF provided a mean of 4.56 (M) with a standard deviation of 0.35 (SD). See **Table 6-1**. After the confirmatory factor analysis (CFA), which is presented in the following section, the mean and standard deviation were recalculated to account for the change in scale structure as a construct was eliminated for the CFA's calculation. See **Table 6-2**.

Table 6-1 Initial VRNEF Construct Results

Construct	Mean	Standard Deviation
Narrative understanding	4.89	0.18
Narrative presence	4.40	0.44
Spatial presence	4.31	0.62
Emotional engagement	4.29	0.66
Suspense	4.53	0.60
Curiosity Environment	4.46	0.55
Curiosity Story	4.61	0.45

Enjoyment	4.77	0.34
Aesthetic value	4.75	0.34
Overall	4.56	0.35

After the CFA, *Narrative Understanding* still recorded the highest mean at 4.9 (M), and *Spatial Presence* the lowest at 4.06 (M). Similarly, *Narrative Understanding* still had the lowest deviation at 0.23 (SD) but *Spatial Presence* recorded the highest deviation at 0.8 (SD). Notably, *Narrative Presence* was not calculated as it was eliminated from the CFA. Overall, the mean reported 4.55 (M) with a deviation of 0.37 (SD). The total calculated score for the scale was 36.41.

Table 6-2 Adjusted VRNEF Results and Total Score

Construct	Mean	Standard Deviation
Narrative understanding	4.9	0.23
Narrative presence	--	--
Spatial presence	4.06	0.8
Emotional engagement	4.29	0.66
Suspense	4.53	0.60
Curiosity Environment	4.62	0.58
Curiosity Story	4.64	0.5
Enjoyment	4.75	0.43
Aesthetic value	4.62	0.48
Overall	4.55	0.37

Total Average Score	36.41

6.2.2 Presentation of Qualitative Data for Final Study

Qualitative data for the final study was gathered via observation during the virtual reality experience. Although participants were aware that they were being observed, again there was no interaction from the researcher during the observations. The data was hand recorded, then transcribed into documents and coded into similar themes. This data was coded into the following themes:

- Focus on Characters
- Interaction with Character
- Response to Environment Stimuli
- Interact with Meaningful Items
- Focus on Raven (*diegetic item*)
- Aesthetic focus(*environment*)
- Aesthetic focus (*Life*)
- Interaction with other objects

Table 6-3 indicates the percentage of participants for which each code appears. **Table 6-4** shows the frequency of each code per participant. The coding was recorded and calculated via the program MAXQDA.

Table 6-3 Codes at a Glance (Percentages)

Codes	Percentage of participants
Focus on Characters	100%
Interaction with Character	100%
Response to Environment Stimuli	100%

Interact with Meaningful Items	100%
Focus on Raven (*Diegetic*)	100%
Aesthetic focus (*Environment*)	100%
Aesthetic focus (*Life*)	100%
Interaction with other objects	100%

Table 6-4 Codes at a glance (Frequency per participant)

Code System	1	2	3	4	5	6	7	8	9	10	...	SUM
Interaction with other objects	8	6	6	6	5	6	5	6	6	4		328
Aesthetic Focus (life)	9	8	8	9	9	8	9	9	9	9		550
Aestetic Focus (environment)	15	13	13	15	15	13	15	15	15	15		898
Focus on Raven	5	3	3	5	5	3	5	4	3	5		281
Interact with Meaniful Items	4	4	4	4	4	4	4	4	4	4		232
Response to Environment stimuli	9	9	9	9	6	9	9	7	9	9		491
Interaction with Character	10	7	7	8	7	7	6	6	5	3		387
Focus on Characters	16	14	14	15	16	14	16	15	15	16		966
SUM	76	64	64	71	67	64	69	66	66	65		4132

As **Table 6-3** demonstrates, 100 percent of the participants experienced all the available codes. This means that all of the codes appeared at least once for each participant. **Table 6-4** reveals an excerpt of the frequencies of the codes per participant (10 out of 62) and their totals. See **Appendix: I** for full frequency map. As similar to the pilot study from *Phase One*, the totals are not necessarily an indication of priority of one code over another, as each code holds a different purpose and the opportunity for each code was only given in specific scenes. For this reason, each code will be evaluated and analysed independently.

Additionally, **Figure 6-16** shows another visual example of a single case model of these frequencies. This figure shows the maximum occurrences allowed for each of the codes in parenthesis, for example *Focus on characters* is (16), also noted in **Table 6-5**. The line weight in the model reflects the code frequency, the thicker the line, the more the code occurred.

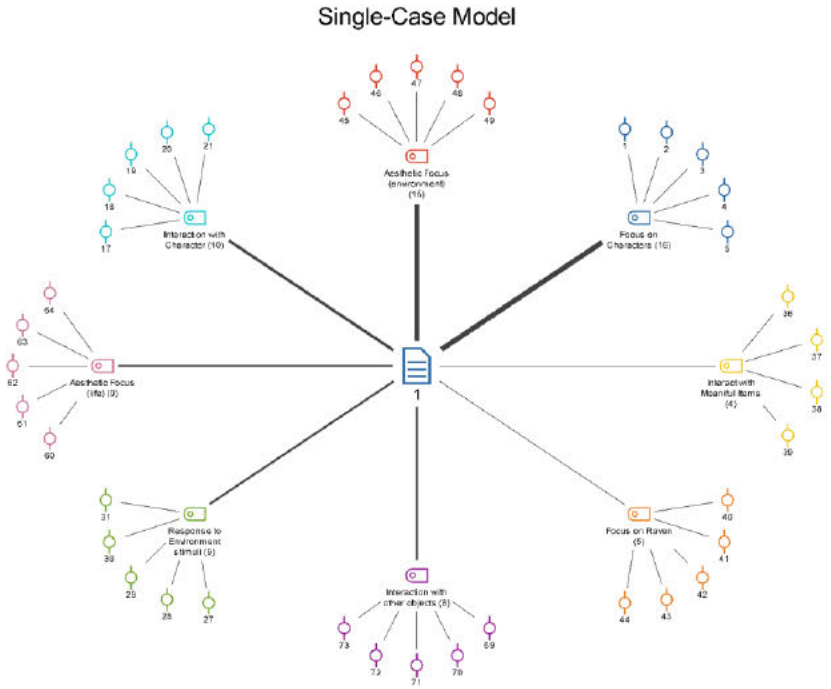


Figure 6-16 Single Case Model

(Original image created by Austin Wolfe)

Table 6-5 Codes and Maximum Allowances

Codes	Maximum Allowance per Participant
Focus on Characters	16
Interaction with Character	10
Response to Environment Stimuli	9
Interact with Meaningful Items	4
Focus on Raven (*Diegetic*)	5
Aesthetic focus (*Environment*)	15
Aesthetic focus (*Life*)	9
Interaction with other objects	8

With this in mind, the total number of frequencies was divided by the maximum allowance and the number of participants to provide percentages for each code. This resulted in the following:

- *Focus on Characters*: 97% of users reached the maximum allowance.
- *Interaction with Character*: 62% of users reached the maximum allowance.
- *Response to Environment Stimuli*: 87% of users reached the maximum allowance.
- *Interact with Meaningful Items:* 93% of users reached the maximum allowance.
- *Focus on Raven (Diegetic)*: 90%of users reached the maximum allowance.
- *Aesthetic focus (Environment)*: 96% of users reached the maximum allowance.
- *Aesthetic focus (Life)*: 98% of users reached the maximum allowance.
- *Interaction with other objects*: 66% of users reached the maximum allowance.

6.2.3 Reliability and Validity of Final Study

The following sections present the data for the final reliability and validity examination pf the VRNEF measurement scale. To summarise, this test was completed for a second time to account for changes to the original VRNEF scale, and to allow for a larger number of participants to improve accuracy.

6.2.3.1 Cronbach's α

As mentioned in **Section 3.4.1**, Cronbach's α is used in conjunction with the CFA to measure reliability. It accomplishes this by measuring the internal consistency of a scale, with the measurement expressed as any number between 0 and 1.

Table 6-6 Initial Cronbach's A In 3rd Phase

Construct	Cronbach's α	Number of Items
Narrative understanding	.363	4
Narrative presence	.477	5
Spatial presence	.794	6
Emotional engagement	.855	5
Suspense	.852	5
Curiosity Environment	.688	4
Curiosity Story	.758	5
Enjoyment	.743	5
Aesthetic value	.772	7

Initial values of the Cronbach's α ranged from the lowest at .363 (*Narrative Understanding*) to the highest at .855 (*Emotional Engagement*). Under the previously mentioned recommendations (Hinton, McMurray, and Brownlow, 2004), the concepts on *Enjoyment*, *Suspense*, *Emotional Engagement*, *Spatial Presence*, *Curiosity Story*, and *Aesthetic value*, all rated as having good reliability. The concepts of *Narrative presence* and *Narrative Understanding* are rated as having unacceptable reliability and *Curiosity Environment rated* as acceptable. During the reliability calculations, the lowest factor loading questions were dropped in order to raise the final values of Cronbach's α. This included the elimination of NU002, CS005, AV002, AV001, SP002, SP003, CE002, and EN005.

Table 6-7 Adjusted Cronbach's α In 3rd Phase.

Construct	Cronbach's α	Number of Items
Narrative understanding	.635	3
Narrative Presence	.477	5
Spatial Presence	.818	4
Emotional engagement	.855	5
Suspense	.852	5
Curiosity Environment	.753	3
Curiosity Story	.823	4
Enjoyment	.756	4
Aesthetic value	.772	5

As noted in **Table 6-4**, the adjustment of the constructs raised the values in each categories. The most noteworthy was *narrative understanding*, giving it an acceptable reliability at .635. Additionally, *Curiosity Environment* was now rated with good reliability. *Narrative Presence* however could not be improved and remained at an unacceptable value of .477.

6.2.3.2 Confirmatory Factor Analysis

As stated in **Section 5.1.2.2**, the CFA was again run in two programs, SPSS AMOS and STATA to account for discrepancies. The STATA calculations were run using Satorra-Bentler adjustments for better accuracy when non-normal and asymmetrical data is involved. (Satorra and Bentler, 2010).

As with the previously conducted CFA in **Section 5**, the analysis calculations would not run properly without the removal of some variables. However, this was expected, and part of the reason for adding extra variables to allow for this. To run the CFA, the same variables were removed from the scale that were removed from the Cronbach's α calculations above. Again, these were: NU002, CS005, AV002, AV001, CE002, SP001, SP002, and EN005. Ultimately however, the entirety of *Narrative Presence* needed to be removed due to poor factor loadings and an inability to calculate CFA.

As noted from **Section 5.1.2.2**, that the Confirmatory Factor Analysis (CFA) assesses both convergent and discriminant validity and that these are reported and measured by the Average Variance Extracted (AVE) and Composite Reliability (CR). CR has acceptable value of .7 and above, and AVE has acceptable value of .5.

Taking this into account, according to SPSS AMOS, all constructs had a CR above .7, with the highest rating at .879 for *Suspense*, and the lowest at .700 for *narrative understanding*. Additionally, with the exception of *narrative understanding*, all constructs are rated above .5 with AVE, rating the highest at .635 for *Curiosity Environment*.

Table 6-8 SPSS AMOS Validity Values

Construct	CR	AVE
Narrative understanding	.700	.471
Narrative Presence	Fail (would not compute)	Fail (would not compute)
Spatial Presence	.824	.549
Emotional engagement	.862	.556
Suspense	.879	.597
Curiosity Story	.830	.553
Curiosity Environment	.839	.635
Enjoyment	.774	.595
Aesthetic value	.824	.549

The STATA values were remarkably similar to the AMOS values. There were nominal changes, with the highest CR at .880 for Suspense, and the lowest at .693 for *narrative understanding*. The same is true for the AVE, With the highest at 6.36 for Curiosity Environment, and the lowest again at .454 for *narrative understanding*.

Table 6-9 STATA Validity Values

Construct	CR	AVE
Narrative understanding	.693	.454
Narrative Presence	Fail (would not compute)	Fail (would not compute)
Spatial Presence	.824	.550
Emotional engagement	.861	.554
Suspense	.880	.597
Curiosity Story	.830	.553
Curiosity Environment	.839	.636
Enjoyment	.773	.595
Aesthetic value	.830	.549

6.3 Demographic Considerations

It is important to note that for these studies, demographic information was not recorded from the participants, nor used for any inclusion/exclusion criteria. Moreover, although previous inexperience in virtual reality was preferred, more experienced users were not excluded from participation. This is a potential limitation as the demographic nature of the participants cannot be included in the assessment of the data. This is particularly the case regarding the user's previous VR experience. Less experienced users can potentially have more of an "awe" factor when it comes to new VR experiences, and thus record higher scores. Likewise, more experienced users may score lower as they have high expectations for the application and interactions. However, as this is a mix of people with varying experience levels, the data recorded does not reflect any discrepancies that this may have had any significant effect.

This demographic information was purposefully omitted during the studies. In pursuit of the creation of the VRNEF, the goal was to create a universal framework that would work across varying subjects, age groups, genders, ethnical backgrounds etc. In doing so, this would allow future work to refine this universal framework and potentially adapt it to target specific demographics.

7 Final Analysis

The final analysis of this research is considered in four parts. First, an analysis of the quantitative data is conducted. Second, the qualitative data is evaluated. Thirdly, the final reliability and validity of the VRNEF scale is assessed. Finally, a summary of the data concludes the chapter.

7.1 Quantitative Analysis of Final Study

The analysis of the quantitative data recorded for the final study focuses on the adjusted VRNEF results as noted in **Table 6-2** from **Section 6**. Therefore, *narrative presence* is omitted from this analysis, as it was eliminated following the CFA. To review, the highest mean was recorded at 4.9 (M) for *narrative understanding* and the lowest at 4.06 (M) for *spatial presence*. Likewise, *narrative understanding* also had the lowest deviation at 0.23 (SD), with *spatial presence* recording the highest at 0.8 (SD). All other constructs had high averages and lower deviations between these ranges and were fairly consistent in their values.

This is notable. As previously discussed from the *Phase One* pilot study, the standardised questionnaires that were employed had more variability in their results. For instance, some constructs had a mean below four and had higher standard deviations above one. This indicates that the adjusted constructs created for the VRNEF appear to work more cohesively together than the previously used concepts in the standardised questionnaires. To clarify, the concepts that were selected that make up narrative engagement give the impression that they not only work together, but also do in fact make up the concept of narrative engagement itself.

Regarding the concepts themselves, the low deviation and high mean in *narrative understanding* could potentially indicate that *narrative understanding* is a crucial part of narrative engagement. As mentioned from **Section 6.1.1** and the guidelines in **Section 5.2.1**, that in terms of creating *narrative understanding*, it was essential to choose an appropriate narrative structure. In the case of the final study, Propp's morphology was chosen (1928). Therefore, these scores from the *narrative understanding* construct confirm that the narrative structure itself is a fundamental element in creating a virtual reality experience specifically for narrative engagement. Similarly, the concept of *enjoyment* scored the second highest mean at 4.75 (M) in the second lowest deviation at 0.43 (SD). This indicates that *enjoyment* is also an essential element, and more specifically, so are the concepts of control and immersion as stated in **Section 5.2.8** (Sweetser and Wyeth, 2005). In terms of creating immersion for enjoyment, and to summarise from **Section 6.1.8**, that the transportability map of sci-fi and fantasy was chosen for this particular VR experience (Bilandzic and Busselle, 2011). This unique map states that narrative realism has a positive effect on transportation, identification, and immersion; while external realism has a positive effect on identification only. This signifies that narrative realism requires consistent motivations and goals from the characters, and external realism requires the story to be consistent with actual world experiences or expectations from the point of view of the user. Therefore, both narrative realism and external realism are directly linked to the story structure. It is understandable then, that both *narrative understanding* and *enjoyment* would have similar values as they are intertwined. Additionally, note that if the external realism in the story failed, it would prompt critical thoughts and disrupt the narrative experience, interrupting the story structure. As a result, it could be assumed that the results from the *narrative understanding* construct would have been lowered.

Conversely, the *spatial presence* construct had the lowest mean at 4.06 (M), and the highest deviation at 0.8 (SD). The higher deviation is partially due to the fact that a few of the variables needed to be eliminated to run the CFA. After the CFA, SP002 and SP003 were removed to better fit this analysis. This dropped the average of this construct while simultaneously raising the deviation. However, these were minimal changes, with a decrease of 0.25 (SD) and increase of 0.2 (SD)respectively. Therefore, there was little adjustment in the outcome of the construct itself. It is important to note though, that the standard deviation

was still lower than the original IPQ (Igroup presence questionnaire) at 1.35 (SD) that was used to measure presence in *Phase One*.

Overall, the measurement scale had a high mean of 4.55 (M) and a low deviation of 0.37 (SD). Again, this reiterates that constructs appear to be working very well together. In addition to this, assuming that the scale is deemed to be valid and reliable, this also shows that the VRNEF guidelines were able to correctly assist in the creation of narrative engagement for the VR experience. To clarify, all of the suggestions that were targeted for each of the concepts that make up narrative engagement were effective in actually creating that narrative engagement. This is backed by the fact that the overall score was 36.41. This score is out of a total of 45 (including the concept of *narrative presence*) or out of 40 (excluding *narrative presence*). Regardless of whether or not *narrative presence* was included in the calculation (in this case it was not) the total is still well above the threshold of 25 as determined in **Section 5**. This indicates that the VR experience created for *Phase Three* did have a high level of narrative engagement and was effective in being able to keep users engaged in the story.

7.2 Qualitative Analysis of Final Study

The following section provides the analysis of the qualitative data gathered during the VR experience. This includes the hand recorded data as well as some notable unexpected observed outcomes.

In addition to the quantifiable data provided by the VRNEF, qualitative data was gathered via hand recorded observation during the virtual reality experience. This data was then compiled and coded into similar themes. These were:

- Focus on Characters
- Interaction with Character
- Response to Environment Stimuli
- Interact with Meaningful Items
- Focus on Raven (*diegetic item*)
- Aesthetic focus(*environment*)
- Aesthetic focus (*Life*)
- Interaction with other objects

Each code had a maximum allowance attributed to it, i.e., they could only be triggered a certain number of times. Moreover, each code can be linked to the nine concepts of narrative engagement with some crossover. Bearing in mind the VRNEF guidelines on creating narrative engagement, it can be assumed that the following codes are linked with these possible constructs:

Table 7-1 Codes linked to concepts.

Focus on Characters	Aesthetic value, Narrative understanding, Narrative presence
Interaction with Character	Curiosity Story, Emotional engagement
Response to Environment Stimuli	Curiosity Environment, Suspense
Interact with Meaningful Items	Curiosity Story, Emotional engagement
Focus on Raven (*diegetic item*)	Curiosity Environment
Aesthetic focus(*environment*)	Aesthetic value, Suspense
Aesthetic focus (*Life*)	Aesthetic value
Interaction with other objects	Curiosity Environment, Curiosity Story, Enjoyment

Note that **Table 7-1** may not contain all crossovers for the constructs as the concepts are heavily intertwined. However, by using this as a base, it might be possible to identify which concepts are strongest and which are the weakest.

As noted from **Section 6.2.2** the total amount of the frequencies of the eight codes totalled 4132 across the 62 participants. The codes *focus on characters*, *aesthetic focus environment*, and *aesthetic focus life* made up the majority of that total with 966, 898, and 550 respectively. Based on these numbers alone, this accounts for over half of the frequencies of the codes that were triggered. Additionally, the aesthetic codes alone make up over a third of the total amount. As postulated in *Phase One*, this again indicates that *aesthetic value* plays a very large role when it comes to creating narrative engagement in VR experiences. A close second to that being the code *focus on characters*. However, as indicated in **Table 7-1**, *focus on characters* can also be considered a part of aesthetic value. This is because the concept includes the visual creation of the characters, and this may be aiding the focus upon them. A similar argument could be made for *curiosity environment* as it also spans three of the codes, the total of which equal 1100. Conversely, based on this table, *enjoyment* has the lowest value at 328. This may indicate that it is the weakest concept. However, the maximum allowance of the frequencies also needs to be considered.

As a reminder, the maximum allowance for each code can be viewed in **Table 6-3** in **Section 6**. This allowed the calculation of the percentages of users triggering the codes resulting in the following:

- *Focus on Characters*: 97% of users reached the maximum allowance.
- *Interaction with Character*: 62% of users reached the maximum allowance.
- *Response to Environment Stimuli*: 87% of users reached the maximum allowance.
- *Interact with Meaningful Items:* 93% of users reached the maximum allowance.
- *Focus on Raven (Diegetic)*: 90%of users reached the maximum allowance.
- *Aesthetic focus (Environment)*: 96% of users reached the maximum allowance.
- *Aesthetic focus (Life)*: 98% of users reached the maximum allowance.
- *Interaction with other objects*: 66% of users reached the maximum allowance.

In comparison to **Table 7-1**, it appears that aesthetic value still holds the largest weight as *focus on characters, aesthetic focus environment*, and *aesthetic focus life* have the highest percentages at 97%, 96%, and 98% respectively. Interestingly, if *interaction with other objects* is linked with the *enjoyment* concept as noted in **Table 7-1**, potential of *enjoyment* being a weaker concept is reinforced as it has a low percentage of 66%. However, the lowest percentage is 62% for *interaction with character*. This could implicate that *emotional engagement* is in fact weaker, or possibly *curiosity story*, as *curiosity story* is also linked with the *interaction with other objects* code. Additionally, since both of these concepts are linked with *interaction with other objects*, this also could indicate that it may not be necessary to have an extensive range of interactions for cinematic VR in order to be effective in creating narrative engagement. Conversely, it could also implicate that interactions in general need to be redefined specifically for cinematic virtual reality to include interactions outside of the physical touch realm.

As mentioned in **Section 6**, all the codes appeared for all of the participant's 100% of the time regardless of the amount of the frequencies per participant. This signifies that the concepts identified that make up narrative engagement do in fact make up narrative engagement and that the scale reflects that the guidelines were effective in creating the narrative engagement.

Along with the coded themes gathered by the observational data, there were also some surprising and interesting results that were observed during the conduction of the study. Some of the interesting observations concerned the physical movement of the users. These included people physically moving about the space such as: engaging in more exploration; physically ducking out of the way of things like tree branches; crouching under objects; trying to physically move away from suspenseful elements like

the kelpie running towards them; and in some instances, even trying to fight or push the kelpie away. Some users even tried to physically console one of the children when they were crying.

In addition to this, there was also a significant number of vocal observations that were made. These included more vocal exclamations when something suspenseful would happen and included some participants even verbally admonishing the antagonist. These unexpected observations may possibly be due to the fact that suspense played a larger role in the experience. Although there was not any kind of fear response to any of the environment stimuli, there were more opportunities presented for surprise. This also reiterates the theory that curiosity, suspense, and surprise are all intertwined (Brewer and Lichtenstein, 1982; Hoeken and Sinkeldam, 2014)

A final interesting outcome was the users' reactions in the different environments. As mentioned in **Section 4**, the *Phase One* pilot study included an environmental map that was set up as a singular map so that the user could move around and still see where they had previously been, limiting the amount of time that they spent reorienting themselves. Conversely, each scene in the final VR experience was significantly different from the last with varying locations. However, it didn't appear that users were spending any extra time reorienting themselves in each scene. Curiously, they appeared to first search for the characters with each new scene. This indicates that if may not be necessary to be concerned about reorientating users in a virtual space, as long as the story is engaging enough to hold their attention.

Both the coded observation data and the observed unexpected outcomes indicate that the VR experience had a strong engagement value with the users. This backs up the claim that the VRNEF guidelines suggestions were effective an assisting in creating narrative engagement.

7.3 Validity and Reliability Analysis of Final Study

This section reviews the final validity and reliability calculations from *Phase Three* for the VRNEF measurement scale. As stated in the previous sections, the VRNEF required two separate validity and reliability calculations. The first of which was conducted on the pilot VR experience and the second one was conducted on the final VR experience. Although the first analysis did show sufficient validity and reliability, due to the small sample size and the necessity of eliminating certain variables from the measurement scale, it seemed prudent to run a second test with a larger sample size and modifications to the scale. With this in mind, this does not necessarily mean that the first CFA should be disregarded, but rather, that the second CFA simply provides additional data that can be analysed in greater depth.

In terms of reliability, as mentioned from the previous sections, the scale was assessed using Cronbach's α as mentioned in **Section 3.4.1**. Again, this measurement is expressed as any number between 0 and 1, with a value of .5 being satisfactory, and .7 being good (Hinton, McMurray, and Brownlow, 2004). Both *narrative presence* and *narrative understanding* did not reach the acceptable value of .5 initially. However, after the adjustment of the scale, only *narrative presence* failed to meet .5, at a value of .477. All other constructs were at an acceptable or good value. Based on the Cronbach's α alone, this shows that the scale may have an acceptable reliability overall, however, clearly indicates that there are still adjustments that need to be made to the *narrative presence* category, and additionally, probably the *narrative understanding* construct (as six variables needed to be eliminated to raise its value). This is further enforced by the confirmatory factor analysis.

To summarise, in a Confirmatory Factor Analysis both convergent and discriminant validity are assessed. These are reported as the Average Variance Extracted (AVE) and Composite Reliability (CR). AVE has an acceptable value of .5, with .7 being considered good. CR has an acceptable value of .7 and above.

The CFA required the entirety of *narrative presence* to be eliminated to even calculate the values. With this elimination, both the Amos and STATA CFAs had similar values, with only *narrative understanding* failing to hit .5 for the AVE in both programs. The CR however was at .7 or above for all constructs during

the Amos calculation. *Narrative understanding* fell slightly below this mark during the STATA calculation. However, consider that Malhotra and Dash (2011) argue that AVE is often too strict, and reliability can be established through CR alone. Therefore, with the elimination of *narrative presence* altogether, it would appear the that the scale does have an acceptable degree of validity and reliability. In practical terms, this means that with the elimination of *narrative presence*, the scale is reliably measuring variables of constructs that it is intended to measure, and moreover, it is consistent in that measurement.

It is important to note that although we were able to reach a larger sample size for the second CFA than the first, 62 vs 32 respectively, the targeted amount of 96 participants was still not met. The targeted participant count was not met due to the timeframe and available resources. Although it is difficult to fully quantify the entirety of running the final study, an approximation of time spent is calculated in **Table 7-2**.

Table 7-2 Approximation of Quantified Time

Study time for participants (including travel time to location, set up, runtime of the study, debriefing, and sanitising equipment between participants)	180 hrs
Data gathering (including recording, entry, extrapolating of themes, and scoring)	80 hrs
Confirmatory factor analysis (including entry, learning of the programs, and adjustments for final calculations)	60 hrs

As noted above, approximately over 300 hours were spent on the running of the final study, spread out over many months. Therefore, due to the timeframe, it was not feasible to conduct the study for a further 34 participants, as this likely would have taken an additional 100 hours to complete. Thus, our analysis would benefit from an additional experiment on the remaining 34 participants so that the numbers can be re calculated.

It is also important to note that although some variables still needed to be eliminated, including the construct of *narrative presence*, there were less variables that needed to be removed opposed to the first CFA. This could possibly be because there was a much larger sample size or due to the other modifications that were made with the scale. With this in mind, if the minimum target of participants was reached, it's likely that elimination of some of the variables and even the removal of the *narrative presence* construct may not have been needed at all.

7.4 Summary of Research Data

Several conclusions have emerged from this analysis. Firstly, concerning the VRNEF, due to the high overall score, it can be assumed that the VRNEF guidelines were effective in creating narrative engagement for the final virtual reality experience. It can also be assumed therefore, that if the VRNEF guidelines were effective, that the measurement scale was equally effective in measuring the correct elements that the narrative engagement was comprised of.

Additionally, the coded qualitative data that was recorded appeared to reiterate this as the codes can be directly linked to some of the constructs. Moreover, the qualitative data provided possible insight into which of the constructs holds more weight over the others and which of the constructs is the weakest. From this analysis, it can be assumed that *aesthetic value* is the strongest construct and that either *enjoyment* or *curiosity story* are the weakest concepts. This is beneficial, as the entirety of the scale is scored based on the numerical value of the Likert scale and is therefore not weighted (with the exception of *curiosity environment*). If one construct appears stronger or weaker than the rest this could potentially indicate that the scale needs to be reassessed with weighted scoring to compensate for that. Furthermore, as those

weaker identified concepts are linked with interactions, they may also indicate that an extensive array of physical interactions are not necessary for cinematic virtual reality experiences.

Finally, the final reliability and validity analysis do indicate that the scale is reliable and valid, however, as the minimum target of participants was not reached it would be prudent to retest the remaining number of participants and recalculate the final results. It is possible that with a recalculation the elimination of certain variables and the construct of *narrative presence* may not be necessary. This can be reiterated simply due to the fact that the VR experience was created based off of the VRENF guidelines which included those eliminated variables and the construct of *narrative presence*. Since the experience had a high score on the scale before the elimination of these elements, this could indicate that they were still important factors in the overall scale.

8 Conclusion

The following sections conclude the dissertation with a discussion of the most significant findings, as well as the limitations of the third project phase. Additionally, it discusses what the VRNEF could potentially mean for the design of narrative cinematic virtual reality experiences and recommendations for future exploration.

8.1 Introduction

In conclusion, this research has answered the primary research question: Can a reliable narrative engagement evaluation framework be designed for cinematic virtual reality experiences? This exploratory work identified concepts and elements related to narrative engagement and applied them to the creation of two VR experiences and the Virtual Reality Narrative Engagement Framework (VRNEF). Moreover, VRNEF was evaluated, analysed, and found to be reliable and valid.

This research focused on investigating narrative engagement in cinematic virtual reality experiences. The aim of which was to create a method to measure or create narrative engagement expressly for this context. Through our investigation, we theorised and created an analytical framework, named the VRNEF, which will support a growing body of knowledge and understanding in the development and directing of cinematic virtual reality outputs. To clarify, this framework will assist creators and researchers in producing engaging stories in VR and be able to measure that engagement. Whilst conducting this investigation, this research focused on the following objectives:

- Understand IDN and immersive VR contexts (O1)
- Investigate engagement measures towards narratives (O2)
- Creation of Narrative engaging VR experiences (O3)
- Create and validate usability of narrative engagement scale (O4)
- Establish guidelines for creating narrative engagement in VR based on design elements (O5)
- Apply principles towards the design of VR experiences and their evaluations (O6)

The first (O1) and second objectives (O2) were met by reviewing current literature on storytelling and narrative engagement in both virtual and conventional environments. By doing so we were able to identify concepts and elements that contribute to narrative engagement. These concepts were *narrative understanding*, *narrative presence*, *spatial presence*, *emotional engagement, suspense*, *curiosity of story*, *curiosity of environment*, *enjoyment*, and *aesthetic value*.

The third objective (O3) was met by the creation of the cinematic VR experiences. The first experience (pilot) involved the designing of a virtual reality experience surrounding Scottish folklore. This experience was designed based upon the recommendations identified from reviewing the current literature on storytelling and aesthetic value elements. The first virtual reality experience took approximately six months to complete from start to finish. The second virtual reality experience was also based on Scottish folklore for consistency, albeit it was a different story with a different story structure. The second VR experience was designed using the newly created VRNEF guidelines. This experience took approximately nine months to design and complete from start to finish.

The fourth (O4) and fifth objectives (O5) involved creating the two-part narrative engagement framework, the VRNEF. This concerned the creation of the measurement scale as well as the guidelines for creating engagement in virtual reality experiences. The measurement scale was created based upon information gathered from the literature review and from available standardised questionnaires regarding narrative engagement in various contexts. Likewise, the guidelines were also created based upon the information from the literature review. The scale was analysed for reliability and validity with each of the virtual reality experiences. Analysing twice was necessary as there was a significantly smaller sample size with the first

study, which likely led to the need for elimination of several variables in order to run the analysis. Although the second reliability analysis also required some elimination of variables, there were far less that needed to be removed than from the first study. With both analyses however, the results showed that the scale was equally reliable and valid, thus meeting the fourth and fifth objectives.

Lastly, the final objective (O6) was met with the creation of the new virtual reality experience based on the guidelines that were created from the fifth objective. Additionally, it involved the testing of the new measurement scale. The results of the scale showed a high overall score (36.41), indicating that the virtual reality experience did have great narrative engagement according to the threshold of the scale.

8.2 Cinematic VR Narrative Experiences Created

It is notable that in pursuit of this research, two cinematic storytelling virtual reality experiences were created. These applications were created so that their design directly reflected the literature and findings from **Section 2**, and the VRNEF guidelines. Other existing cinematic VR experiences may not have fit the model of the VRNEF guides, and this was crucial to determine the efficacy of the VRNEF measurement scale. While these applications were primarily created for the purpose of fulfilling the need of having and creating narrative experiences to test the scale and guidelines of the VRNEF, these experiences themselves are valuable cultural outputs of work. This is reflected in their acceptance and screenings to a number of film festivals, including Raindance, Aesthetica, AniFilm, and the Yugo International Student Bafta awards, the latter of which resulted in an award received for the application titled *Aonar*.

8.3 Summary of Research Findings and Conclusions

To summarise, this research identified and measured concepts and elements that make up narrative engagement. These were the concepts of *narrative understanding*, *narrative presence*, *spatial presence*, *emotional engagement, suspense*, *curiosity story*, *curiosity environment*, *enjoyment*, and *aesthetic value*.

In the context of this research, *narrative understanding* is the comprehension and ease of its conception of the story within the experience. This concept relies on the storyline of the narrative experience and involves the implementation of a story structure (Koenitz *et al*., 2018, pp. 107-120; Propp, 1928; Bucher, 2017). *Narrative Presence* is defined as the participant's involvement in the story. This is the concept of being mentally present within the narrative. This concept relies on the the ability of the story to persuade users through the events of the story and creating character connection (Dahlstrom, 2012; Strange and Leung, 1999). *Spatial presence* is comprised of *location* and *action*. *Location* is defined as a feeling of "being there", and *action* is the possible actions that the participant can perform in the virtual space (Vorderer *et al*., 2004). *Emotional engagement* involves both design elements and psychology. It utilises the Lazarus Theory of Cognition (Folkman *et al*., 1986), colour psychology (Karr, 2013; Ekman, 2016; Wilms and Oberfeld, 2018), audio and music (Bhide, Goins and Geigel, 2019; Västfjäll, 2000; Balkwill, and Thompson, 1999; Juslin and Sloboda, 2001; Jacquet, 2014), and character development (McCrae, Gaines and Wellington, 2012; Isbister, 2006, pp. 23-40). *Suspense* focuses on the use of the suspense effect structure (Brewer and Lichtenstein, 1928; Smith, 2000) and lighting (Bound, 2016; Eitsen, 2010). The construct of *Curiosity Story* correlates to the curiosity event structure (Brewer and Lichtenstein,1982), which states that it must contain a significant event early within the story. *Curiosity environment* is based upon the use and application of curiosity types: adjustive reactive, complex/ambiguous, manipulatory, conceptual, and perceptual (To *et al*., 2016). *Enjoyment* involves providing control and immersion (Sweetser and Wyeth, 2005). To provide control, the user should have a sense of control over their movements and interaction; have a sense of impact on the virtual world; and be able to engage with the experience the way that they want to. Regarding *immersion*, users should become less aware of their surroundings, less self-aware and experience an altered sense of time. A*esthetic value* for virtual reality encompasses emotion (personal experiences), imagery, and design elements (Arnheim, 1954; Pentak and Lauer, 2015) such as visual (Solarski, 2017, p. 13), or audio components and haptics (Carbon and Jakesch, 2013; Wang, 2019; Richard, 2021).

Through the identification of these concepts, a two-part framework was able to be created, the virtual reality narrative engagement framework (VRNEF), which consists of a scale to monitor narrative engagement and a set of guidelines to create a satisfying level of engagement. To clarify, this framework effectively measures the concepts that encompass narrative engagement, as well as provide practical suggestions to creators and researchers on how to improve narrative engagement in cinematic storytelling virtual reality experiences. The VRNEF scale consists of the nine identified concepts and is scored on a Likert scale of 1 to 5, with a maximum score of 5 per construct and 45 overall. This scale was analysed for reliability and validity twice, and in both instances found to be valid and reliable. This indicates that the scale is able to accurately measure what it is intending to measure.

Additionally, the final virtual reality experience that was created was created based upon the VRNEF guidelines. This VR experience was assessed with the VRNEF, which resulted in an overall score of 36.41. This indicates that the experience created based on the guidelines was considered to have a great amount of narrative engagement, demonstrating that the guidelines were effective in their suggestions for creating this engagement.

8.4 Limitations

Although this research was successful in its endeavour to create a framework for monitoring and creating narrative engagement, there are several limitations that should be considered.

The first limitation is that of the inability to reach the target participant sample size. As noted in **Section 3**, the methodology of this research included the conduction of a confirmatory factor analysis (CFA) to measure the reliability and validity of the VRNEF scale. It suggested that a larger sample size is needed in order to accurately calculate the analysis, approximately using a ratio of 2 to 3 participants per item in each construct (Gagne and Hancock, 2006). Therefore, the final VRNEF would ideally have had a participant count of at least 96 as it had 48 items. However, due to time constraints, the final validity study was only able to secure 62 participants. If the target amount is not reached, the data entered may require that some variables need to be eliminated to be able to run the CFA. As in the case of this research, variables did need to be removed, including the entire construct of *narrative presence*. While the removal of a few variables is minor, the removal of a construct is not. As discovered through this research, *narrative presence* is a crucial part of narrative engagement, and therefore should be included in the final VRNEF. Thus its removal to run the CFA, which is due to the inability to reach the target sample size, remains a limitation.

Although it was not possible to fully validate the VRNEF scale without the removal of certain variables, the partial validation still represents a significant contribution to knowledge despite this limitation. This validation was the result of many factors, such as the time required for conducting individual testing, as well as the time-consuming nature of data entry and conducting the analysis. In addition, a significant amount of time needed to be devoted to learning the programmes involved in the data entry and calculations (SPSS AMOS, STATA, and MAXQDA).

Next, the limitations of using self-reporting measures for the VRNEF scale should be considered. Although widely used in research, self-reporting measures carry the possibility of providing invalid answers. This may be due to a number of factors. Firstly, there can be inaccuracy due to the user having to remember events, feelings, or interactions, as the questionnaire is administered following the completion of the experience. This increases the likelihood that they may erroneously recall the experience. Secondly, the phenomenon known as *social desirability bias* can cause people to answer in a way that they deem as socially acceptable. To clarify, they may answer in a way that they think they *should* answer, disregarding the actual truthful response. Likewise, their answers can also be affected by *response bias*, which is an individual's tendency to respond in a certain way regardless of the question. For example, individuals may be more likely to score things high or low depending on their own predispositions. The last issue in using

self-report questionnaires might be the clarity of the items, which brings the risk of obtaining different interpretations of questions (Demetriou, Ozer, and Essau, 2015). Some of these limitations were mitigated by providing the questionnaire immediately upon completion of the virtual reality experience and refining the VRNEF questions to ensure clarity.

A final limitation that should be considered is in regard to the data results. It is generally accepted when calculating the mean and standard deviation of questionnaires, that a higher mean and lower standard deviation indicates that the majority of participants are in agreement about the concept being measured (Brinkman, 2009). However, a larger deviation does not necessarily mean that the questionnaire is less accurate or that the application is less accurate in its portrayal of the concept. To clarify, users may have different preferences towards varying concepts that may lead them to score higher or lower. This may not directly translate to the concept being more or less successful, but rather reflect the individual's preference on how they view or feel about a specific construct. For example, recall that in **Section 4.2.1**, while using the standardised test the NES (Busselle and Bilandzic, 2008), the construct of *attentional focus* had a larger deviation of 1.57. The questions associated with this construct were as follows:

- I found my mind wandering while the during the story experience.
- While in the virtual world I found myself thinking about other things.
- I had a hard time keeping my mind on the story.

In consideration of these statements, depending on user preference, a user maybe less or more likely to sympathise with these statements, thus resulting in a larger deviation. Likewise, in consideration of the VRNEF scale, it too could see larger deviations in certain constructs due to this individual preference. For example, although the curiosity constructs (*environment* and *story*) had low deviations in this study, they could potentially have higher deviations in future studies, as the users may have different inclinations on what they feel curious about. In this instance, the data may still be regarded as accurate if the user preference is taken into account. Therefore, a lower deviation is not a sole indicator that the constructs are more precise, rather, they should be assessed in conjunction with other assessed factors such as the CFA, Cronbach's alpha, and user demographics.

8.4.1 Technical Limitations

A further possible limitation regarding this research study concerns the available resources. For the final study, all users used the same virtual reality headset, the Oculus RiftS, as this was the accessible resource. Although this hardware was sufficient for this study, it has its own limitations, particularly when compared with other newer available headset sets with respect to resolution and field of view. See **Table 8-1**.

Table 8-1 Virtual Reality Headset Comparison

Headset	Resolution	Refresh rate	Field of view
RiftS	1280 x 1440 pixels per eye	80hz	110 degrees
Meta Quest 3	2064 x 2208 pixels per eye	90hz to 120hz	110 degrees
Vive Pro 2	2448 × 2448 pixels per eye	90hz to 120hz	120 degrees
Vive Cosmos	1440 x 1700 pixels per eye	90hz	110 degrees
Valve Index	1440 ×1600 pixels per eye	90hz to 120hz	120 degrees

As visible in the above table, the RiftS has the lowest resolution (1280 x 1440 pixels per eye) when compared with other available headsets on the market. This is significant as this is the max resolution that can be seen. To clarify, even if the virtual reality experience is utilising high resolution 4k textures, the headset will limit that resolution to the maximum that the headset can handle. This could potentially affect the aesthetic value components as this will heavily impact the visuals, which may possibly lessen immersion and narrative engagement. Additionally, the RiftS also has the lowest refresh rate. Again, this

may introduce issues such as stuttering that may not be present in other hardware. Finally, it has a lower field of vision then the Vive Pro 2 and Valve Index. This is the distance to which the user can see without having to move their head. Having a lesser field of view may hinder an individual's ability to notice certain things, and they may not see important plot points, characters, objects, or other meaningful items, particularly those that emerge in peripheral vision.

In addition to the headset, the controllers also present some limitations. A good VR controller is essential for a seamless and immersive VR experience. It enhances the ability to interact with the virtual environment and contributes to the overall comfort and enjoyment the experience. A controller should be comfortable and allow for natural and intuitive movements, making the user forget that they are holding a device, and therefore be able to fully immerse themselves in the virtual world. They should also be accurate, and precise, allowing for detailed manipulation in the environment. A comparison on these aspects can be seen in the table below.

Table 8-2 Virtual Reality Controller Comparison

Headset	Hand Tracking Compatible	Sensors	Ergonomic Rating	Tracking
RiftS	No	2	Medium	Inside-Out
Meta Quest 3	Yes	3	Medium	Self-tracking
Vive Pro 2	Yes	24	Low	Outside-In
Vive Cosmos Elite	Yes	24	Medium	Outside-In
Valve Index	Yes	87	High	Outside-In

As listed above, the RiftS is the only headset that is not compatible with hand tracking, i.e., it is unable to track hands so the user must use controllers. The ability to experience VR without the need for controllers can greatly enhance immersion, as users can simply use their hands to interact with the virtual world. Additionally, the RiftS utilises inside-out tracking, this means that in order to track controller movements, the headset cameras have to always "see" controllers or at least detect part of them in their line of sight. This can lead to issues such as tracking collisions when one controller is in front of the other, and the inability to see controllers behind the back. Outside-In and self-tracking, however, eliminates these issues as the controllers are always "seen". Lastly, the Valve Index controllers have unparalleled tracking, with 87 sensors that are used to track finger movements. This enhances the "life-like" feel of the experience, thus increasing immersion and engagement in the experience. Based on this information, the RiftS controllers are subpar in comparison. This is especially important wen running a study, as there often are individuals that participate who are unfamiliar with game controllers or have physical limitations that make it difficult to hold non-ergonomic device.

To summarise, the studies for this research were conducted on older hardware, which may have resulted in participants reporting the experience to be *less* engaging. However, this is likely not a significant limitation, as the results reported in **Section 6** indicated a high score on the VRNEF scale. This further supports the guidelines of the VRNEF, as narrative engagement was still significantly high despite the applications being experienced on older hardware.

8.5 Future Work

8.5.1 Completing the CFA on the VRNEF

There is a great deal of opportunity for future work regarding this research. Recommendations, based upon the limitations outlined in the previous section, would first and foremost be a continuation of the study with the remaining 34 participants to ensure that the confirmatory factor analysis is correct and accurate for the full VRNEF, not just the subset that was tested. This would be using the same virtual reality

experience, conditions, and the full VRNEF scale (before the elimination of variables) with just the remaining 34 participants, rather than starting again from scratch. This will enable us to reach the targeted number of participants to run the confirmatory factor analysis (CFA), which will eliminate non-normal data in the calculations.

By doing so, we would hope to show that the elimination of certain variables was not necessary. In addition, if shown to be valid and reliable after conducting another CFA, this will increase the degree of confidence of that validity and reliability outcome. However, if the variables still need to be eliminated to achieve good reliability and validity, then further research will need to be carried out to either restructure or modify the final scale, particularly the *narrative presence* construct. If restructuring or modification is required, the VRNEF scale itself may first benefit from refining the questions to ensure clarity and eliminate any possible misconceptions. This may prove helpful in further increasing the confidence of the CFA. However, it is important to note that any changes to the questions would likely require a new validation and reliability test (CFA).

It would also be of interest to develop future work with some more recent hardware and equipment that is currently available in the market. This would be more likely to match what users probably already have access to and ensure that the research is able to utilise the best aspects of VR, i.e., having the ability to use strong visuals and interactions to enhance immersion as this is a crucial part of creating and keeping engagement within a VR experience. We would anticipate that this might result in slight improvements to reported engagement, as discussed above.

Future work could potentially also consider some fine tuning of the weightings of the constructs and items in the VRNEF scale. Currently, the scale holds no weightings and is scored directly based on the values on the Likert scale. It is possible that this may need to change as it was discovered in **Section 7** that some constructs may hold more weight than others, for example *aesthetic value* appears to be the strongest concept while *emotional engagement* and *curiosity environment* are the weakest.

Continuing this theory, since *emotional engagement* and *curiosity environment* both include interactivity with objects and characters, their weaker value could imply that physical interactivity expressly for cinematic virtual reality experiences either can be safely limited, or the concept of interactivity should be redefined for this genre. In **Section 2.4.1**, interactivity for interactive digital narratives (IDNs) was defined as a type of play, presented in two forms: the narrative game and the playable story (Ryan, 2002, pp. 595-596). Either form can consist of internal interactivity, which will result in the user's personification, or external interactivity, which involves the ability for users to navigate, alter their perspective, or examine objects to learn about the virtual world. Alternatively, recent research provides the following definition regarding interactivity for IDNs:

> Interactivity describes an active relationship between two or more entities, people, or objects. In digital media, interactivity represents a two-way flow of information between the devices and its user. In other words, it is the ability of a computer to respond to the user's input (Perkis *et al*., 2023)

Moreover, for the VRNEF creation, **Section 5.2.3** provided the definition of interactivity for IDNs under the *spatial presence* construct as interactions that are physical (concerning the senses: sight, hearing, touch), cerebral (strategy), and emotional (empathising and identifying with a character) (Designing Interactivity into Game Play, 2019).

In the context of this research, the creation of interactivity in the construct of *curiosity environment* relied mostly on the physical, particularly with using curiosity types to create interactable objects (To *et al*., 2016). To clarify, although some perceptual stimuli was created, such as audio cues and music, the VR experience focused more on items the user could pick up, influence, and physical exploration.

However, the above definitions are very broad and encompass many types of IDNs, with none specifically targeting cinematic storytelling in virtual reality. This can make it difficult to provide the appropriate types of interactivity for this genre, and therefore, potentially effect the strength of the narrative engagement of the experience. Thus, further work is necessary on creating a more in-depth definition of interactivity that targets this format.

Additionally, the concept of embodiment is included in the construct of *aesthetic value* and is implemented in the VRNEF guidelines through the form of haptics and perceived physics. However, the concept of embodiment may need to be expanded further. As mentioned in **Section 2.5.1.2**, it is closely tied to empathy, narrative engagement and presence. This may indicate that either *aesthetic value* needs to be expanded to incorporate more elements of embodiment or a separate construct may need to be created specifically for embodiment.

Finally, considering that the VRNEF is reliable, valid, and accurate, the next step in its evolution is utilising it to create narrative engagement in order to affect change and impact the public. In previous research (Wolfe, Louchart, and Loranger, 2022), it was discovered that interactive digital narratives (IDN) offer a greater potential for impact on their audience particularly in virtual reality due to its high levels of immersion. This research explored how the combined elements of light, colour, shape, and music can successfully influence users within an immersive VR experience. As these elements are a part of the *aesthetic value* construct, which is a component of narrative engagement, it can be presumed that if narrative engagement is present and has a high score on the VRNEF, it potentially has the ability to motivate, elicit emotions, create behavioural change, and inspire self-reflection. Therefore, conducting further research on utilising the VRNEF expressly to improve narrative engagement and impact the public could be greatly beneficial and have unlimited implications. In short, this could be used to change minds, opinions, inspire and even change the behaviour of a user.

Appendix A: Participation Information Sheet

Narrative Engagement in Interactive Cinematic VR Experiences

Welcome!

You are being invited to take part in a research study. Before you make your decision, it is important for you to understand why the research is being done and what it will involve.

- Please take time to read the following information carefully and discuss it with others if you wish.
- Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

This project is being conducted as a student master's project in pursuit of a degree in Research. The researcher, Austin Wolfe, is supervised Dr. Sandy Louchart[1]and Dr. Daniel Livingstone[1]

[1]School of Innovation and Technology, The Glasgow School of Art.

What is the purpose of the study?
This study proposed to explore the opportunities offered by VR in terms of storytelling towards a framework for creating and monitoring narrative engagement in interactive cinematic VR experiences.

Why have I been chosen?
Ideally this study would be able to be experienced by everyone in the general public, regardless of their experience or access with virtual reality. However, due to current distancing restrictions, individuals who currently have access to VR equipment are prioritised to take part in the study.

Do I have to take part?
No, it is up to you to decide whether or not to take part. If you decide to take part, you are still free to withdraw at any time and without giving a reason. Any data recorded anonymously may still be used if you withdraw.

If you are GSA SimVis student

Choosing to participate or withdrawal from the study will not have any bearing on your studies at GSA and course grading.

What does this involve if I take part?

If you decide to take part, you will first be provided with a consent form, and a disclaimer for the use of Oculus equipment.

As the study must be conducted online, access to everything required will be provided through links. You will be provided with the following assets:

- Consent Form
- Project Download
- A short instruction sheet.
- VR user safety information sheet
- Post experience Questionnaire (LimeSurvey)

After completion of the consent and participation forms, you will be asked to then experience the standing room application. You will follow a story within a virtual world and afterwards be asked to complete a final questionnaire regarding your experience. During the experience, the researcher will be collecting and recording observation data

through video chat. Observation data is recorded in Realtime, no footage is recorded. Upon completion of the experience, you will be asked to complete a short survey consisting of about 30 questions.
This study will take approximately 25-30 minutes in total to complete.

What are the requirements?

- You need to be 18+
- Have normal or corrected-to-normal vision (e.g., glasses, contact lenses)

Due to the current restrictions, the research cannot be completed on campus, and must be done inside of individuals' homes. Therefore, you must have access to the following:

- A VR headset and headphones (Oculus Rift, Rift S, Quest)
- Adequate floor space (at least 1.5 m x 1.5 m)
- Have access to internet connection.
- Have the ability to participate in a video chat (access to a camera)

Will my taking part in this study be kept confidential?
Absolutely. Each questionnaire is filled out and recorded anonymously through online surveys. All data will be dealt with in confidence so that anonymity will be preserved. Anonymised extracts from the questionnaire may be quoted in the dissertation for this study.

Are there any risks and benefits?
People who are prone to motion sickness may experience similar feeling in VR. This application has taken care to minimise those risks during its creation.
Please refer to included VR safety Sheet for full information on safety procedures and risks.
By participating you will be assisting VR developers in implementing storytelling elements into future applications.

What will happen to the results of the research study?
The aggregate results of the survey questions will be published with my dissertation, and permanently recorded. The individual survey data you provide, however, will be kept secure and anonymous for the duration of the dissertation, up to a maximum period of six months, and then destroyed.

10. Who has reviewed the study?
The project has been reviewed by the Dr. Sandy Louchart, Dr. Daniel Livingstone and Dr. Marianne McCara.

Who to Contact for Further Information
If you have any questions or require more information about this study, please contact me using the following contact details:

Principal Investigator: Austin Wolfe, [redacted]
Primary Supervisor: Sandy Louchart, [redacted]

Thank you for reading this information sheet and for considering taking part in this research. Please keep this sheet for future reference.

Appendix B: Participation Consent Forms (Health and Safety)

Title of Project: Narrative Engagement in Interactive Cinematic VR Experiences

Name of Researcher: Austin Wolfe

1. I confirm that I have read and understand the Participant Information Sheet for the above study and have had the opportunity to ask questions.
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. However, data already given anonymously cannot be withdrawn.
3. I understand that participation involves the use of my personal VR headset and filling out a post experience questionnaire.
4. I understand that anonymised extracts from my questionnaire may be quoted in the dissertation for this study.
5. I understand I will be observed during the VR experience and that data will be recorded by the researcher during the observation. Footage will not be recorded.
6. I understand that in any report on the results of this research my identity will remain anonymous and that all information I provide for this study will be treated confidentially.
7. I understand that signed consent forms retained by the conductor of the study until GSA's exam board confirms the result of the dissertation.
8. I understand that I am free to contact any of the people involved in the research to seek further clarification and information.
9. I agree to take part in the above study and understand that I will not benefit directly from participating in this research.
10. I understand the information I provide will be kept secure and anonymous for the duration of the dissertation, up to a maximum period of six months, and then destroyed.
11. *(If you are GSA SimVis student) * I understand that choosing to participate, or withdrawal from the study will not affect my studies at GSA and course grading.

Name of Participant	Date	Signature
Austin Wolfe	24/04/2021	[redacted]
Researcher	Date	Signature

Play Space Environment

WARNING Risks associated with freedom of movement

Your headset tracks your movement in six degrees of freedom (6DOF): your movement forward and backward, up and down, left and right, while also tracking the rotational movement of your head. This allows your movement in your physical world to be translated into movement in your virtual world.

There are additional responsibilities you should follow to have a safe experience while exploring your virtual world.

WARNING **Use Only in a Safe Environment:** The headset produces an immersive virtual reality experience that distracts you from and completely blocks your view of your actual surroundings.

Setting up Your Safe Play Space

- **Always be aware of your surroundings before beginning use and while using the headset. Use caution to avoid injury.**
- You are responsible for creating and maintaining a safe environment for use at all times.
- Only use your headset indoors.
- Serious injuries can occur from tripping or running into or striking walls, furniture, other objects or people, so clear an area for safe use before using the headset.

- Take special care to ensure that you are not near items that you may hit or strike, or areas which may cause you to lose your balance when using—or immediately after using—the headset, like other people, objects, stairs or steps, ramps, sidewalk(s), balconies, open doorways, windows, furniture, open flames (like candles or fireplaces), ceiling fans or light fixtures, televisions or monitors, or other things.
- Proper use of the Guardian system is important for setting up a safe environment. Please set up the Guardian system prior to use as described in the Guardian system section below.
- Consider having another person act as a spotter while you move around in your virtual world.
- Take appropriate steps to prevent people (particularly children) or pets who do not understand that your perceptions are limited from entering your play space.

Interaction of the Real World and the Virtual Environment

- Ease into the use of the headset to allow your body to adjust; use for only a few minutes at a time at first, and only increase the amount of time using the headset gradually as you grow accustomed to virtual reality. Looking around and using the input device when first entering virtual reality can help you adjust to any small differences between your real-world movements and the resulting virtual reality experience.
- Take at least a 10- to 15-minute break every 30 minutes, even if you don't think you need it. Each person is different, so take more frequent and longer breaks if you feel discomfort. You should always take regular breaks and you should decide what break schedule works best for you.

- Move carefully while you explore the virtual world. Fast or abrupt motion may cause a collision or loss of balance.
- Use of the headset and Oculus controllers may result in a loss of balance. If your balance feels affected, remove your headset and take a break until normal balance returns.
- Remember that the objects you see in the virtual environment do not exist in the real world, so don't sit or stand on them or use them for support.
- Remain seated unless your game or content experience requires standing or moving around your play space. If you are using the headset while seated, make sure you are seated on a secure surface and stable platform.
- Use of the headset with glasses may increase the risk of facial injury if you fall or hit your face.
- While using the headset with controllers, you may extend your arms fully out to the side or over your head, so make sure those areas are clear of objects or potential hazards.
- Make sure your play space has a level, firm, and even surface without loose carpeting or rugs, uneven surfaces, or similar hazards. Remove any tripping hazards from the play space before using the headset. Take care that the cable connecting your headset to a computer does not become a choking or tripping hazard.
- Remember that while using the headset you may be unaware that people and pets may enter your play space. Secure your play space while in use, and if you sense something or someone has entered your play space, remove your headset and pause your VR experience to make sure your play space is still safe.
- Your view of your surroundings is completely blocked while you are using the headset, so do not hold or handle things that are dangerous, may injure you, or may be damaged.
- The rings on your controllers extend away from your hands. Use caution when moving your hands and arms so you do not strike yourself with the controllers.

Prohibited Uses

- The headset is designed for use indoors. Use of the headset outdoors creates additional and uncontrolled hazards, like uneven and slippery surfaces and unexpected obstacles, vehicles (traffic), persons or pets. Also, the Guardian system (see below) may not work properly outdoors.
- Never wear the headset in situations that require attention, such as running, bicycling, or driving.
- Do not use the headset while in a moving vehicle such as a car, bus, or train, as variation in speed (velocity) or sudden movements may increase your susceptibility to adverse symptoms.

Health & Safety Warnings

WARNING HEALTH & SAFETY WARNINGS: To reduce the risk of personal injury, discomfort or property damage, please ensure that all users of the headset read the warnings below carefully before using your VR system.

Visit the Oculus Safety Center at *support.oculus.com* for more information on the safe use of your VR system.

Throughout this Guide, we include icons to illustrate and orient you to health and safety issues. The icons are not a substitute for the text of this Guide, so please use them both together.

WARNING Before Using Your VR System

- Read and follow all setup and operating instructions provided with the headset.
- Review the hardware and software recommendations for use of the headset. Risk of discomfort may increase if recommended hardware and software are not used.
- Your headset and software are not designed for use with any unauthorized device, accessory, software and/or content. Use of an unauthorized device, accessory, software and/or content or hacking the device, software or content may result in injury to you or others, may cause performance issues or damage to your system and related services, and may void your warranty.
- **Headset Adjustment.** To reduce the risk of discomfort, the headset should be balanced and centered. Please adjust the top strap and adjust the headband by twisting the fit wheel on the back to ensure comfortable placement of the headset and that you see a single, clear image. Adjust the lenses by pressing the button located on the right underside of your headset to accommodate glasses or improve comfort. Re-check the settings before resuming use after a break, to avoid any unintended changes to any adjustments.

- **Content Selection.** Virtual reality is an immersive experience that can be intense. Frightening, violent or anxiety provoking content can cause your body to react as if it were real. Carefully choose your content if you have a history of discomfort or physical symptoms when experiencing these situations. Oculus provides comfort ratings for some content, and you should review the comfort rating for your content before use. (For more details on comfort ratings and how they can assist in providing a comfortable experience, go to ***https://support.oculus.com/comfort***). If you have a history of discomfort when exposed to certain content or experiences or are new to virtual reality, start with content rated Comfortable, before trying Moderate, Intense or Unrated content.

- **Use Only When Unimpaired.** A comfortable virtual reality experience requires an unimpaired sense of motion and balance. Do not use the headset when you are:
  - Tired;
  - Need sleep;
  - Under the influence of alcohol or drugs;
  - Hung-over;
  - Experiencing or have digestive problems;
  - Under emotional stress or anxiety; or
  - Suffering from cold, flu, headaches, migraines, or earaches

  as this can increase your susceptibility to adverse symptoms.

WARNING Pre-Existing Medical Conditions

- Consult with your physician before using the headset if you are pregnant, elderly, have pre-existing binocular vision abnormalities or psychiatric disorders, or suffer from a heart condition or other serious medical condition.
- **Seizures.** Some people (about 1 in 4,000) may have severe dizziness, seizures, eye or muscle twitching or blackouts triggered by light flashes or patterns, and this may occur while they are watching TV, playing video games or experiencing virtual reality, even if they have never had a seizure or blackout before or have no history of seizures or epilepsy. Such seizures are more common in children and young people. Anyone who experiences any of these symptoms should discontinue use of the headset and see a doctor. If you previously have had a seizure, loss of awareness, or other symptom linked to an epileptic condition, you should see a doctor before using the headset.
- **Interference with Medical Devices.** The headset and controller(s) may contain magnets or components that emit radio waves, which could affect the operation of nearby electronics, including cardiac pacemakers, hearing aids and defibrillators. If you have a pacemaker or other implanted medical device, do not use the headset and controller without first consulting your doctor or the manufacturer of your medical device. Maintain a safe distance between the headset and controller and your medical devices. Stop using the headset and/or controller(s) if you observe a persistent interference with your medical device.

WARNING Age Requirement/Children

This product is not a toy and should not be used by children under the age of 13, as the headset is not sized for children and improper sizing can lead to discomfort or adverse health effects, and younger children are in a critical period in visual development. Adults should make sure children (age 13 and older) use the headset in accordance with these health and safety warnings, including making sure the headset is used as described in the Before Using Your VR System and the Use Only in a Safe Environment section. Adults should monitor children age 13 and older who are using or have used the headset for any of the symptoms described in these health and safety warnings (including those described under the Discomfort and Repetitive Stress Injury sections), and should limit the time children spend using the headset and ensure they take breaks during use. Prolonged use should be avoided, as this could negatively impact hand-eye coordination, balance, and multi-tasking ability. Adults should monitor children closely during and after use of the headset for any decrease in these abilities.

Hearing Damage

- To prevent possible hearing damage, do not listen at high volume levels for long periods.

⚠ WARNING System Alerts

For your protection, you should take immediate action when prompted by system alerts. The headset may provide you with the following alerts:

- **Sound Volume Alert.** A visual alert in the event of high volume levels. If that alert appears, lower the sound volume to reduce the risk of hearing loss.
- **Outside of Play Space Alert.** A visual alert if you are outside of your play space. If that alert appears, remove your headset or go back to your play space to continue your experience, if desired.
- **Tracking Error System Alerts.** A visual alert if the headset's tracking system is not operating properly. Note if the headset is experiencing tracking issues, then the Guardian system may not be functioning properly or may be disabled. If this alert appears, remove the headset and move to a safe space. Afterwards, follow the instructions provided on-screen to address the issue.

⚠ WARNING Discomfort

- Immediately discontinue using the headset if any of the following symptoms are experienced:
  - Seizures;
  - Loss of awareness;
  - Eye strain;
  - Eye or muscle twitching;
  - Involuntary movements;
  - Altered, blurred, or double vision or other visual abnormalities;
  - Dizziness;
  - Disorientation;
  - Impaired balance;
  - Impaired hand-eye coordination;
  - Excessive sweating;
  - Increased salivation;
  - Nausea;
  - Lightheadedness;
  - Discomfort or pain in the head or eyes;
  - Drowsiness;
  - Fatigue;
  - Any symptoms similar to motion sickness.
- **Just as with the symptoms people can experience after they disembark a cruise ship, symptoms of virtual reality exposure can persist and become more apparent hours after use.** These post-use symptoms can include the symptoms above, as well as excessive drowsiness and decreased ability to multi-task. These symptoms may put you at an increased risk of injury when engaging in normal activities in the real world.
- Do not drive, operate machinery, or engage in other visually or physically demanding activities that have potentially serious consequences (i.e., activities in which experiencing any symptoms could lead to death, personal injury, or damage to property), or other activities that require unimpaired balance and hand-eye coordination (such as playing sports or riding a bicycle, etc.) until you have fully recovered from any symptoms.

- Do not use the headset until all symptoms have completely subsided for several hours.
- Be mindful of the type of content that you were using prior to the onset of any symptoms because you may be more prone to symptoms based upon the content being used. Review the comfort rating for the content you were using, and consider using content with a less intense comfort rating.
- See a doctor if you have serious and/or persistent symptoms.

⚠ WARNING Electrical Safety

Your headset is sensitive electronic equipment. Improper use of it, including improper connection to a computer, may result in fire, explosion, or other hazard. Follow these instructions to reduce the risk of injury to you or others, or damage to your product or other property.

- Only power and run your headset with the included cable or an approved cable. Do not use other cables or power adapters. If you are unsure about whether a cable or power adapter is compatible with your headset, contact Oculus Support.
- Periodically inspect connection cords and connector tips for damage or signs of wear. Do not use your cable if prong(s), enclosure, connector part(s), connector cable(s), or any other part is damaged, cracked, or exposed.
- Do not use external battery packs or power sources other than authorized accessories to power the headset.
- Avoid dropping your headset. Dropping it, especially on a hard surface, can potentially cause damage to the headset or cords. Inspect your headset for visual damage before each use. If you suspect damage to your headset or cords, contact Oculus Support.
- Do not let your headset get wet or come in contact with liquids. If the headset gets wet, contact Oculus Support, even if the headset appears to be working normally.

Do not place your headset in areas that may get very hot, such as on or near a cooking surface, cooking appliance, iron or radiator or in direct sunlight. Excessive heating can damage the headset and could create a risk of injury. Do not dry a wet or damp headset with an appliance or heat source such as a microwave oven, hair dryer, iron or radiator. Avoid leaving your headset in a car in high temperatures. Follow any thermal warnings and advisory that may appear on your device's screen

Appendix C: *Phase One* Beat Sheet Script

Aonar Storyline

SCENE 1 (Opening Image)

In the far north there are islands, where sea and land become one. Sand, stone, water, and sky shift together like liquid, eternally in a state of in between. Where movement is constantly balanced with calm. In this place you will find the Mother of the Sea.
During the summer months, she soothes the waters of the islands. She fills the sea with all manner of life. She delivers fair winds to travel on. She provides for the islands.
The Mother of the Sea, however, has an enemy. Teran. He is fierce and rageful and wishes only to darken the sea. He seethes with bitterness, chained to the bottom of the ocean, while the Mother of the Sea reigns and brings prosperity.
But when the summer is over, Teran grows strong and breaks the chains that bind him. With his freedom he brings storms, darkness and sorrow. So powerful is his wrath that he forces the Mother of the Sea from the ocean to land, for she is too weak to fight his hatred.
When the Spring returns, she will have regained her strength, and once again return to the sea. There, she will beat Teran and imprison him once more, resigning him to the depths. And thus, it persists, in a continual battle, raging every year as the seasons change.

SCENE 2 (Set up)

Our story takes place at the beginning of spring, when Teran is again confined to the sea floor and the sea is full of life. On the northernmost island of Scotland lived a young lighthouse keeper.
His lighthouse was worn by weather and waves, but very much cared for.
His life was solitary and as such he spent much of his time fulfilling his commitment to warn ships at sea. (at Lighthouse at day) (Interaction items: lighthouse light, character, seabirds)

SCENE 3 (Set up continued)

When not looking after the lighthouse, the young keeper took a small fishing boat and enjoyed the beauty of the vast ocean.
He would gaze at the fishes under the water, and delight in the shadows of seals darting in and out from under his keel. He often marvelled what it would be like to live in their world, to swim so easily in the waters below. (on boat at day) (Interaction items: boat sail, character, water, boat—encourage to sit)

SCENE 4 (Set up continued)

When the night came, his home was filled with the sounds of crashing waves and wind. And the melody of the sea would lull him to sleep, and he would be at peace. (In house at night) (Interaction items: books, character, lantern, window, photographs)

SCENE 5 (Catalyst and Debate)

But the lighthouse keeper was also lonely.
Sometimes, when the moon was full, and his grief overwhelmed him, he would sit on a rock by the sea, and stare into its dark waters, his loneliness looming over him as a shadow.
One night, as he sat there, with his loneliness, he spied a large shell.
It was a peculiar shell, a perfect spiral, but with four evenly placed holes.
For reasons unknown to him, his sorrow swelled, and he felt compelled to pick it up.
Placing his fingers over the holes, he blew into the shell.

(Calls 3x, after 3rd call, there is a sound in return.)
There was a honking calling from the sea.
A dark creature was bobbing up and down in the waves.
And for a moment, his loneliness left him. (On Beach at night) (Interaction items: lantern, character, rocks, seashells, crab)

SCENE 6 (Choosing Act 2)

Each night he returned and blew the shell. And always, on the third blow, the creature appeared to answer him.
On the seventh night, the keeper blew his shell, his call was unanswered.
He blew and blew, until he had no more breath to give. But the creature did not show. Defeated, and feeling the shadow of his loneliness once more, he went home. (On Beach at night) (Interaction items: lantern, character, rocks, seashells)

SCENE 7 (Promise of Premise)

(Soft rapping at the door, he opens the door)
There in the doorway, a beautiful woman with raven hair. In her arms was a shimmering silver skin. For she was a selkie, the creature who hand been answering his call.
She handed him her skin, instructing him to keep it safe.
In return, she would stay with him a while to ease his loneliness.
The keeper took the skin, and carefully hid it away in a chest.
(In house at night) (Interaction items: chest, character, sealskin, books, photographs)

* * *

SCENE 8 (Midpoint)

For six years the pair lived in joy and peace.
And during this time, the mother of the sea and Teran continued their battle year after year.
In the Summer they celebrated life, tending to the garden. (In garden at day) (Interaction items: plants, character, watering can, rabbit, crows, fruit)

SCENE 9 (Midpoint Continued)

In the winter months, they celebrated death and stood on the top of the light house and watched the northern lights, the merry dancers whose souls had passed over into the next world. (at Lighthouse at night) (Interaction items: lighthouse light, character)

SCENE 10 (Midpoint Continued)

He showed her the wonders of the land. Like the standing stones that were once great giants, turned to stone many years ago. (small Island of standing stones at day) (Interaction items: stones, character, butterflies, fairy circle mushrooms)

SCENE 11 (Midpoint Continued)

In return, she showed him to wonders of the sea. (In the ocean at day, user floating) (Interaction items: fish)

SCENE 12 (Bad guys close in and All is lost)

Upon the seventh year, something started to change. The woman started to grow thin and pale, her once raven hair fading and becoming dull and brittle.
She had been on land for too long, denying the call of the sea.

It became clear.
She must return to the sea and live or stay on the shore with her love and die. The fisherman sat for hours at night staring at the locked chest holding her skin, not knowing what to do. (In house at night) (Interaction items: chest, character, sealskin, books, photographs)

SCENE 13 (choosing Act 3)

When morning came, he placed the skin gently in her hands. *(She handed him his shell, now intricately carved)* (In house at day) (Interaction items: chest, character, books, photographs)

SCENE 14 (Finale and Final image)

The fisherman sat on his stone, looking out into the dark waters.
When the moon was full, the carvings on his shell would light, and he would call out to the sea.
Many dark figures would greet him, bobbing in the water. And, no longer afraid, he finally let his loneliness embrace him, as if he were welcoming an old friend.
(Character looks pointedly at user, invites them to sit with him, hands them the shell.)
(On Beach at night) (Interaction items: lantern, character, rocks, seashells, crab)

Appendix D: *Phase One* Questionnaires

Original Questionnaires used in *Phase One*

Narrative Engagement in Interactive Cinematic VR Experiences

Thank you for your participation in this study. Please complete this questionnaire following the VR experience. There is a total of 35 questions and it will take you approxiamtely 5-10 min to complete.

There are 10 questions in this survey.

Narrative Engagement

Rate your level of agreement with each statement *

Please choose the appropriate response for each item:

	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
During the experience, my body was in the room, but my mind was inside the world created by the story	○	○	○	○	○
The experience created a new world, and then that world suddenly disappeared when the application ended	○	○	○	○	○
At times during the experience, the story world was closer to me than the real world	○	○	○	○	○

Rate your level of agreement with each statement *

Please choose the appropriate response for each item:

	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
The story affected me emotionally	○	○	○	○	○
During the experience, when a main character succeeded, I felt happy, and when they suffered in some way, I felt sad	○	○	○	○	○
I felt sympathy for some of the characters in the story	○	○	○	○	○

Rate your level of agreement with each statement *

Please choose the appropriate response for each item:

	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
I found my mind wandering while the during the story experience	○	○	○	○	○
While in the virtual world I found myself thinking about other things	○	○	○	○	○
I had a hard time keeping my mind on the story	○	○	○	○	○

Rate your level of agreement with each statement *

Please choose the appropriate response for each item:

	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
At points, I had a hard time making sense of what was going on in the experience.	○	○	○	○	○
My understanding of the characters is unclear	○	○	○	○	○
I had a hard time recognizing the thread of the story	○	○	○	○	○

Suspense

Rate your level of agreement with each statement *

Please choose the appropriate response for each item:

	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
At some moments I was anxious to find out what would happen next	○	○	○	○	○
Sometimes I was worried about how the story would develop	○	○	○	○	○
Some moments were rather suspenseful	○	○	○	○	○
I found myself wishing for a particular story outcome	○	○	○	○	○

Curiosity

Rate your level of agreement with each statement

During the experience I felt.....

*

Please choose the appropriate response for each item:

	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
Curious	○	○	○	○	○
Interested	○	○	○	○	○
Inquisitive	○	○	○	○	○

Flow

Rate your level of agreement with each statement

During the experience. . .

*

Please choose the appropriate response for each item:

	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
I felt competent enough to meet the demands of the situation	○	○	○	○	○
I acted spontaneously and automatically without having to think	○	○	○	○	○
I had a strong sense of what I wanted to do	○	○	○	○	○
I had a good idea while I was performing about how well I was doing	○	○	○	○	○
I was completely focused on the task at hand	○	○	○	○	○

Presence

Rate your level of agreement with each statement

*

Please choose the appropriate response for each item:

	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
In the experience I had a sense of "being there"	○	○	○	○	○
I felt present in the virtual space	○	○	○	○	○
The virtual world seemed more realistic than the real world	○	○	○	○	○
I was not aware of my real environment	○	○	○	○	○

Enjoyment

Rate your level of agreement with each statement

The experience was...

*

Please choose the appropriate response for each item:

	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
...was entertaining	○	○	○	○	○
...was enjoyable	○	○	○	○	○

Aesthetic Pleasantness

Rate your level of agreement with each statement

The experience...

*

Please choose the appropriate response for each item:

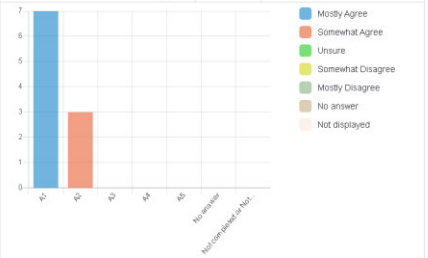
	Mostly Agree	Somewhat Agree	Unsure	Somewhat Disagree	Mostly Disagree
...made me think	○	○	○	○	○
...makes me relate the artwork to my personal situation	○	○	○	○	○
...told me something about life	○	○	○	○	○
...was inspiring	○	○	○	○	○
...moved me like a piece of art	○	○	○	○	○

Appendix E: *Phase One* Data Graph

Summary for IPQ[IPQG01F][In the experience I had a sense of "being there"]

Rate your level of agreement with each statement

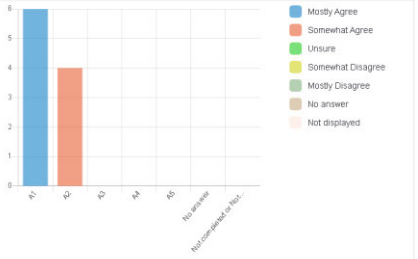
Answer	Count	Gross percentage
Mostly Agree (A1)	7	70.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for IPQ[IPQSP01F][I felt present in the virtual space]

Rate your level of agreement with each statement

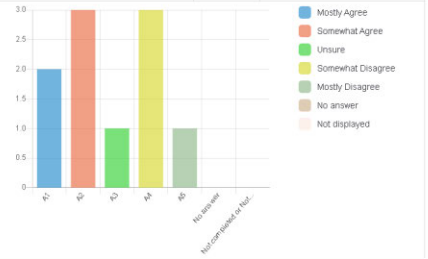
Answer	Count	Gross percentage
Mostly Agree (A1)	6	60.00%
Somewhat Agree (A2)	4	40.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for IPQ[IPQER01F][The virtual world seemed more realistic than the real world]

Rate your level of agreement with each statement

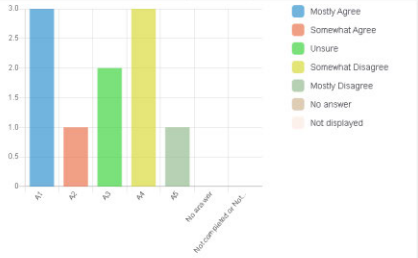
Answer	Count	Gross percentage
Mostly Agree (A1)	2	20.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	1	10.00%
Somewhat Disagree (A4)	3	30.00%
Mostly Disagree (A5)	1	10.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for IPQ[IPQINV01F][I was not aware of my real environment]

Rate your level of agreement with each statement

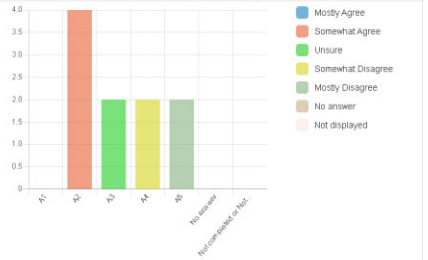
Answer	Count	Gross percentage
Mostly Agree (A1)	3	30.00%
Somewhat Agree (A2)	1	10.00%
Unsure (A3)	2	20.00%
Somewhat Disagree (A4)	3	30.00%
Mostly Disagree (A5)	1	10.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESAF[AF01B][I found my mind wandering while the during the story experience]

Rate your level of agreement with each statement

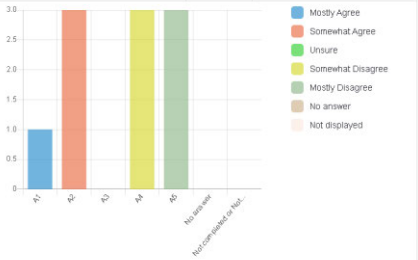
Answer	Count	Gross percentage
Mostly Agree (A1)	0	0.00%
Somewhat Agree (A2)	4	40.00%
Unsure (A3)	2	20.00%
Somewhat Disagree (A4)	2	20.00%
Mostly Disagree (A5)	2	20.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESAF[AF02B][While in the virtual world I found myself thinking about other things]

Rate your level of agreement with each statement

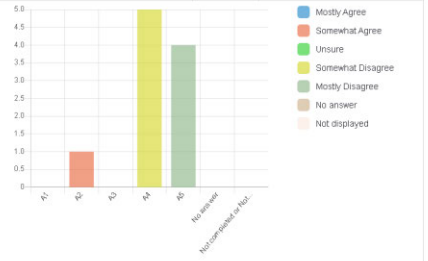
Answer	Count	Gross percentage
Mostly Agree (A1)	1	10.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	3	30.00%
Mostly Disagree (A5)	3	30.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESAF[AF03B][I had a hard time keeping my mind on the story]

Rate your level of agreement with each statement

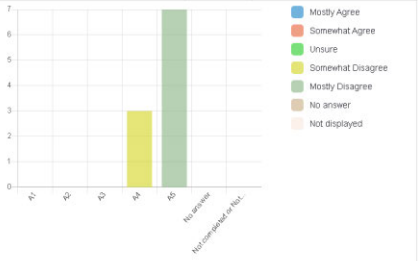
Answer	Count	Gross percentage
Mostly Agree (A1)	0	0.00%
Somewhat Agree (A2)	1	10.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	5	50.00%
Mostly Disagree (A5)	4	40.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESNU[NU01][At points, I had a hard time making sense of what was going on in the experience.]

Rate your level of agreement with each statement

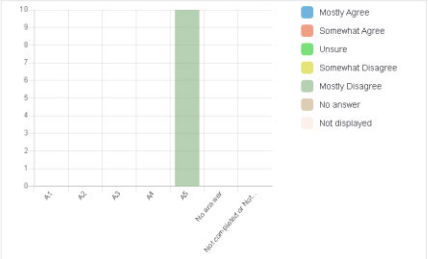
Answer	Count	Gross percentage
Mostly Agree (A1)	0	0.00%
Somewhat Agree (A2)	0	0.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	3	30.00%
Mostly Disagree (A5)	7	70.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESNU[NU02][My understanding of the characters is unclear]

Rate your level of agreement with each statement

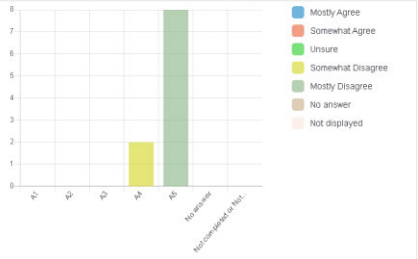
Answer	Count	Gross percentage
Mostly Agree (A1)	0	0.00%
Somewhat Agree (A2)	0	0.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	10	100.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESNU[NU03B][I had a hard time recognizing the thread of the story]

Rate your level of agreement with each statement

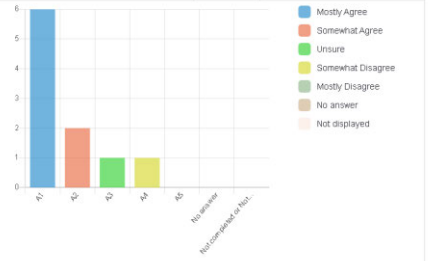
Answer	Count	Gross percentage
Mostly Agree (A1)	0	0.00%
Somewhat Agree (A2)	0	0.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	2	20.00%
Mostly Disagree (A5)	8	80.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESEE[EE02F][During the experience, when a main character succeeded, I felt happy, and when they suffered in some way, I felt sad]

Rate your level of agreement with each statement

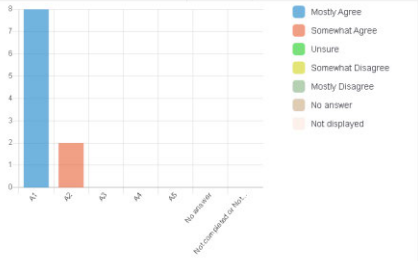
Answer	Count	Gross percentage
Mostly Agree (A1)	6	60.00%
Somewhat Agree (A2)	2	20.00%
Unsure (A3)	1	10.00%
Somewhat Disagree (A4)	1	10.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESEE[EE03F][I felt sympathy for some of the characters in the story]

Rate your level of agreement with each statement

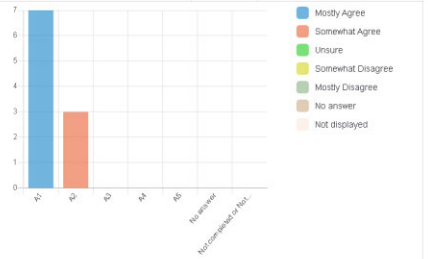
Answer	Count	Gross percentage
Mostly Agree (A1)	8	80.00%
Somewhat Agree (A2)	2	20.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESNP(NP01F)[During the experience, my body was in the room, but my mind was inside the world created by the story]

Rate your level of agreement with each statement

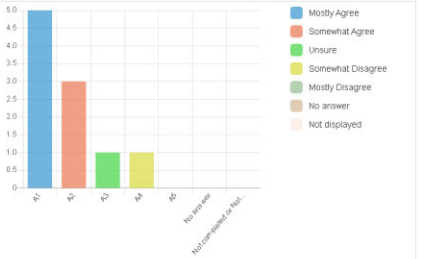
Answer	Count	Gross percentage
Mostly Agree (A1)	7	70.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESNP(NP02F)[The experience created a new world, and then that world suddenly disappeared when the application ended]

Rate your level of agreement with each statement

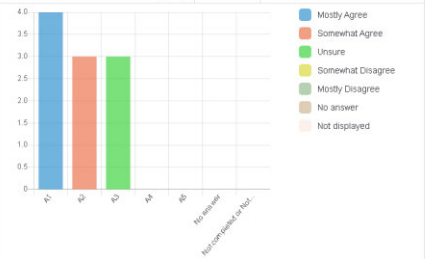
Answer	Count	Gross percentage
Mostly Agree (A1)	5	50.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	1	10.00%
Somewhat Disagree (A4)	1	10.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESNP(NP03F)[At times during the experience, the story world was closer to me than the real world]

Rate your level of agreement with each statement

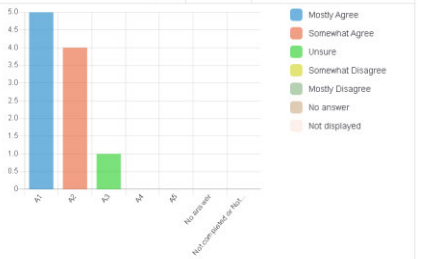
Answer	Count	Gross percentage
Mostly Agree (A1)	4	40.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	3	30.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for NESEE(EE01F)[The story affected me emotionally]

Rate your level of agreement with each statement

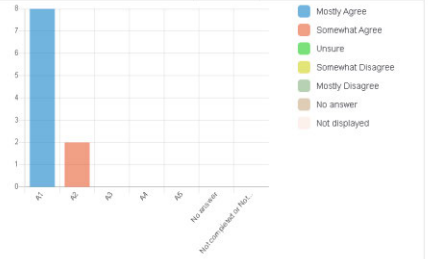
Answer	Count	Gross percentage
Mostly Agree (A1)	5	50.00%
Somewhat Agree (A2)	4	40.00%
Unsure (A3)	1	10.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for ES(ES01F)[. . . was entertaining]

Rate your level of agreement with each statement **The experience was...**

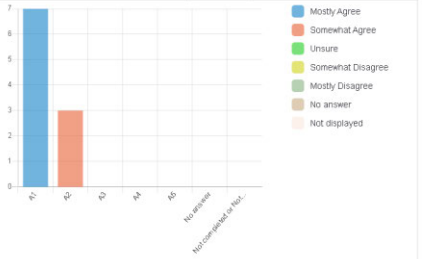
Answer	Count	Gross percentage
Mostly Agree (A1)	8	80.00%
Somewhat Agree (A2)	2	20.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for ES(ES02F)[. . . was enjoyable]

Rate your level of agreement with each statement **The experience was...**

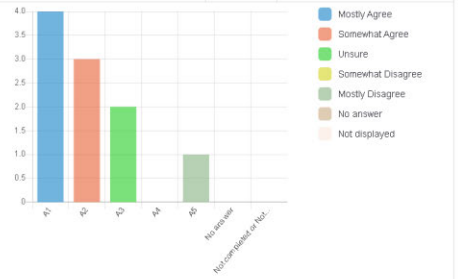
Answer	Count	Gross percentage
Mostly Agree (A1)	7	70.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for SS(SS01F)[At some moments I was anxious to find out what would happen next]

Rate your level of agreement with each statement

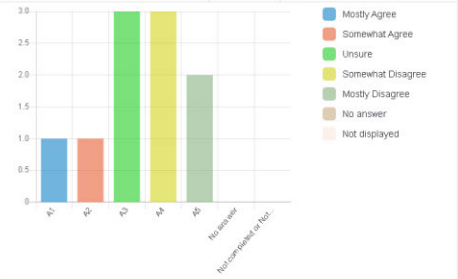
Answer	Count	Gross percentage
Mostly Agree (A1)	4	40.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	2	20.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	1	10.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for SS(SS02F)[Sometimes I was worried about how the story would develop]

Rate your level of agreement with each statement

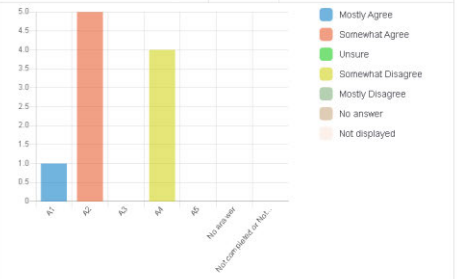
Answer	Count	Gross percentage
Mostly Agree (A1)	1	10.00%
Somewhat Agree (A2)	1	10.00%
Unsure (A3)	3	30.00%
Somewhat Disagree (A4)	3	30.00%
Mostly Disagree (A5)	2	20.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for SS(SS03F)[Some moments were rather suspenseful]

Rate your level of agreement with each statement

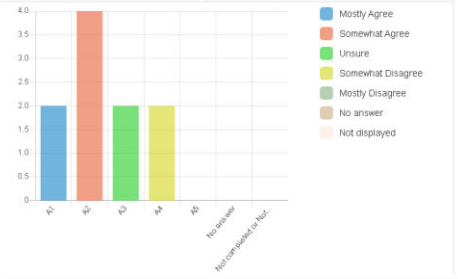
Answer	Count	Gross percentage
Mostly Agree (A1)	1	10.00%
Somewhat Agree (A2)	5	50.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	4	40.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for SS(SS04F)[I found myself wishing for a particular story outcome]

Rate your level of agreement with each statement

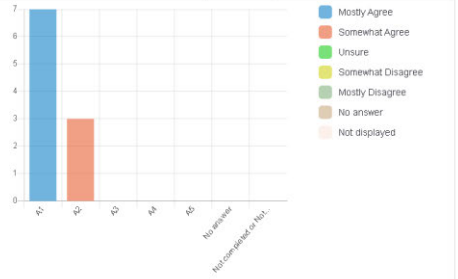
Answer	Count	Gross percentage
Mostly Agree (A1)	2	20.00%
Somewhat Agree (A2)	4	40.00%
Unsure (A3)	2	20.00%
Somewhat Disagree (A4)	2	20.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for CS(CS01F)[Curious]

Rate your level of agreement with each statement During the experience I felt.....

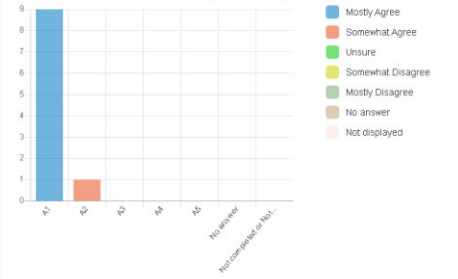
Answer	Count	Gross percentage
Mostly Agree (A1)	7	70.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for CS(CS02F)[Interested]

Rate your level of agreement with each statement During the experience I felt.....

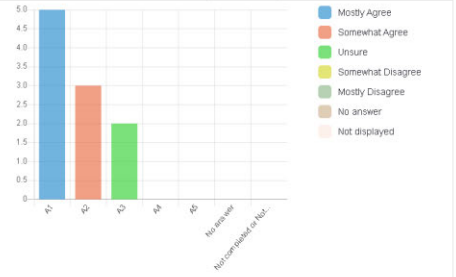
Answer	Count	Gross percentage
Mostly Agree (A1)	9	90.00%
Somewhat Agree (A2)	1	10.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for CS[CS03F][Inquisitive]

Rate your level of agreement with each statement During the experience I felt.....

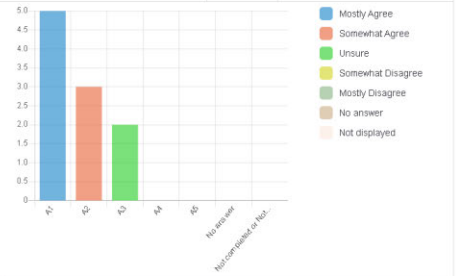
Answer	Count	Gross percentage
Mostly Agree (A1)	5	50.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	2	20.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for FFS2[FFS201F][I felt competent enough to meet the demands of the situation]

Rate your level of agreement with each statement During the experience. . .

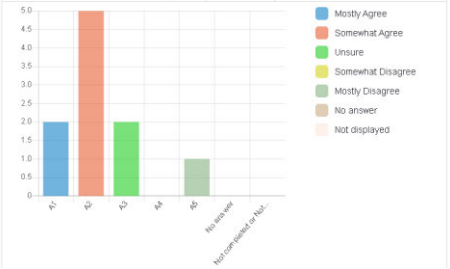
Answer	Count	Gross percentage
Mostly Agree (A1)	5	50.00%
Somewhat Agree (A2)	3	30.00%
Unsure (A3)	2	20.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for FFS2[FFS202F][I acted spontaneously and automatically without having to think]

Rate your level of agreement with each statement During the experience. . .

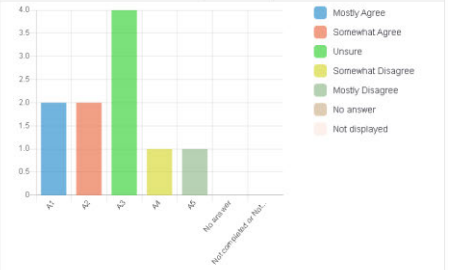
Answer	Count	Gross percentage
Mostly Agree (A1)	2	20.00%
Somewhat Agree (A2)	5	50.00%
Unsure (A3)	2	20.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	1	10.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for FFS2[FFS203F][I had a strong sense of what I wanted to do]

Rate your level of agreement with each statement During the experience. . .

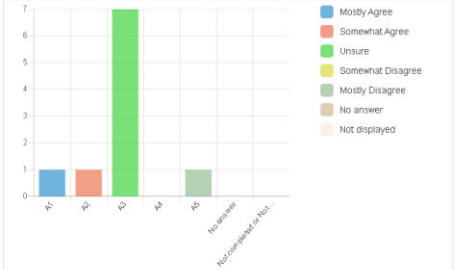
Answer	Count	Gross percentage
Mostly Agree (A1)	2	20.00%
Somewhat Agree (A2)	2	20.00%
Unsure (A3)	4	40.00%
Somewhat Disagree (A4)	1	10.00%
Mostly Disagree (A5)	1	10.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for FFS2[FFS204F][I had a good idea while I was performing about how well I was doing]

Rate your level of agreement with each statement During the experience. . .

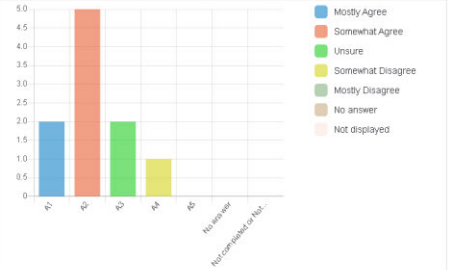
Answer	Count	Gross percentage
Mostly Agree (A1)	1	10.00%
Somewhat Agree (A2)	1	10.00%
Unsure (A3)	7	70.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	1	10.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for FFS2[FFS205F][I was completely focused on the task at hand]

Rate your level of agreement with each statement During the experience. . .

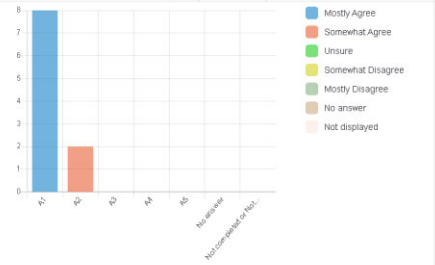
Answer	Count	Gross percentage
Mostly Agree (A1)	2	20.00%
Somewhat Agree (A2)	5	50.00%
Unsure (A3)	2	20.00%
Somewhat Disagree (A4)	1	10.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for APS[APS01F][. . . made me think]

Rate your level of agreement with each statement The experience...

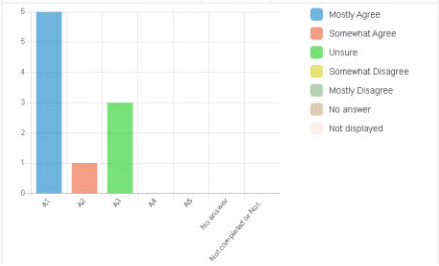
Answer	Count	Gross percentage
Mostly Agree (A1)	8	80.00%
Somewhat Agree (A2)	2	20.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for APS[APS02F][. . . makes me relate the artwork to my personal situation]

Rate your level of agreement with each statement The experience...

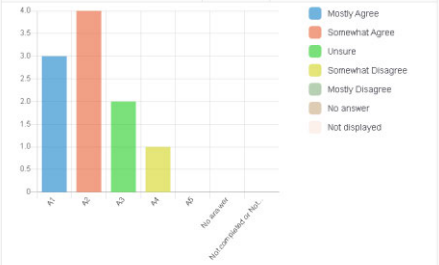
Answer	Count	Gross percentage
Mostly Agree (A1)	6	60.00%
Somewhat Agree (A2)	1	10.00%
Unsure (A3)	3	30.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for APS[APS03F][. . . told me something about life]

Rate your level of agreement with each statement The experience...

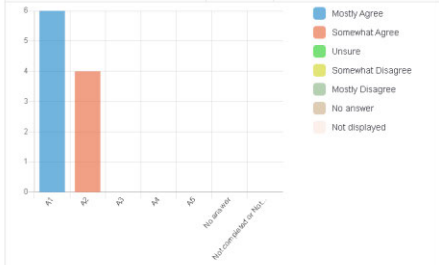
Answer	Count	Gross percentage
Mostly Agree (A1)	3	30.00%
Somewhat Agree (A2)	4	40.00%
Unsure (A3)	2	20.00%
Somewhat Disagree (A4)	1	10.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Summary for APS[APS04F][. . . was inspiring]

Rate your level of agreement with each statement The experience...

Answer	Count	Gross percentage
Mostly Agree (A1)	6	60.00%
Somewhat Agree (A2)	4	40.00%
Unsure (A3)	0	0.00%
Somewhat Disagree (A4)	0	0.00%
Mostly Disagree (A5)	0	0.00%
No answer	0	0.00%
Not displayed	0	0.00%
Total(gross)	**10**	**100.00%**



Appendix F: VRNEF Measurements and Guidelines

Final VRNEF Measurement Scale (SinglePlayer)

The following scale is measure on a 5-point Likert scale using forward scoring of 1 to 5.

Narrative Understanding
- NU001 At moments in the story, it was easy to make sense of what was going on in the experience.
- NU002 My understanding of the characters is clear.
- NU003 The plot of the story was easy to recognise.
- NU004 I was able to understand the story.

Narrative Presence
- NP001 I was unaware of time in the virtual world.
- NP002 I felt involved in the story.
- NP003 I was unaware of the physical world outside the experience.
- NP004 I found it easy to keep my mind on the story.
- NP005 I was completely captivated by the story.

Spatial Presence
- SP003 I felt like I was actually there in the virtual environment (L)
- SP004 I felt like I could interact with objects in the virtual environment (A)
- SP005 I felt like I could move around the environment (A)
- SP006 I felt like I could have some effect on things in the environment (A)

Emotional Engagement
- EE001 The story affected me emotionally.
- EE002 I felt how the character/s were feeling in the story.
- EE003 I felt sympathy for some of the character/s in the story.
- EE004 I felt connected to the character/s in the story.
- EE005 felt for what happened in the story.

Suspense
- SS001 At moments in the story, I was eager to find out what would happen next.
- SS002 Some moments were rather suspenseful.
- SS003 At moments in the story, the outcome seemed uncertain.
- SS004 At moments in the story, I experienced anticipation.
- SS005 At moments in the story, I experienced tension.

Curiosity Story
- CS001 I found the story interesting.
- CS002 I felt interested in how the story would end.
- CS003 I found the story stimulating.
- CS004 I felt focused on the story.

Curiosity Environment
- CE001 I was interested in exploring the environment (A/R)
- CE002 I was interested in the main characters (C/A)
- CE003 I was interested in the objects around me (M)
- CE004 I was interested in how I could affect the virtual world (C)

Enjoyment
- EN001 During the experience I felt moments of enjoyment.
- EN002 During the experience I felt great interest in the story.
- EN003 I would describe this experience as enjoyable (IMI)
- EN004 This experience held my attention well (IMI)

Aesthetic value

- AV003 The experience was aesthetically pleasing.
- AV004 The experience was rich in different elements.
- AV005 The experience was unique.
- AV006 The experience was moving.
- AV007 The experience was beautiful.

* * *

Score Sheet for VRNEF

	Construct Score	**Mean (M)**	**Standard Deviation (SD)**
Narrative Understanding			
Narrative Presence			
Spatial Presence			
Emotional Engagement			
Suspense			
Curiosity Story			
Curiosity Environment			
Enjoyment			
Aesthetic Value			
Overall Scoring			

* * *

VRNEF Guidelines

The following guidelines are suggestions to use following the scoring on the scale. Use these guidelines in order to increase the scores for each of the constructs and improve the overall score.

Narrative Understanding

If the construct of Narrative Understanding records a mean of <2.6, the construct may be negatively influencing the narrative engagement of the experience. To increase narrative understanding, choosing and applying a narrative structure is crucial as it can be used as a blueprint for the plot, to form patterns, and create a more cohesive story. Some possible story structures for a cinematic VR experience are listed below:

- Aetiological oral narratives, Gangan Comics, Sira narratives, epiphanic structure.
- Propp's morphology of folklore.
- Three-act structure of Aristotle that starts with an inciting incident.

The threshold for *narrative understanding* is a mean of 2.6 or greater for a positive effect on narrative engagement.

Narrative Presence

If the construct of Narrative Presence records a mean of <2.6, the construct may be negatively influencing the narrative engagement of the experience. To increase narrative presence, the participants' involvement should be increased. There are two suggestions in order to do so. The first is the use of a Cause-and-effect structure that increases the ability to persuade the user through its events. Cause-and-effect is a

series or chain of events/actions that progress the direction of the narrative. For example, a character is motivated to achieve a goal; they go on a mission to reach it; which then leads to other characters helping or preventing this achievement.

The second suggestion for creating narrative presence is the concept of character connection. To create this connection, users can be reminded of experiences in their own lives that relate to those in the narrative, which will create a link between story content and the user's past personal or media-based experiences. The threshold for *Narrative Presence* is a mean of 2.6 or greater for a positive effect on narrative engagement.

Spatial Presence

If the construct of Spatial Presence records a mean of <2.6, the construct may be negatively influencing the narrative engagement of the experience. Spatial presence is comprised of location and action. Location is the classic definition of "being there" and action is the possible actions that the participant can perform in the virtual space.

SP001, SP002, SP003-Spatial Presence (regarding location) may be improved by the use of minimaps, waypoint navigation and landmarks. Waypoints may allow participants to move quickly from specifically marked locations. Minimaps may be attached to controllers within the environment and display the participants relative position-the minimap moves with the player but does not rotate, as it maintains the same orientation as the landscape. Landmarks are an inexpensive way to orient the participant, and if given meaning within the environment, can prove to be an effective tool for improving spatial presence.

SP004, SP005, SP006-Spatial Presence (regarding action) may be improved with the implementation of interactivity. This interactivity involves the physical aspect, such as how the user can touch and how they can move within the environment. Therefore, the interactivity for this construct needs to contain the ability to pick up, move, or interact with objects in some way; allow the physical movement of the user through the virtual space; and allow the interactive items to have some effect on the environment or story.

The threshold for *spatial presence is* a mean of 2.6 or greater for a positive effect on narrative engagement.

Emotional Engagement

If the construct of Emotional Engagement records a mean of <2.6, the construct may be negatively influencing the narrative engagement of the experience. Emotional engagement may be improved with the use of the Lazarus Theory of Cognition, colour theory, the Musical Mood induction Procedure (MMIP), and character development. To implement the Lazarus Theory of Cognition, the following steps are followed in order:

- A stimulus is introduced.
- The individual creates a cognitive appraisal of the stimulus.
- An emotional response is produced based on the cognitive appraisal.
- A physiological response is formed based on the emotional response.

To increase emotional engagement via colour theory, Ekman's emotions are used with associated colours in the following table:

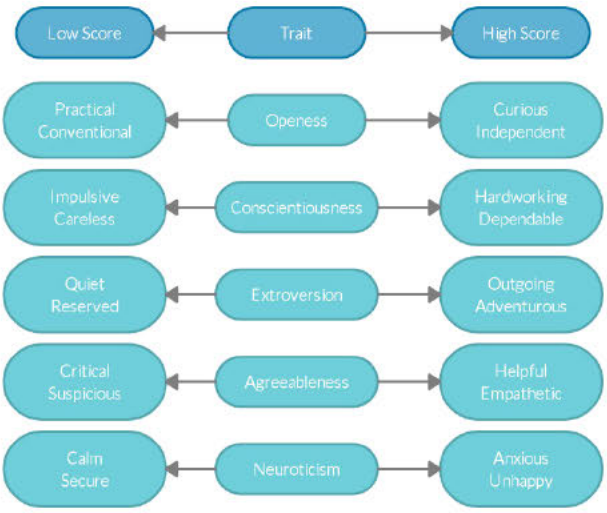
Ekman's Emotions	Associated Colours
Fear	*Purples*
Anger	*Saturated Reds*
Disgust	*Yellow-Greens*
Enjoyment	*Saturated yellows and oranges, light blues*

Surprise	*Medium saturated blue-greens*
Contempt	*Red-orange*
Sadness	*Desaturated blues*

To increase emotional engagement via audio, the MMIP can be employed in conjunction with Ekman's emotions in the following table:

Ekman's Emotions	Pitch	Tempo
Fear	*Low to medium*	*Medium to fast*
Anger	*Medium*	*Fast*
Disgust	*Low*	*Slow*
Enjoyment	*High*	*Fast*
Surprise	*Medium to high*	*Medium to fast*
Contempt	*Medium*	*Slow to medium*
Sadness	*low*	*Slow*

To increase emotional engagement character development, the Five Factor Model (FFM) can be used. This can be designed by choosing a low and high score for each of the five domains of personality as seen below.



The threshold for *Emotional Engagement* is a mean of 2.6 or greater for a positive effect on narrative engagement.

Suspense

If the construct of Suspense records a mean of <2.6, the construct may be negatively influencing the narrative engagement of the experience. To improve suspense use of the suspense effect structure can be implemented. This structure should include the following:

- Delay of story outcome
- Event happens early in the discourse.
- Resolution of suspense
- Use of either vicarious (spectator knows more than the character) or direct suspense (spectator experiences suspense alone)

Additionally, use of lighting can be used to aid in creating suspense. Lighting can hide or delay story information from the viewer, resulting in the following options:

- Bright light can construct suspense by revealing story information.
- Periods of darkness can increase anxiety/anticipation for suspense.

The threshold for *Suspense* is a mean of 2.6 or greater for a positive effect on narrative engagement.

Curiosity Story

If the construct of Curiosity Story records a mean of <2.6, the construct may be negatively influencing the narrative engagement of the experience. This may be remedied by using a curiosity event structure within the storyline.

The curiosity event structure states that it must contain a significant event early within the story. However, the significant event is omitted from the story and the participant is given just enough information to know that the event is missing. The curiosity is resolved when enough information is provided later in the story for the participant to reconstruct the event.

The threshold for *curiosity story* is a mean of 2.6 or greater for a positive effect on narrative engagement.

Curiosity Environment

If the construct of Curiosity Environment records a Mean of <1.8 or <2.6 (see below), the construct may be negatively influencing the narrative engagement of the experience. This may be due to one or more of the curiosity types not being implemented appropriately or missing from the application. Curiosity types include adjustive reactive, complex/ambiguous, manipulatory, conceptual, and perceptual.

CE001-Adjustive/reactive curiosity is engaged when participants explore the functions of objects in a way that is common to that object. This depends on two things: the participants expectations of the environment, and the participants' ability to perceive the environment. Curiosity is created when the participant must probe the environment to understand how the ordinary objects behave in it.

CE002-Complex/Ambiguous involves a participant's preference to interact with something complex over something simple. Having some interactable objects that are variable or have multiple uses or purpose within the experience can help to create this specific curiosity type.

CE003-Manipulatory curiosity can be observed in the desire of participants to touch and interact with game objects in the virtual world. An implementation of manipulatory curiosity may involve the physical manipulation of objects to advance in the experience, solve puzzles, learn, or simply to play. This may be the easiest type to implement in VR, as VR allows participants to interact physically with objects in a virtual world by design.

CE004-Conceptual curiosity refers to active information seeking. To utilise this type, an information gap must be created within the experience. This allows the players to investigate or uncover information, stories, mechanics, or other aspects that will keep them engaged in the experience.

CE005-Perceptual curiosity can be achieved by providing music, sound, visual highlights in the environment, and haptic feedback. Creating a situation that provokes perceptual curiosity can be accomplished by making participates aware of a knowledge gap through the introduction of novel stimuli.

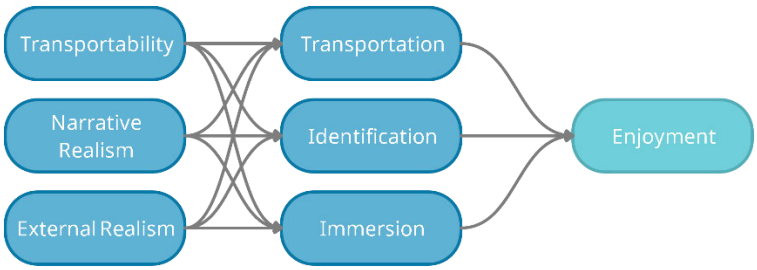
The threshold for Curiosity Environment differs from the other constructs. As long as at least one curiosity type is scoring high, this construct has a mean of 1.8 or greater for a positive effect on narrative engagement. This is because not all curiosity types need to be used, and the construct is weighted to account for this. However, in the event that the construct meets the threshold of 1.8, but the responses

are more symmetrical (with none targeting a high score of a specific type), this would be seen as a failure unless the mean reaches 2.6 overall for the construct.

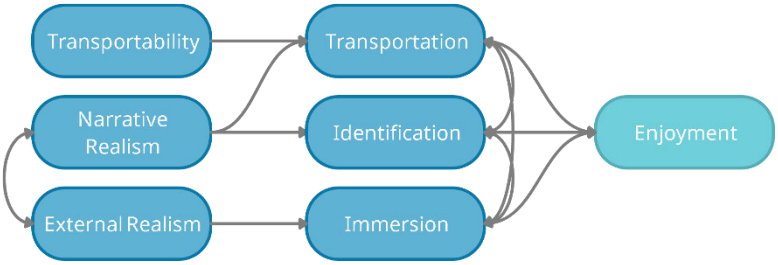
Enjoyment

If the construct of Curiosity Environment records a Mean of <2.6, the construct may be negatively influencing the narrative engagement of the experience. To increase enjoyment, the concepts of transportability, external realism, and narrative realism can be employed.

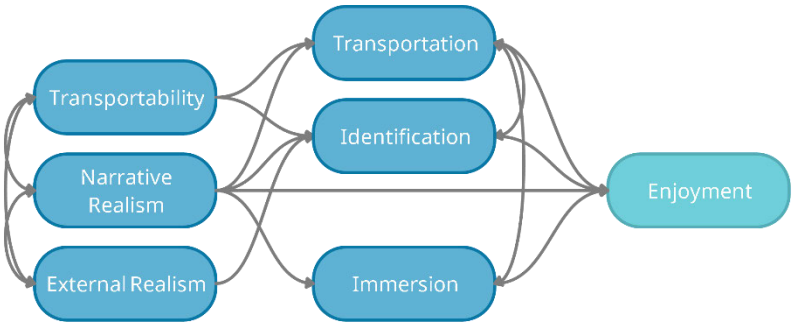
Narrative realism requires consistency in the story, i.e., the character's motivations and goals. External realism requires consistency in the real world, meaning that divergence from the actual world needs to be backed by story-world logic. Practical use of these can be used through the following relationship mappings:



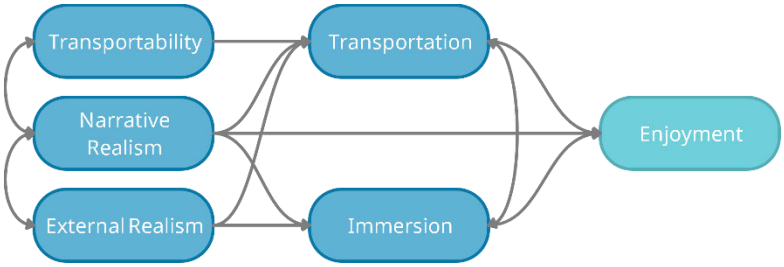
Original relationship for transportability.



Romantic comedy relationship for transportability.



Sci-Fi and fantasy relationship for transportability.



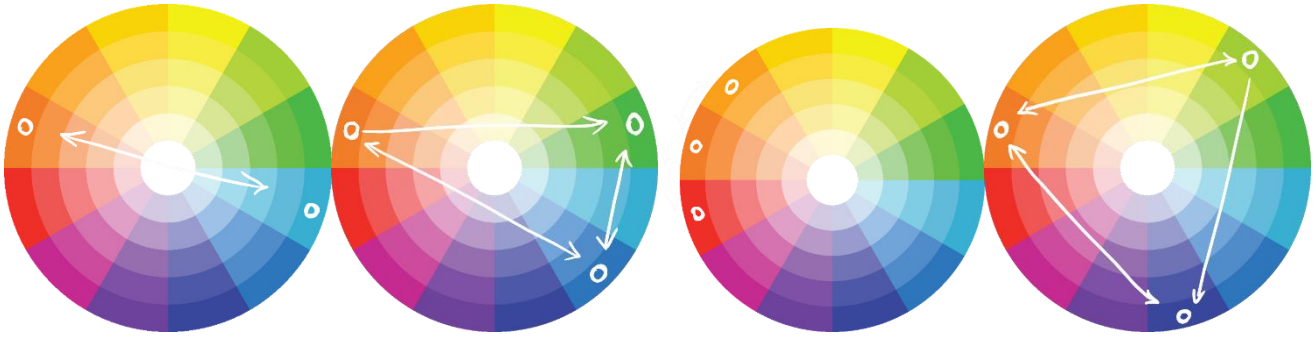
Thriller relationship for transportability.

The threshold for Enjoyment is a mean of 2.6 or greater for a positive effect on narrative engagement.

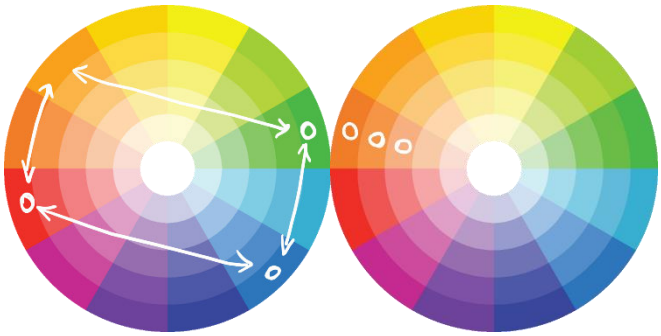
Aesthetic Value

If the construct of Aesthetic Value records a Mean of <2.6, the construct may be negatively influencing the narrative engagement of the experience. To increase aesthetic value, the concepts of emotion, imagery, and design elements should be employed. For this context, there are three practical suggestions: introducing a visual style of characters and story-world; implementing meaningful items in the story-world; and the integration of haptic feedback.

To create a visual style, care should be taken with colour, shape, light, form, movement, and scale. In regard to colour, by utilising the colour wheels below, harmonies can be chosen to create pleasing visuals.



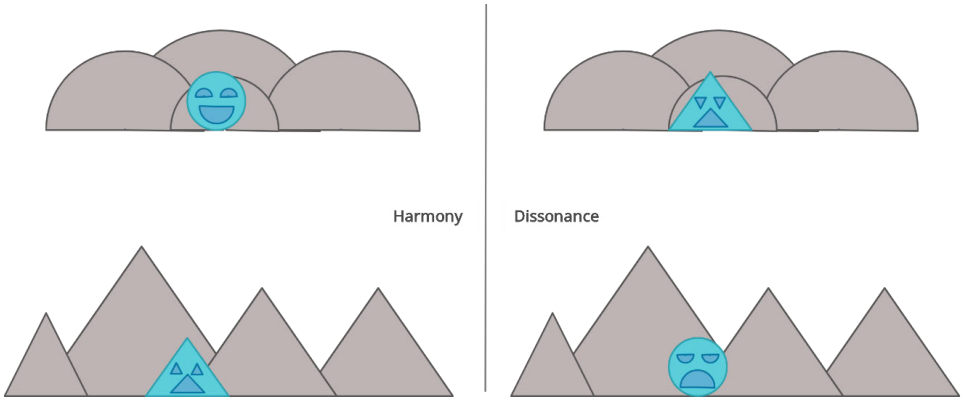
Complimentary **Split Complimentary** **Analogous** **Triadic**



Tetradic **Monochromatic**

Take care not to overuse colour as it creates clutter and confusion. Regarding shape and form, use of angular and circular characters can be utilised. A circular shape/form is often linked to something innocent,

safe, or comforting. Angular shapes are often linked to aggression, force, or fear. Both can be used to create harmony or dissonance. See image below:



Additionally, adding meaningful items can assist in creating aesthetic value. People are attracted to noticeable details that they find meaningful, such as an object that is mentioned or is essential to the storyline.

The final suggestion is use of haptics to increase embodiment. This allows for sensory input with while the user is within the experience. This may be in the form of controller vibrations, haptic vests, gloves, or other sensors attached to the body. This may also include physics based interactable items that mimic having weight in the virtual world.

The threshold for Aesthetic Value is a mean of 2.6 or greater for a positive effect on narrative engagement.

Overall Scoring

The experience must get a high score on at least five constructs (a total 25 points) to be considered as having acceptable narrative engagement. A score of 30 is considered good, a score of 35 is considered great, and 40-45 is considered excellent.

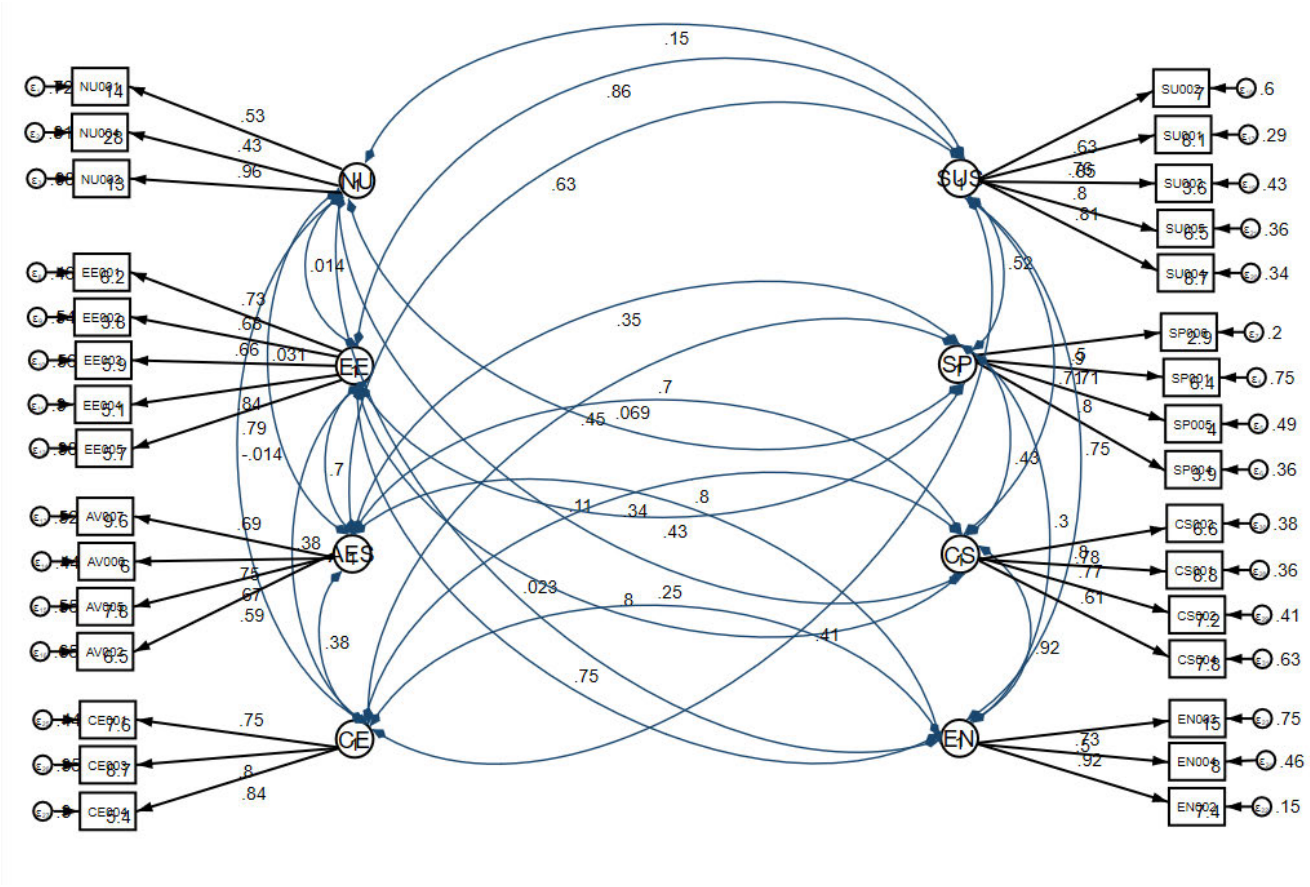
References

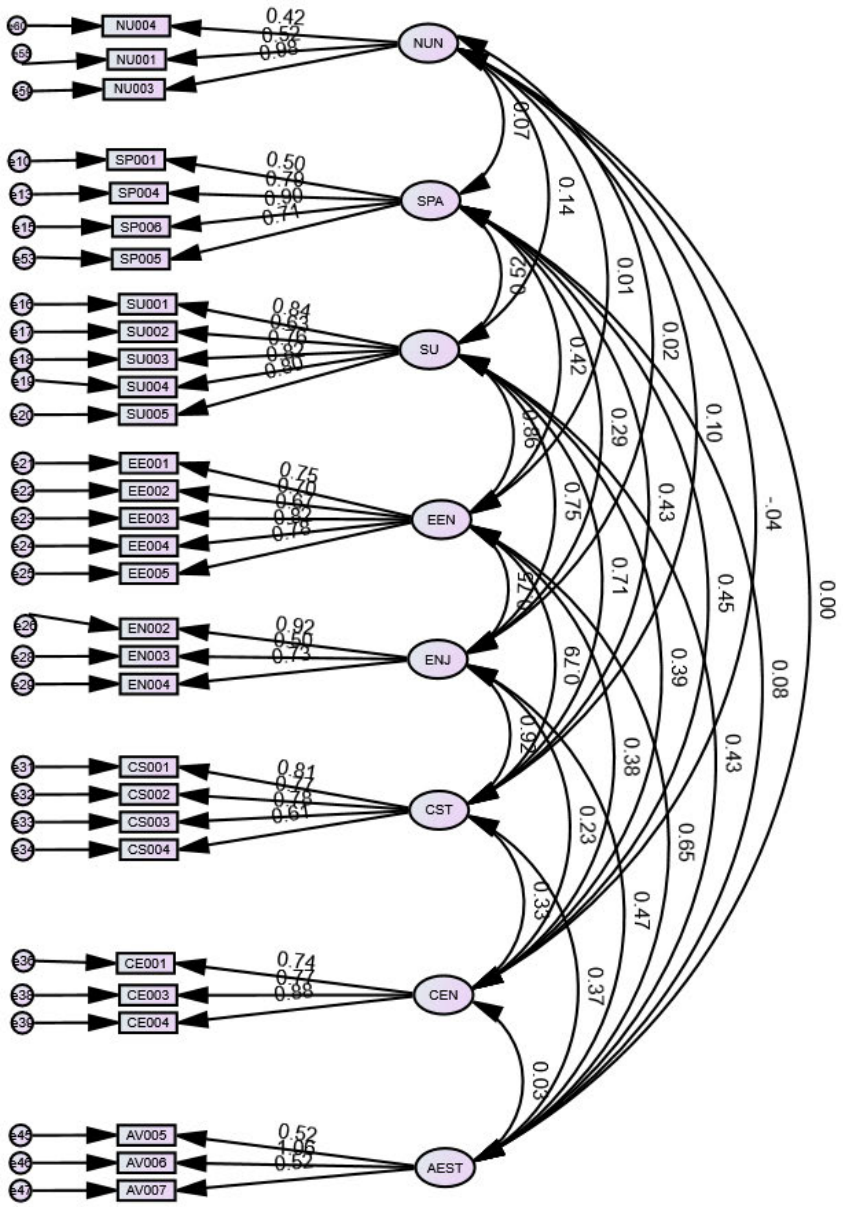
- Arnheim, R. (1954) *Art and Visual Perception*. University of California Press. pp.10-444
- Bilandzic, H. and Busselle, R. W. (2011) 'Enjoyment of films as a function of narrative experience, perceived realism and transportability', *Communications*. De Gruyter Mouton, 36(1), pp. 29–50. doi: 10.1515/COMM.2011.002/MACHINEREADABLECITATION/RIS.
- Bucher, J. K. (2017) *Storytelling for virtual reality: Methods and principles for crafting immersive narratives*. 1st edn. Edited by Routledge. Available at: https://doi.org/10.4324/9781315210308 (Accessed: 17 April 2022)
- Dahlstrom, M. F. (2012) 'The Persuasive Influence of Narrative Causality: Psychological Mechanism, Strength in Overcoming Resistance, and Persistence Over Time', *Media Psychology*. Taylor & Francis Group, 15(3), pp. 303–326. doi: 10.1080/15213269.2012.702604
- Ekman, P. (2016) 'What Scientists Who Study Emotion Agree About', *Perspectives on Psychological Science*. SAGE Publications Inc., 11(1), pp. 31–34. doi: 10.1177/1745691615596992
- Folkman, S. *et al.* (1986) 'Dynamics of a Stressful Encounter. Cognitive Appraisal, Coping, and Encounter Outcomes', *Journal of Personality and Social Psychology*, 50(5), pp. 992–1003. doi: 10.1037/0022-3514.50.5.992
- Koenitz, H. *et al.* (2018) 'The Myth of `Universal' Narrative Models', in Rouse, R., Koenitz, H., and Haahr, M. (eds) *Interactive Storytelling*. Cham: Springer International Publishing, pp. 107–120
- Kotlarek, J., Lin, I.-C. and Ma, K.-L. (2018) 'Improving Spatial Orientation in Immersive Environments'. ACM, p. 10. doi: 10.1145/3267782.3267792.

- McCrae, R. R., Gaines, J. F. and Wellington, M. A. (2012) 'The Five-Factor Model in Fact and Fiction', in *Handbook of Psychology, Second Edition*. doi: 10.1002/9781118133880.hop205004
- Pentak, S. and Lauer, D. A. (2015) *Design Basics*. Nineth. Cengage Learning EMEA. pp. 27-288
- Propp, V. J. (1928) *Morfologija Skaski*. Leningrad: Academia
- Strange, J. J. and Leung, C. C. (2016) 'How Anecdotal Accounts in News and in Fiction Can Influence Judgments of a Social Problem's Urgency, Causes, and Cures', *Personality and Social Psychology Bulletin*, 25(4), pp. 436–449. doi: 10.1177/0146167299025004004
- To, A. *et al.* (2016) 'Integrating Curiosity and Uncertainty in Game Design', *Proceedings of 1st International Joint Conference of DiGRA and FDG*, pp. 1–16.
- Västfjäll, D. (2001) 'Emotion induction through music: A review of the musical mood induction procedure', *Musicae Scientiae*. SAGE Publications, 5(1_suppl), pp. 173–211. doi: 10.1177/10298649020050S107
- Vorderer, P. *et al.* (2004) *MEC spatial presence questionnaire (MEC-SPQ)*
- Wilms, L. and Oberfeld, D. (2018) 'Color and emotion: effects of hue, saturation, and brightness', *Psychological Research*. Springer Verlag, 82(5), pp. 896–914. doi: 10.1007/S00426-017-0880-8.

Appendix G: *Phase Two* Reliability and Validity Data

Final Study CFA—Satorra Bentler

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0.25

Appendix H: *Phase Three* Morphology Script

The Isle

Scene (Cloud flyover) INTRO

I will tell you a story. But it is up to you to heed the words.
In the North, there is an island. Cloaked by mist, as if it were floating in the sky among clouds. It drifts through the fog, shrouded in near silence, concealing life and magic within.

Scene (outside home) SETTING

On this island, a crofter lived with his son, Alasdair, and daughter, Fia.
Alasdair was a strong, cautious lad, and although only a few minutes older, fiercely protective of his sister. Fia was inquisitive and fearless. Their father loved them both dearly. Most days, the children helped their father care for the land.

Scene (forest) INTERDICTION γ1

When not working on the croft, the children had their own adventures in the dark forest. Among the creaking trees and clumps of moss, the children became fierce warriors, travellers of faraway lands, and legendary monster fighters of land and sea. However, they knew well not to stray far from their home, and to stay away from the Loch.

Scene (forest) (ABSENTATION β3) (INTERDICTION IS VIOLATED δ1) (Villainy A1)

On an ordinary day, while the mist crawled through the trees, Alasdair and Fia were playing in their secret hideaway in the forest. They did not notice as night began to fall. (looking under rocks, Fia notices a glow and moves toward it) The will-o-the-wisp. A mischievous spirit of the dead. (Fia follows) Further and further, it guided her, winding deeper into the forest. (comes to rest) (Fia jumps towards it, it disappears behind a rock) Fia, searched and searched, but the wisp had vanished. (scene darkens) From the shadows appeared a magnificent horse, elegant and powerful. Having never seen such a beast, its beauty entranced Fia. (Alasdair appears and runs toward her) (Fia's hand reaches out) (Fade to black) Alasdair rushed to stop Fia. Before he could reach her, Fia had clambered onto the horse's back. As soon as her hands touched his mane, the horse screamed. Frightened, Fia tried to dismount, but found her hands stuck fast in his hair. In horror, Alasdair watched helplessly as the horse took off at a gallop, his sister unable to alight.

Scene (loch)

The horse barrelled out of the woods, aiming straight for the edge of the Loch. And then, into the cold dark water. With a splash, Fia was lost. Alasdair stared into the Loch, despair enveloping him.

Scene (home inside) (LACK a1)

Heartbroken at the loss of his daughter, the crofter fell into a deep depression. He became despondent and distant, refusing to eat or work the land. Alasdair watched as his father drowned himself with bottle after bottle.
He knew something must be done.

Scene (outside shaman) (MEDIATION B4) (DEPARTURE ↑)

Alasdair had long heard the rumours of a mysterious Spae-wife who lived in a cottage, far from the shores of the Loch. If anyone could help get his sister back from the clutches of the Kelpie, it would be her. So, one evening, while his father was out, Alasdair packed his things and travelled to the wise woman's home in search of aid.

Scene (shaman hut) (FIRST FUNCTION OF THE DONOR D1)

Steadfast, Alasdair implored the Spae-wife for help. She agreed, but he must prove himself first. She instructed Alasdair that there was only one night of the year when he might be able to bring his sister back from the Kelpie's Lair. In a weeks' time, Samhain would begin. This marked the end of summer and the beginning of winter. When the sun sets on the eve of Samhain, the Otherworld becomes visible to the world of the living. Then, and only then, souls can cross from one world to another. In order to cross over, Alastair must gather three magical items: a selkie's plaidie, salt from a giant's thumb, and an iron bridle bestowed by a fairy. Then he must return and meet the Spaewife at the edge of the Loch. There, she would be able to open the portal to the otherworld.

Scene (fairy pools) (HEROS REACTION E1) (MAGICAL AGENT F1)

The fairy pools were a mystical and wondrous place. When the moon was full, the pools attracted selkies, shapeshifters who shed their skins to bathe in the twilight hours. And sometimes, the Selkies would lay a plaidie on the rocks to sit upon, to soak up the moonlight. (Boy sneaks and steals the plaidie)

Scene (Storr) (HEROS REACTION E1) (MAGICAL AGENT F1)

The second item required was the salt of a giant's thumb. The giants that roamed the Isle had died out many years ago. So, Alasdair needed to find where one was buried. The Spae-wife had told him of where one had been laid to rest, his body sunken into the land. He would recognise it by his thumb jutting out of the landscape. But it would be a treacherous climb. (Climbs up gathers salt)

Scene (fairy glen) (HEROS REACTION E1) (MAGICAL AGENT F1)

The final item was an iron bridle. Alasdair needed to be granted one from a fairy, and the only place to make such a wish was at a fairy circle. But fairies are tricksters and not to be trusted easily. He recalled the Spae-wife's instructions. "Walk around the fairy ring counterclockwise until you reach the centre." "Place the something of value on the middle rock." "Step out of the circle, take care and do not turn your back. If you are worthy, your wish will be granted." (Flash of lightning, bridle appears) With all the magical items gathered, it was time to return to the Spae-wife.

Scene (Loch)

On the eve of Samhain, Alasdair walked to the edge of the Loch to meet the spae-wife to give her the items she requested. When the sun set, the spaewife poured a potion into the loch.
(portal appears) It was time to face the kelpie. (boy gets into boat)

Scene (underwater lair) (TRANSFERENCE G2)

The path to the kelpie's lair was twisted and cold. (travels in boat) In the centre, affixed to stone, an iron cage swung to and fro, a small child locked inside. Fia. Alasdair carefully traversed the path and unlocked his sister's cage. (Horse screams, scene darkens, fade to black) (everyone's in the boat travelling back, kelpie starts galloping after, burst through portal)

Scene(loch) (STRUGGLE H1) (VICTORY I1) (LIQUIDATION K4)

On the other side of the portal, Alasdair and Fia hurried home. (Kelpie blocks path, rears, screams)
But Alasdair was prepared. He quickly took the iron bridle from his bag and slipped it over the horse's head. (It immediately quieted) He then tossed the plaidie across its back and crushed the salt between his hands. Now he would not stick to the Kelpie's back or mane. Gathering his sister, they climbed on the horse and rode towards home.

Scene (home) (HERO Returns ↓)

(arrive at home, dismount kelpie) and remove bridle)
(kelpie screams and runs off)

Scene (home inside) (SOLUTION N)

(Knock on door, father embraces children)
(wind howls, thunder, Kelpie screams in the distance)

Appendix I: *Phase Three* Data and Reliability/Validity

Observational Code Frequencies

Code System	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Interaction with other objects	8	6	6	6	5	6	5	6	6	4	4	6	5	3	6	4	7	5	6	5
Aesthetic Focus (life)	9	8	8	9	9	8	9	9	9	9	8	9	9	9	9	9	9	9	9	9
Aestetic Focus (environment)	15	13	13	15	15	13	15	15	15	15	13	15	13	13	15	15	13	14	15	15
Focus on Raven	5	3	3	5	5	3	5	4	3	5	3	4	5	5	5	5	5	5	5	5
Interact with Meaniful Items	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	4	4	3	4	4
Response to Environment stimuli	9	9	9	9	6	9	9	7	9	9	9	6	7	8	9	9	6	9	9	7
Interaction with Character	10	7	7	8	7	7	6	6	5	3	7	6	8	8	8	3	5	7	6	8
Focus on Characters	16	14	14	15	16	14	16	15	15	16	14	16	16	16	16	16	16	15	16	15
Σ SUM	76	64	64	71	67	64	69	66	66	65	62	66	67	65	71	65	65	67	70	68

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
4	5	5	6	8	6	5	5	5	5	4	6	5	4	6	5	6	8	4	8
9	8	9	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9	9
15	13	15	15	15	15	15	13	15	15	15	15	13	15	13	15	15	15	14	15
5	3	5	5	4	4	5	5	5	5	4	4	5	5	3	5	5	5	5	5
3	4	4	4	4	4	4	4	4	4	4	2	4	4	4	4	4	4	4	4
9	9	8	9	8	7	6	6	9	9	6	9	4	9	9	7	9	9	7	9
3	7	7	7	7	4	7	7	6	4	6	5	4	3	7	4	10	6	8	10
16	14	16	15	16	16	16	16	16	16	16	16	15	16	14	15	16	16	15	16
64	63	69	70	71	65	67	65	69	67	64	66	59	65	64	64	74	72	66	76

41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	SUM
4	5	6	6	5	6	6	4	4	5	6	3	7	5	3	2	4	5	6	4	6	7	328
9	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	550
15	15	15	15	14	15	15	15	15	15	15	15	13	14	15	15	15	15	15	15	13	13	898
5	5	5	5	5	4	5	4	5	5	4	5	5	4	5	5	4	5	3	5	3	5	281
3	2	4	2	4	2	4	4	4	2	3	4	4	3	4	4	4	4	4	4	4	4	231
9	6	6	7	9	7	9	5	9	9	9	9	4	9	8	8	7	6	9	9	9	6	491
4	7	5	9	10	6	10	6	5	7	7	3	4	7	4	4	6	7	5	3	7	7	387
16	16	16	15	16	16	16	16	16	16	16	16	16	15	16	16	16	16	15	16	14	16	966
65	65	66	68	71	65	74	63	67	68	69	64	62	66	64	63	65	67	66	65	64	67	4132

Reliability/Validity

SPSS Amos 28

	CR	AVE	MSV	MaxR(H)	EEN	CST	AEST	CEN	ENJ	SU	SPA	NUN
EE	0.862	0.556	0.739	0.869	**0.745**							
CS	0.830	0.553	0.852	0.845	0.792***	**0.744**						
AES	0.824	0.549	0.428	1.144	0.655***	0.370**	**0.746**					
CE	0.839	0.635	0.200	0.856	0.379*	0.331*	0.032	**0.797**				
EN	0.774	0.595	0.852	0.880	0.750***	0.923***	0.471***	0.227	**0.739**			
SU	0.879	0.597	0.739	0.892	0.859***	0.705***	0.428**	0.388*	0.751***	**0.773**		
SP	0.824	0.549	0.270	0.881	0.424*	0.431*	0.077	0.447*	0.292†	0.520*	**0.741**	
NU	0.700	0.471	0.018	0.963	0.011	0.104	0.003	-0.042	0.016	0.136	0.066	**0.686**

STATA MP 17

Average-Variance-Extracted & Composite-factor-Reliability:

AVE_NU: 0.4540 CR_NU: 0.6931
AVE_SP: 0.5496 CR_SP: 0.8244
AVE_EE: 0.5544 CR_EE: 0.8606
AVE_AES: 0.5531 CR_AES: 0.8301
AVE_SUS: 0.5971 CR_SUS: 0.8801
AVE_EN: 0.5955 CR_EN: 0.7728
AVE_CE: 0.6361 CR_CE: 0.8396
AVE_CS: 0.5537 CR_CS: 0.8308

Appendix J: Scottish Book Resources

- Orkney Folk Tales by Tom Muir
- Wester Isles Folk Tales by Ian Stephen
- The Selkies Mate by Nicola Davies
- The Anthology of Scottish Folk Tales by Scottish Storytelling Centre
- The Mammoth Book of Celtic Myths and Legends by Peter Berresford Ellis

Appendix K: Published Research

The Impacts of Design Elements in Interactive Storytelling in VR on Emotion, Mood, and Self-Reflection

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Abstract. Storytelling entertains, educates, and inspires people of all ages and a compelling story has the power to motivate, elicit emotions, behavioural change, and inspire self-reflection. Interactive Digital Narratives (IDN) offer, arguably, a greater potential for impact on their audience due to the participative nature of interaction whilst storytelling in Virtual Reality (VR), benefits from high levels of immersion. This work focuses on the design and development of compelling narrative elements towards a non-narrated and unguided VR experience aimed at portraying and evoking emotions, moods, and self-reflection. We explore how the combined elements of light, colour, shape, and music can play a role in creating compelling stories and influence users within an immersive VR experience. Finally, this article presents an extensive study of relevant literature, the design of an impactful immersive VR narrative experience and an exploratory practice-based study.

Keywords: Immersive Storytelling, Interactive Storytelling, Self-Reflection

Introduction

From childhood to adulthood, stories are part of everyday life and represent an important way to connect and influence with any audience whether they are told, written, or shown. “Stories have a transformative power to allow us to see the world in a different way than we do if we just encounter it on our own. Stories are an entry point to understanding a different experience of the world” [1]. It gives people the opportunity to learn and it can shape, strengthen, or question their opinions and values. When a story captures a person’s attention and captivates them, they are more likely to absorb the message and meaning. Similarly, if a person can experience a world in the way others might perceive it, emotions such as empathy or fear can be elicited.[1]

Like traditional storytelling, virtual reality has played a pivotal role in influencing and impacting people’s lives through its immersive nature. Immersion is the perception of a physical presence in a non-physical world. In contrast to traditional storytelling, where the recipient is the passive witness of the characters, VR allows the user to become a character. In essence, VR transforms the storytelling experience through having a presence in the world, and by becoming part of the narrative environment, VR. This immersive narrative experience has the potential to put across powerful messages and connect an audience emotionally as illustrated in Nonny de la Peña’s work such as Hunger in Los Angeles [2] which invites the participant to experience poverty while waiting in line at a food bank, or Across the Line [3], a production focused on pro-choice and abortion legal rights. Additionally, Aardman Animations’ We Wait follows a Syrian family seeking asylum in Greece, and the hopes and fears that follow [4]. VR storytelling projects such as the ones presented above have the potential to trigger strong emotional reactions from their audience and can connect people visually and emotionally in ways that other media cannot. As such, we argue that there is growing potential for impactful VR production targeted at emotional well-being and self-reflection interventions.

Emotional well-being is inextricably linked to mental health and a positive emotional well-being can help people make better decisions, be optimistic, be more productive, and influence physical health [5]. Self-reflection, on the other hand, is the ability to think about one's own feelings and behaviours and the reasons behind them. Engaging in practices that exercise these abilities lead to many benefits, including increased compassion, self-acceptance, and self-confidence, as well as improving the quality of life and the reduction of stress-related health disorders [6].

The aim of this research is to investigate the potential of unguided immersive storytelling on emotional wellbeing and self-reflection. Against this background, we pro-pose to provide a critical review of previous implementations of immersive storytelling for emotional and behavioural therapies, investigate how immersive storytelling can produce emotional and psychological outcomes and identify key aspects of compelling storytelling towards the development

and assessment of an immersive narrative VR experience (*The Journey).* Whilst providing a practical illustration through which to explore participants' experiences, we hope this work can provide a foundation onto which future immersive stories can build upon towards facilitating better emotional and behavioural therapies.

Affect and Storytelling

This section focuses on emotional regulation, self-reflection, general well-being, and mindfulness through storytelling. In particular, the emotional outcomes and impacts on mindfulness and the self in non-goal-oriented, story-based virtual environments. Our aim is twofold and consists in exploring emotional and physiological outcomes associated with immersive experiences (i.e. presence, avatars) and investigating the emotional impacts of immersion in natural environments, and the narrative elements supporting emotional connection and self-reflection. Immersive and otherwise participatory storytelling in a virtual environment offers not only the opportunity to share a story, but also to support meditation [7] and to improve understanding of empathetic responses to stimuli [8]. Studies suggest that even casual video games have had positive emotional influences, including improved perceived mood and lowering stress [9]. In view of this knowledge, it is reasonable to continue to use these interdisciplinary effects of virtual reality beyond the entertainment industry. If casual games have the ability to positively influence social and emotional well-being, then it is reasonable that targeted, serious virtual environments could have the same, if not greater, impact.

Emotional Responses in Immersive Environments

Immersion in an alternative, but similar and understandable world, which allows for free exploration and opportunity for meaningful problem solving and interaction, often has several positive social and emotional effects. Much research on mood and social emotional well-being focuses on casual video games (CVG) and massively multiplayer online role-playing games (MMORPG). However, these research results are equally applicable to both virtual and serious gaming. Consider the following example:

Russoniello, O'Brien, and Parks [9] set out to determine if casual video games had an impact on players' mood outside of the game, specifically positive perceived mood and/or a decrease in stress. 134 participants were randomly assigned to a control group or to the game. Together with brainwave and heart rate data, all participants completed the Profile of Mood States [10] before and after the study to determine whether mood changes occurred before and after the tasks. Participants were given a choice of three CVGs to play, while the control group completed internet searches on a health topic. "The POMS scores on Total Mood Disturbance significantly changed for all three games, supporting the theory that while there were effects on brain wave activity in different parts of the brain, the end result was improved perceived mood" [9]. Moreover, measuring empathetic responses to virtual avatars [8] and animals [7] deepen our understanding of what empathetic responses are, on a physiological level, but also about the dynamic nature of self-awareness and im-portance of self-reflection and personal growth.

Physiological Connection and Presence

Given a simple virtual scenario of a hand at a desk, researchers Fusaro, Tieri, and Aglioti [8] set out to compare the "behavioural and physiological reactivity of participants who observed pain and pleasure stimuli delivered to the body of an embodied avatar when viewed from an egocentric perspective [8]. Participants in the study, were seated at a desk in an unadorned room with their right hand on the desk to align with their avatars'. Participants were then told that their avatar's hand would experience three different types of stimuli from a first and the third-person perspective. Researchers fitted the participants with Oculus sets and electrode systems to monitor the heart rate (ECG) and skin conductance responses (SCR). The stimuli in the virtu-al environment used were needle penetration, a caress from another hand, and a ball gently touching. Respectively, this translated to pain, pleasure, and neutral stimuli. The scene was devoid of any facial cues, and participants observed only the hands on the desk. After each stimulus, participants were asked to respond with the visual analog scale 0-100 for illusory ownership, intensity, and (un)pleasantness. Illusory ownership was found higher in first rather than third person perspectives. Ownership also gained a marginal increase in relation to the pain stimuli vs the pleasure.

The results of possession and presence were more significant between the first and third perspectives, but the physiological responses were only marginally different, possibly due to variations in personal perspective and cultural background about physical touch. Further clarity about the pleasure stimulus, and perhaps a more diverse stimulus, is needed to assess whether pain really has a greater empathetic response than pleasure. Additional research could also examine response variations in various virtual environments, especially from the first person within a complete environment in which the player has little to no control over the scenarios. If participants have the ability to empathize with a disembodied hand on a desk without any other context, then it is reasonable to conclude that a deeper

empathetic response and potentially more connected presence would be experienced in a saturated, precisely created environment.

Compassion Based Interventions

Compassion-based interventions (CBIs) can be effective for increasing empathy and compassion, and reducing stress, anxiety, and depression. [11] With this background in mind, researchers Cebolla et.al [11] compared the efficacy of immersive technologies versus casual meditation systems using modified virtual reality and casual meditation procedures with regard to self-compassion. Notably, the VR experience also included a post meditation body-swap experience that 'allows participants to see themselves from a third perspective and have the illusion of touching themselves from outside' [11]. The 16 participants in the study were assigned randomly to either the usual meditation (CAU) or Meditation the Machine to Be Another (TMTBA-VR). Both groups used the same audio guidance for either medication method. The Cebolla et.al [11] study found that while there was some variance in outcome, both groups showed similar and impactful increases in positive self-image. Prior to the Cebolla et. al. [11] study, Falconer et. al, [12] looked deeper into the concept of self-compassion in VR. This was achieved comparing first and third person perspectives in participatory virtual reality. As with the Cebolla et. al. study [11], participants were immersed in a simple room visually matching their actual surroundings. Recordings of head movement and physiological responses were taken during the trial. First, they proceeded through a scenario of a crying child to elicit compassion responses in a third person view, and then were immersed in the story again in first person as the child. The key finding from the Falconer study was that VR had an additional effect of positively increasing self-compassion in naturally self-critical individuals [12].

Using Music, Colour, Shape and Light in Design to Affect

While the potential of influence of emotional responses and mood can be deduced from the previously mentioned studies, the environment of the experience can play a significant role in aiding this, particularly on the concepts of music, colour, shape, and light.

The Musical Mood Induction Procedure (MMIP) has been used in music research for over thirty years [13]. Overall, research shows that music does have an impact on emotion, but due to variation in self-reporting and other extrinsic factors it is difficult to know with certainty what is truly altered and what is situational. Therefore, the use of technology has been implemented by the use of functional magnetic resonance imaging (fMRI) and positron emission tomography (PET). A review of current studies in music showed that evoked emotions, fMRI, and PET based studies identified areas of the brain activated during specific songs or sounds. Interestingly, fMRI shows emotional response as energy, while PET shows the same response on a molecular level. Regardless of the music sampled, participants showed autonomic response [14]. Västfjäll [13] mapped variations of musical elements and their likely emotional responses. Slow tempo produces seriousness, sadness, anxiety and even serenity, while a higher tempo can evoke humour, happiness, or excitement. Low pitches tend to evoke seriousness, sadness, and fear, while medium and higher pitches evoke serenity, humour, happiness, and excitement. [13, 14]. With this knowledge in mind, the creators of serious games and immersive experiences will be better able to refine their musical choices to induce certain emotional responses in the average player.

As with music, creators of impactful serious games and immersive realities must also make use of colour theory to create the intended ambiance of a scene or story. Anecdotally, colour matters, but Wilms and Oberfeld [15] explored the physiological responses to colour, hue, and saturation along with perceived mood. 62 participants viewed 27 chromatic colours and 3 achromatic colours for 30 seconds each and rat-ed their emotional state while skin conductance and heart rate were measured continuously. "The emotion ratings showed that saturated and bright colours were associated with higher arousal. The hue also had a significant effect on arousal, which increased from blue and green to red." [15]. For creators, the impact of this knowledge is clear. In order to create scenes and serious games with high emotional impact, colour saturation and hue are key.

Another crucial element is shape. Shape has long been used in art to convey emotions and personalities in stories. Regarding the psychology of shape, Arnhiem [16] suggested that shapes are simplified into three categories:

- Circle: innocence, youth, energy, femininity
- Square: maturity, stability, balance, stubbornness
- Triangle: aggression, masculinity, force

Psychologically, people associate with these shapes and their corresponding concepts due to real-life experience and the sense of touch. Through touch, people visually assess the characteristics of objects based on experience

(angular = sharp = harmful). These shapes can be used to influence an individual's perception of certain elements in a VR environment, and in extension affect their mood through that perception.

Finally, the use of light is an invaluable asset in VR. Light can influence the psychophysical wellbeing of an individual as it affects their perception of the world [17]. According to Tomassoni [17] light may stimulate perception through type and range of exposure and its colours can induce specific emotional states or behaviour. This stimulus is able to "excite, move, impress, communicate, heal, and generate wellness, and

create a sense of harmony and syntony." The strategic layout and modulation of lighting by VR designers may influence the perceiver's mood, creating a sense of calm and rest, or add mystery and suspense.

Practices of mindfulness and self-reflection are well-known to have positive effects and change on an individual's well-being and the above studies indicate that immersive experiences are able to connect people visually and emotionally in a way that TV, books, and other forms of entertainment may not. Moreover, the creation of an immersive natural world inevitably leads to a deeper emotional response; however, eliciting this response requires a degree of openness and awareness on the part of the participant. In other words, emotions are influenced by past emotional states or pre-existing individual characteristics, dispositions, and context factors [18, 19].

The Journey and Evaluation

The Virtual Reality Experience

Story plays a strong role in the emotional connection and involvement of people in all of the media in which it is represented. It was therefore an integral part of creating the immersive experience. Therefore, a storyboard was used to capture the overall movement of the scenes as well as base colours, and to set written guidelines for the story sequence. For this project (see Fig 3), our approach was oriented more towards a cinematic quality than one of pure game play and we developed an immersive virtual reality in Unreal [20], based on the composition of marine elements from reference images of ocean ecosystems. The models used were selected on a scientific basis of animals that co-existed in nature, interacted regularly with each other, and were native to specific locations in the Pacific [21]. The project consisted of a total of seven scenes. The scenes were conceptualized in order to elicit different emotions, namely, scene 1 (Joyful), scene 2 (Worry), scene 3 (Sad), scene 4 (Anxious), scene 5 (Mysterious), scene 6 (Calm) and scene 7 (Relief). Each scene ranged from a minimum of 1:30 min to 2:30min, depending on the music/animation involved. Each scene flowed into the next in a continuous manner, separated by a 3 second fade to black to mark the scene change. To influence the targeted emotions/moods of each scene, the concepts of music, colour, shape, and light were implemented.

The story structure of each scene attempted to follow these emotions as well. In scene 1(joyful) the user observed a playful mother whale and calf swimming together and around the user. Scene 2 (worry) showed a murkier scene, with the mother and calf swimming higher overhead. In this scene a fishing boat comes along and captures the mother with the calf swimming and calling after it. Scene 3 (sad) has the calf swimming up to the user with a fin tangled in rope that the user must remove. In scene 4 (anxious) the calf encounters and is chased by several sharks, swimming tightly around the user. In Scene 5 (mysterious) the user floats along with the calf through a dark cave with glowing corals and fish. Scene 6 (calm) has the user again moving with the whale but joined with a large array of slow-moving sea turtles. Finally, scene 7 (relief) shows the calf finding and joining another pod of whales.

Using the aforementioned research on the influence of music, the animation, story, and movement of each scene were all created to revolve around the music. It needed to enhance and, in some instances, cause the change of mood as the story progressed. Therefore, the tempo, volume, rhythm, and harmony were carefully chosen for each scene [13, 14]. To demonstrate, music was categorised as having tempo range (high, medium, low), a pitch range (high, medium, low), a volume range (high, medium, low), and a rhythm range (fast, medium, slow) Thus, the music was applied in the following manner:

Table1. Scene Music

Scene	Tempo	Pitch	Volume	Rhythm
Joyful	High	High	High	Fast
Worry	Low	Low	Medium	Medium
Sad	Low	Low	Medium	Slow
Anxious	High	High	High	Fast
Mysterious	Low	Medium	Medium	Medium
Calm	Low	Medium	Medium	Slow
Relief	High	Medium	Medium	Medium

Likewise, ambient whale sounds played a pivotal role. Raw whale audio vocalisations were added through the story to convey emotional aspects of the whales. For instance, the 2nd scene included a whale crying out for its mother to evoke worry, while the final scene includes the inviting sounds of a pod of whales, calling out and welcoming the young calf in to join them to evoke the emotion of relief.

As mentioned previously, colour is a powerful tool that can be used to influence mood and emotions. Consequently, the psychology of colour was carefully applied throughout the project and was at the forefront of the design process. Since each scene was broken down into a target emotional response, colour was added according to the mood. To give an example, the first scene was meant to have a jovial, energetic ambience, therefore oranges and yellows were used in more abundance as these colours tend to elicit feelings of enthusiasm and excitement. Conversely, the third scene was designed with a solemn and lonely atmosphere, and as a result, deep blues and desaturated colours were used instead [22].

Light and fog were implemented per scene to fit the corresponding targeted moods. An illustration of this would be the second scene in the story. This scene was a pivotal point in the story, one that involves tragedy and loss. Hence, there is a greater amount of fog and murkiness, framing the shapes in the distance to appear unsettling and slighting out of focus. Additionally, the sunlight did not shine as brightly through the surface of the water as it had in the previous scene. This in turn helped create a general sense of uneasiness and foreboding.

For the table below, *Colour* notes the dominate colour; *Saturation* notes the intensity of the saturation of the colour, and *Visibility* documents the clarity in which the scene elements were visible in the scene.

Table 2. Scene Colour

Scene	Colour	Saturation	Visibility
Joyful	Oranges and yellows	Full	Clear
Worry	Blues	Low	Low
Sad	Blues and greys	Low	Medium
Anxious	Reds	Full	Clear
Mysterious	Blues, purples, oranges	Full	Medium
Calm	Greens and blues	Medium	Medium
Relief	Blues, yellows, oranges	Medium	Clear

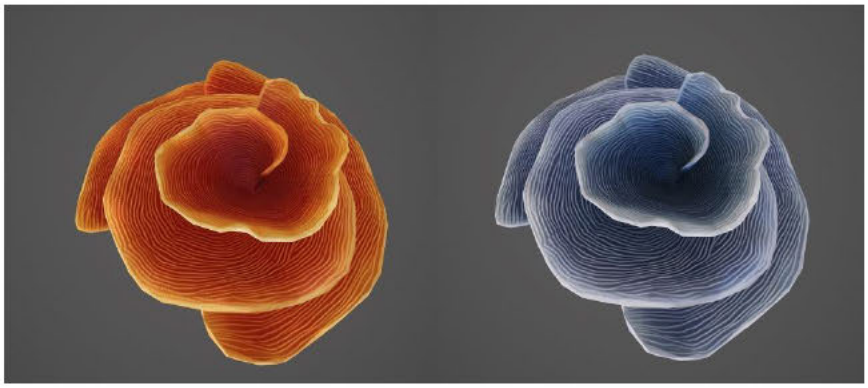

Fig. 1. Colour change: Joyful (left); Sad (right)

Finally, shape theory was also applied to the environment of the experience. This was achieved by adding softer, rounder elements (such as rocks and coral) in the beginning scenes, and as the mood and narrative became more tense, harsher, sharper elements were introduced to surround the viewer.

Table 3. Scene Shape

Scene	Primary Shapes	Texture
Joyful	Round	Mixture soft/rough
Worry	Mixture of round and complicated, angular	Rough/sharp
Sad	Round	Soft

Anxious	Complicated, angular	Rough/sharp
Mysterious	Round	Rough
Calm	Round	Soft
Relief	Mixture of round and complicated, angular	Mixture soft/rough

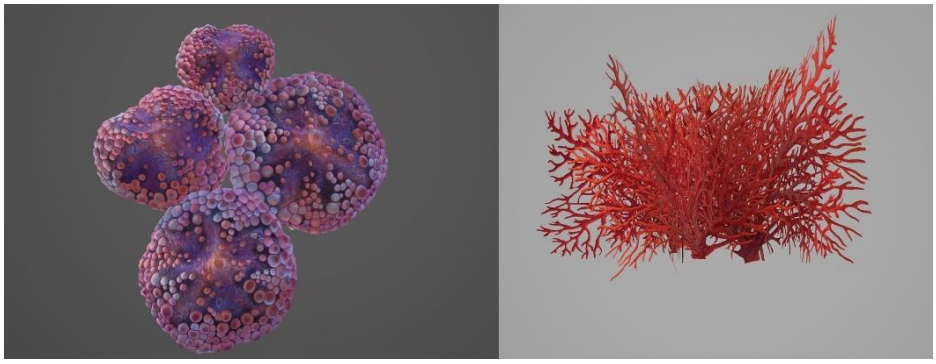

Fig. 2 Round soft shape Vs Complicated/Angular sharp shape

Fig. 3. A screenshot of the Immersive VR Narrative "The Journey" for scene 3. The project is available for download at the following location (https://drive.google.com/file/d/12az6FCSVJtclQ0fQUqLRvixuFL6IR41o/view?usp=sharing).

Measurements protocol

After the completion of the project, a study was conducted using self-reporting measures. For each participant, these questionnaires were used and collected via an online link. These were applied in two phases: the baseline and the reflection.

For the baseline phase, the questionnaires were implemented before the playthrough of the experience to establish their natural baselines. These questionnaires consisted of a mood evaluation (MQ), the Positive and Negative Affect Schedule (PANAS), and the modified Five Factor Mindfulness Scale (FFMQ-15).

The (MQ) required participants to rate how they feel at this moment in time on a 7-point Likert scale (where 1 = not at all to 7 = extremely), with reference to each of the moods measuring Happiness, Sadness, Anger, Surprise, Disgust, Anxiety, and Quietness. The (PANAS) was composed of a list of 20 adjectives used to describe 10 positive emotions (which compose the global Positive Affect Score) and 10 negative emotions (which compose the global Negative Affect Score). Respondents are required to indicate the extent they experience the emotions included on the schedule "in the past week" on a five-point scale (where 1 = very slightly or not at all, to 5 = extremely). The (FFMQ-15) is the short form of the 39-item FFMQ [23]. It includes the same five facets at the long form: Observing, Describing, Acting with Awareness, Non-Judging of inner experience, and Non-Reactivity to inner experience. This measure is composed of a list of 15 statements used to describe the participants. Respondents are required to indicate the extent the statement is true to themselves on a five-point scale (where 1 = Never, or very rarely, to 5 = Very often or always true).

For the reflection phase, participants completed questionnaires after the completion of the VR experience. During this phase, these questionnaires were applied per each scene to assess each targeted emotion. These were the (MQ), (PANAS), emotional storytelling questions (ESQ), and the modified Slater-Usoh Steed Questionnaire (SUS-3). The (ESQ) rates how connected participants felt to the story at the moment of the scene on a 5-point scale (where 1 = not at all to 5 = extremely), with reference to targeted responses per each scene. Participants were asked three scene specific questions pertaining to their emotional connection. The (SUS-3) measures presence on a 7-point Likert scale asked the questions per each scene:

Table 4. VR (SUS-3) Questionnaire.

SUS1	"To what extent were there times during the experience when the environment was reality for you?"
SUS2	"Rate your sense of being in the specific environment?"
SUS3	"During the time of the experience, which was the strongest on the whole, your sense of being in the environment, or of being elsewhere?"

Results and Discussion

Experiment

Ten virtual reality equipment owners took part in the experiment. Participants did not receive any payment or credit for their collaboration and were all volunteers. All users of the application experienced the VR experiment in their own homes and without supervision. Participant demographics consisted of persons between the ages of 20 to 50, with normal or corrected vision and hearing. Although owners of the equipment, participants had little experience of VR or other VR applications. There was no limit in regard to geographical location of this study, as it was conducted online. Therefore, the participants ranged from locations in the US to areas in England, Scotland, and Sweden.

The virtual program was run on the participants' home headset and personal computer. The headset was required to be an Oculus, either the Rift, Rift S, or the Quest, with the latter requiring Oculus Link. The PC to operate the program was expected to have a graphics card equivalent to a GeForce Nvidia 1060 or similar compatible card, as well as at least one controller. As the physical space was unable to be regulated, each participant was advised to have a standing room area of at least 1.5 meters by 1.5 meters. The experiment was then divided into three main phases: baseline, navigation, and reflection. This was due to Covid restrictions, as at the time in person studies were unable to be conducted. The study consisted of four phases: Baseline, Navigation, Reflection, and Analysis.

Baseline phase. For the first phase, participants were invited to complete the MQ, PANAS, and FFMQ-15 questionnaires to assess their baseline emotional and mindfulness state. It is important to note that the administration of the FFMQ-15 was only administered in this phase. This measurement was meant as an indicator for the user's proclivity towards mindfulness, so that it may be assessed for the accuracy of their ability to recall their emotions/moods upon the completion of the program. These questionnaires were completed online via a provided link to each participant. At the end of the questionnaires, participants were provided with one link to download the project and a second link providing the final set of questionnaires to be completed after the VR program.

Navigation phase. Once the participants had downloaded the program, it was then played through to its entirety. Navigation for the user in each scene was open to their available standing room and lasted about 2 minutes per scene, with the user having little influence on the progression of the story. At the end of the seventh scene, the credits rolled, and provided a passcode for the user. This passcode was then used to access the post questionnaires. This was made to ensure that the participants fully completed the program before being able to access and answer the final survey.

Reflection phase. After the completion of the VR experience, participants returned to the link previously provided in the baseline phase to complete the final set of questionnaires. The MQ, PANAS, ESQ, and SUS-3 were provided per each of the seven scenes in order to assess their emotional state, presence, and emotional story connection elicited by each environment. Each scene was marked with a description and thumbnail of a screenshot per scene to assist users in their recollection of each scene, as each scene was markedly different.

Table 5. Scene Descriptions

Scene	Description
Joyful	Intro scene with mother and calf
Worry	Fishing boat
Sad	User must grab the rope off the calf
Anxious	Sharks swimming around you
Mysterious	The glowing cave

Calm	Swimming with sea turtles
Relief	Final scene with multiple whales swimming

Analysis

The analysis began with scoring calculations for the standard questionnaires to assess the effectiveness of virtual environments in evoking emotions. The PANAS, MQ, SUS-3, and ESQ were all scored with direct scoring, and the FFMQ-15 with a combination of direct and reverse scoring. This resulted in a mean (M) and a standard deviation (SD) based on sample size.

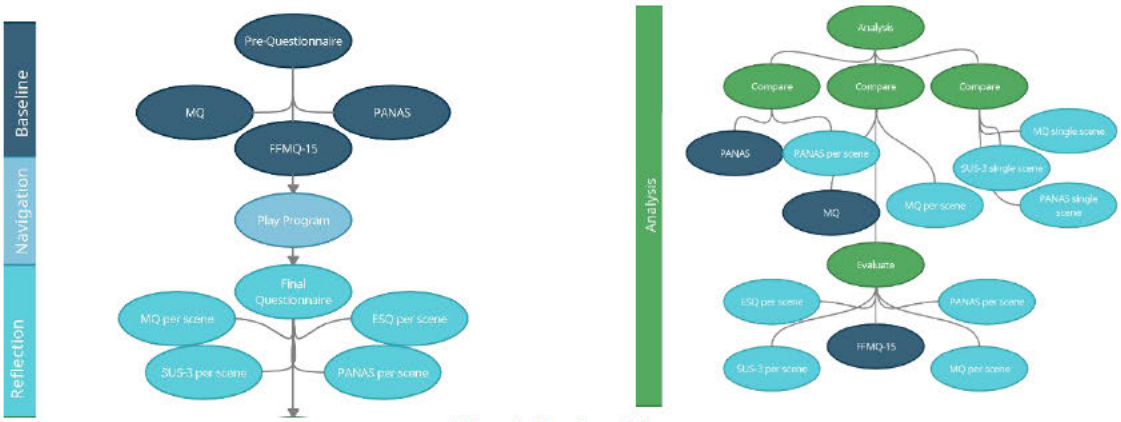

Fig. 4. Project Phases

Results

A comparison was carried out to explore the changes of the mood states (PANAS and MQ) before (baseline) and after the first scene of the application. As the baseline PANAS measured the participants' mood over the past week compared to at this moment of the first scene, the data showed different significant changes. The first scene indicated a reduction in the positive affect and the negative affect schedules (see Table 2). The initial intention behind using the in the last week as opposed to at this moment was to get an indication of the total range of moods from the participants. In contrast, the MQ was measured both as at this moment before and after the first scene. Consequently, it showed an increase/decrease as expected. The scene significantly increased happiness and surprise, while reducing sadness and anxiety (see Table 6).

Table 6. Comparison of Mood States.

PANAS	**Baseline (Pre-Questions)**	**Scene 1 (Joyful)**
Positive Affect	M = 33.8 / SD = (1.16)	M = 28.8 / SD = (1.33)
Negative Affect	M = 18.8 / SD = (1.21)	M = 11.1 / SD = (.35)
Mood (MQ)		
Happiness	M = 4.8 / SD = (1.03)	M = 5.7 / SD = (1.25)
Sadness	M = 1.6 / SD = (.69)	M = 1 / SD = (0)
Anger	M = 1.1 / SD = (.32)	M = 1.2 / SD = (.63)
Surprise	M = 1.6 / SD = (1.07)	M = 2.8 / SD = (1.87)
Disgust	M = 1.1 / SD = (.32)	M = 1.2 / SD = (.63)
Anxiety	M = 3 / SD = (1.6)	M = 1.3 / SD = (.67)
Quietness	M = 3.9 / SD = (2.56)	M = 3.3 / SD = (2.31)

In addition, the FFMQ-15 was analysed to determine a general mindfulness/self-reflection factor of the participants before the experience. This was divided into its five factors and assessed accordingly. These subscales are rated with a range of 3-15. The highest score was achieved with a mean (M) of 11.9 in Observing, followed by Describing (11.1). The lowest levels were noted in Acting with Awareness (9.18) and Non-Reactivity (9.00) (see Table 7).

Table 7. Baseline of Mindfulness Factors.

Five Facet Mindfulness Questionnaire (FFMQ-15)	Baseline (Pre-Questions)
Observing	M = 11.9 (3.93) / SD = (1.05)
Describing	M = 11.1 (3.70) / SD = (.98)
Acting with Awareness	M = 9.18 (3.06) / SD = (1.14)
Non-Judging	M = 10.90 (3.63) / SD = (.92)
Non-Reactivity	M = 9.00 (3.00) / SD = (1.08)

Following the preliminary survey, separate analyses of mood and emotion were carried out from each of the seven scenes.

First, the PANAS was considered across all seven scenes. The positive affect schedule showed some variation through all scenes, with the lowest recorded at 21.4 and the highest at 28.7. In contrast, the negative affect schedule showed a significant difference between the lowest (11.0) and the highest (22.9). As expected, scene 6 (calm) and 7 (relief) lead the highest levels on the positive affect schedule, (28.4) and (28.7) respectively. Similarly, scenes 2 (worry), 3 (sad), and 4 (anxious) marked the highest increases on the negative schedule at 22.9, 18.9, and 22.1 (see Table 4). It is also noted that the highest levels all exceed the previously recorded baseline at 18.8 (see Table 2).

Table 8. Difference PANAS across 7 Scenes.

PANAS	Scene 1 (Joyful)	Scene 2 (Worry)	Scene 3 (Sad)	Scene 4 (Anxious)	Scene 5 (Mysterious)	Scene 6 (Calm)	Scene 7 (Relief)
Positive Affect	M = 28.8 SD=(1.33)	M = 21.6 SD=(1.35)	M = 23.9 SD=(1.40)	M = 21.4 SD = (1.42)	M = 27.4 SD = (1.44)	M = 28.4 SD=(1.56)	M = 28.7 SD=(1.51)
Negative Affect	M = 11.1 SD =(.35)	M = 22.9 SD=(1.37)	M = 18.9 SD=(1.25)	M = 22.1 SD = (1.45)	M = 11.5 SD = (.61)	M = 11.0 SD =(.50)	M = 11.1 SD =(.39)

Next the mood questions (MQ) were evaluated across all scenes. As presumed, happiness was recorded at its highest at 6.1 in scenes 1 (joyful), 5 (mysterious), 6 (calm), and 7 (relief). Scenes 2 (worry), 3 (sad), and 4 (anxious) marked a significant decrease in happiness at 1.7, 2.3, and 1.7. Similarly, sadness markedly increased for scenes 2, and 3, at 5.1 and 5.9, with a reduction in scenes 1 (1) and 6(1). Anger and surprise also have notable increases in scenes 2 and 3, the highest being in scene 2 with anger at 3.5 and surprise at 4. Finally, anxiety increased in scenes 2, 3, 4 at 4.4, 3, and 5 respectively. Interestingly, quietness varied from 2.7 to 5 with no discernible pattern, and with the largest standard deviations compared to all other moods (see Table 5).

Table 9. Difference of Mood States across 7 Scenes.

Mood (MQ)	Scene 1 (Joyful)	Scene 2 (Worry)	Scene 3 (Sad)	Scene 4 (Anxious)	Scene 5 (Mysterious)	Scene 6 (Calm)	Scene 7 (Relief)
Happiness	M = 5.7 SD = (1.25)	M = 1.7 SD = (1.56)	M = 2.3 SD = (2.06)	M = 1.7 SD = (1.25)	M = 5 SD = (1.69)	M = 5.6 SD = (1.57)	M = 6.1 SD = (1.1)
Sadness	M = 1 SD = (0)	M = 5.1 SD = (2.08)	M = 5.9 SD = (1.1)	M = 2.2 SD = (1.75)	M = 1.2 SD = (.42)	M = 1 SD = (0)	M = 1.3 SD = (.94)
Anger	M = 1.2 SD = (.63)	M = 3.5 SD = (2.41)	M = 3.2 SD = (1.81)	M = 2.2 SD = (2.29)	M = 1 SD = (0)	M = 1 SD = (0)	M = 1.3 SD = (.94)
Surprise	M = 2.8 SD = (1.87)	M = 4 SD = (1.33)	M = 3 SD = (2.21)	M = 2.8 SD = (1.75)	M = 1.8 SD = (1.31)	M = 2.4 SD = 1.16	M = 1.9 SD = (1.28)
Disgust	M = 1.2 SD = (.63)	M = 2.7 SD = (2.06)	M = 1.6 SD = (.96)	M = 1.5 SD = (.97)	M = 1 SD = (0)	M = 1 SD = (0)	M = 1 SD = (0)
Anxiety	M = 1.3 SD = (.67)	M = 4.4 SD = (2.17)	M = 3 SD = (1.76)	M = 5 SD = (2.4)	M = 1.5 SD = (1.26)	M = 1 SD = (0)	M = 1.4 SD = (.96)
Quietness	M = 3.3 SD = (2.31)	M = 2.9 SD = (2.18)	M = 4 SD = (2.0)	M = 2.7 SD = (2.49)	M = 5 SD = (2.31)	M = 4.9 SD = (1.72)	M = 3.5 SD = (2.54)

Lastly, results gathered to test emotional connections were assessed. On the 5-point Likert scale, all scores remained above 3 during all scenes. Interestingly, there was an unexpected drop in emotional connection during scene 2 (worry), at the lowest recorded (3.43), as well as recording the largest standard deviation. However, as expected, it increased to 4.56 in scene 3 and recorded highest in scene 5 at 4.83 (see Table 6 and Figure 2).

Table 10. Emotional story connections – Emotional Story Questions (ESQ).

	Scene 1 (Joyful)	Scene 2 (Worry)	Scene 3 (Sad)	Scene 4 (Anxious)	Scene 5 (Mysterious)	Scene 6 (Calm)	Scene 7 (Relief)
ESQ	M = 4.2 SD = (.92)	M = 3.43 SD = (1.65)	M = 4.56 SD = (.81)	M = 4.1 SD = (1.49)	M = 4.83 SD = (.87)	M = 4.63 SD = (.76)	M = 4.63 SD = (.61)

After finding that the scenes in the story were able to induce the expected mood states and emotion, the association between presence and emotion was investigated. The data (see Table 7) showed a constant level of presence above 5.6 on the 7-point Likert scale. Furthermore, the level of presence was highest in scene 6 (calm) at 6.36.

Table 11. Presence level between 7 scenes

	Scene 1 (Joyful)	Scene 2 (Worry)	Scene 3 (Sad)	Scene 4 (Anxious)	Scene 5 (Mysterious)	Scene 6 (Calm)	Scene 7 (Relief)

SUS (Presence)	M = 5.9 SD = (1.03)	M = 5.6 SD = (1.27)	M = 6 SD = (1.31)	M = 6.06 SD = (1.14)	M = 6.03 SD = (1.51)	M = 6.36 SD = (1.24)	M = 6.16 SD = (.91)

To better investigate the possible relationship between emotion and presence, two scenes between the presence level (SUS-3) and the PANAS and MQ were analysed (see Table 8). These scenes were scene 6 and scene 2, which had the highest and lowest values of presence respectively. Scene 6 (calm) recorded the 2nd highest level on the positive affect schedule (28.4) and the lowest level on the negative affect schedule (11.0). Furthermore, scene 6 indicated the 2nd highest level of quietness (4.9) and the 3rd highest of happiness (5.6). In contrast scene 2 (Worry) with a presence of (5.6) indicated the 2nd lowest on the positive affect schedule (21.6) and the highest on the negative (22.9). In addition, it had the lowest level of happiness (1.7), the highest level of anger (3.5), disgust (2.7), anxiety (4.4) and surprise (4), with the second highest degree of sadness (5.1).

Table 12. Comparison of Presence and Mood

PANAS	**Scene 2 (Worry)**	**Scene 6 (Calm)**
Positive Affect	M = 21.6 SD = (1.35)	M = 28.4 SD = (1.56)
Negative Affect	M = 22.9 SD = (1.37)	M = 11.0 SD = (.50)
Mood (MQ)		
Happiness	M = 1.7 SD = (1.56)	M = 5.6 SD = (1.57)
Sadness	M = 5.1 SD = (2.08)	M = 1 SD = (0)
Anger	M = 3.5 SD = (2.41)	M = 1 SD = (0)
Surprise	M = 4 SD = (1.33)	M = 2.4 SD = 1.16
Disgust	M = 2.7 SD = (2.06)	M = 1 SD = (0)
Anxiety	M = 4.4 SD = (2.17)	M = 1 SD = (0)
Quietness	M = 2.9 SD = (2.18)	M = 4.9 SD = (1.72)
SUS (Presence)	M = 5.6 SD = (1.27)	M = 6.36 SD = (1.24)

Conclusion

The driving force of this project was the ability to create an immersive story in VR that would effectively portray emotions and induce emotional responses. This endeavour was undertaken by the careful review of storytelling elements, as well as the analysis of relevant immersive models on mindfulness, self-reflection, and emotional impact. While the development of the experience took considerable time to implement, the data recorded suggests a successful execution. The values regarding presence (SUS-3) showed a consistently high rate across all scenes, indicating a high degree of immersion. Furthermore, the ESQ gross values showed an above average emotional connection to the specifics in each scene, as well as the individually evaluated values.

Likewise, as recorded in the results, the targeted MQ followed a distinct pattern across all scenes, with the values indicating the expected targeted emotions for each scene. The exception to this was the quietness value of the MQ. Dissimilar to the other factors, quietness did not have a discernible pattern, and had a larger standard deviation. This may be due to different interpretations of the word. Whereas happiness and sadness are easy to identify with, it is possible that quietness is too complex to connect with, (especially across cultures) suggesting the need to change the word used. If, for instance, the word had been changed to calmness, based on the other MQ values, it would have been expected to have a more recognisable pattern.

Additionally, the PANAS was significantly successful in showing positive values in the scenes deemed to have positive emotions, and negative values in the scenes with negative emotions, so much so that the negative values outweighed the baseline values of participants for the past week. To surmise, the creation of an immersive VR story that portrays and induces emotions is deemed as successful by this study.

The self-reflection after the experience does not have a measured outcome in this study. The use of the FFMQ-15 before the experience set out an overall value of mindfulness and self-reflection values. On average, the participants were in the above average to high range on this scale. However, the success of self-reflection is evident based on the success of the other data recorded after the experience. Participants were required to experience all seven scenes before filling out the final questionnaire. Therefore, participants had to critically reflect on each scene in terms of their emotions, moods, and presence, after the entire experience. Since the recorded data followed the projected result, one can assume that the experience was successful in depicting and evoking emotions. Thus, if the experience in this aspect was meaningful enough for the user to remember and record its effects, one can infer that this high degree of impact corresponds to a high degree of self-reflection.

In addition, based on the expected results of the questionnaire, it was concluded that the combined narrative elements in VR (colour, shape, light, and music) could successfully evoke and represent emotions. The literature identified several elements that create a compelling emotional connection in storytelling: colour, shape, music, and light. On the subject of music, the ESQ did create a strong connection to participants, when asked "the music made me feel..." Additionally, as mentioned in the previous section, the PANAS noted a higher positive affect in scenes that featured saturated bright colours, and a negative affect with desaturated colours. However, colour, shape, and light were not individually evaluated by the user. Instead, they were combined as a stealth element to influence an emotional connection in the storytelling. In this aspect, it is believed to be effective, as the data recorded (ESQ) high emotional connection across, and the expected changes in the PANAS. With that in mind, while these elements are effective combined, further exploration is needed to assess the individual elements pertaining to successful emotional connections in stories. Nevertheless, it is recommended that more specific research be carried out on each element to determine the individual effects and effectiveness, either through qualitative or quantitative methods.

References

1. The Health Foundation (2016) The power of storytelling. In: The Health Foundation. https://www.health.org.uk/newsletter-feature/power-of-storytelling. Accessed 11 Jun 2020
2. Emblematic (2012) Hunger in L.A. In: Emblematic. https://emblematicgroup.com/experiences/hunger-in-la. Accessed 22 Jul 2020
3. Emblematic (2016) Across the Line. In: Emblematic. https://emblematicgroup.com/experiences/across-the-line. Accessed 22 Jul 2020
4. Aardman (2016) We Wait. In: Aardman.com. https://www.aardman.com/work/we-wait. Accessed 28 Jul 2020
5. Fiocco A, Mallya S (2014) The Importance of Cultivating Mindfulness for Cognitive and Emotional Well-Being in Late Life. Journal of Evidence-Based Complementary & Alternative Medicine 20:35-40. doi: 10.1177/2156587214553940
6. 12. Bennett-Levy J, Lee N (2012) Self-Practice and Self-Reflection in Cognitive Behaviour Therapy Training: What Factors Influence Trainees' Engagement and Experience of Benefit?. Behavioural and Cognitive Psychotherapy 42:48-64. doi: 10.1017/s1352465812000781
7. Ahn S, Bostick J, Ogle E et al. (2016) Experiencing Nature: Embodying Animals in Immersive Virtual Environments Increases Inclusion of Nature in Self and Involvement With Nature. Journal of Computer-Mediated Communication 21:399-419. doi: 10.1111/jcc4.12173
8. Fusaro M, Tieri G, Aglioti S (2016) Seeing pain and pleasure on self and others: behavioral and psychophysiological reactivity in immersive virtual reality. Journal of Neurophysiology 116:2656-2662. doi: 10.1152/jn.00489.2016
9. Russoniello, C., O'Brien, K, and Parks, J., 2009. The Effectiveness of Causal Video Games in Improving Mood and Decreasing Stress. Journal of Cybertherapy and Rehabilitation. 2(1), pp. 53-66.
10. McNair, D. M., Lorr, M. & Droppleman, L. F. (1981). Profile of mood states. San Diego: Educational and Testing Industrial Testing Service.
11. Cebolla A, Herrero R, Ventura S et al. (2019) Putting Oneself in the Body of Others: A Pilot Study on the Efficacy of an Embodied Virtual Reality System to Generate Self-Compassion. Frontiers in Psychology. doi: 10.3389/fpsyg.2019.01521
12. Falconer C, Slater M, Rovira A et al. (2014) Embodying Compassion: A Virtual Reality Paradigm for Overcoming Excessive Self-Criticism. PLoS ONE 9:e111933. doi: 10.1371/journal.pone.0111933
13. Västfjäll D (2001) Emotion induction through music: A review of the musical mood induction procedure. Musicae Scientiae 5:173-211. doi: 10.1177/10298649020050s107
14. Schaefer H (2017) Music-Evoked Emotions—Current Studies. Frontiers in Neuroscience. doi: 10.3389/fnins.2017.00600
15. Wilms L, Oberfeld D (2017) Color and emotion: effects of hue, saturation, and brightness. Psychological Research 82:896-914. doi: 10.1007/s00426-017-0880-8
16. Arnheim R. (1954) Art and Visual Perception. University of California Press. pp.10-444
17. Tomassoni R, Galetta G, and Treglia E, (2015) Psychology of Light: How Light Influences the Health and Psyche. Psychology. [e-journal] 6(10), pp.1216-1222. https://doi.org/10.4236/psych.2015.610119.
18. Verduyn P, Brans K (2012) The relationship between extraversion, neuroticism and aspects of trait affect. Personality and Individual Differences 52:664-669. doi: 10.1016/j.paid.2011.12.017
19. Kim S, Park G, Lee Y, Choi S (2016) Customer emotions and their triggers in luxury retail: Understanding the effects of customer emotions before and after entering a luxury shop. Journal of Business Research 69:5809-5818. doi: 10.1016/j.jbusres.2016.04.178
20. Epic Games Unreal Engine https://www.epicgames.com/site/en-US/home
21. NOAA Fisheries (2020) All Species Directory Page. In: Fisheries.noaa.gov. https://www.fisheries.noaa.gov/species-directory. Accessed 10 April 2020
22. Cherry, K., 2020. Can Color Affect Your Mood And Behavior? [online]. Verywell Mind. Available at: <https://www.verywellmind.com/color-psychology-2795824> [Accessed 17 April 2020].
23. Baer R, Smith G, Hopkins J et al. (2006) Using Self-Report Assessment Methods to Explore Facets of Mindfulness. Assessment 13:27-45. doi: 10.1177/1073191105283504

Measuring Narrative Engagement in Interactive Cinematic VR Experiences

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Abstract. This research involves the development of a cinematic VR experience that exhibits narrative engagement and the investigation of possible measurement tools to evaluate that engagement. This is accomplished by the implementation and analysis of standardized self-reporting measures and observational data. The efficacy of these measurement tools is discussed as well as their possible modifications and limitations for storytelling in VR.

Keywords: Immersive Storytelling, Interactive Storytelling, Cinematic VR

Introduction

This research investigates a range of measurement tools towards assessing narrative engagement in interactive cinematic VR experiences. This article describes the design of a cinematic VR experience and its evaluation using standardised self-reporting measures.

For the context of this research, cinematic VR describes immersive experiences with limited interactivity and a strong emphasis on storytelling. Therefore, cinematic VR encompasses immersive storytelling applications with fixed or predetermined stories that have a cinematic quality. Cinematic quality can be considered as "VR with media fidelity approaches found in feature film" [1]. Cinematic VR productions are not game-like experiences, but VR narratives based on targeted design and psychological criteria supported by the technology that VR inherently provides.

This research is important as VR is becoming more prevalent in research and personal use. However, the medium still has an untapped potential for immersive storytelling. Additionally, narrative engagement within the VR storytelling experience is both difficult to create and to evaluate, thus it is valuable to investigate work dedicated to VR storytelling as opposed to a game-like experience. Lastly, this work proposes to develop a dedicated high-quality experience expressly for the purpose of investigating narrative engagement.

Research Design

Project Creation

To explore how narrative engagement could be measured in a virtual reality experience, we designed a VR experience focused on narrative engagement and storytelling. The experience created for this study was made based on the recommendations and findings from [2]. This creation comprised three main phases: the Script, the Assets, and Interactivity and immersion.

The Script: Traditional western story tropes might be ill-suited to VR, due to the possibility that the model of the story line would break because of the immersive and interactive nature of VR [3]. With this in mind, a more general outline was chosen for the script. Using a simplified version of Blake Snyder's [3] Beat Sheet as a guide, an initial script was sketched out and was loosely based on an accumulation of varied Scottish folklore books for content. Additionally, the script included the concept of change [4] that was woven into the script early on to assist with engaging the user from the beginning. Moreover, as Richardson et al. [5] postulated that listening was an active process in co-creation, the script was written to be narrated, filling in details that were not present in the world, as well as leaving out details that were.

The Assets: The assets for the project encompassed the concepts of characters, story-world, and curiosity. These assets helped to inform the aforementioned script, as the story plot was character driven. For the character creation, the characters were given a personality based on the FFM [6]. On this scale, the main character was given high scores for openness, conscientiousness, and agreeableness, with low scores for extroversion and neuroticism. This meant that the character's personality was curious, dependable, reserved, empathetic, and calm. This created a blueprint for how the character would look and act, and therefore, was able to be designed based on these personality traits. To emphasise the personality and identity of the character, other assets were created as behavioural residue [7]. An example of such assets were items like a smoking pipe, picture frames, maps, and wine bottles that gave small indications about the character's life, many of which were interactive. To solidify the character, the story-world was then created based on the character's attributes and persona. The world itself was created on an island, with the scenes occurring in various locations around it; this was done so that when scene changes

occurred, it would lessen the amount of time it took for the user to reorient themselves in the world, since they could see all the other places they had previously been. To bring the story-world to life, life was added through other assets such as birds, rabbits, sea creatures, grasses, and trees.

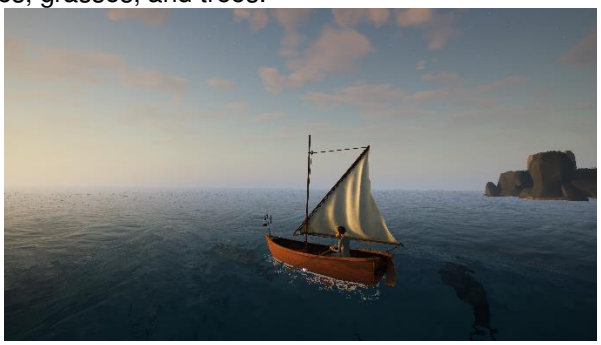


Fig. 1. Example scene from VR experience.

Some of these played multi-purposed roles, contributing not only to the story world and persona of the character but were also employed as curiosity types [8]and diegetic devices [9, 10]. An example of this is a recurring bird whom the user first meets in the menu, and then again in the first scene where it can be interacted with. It is then placed throughout various other scenes to help direct the focus and attention of the player (See Fig. 2).

Fig. 2. Example map diegetic placement.

Curiosity played a dual role in both the assets and the interactivity. To et al. [11] defined curiosity as one's inclination toward uncertainty and willingness to balance between the known and unknown. In their research, they defined types of curiosity and levels of uncertainty in games, to encourage game designers to use curiosity types in moments of uncertainty, thus assisting in balancing the knowledge gap.

There are five key types of curiosity: perceptual/attention to something new, manipulatory, curiosity about complex/ambiguous, conceptual/active information seeking, and adjustive-reactive [8]. For example, perceptual and adjustive-reactive curiosity can effectively combat the frustration of players with difficult puzzles or tasks, to keep the game engaging and not frustrating. For the creation of the experience, 4 out of 5 types were employed. Manipulatory was introduced simply by the use of the controller in the experience, with the ability to grab, hold, or throw items. Complex/ambiguous was utilized by making complex objects to interact with. Some of these included objects such as birds or rabbits that were animated and provided haptic feedback when touched. Others were in the form of picture frames that highlighted or changed their image when handled. Perceptual was implemented through music, sound cues from various objects, and visual highlights. And adjustive reactive constituted the items that were simpler and had a common use, such as a violin that the user could play. Conceptual was left out, simply due to the difficulty of executing it within the narrative.

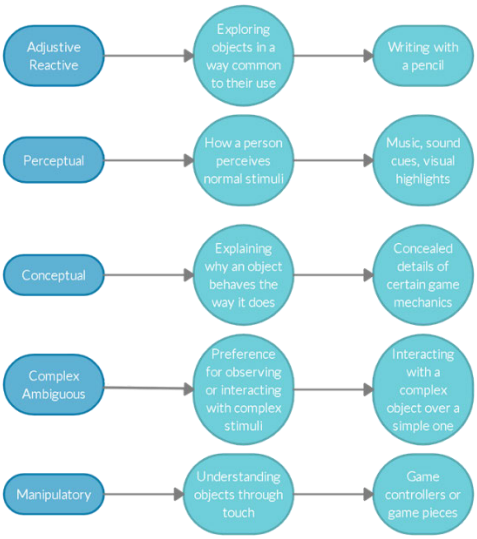
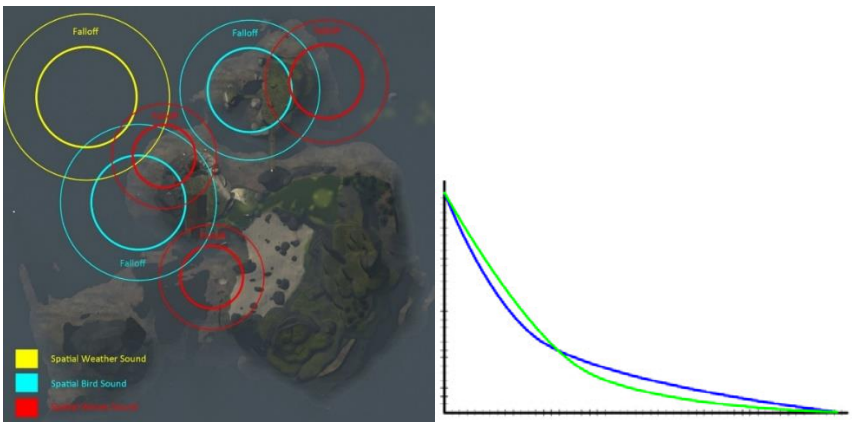


Fig. 3. Example of curiosity types.

Interactivity and immersion: As stated above curiosity also played a role in interactivity, as many of the “curious” objects were also interactive. Along with this, the use of music, audio cues, and highlights were used to focus/gain the user’s attention and increase immersion. In particular, both ambient and spatial sound were used throughout the VR experience [12]. Music and narration were ambient with no discernible source. For narration, as the story was based on Scottish folklore, a local voiceover artist was used to provide the voiceover for authenticity. Likewise, music was also chosen that had a Celtic feel. Specifically, each musical piece was chosen based on the music recommendations regarding tempo/pitch and emotion found in [2]. The spatial sound encompassed everything else. This included elements like waves crashing, bird calls, wind, thunder, rain, and whale calls. Each sound had an individual attenuation radius (the falloff of the source) utilising a natural sound function (See Fig. 5) and employed binaural spatialisation (the sound changed and shifted based on the user’s physical orientation towards the sound). These overlapped with each other to create a more natural environment.



In addition to the spatial and ambient sounds, other interactivity was built into various other assets. As mentioned earlier, examples of some picture frames changed and were highlighted when held, other objects could be collected and thrown or placed down by the user such as vegetables and wine bottles.

Evaluation Protocol

This section describes the self-reporting measures and the observational methods employed in this study along with a discussion on ethical considerations for these two methods.

Self-Reporting Measures

As narrative engagement is a multifaceted concept, several questionnaires can be employed for a well-rounded scope in the context of interactive storytelling VR experiences. For this research, the questionnaires used were based on the following concepts:

- Narrative understanding
- Attention Focus
- Narrative presence
- Emotional engagement
- Suspense
- Curiosity
- Flow
- Presence
- Enjoyment
- Aesthetic pleasantness

For consistency, all scales were measured on a 5-point Likert scale using a combination of forward scoring (F) and backwards scoring (B), as denoted on the following scales. Forward scoring has numerical values attached to the anchors in a forward direction, with fully agree = 5, and fully disagree = 1. Backwards (reverse) scoring has numerical values attached to anchors in the opposite direction, with fully disagree = 5 and fully agree =1.

Narrative Engagement Scale

Busselle and Bilandzic's [13] research interpreted four factors for narrative engagement while developing their Narrative Engagement Scale (NES). These were narrative understanding, attentional focus, emotional engagement, and narrative presence. Although it was not developed specifically for VR, it has been a widely used model in research and other VR studies [14, 6, 15] as well as having a Cronbach's α of over .80. For these reasons, it can potentially be adapted for use in interactive VR stories. The NES consists of 12 questions on a 7-point Likert scale and was adapted to a 5-point scale for consistency across all questionnaires.

Narrative understanding
- At points, I had a hard time making sense of what was going on in the experience. (B)
- My understanding of the characters is unclear. (B)
- I had a hard time recognising the thread of the story. (B)

Attentional focus
- I found my mind wandering while the during the story experience. (B)
- While in the virtual world I found myself thinking about other things. (B)
- I had a hard time keeping my mind on the story. (B)

Narrative presence
- During the experience, my body was in the room, but my mind was inside the world created by the story. (F)
- The experience created a new world, and then that world suddenly disappeared when the application ended. (F)
- At times during the experience, the story world was closer to me than the real world. (F)

Emotional engagement
- The story affected me emotionally. (F)
- During the experience, when a main character succeeded, I felt happy, and when they suffered in some way, I felt sad.
- I felt sympathy for some of the characters in the story. (F)

Suspense Scale

Measuring suspense in interactive storytelling is a somewhat novel idea. Knobloch et al. [16] developed a three-item scale for suspense rating media content in terms of being thrilling, gripping, and exciting. Other scales used to measure suspense are context specific [17], but neither of these are in the context of interactive narratives. Based on these studies and his own research, Roth [18] postulated that the measurement of suspense of interactive narratives should be based on the emotional involvement in the story's outcome. He therefore constructed 10 items to capture suspense based on emotional investment in the story specifically in the context of interactive narratives. This scale was later shortened to four items, based on the items with the highest item-total correlations.

- At some moments I was anxious to find out what would happen next (F)
- Sometimes I was worried about how the story would develop. (F)
- Some moments were rather suspenseful. (F)
- I found myself wishing for a particular story outcome. (F)

Curiosity Scale

Spielberger et al. [19] determined curiosity as a state, thus the State-Trait Curiosity Inventory (STCI) was developed to measure the intensity of curiosity as a transitory emotional state (19, 20]. The STCI includes 10 items on a 4-point scale asking participants to report how they feel at a particular moment. This was adapted to a 5-point

Likert for consistency throughout the other questionnaires, and “in the moment” was rephrased to “during the experience”. Additionally, the 10 items were adapted into three based on the recommendations [18].

During the experience I felt…..

- Curious (F)
- Interested (F)
- Inquisitive (F)

Flow Scale

Csikszentmihalyi [21] proposed eight factors for optimal flow: challenge activity; merging of acting and awareness; clear goals; direct immediate feedback; concentration; a sense of control; loss of self-consciousness; and an altered sense of time. Based on this model, the Flow State Scale (FSS) was developed [22]. Initially, this scale was a 36-item list, and later paired down to 9 items to allow for usage in a wider range of studies. Each item chosen reflected one of the nine higher order factors from the original scale [23]. Findings from the shorter list revealed that it provided a good representation of the long version with high reliability. This was adapted the scale into five items based on the highest item-total correlations.

During the experience. . .

- . . . I felt competent enough to meet the demands of the situation (F)
- . . . I acted spontaneously and automatically without having to think (F)
- . . . I had a strong sense of what I wanted to do (F)
- . . . I had a good idea while I was performing about how well I was doing (F)
- . . . I was completely focused on the task at hand (F)

Presence Scale

There are currently a few standardised presence questionnaires in circulation for VR applications [24, 25, 26]. The IPQ [25] was chosen based on research of the efficacy of presence scales [27] as it provided the highest reliability within a reasonable timeframe. The IPQ is a 14-item list, on a 5-point Likert scale. The items consist of 4 categories: General, Spatial presence (the sense of being physically present in VR), Involvement (measuring the attention devoted to the experience) and Experienced Realism (measuring the subjective experience of realism. Based on these categories, the scale was shorted to contain one item from each category.

- In the experience I had a sense of “being there” (G) (F)
- I felt present in the virtual space (SP) (F)
- The virtual world seemed more realistic than the real world (ER) (F)
- I was not aware of my real environment (INV) (F)

Enjoyment Scale

The measuring of enjoyment has proved somewhat problematic. While the concepts of enjoyment have been used in media research, such as amusement, sense of achievement etc. [28]; there is no study available that has attempted to measure it directly [18, 29]. Therefore, a simple short scale consisting of two questions was created.

The experience. . .

- . . . was entertaining (F)
- . . . was enjoyable (F)

Aesthetic Pleasantness Scale

Aesthetic pleasantness in media is often related to the visuals and audio. Aesthetic evaluations may relate to the physical appearance of characters or landscape imagery. Additionally, aesthetic content can relate to the personal background and previous experiences of the recipient. For instance, the depiction of a scene in a movie, can remind the viewer of feelings that resonate with the recipient’s mood, thus evoking congruent feelings [30]. Therefore, in this context, it is applied to encompass the elements of story-world, characters, and emotion. For this study, the following questionnaire was used to access aesthetic pleasantness [31].

The experience. . .

- . . . made me think (F)
- . . . made me think about my personal situation (F)

- . . . told me something about life (F)
- . . . was inspiring (F)
- . . . moved me like a piece of art (F)

Self-Reporting Limitations

Self-reporting measures to reflect on past experiences can be somewhat limited, as it can be hindered by such things as selective memory, mixing memories of other events, or even exaggeration. However, there is still validity in the use of these methods, as these limitations can be reduced. One such reduction, is the use of standardized questionnaires as they can be backed with research and a high Cronbach α (a reliability coefficient), increasing their validity. Additionally, wording of the questions was kept to the specific standard to avoid confusion or vagueness, with the exception of changing to the phrase “during the experience” across all scales for consistency.

Observation

Observational data for the study was recorded during the experience by the researcher in a nonparticipant role. The data recorded is in a semi-structured format using pre-defined events. The participants were aware that they were being observed, and aware that the researcher would not participate in the experience. The participates were also able to provide open-ended comments after the completion of the post questionnaire. An observational protocol was created for use during the observations. This included the current scene, time, and a record of events (See Table 1).

Table 1. Example of Observation Protocol for Scene 2.

Scene	Time	Description of Events
2	1:10 1:25 1:40	Interaction with bird Following gaze of character Interaction with character

Observation was carried out via online video (Zoom), with the participant sharing their PC screen. This allowed the researcher to view both the participant and their camera view during the experience.

Limitations of observational data can include the researcher being seen as intrusive. The interruption of the experience to conduct survey or interviews can lead to a disruption of the flow, and thus lead to disengagement [14]. To mitigate this, the observational data recorded was non-invasive; participants were not asked questions during the experience.

Data Treatment

After the project was completed, 10 participants were recruited to take part in the experiment. All participants were over the age of 18, with little to no experience in VR. Users were recruited via the online XR research platform XRDRN. The data collection was then divided into 2 main phases: observation and reflection.

Observation phase. Once the participants had their headset on, they started the program and observations were made and recorded throughout their experience. This data was qualitative in nature.

Reflection phase. After the completion of the VR experience, participants were invited to complete a set of self-reporting questionnaires. The Narrative Engagement Scale (NES); the Suspense Scale (SS); Curiosity Scale (CS); Flow Scale (FSS-2); Presence scale (IPQ), Enjoyment Scale (ES), and Aesthetic Pleasantness (APS). This data was quantitative in nature.

After completion of the data collection, the data analysis began consisting of three phases: Analyse Quantitative, Analyse Qualitative, and Mixed Methods. First, the quantitative results were analysed in terms of statistical results. Second, the qualitative database was analysed by coding the data and collapsing the codes into broad themes. The final phase is the mixed methods analysation, which consists of integrating the two databases. The integration of this data uses a data transformation approach; after the qualitative data had been coded into themes, they were counted

and grouped, to form quantitative measures. The following sections will discuss the results of the quantitative and qualitative data.

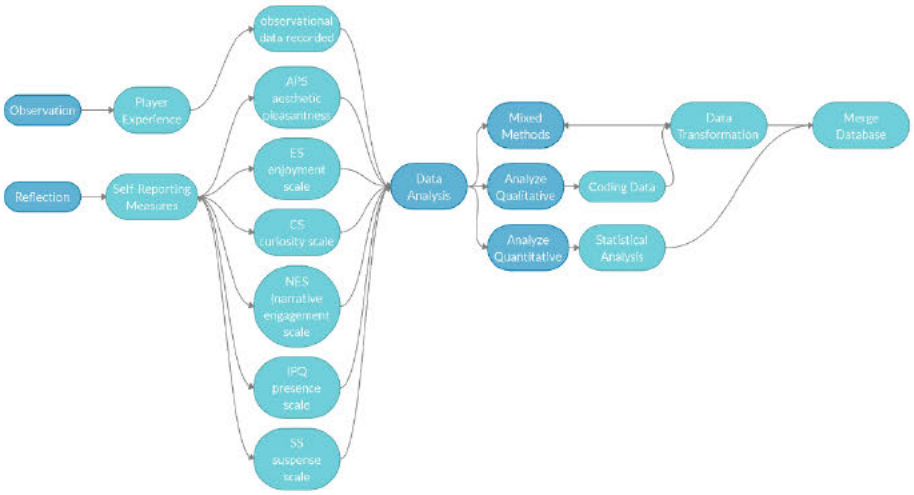


Fig. 6. Phases of Analysis.

Results

Presentation of Quantitative Data

All data was measured on a 5-point Likert scale using a combination of forward and backwards scoring. In this section, the mean and standard deviation are provided for each of the scales. The full record of data is to be published at a later date.

The NES (Narrative Engagement Scale) [15] was considered by the individual factors:

- narrative understanding--the ease in comprehension of the story.
- attentional focus—concept that one should not be aware that one is distracted.
- emotional engagement--feeling for or with the characters.
- narrative presence—sensation that one has left the actual world and entered the story.

Narrative understanding recorded both the highest mean at 4.83, and lowest standard deviation at .37. Likewise, Emotional engagement and Narrative presence also recorded high values with low deviations. Attentional focus saw the lowest data with a mean of 3.60, and the highest variation at 1.57 (See Table 2).

Table 2. Narrative Engagement Scale Data.

	Narrative understanding	Attentional Focus	Narrative presence	Emotional engagement
NES (Narrative Engagement Scale)	M = 4.83 SD = 0.37	M = 3.60 SD = 1.57	M = 4.33 SD = 0.82	M = 4.50 SD = 0.76

Along with the individual factors, the NES was combined with the remaining scales for further analysis. Combined, the overall NES was recorded with a mean of 4.32 and the second lowest standard deviation of .45. The ES (Enjoyment Scale) recorded the highest at 4.75, and lowest deviation at .43. It is also important to note that the lowest scoring scales were the SS (Suspense Scale) at 3.35, with a fairly large deviation at 1.23, as well at the FFS-2 (Flow Scale) at 3.64. Although scoring fairly high comparatively, the IPQ (Presence scale) all showed a larger deviation at 1.25. These results and fluctuations in data will be discussed further during the analysis of this paper (See Table 3).

Table 3. Combined Assessment Data

NES (Narrative Engagement Scale)	M = 4.32	SD = 0.45
SS (Suspense scale)	M = 3.35	SD = 1.23
CS (Curiosity Scale)	M = 4.63	SD = 0.60

FFS-2 (Flow Scale)	M = 3.64	SD = 1.07
IPQ (Presence Scale)	M = 3.92	SD = 1.25
ES (Enjoyment Scale)	M = 4.75	SD = 0.43
APS (Aesthetic Pleasantness Scale)	M = 4.43	SD = 0.83

Presentation of Qualitative Data

Qualitative data for this study was gathered via observation during the VR experience. The data was hand recorded, then transcribed into documents and coded in to like themes. The coding was recorded and calculated via the program MAXQDA, with the results showing the number of times each code appeared for each participant. This data was coded into the following themes:

- Focus on Characters
- Interaction with Character
- Follow character gaze
- Interact with shell (meaningful item)
- Focus on crow (diegetic item)
- Aesthetic focus (environment)
- Aesthetic focus (Life)
- Interaction with other objects

Table 4. Codes at a Glance (Percentages)

Codes	Percentage of participants
Focus on Characters	100%
Interaction with Character	100%
Follow Character gaze	90%
Interact with Shell (Meaningful Item)	100%
Focus on Crow (Diegetic)	100%
Aesthetic focus (Environment)	100%
Aesthetic focus (Life)	100%
Interaction with other objects	80%

Code System	10	9	8	7	6	5	4	3	2	1	SUM
Interact with other objects	1	1	5	7	1	2		11	3		31
Aesthetic Focus (Life)	4	5	9	8	5	7	8	4	3	3	56
Aesthetic focus (Environment)	7	5	7	2	4	3	7	3	3	4	45
Focus on Crow (Diegetic)	2	1	1	3	1	3	3	1	2	2	19
Interact with Shell (Meaningfull Item)	2	2	2	1	2	1	1	2	4	1	18
Follow Character Gaze	2	1	6	2	1	1	2		2	1	18
Interact with Character	1	1	1	1	1	1	1	4	1	1	13
Focus on Characters	15	11	14	11	10	16	13	11	10	9	120

As Table 4 demonstrates, the majority of the codes appeared for each participant with the exception of follow character gaze, which was reported at 90 percent, and interaction with other objects which was reported at 80 percent.

It is important to note that while Table 5 reveals the frequencies of the codes per participant, and their totals, the totals are not necessarily an indication of priority of one code over another, as each code holds a different purpose. For this reason, each code will be evaluated and analysed independently.

Firstly, both the Focus on Crow (Diegetic) code and Interact with shell (meaningful) code had a max amount of 4 possible occurrences within the experience. The diegetic code revealed the following:

- 30 percent focused on the object 75 percent of the maximum allowance.
- 30 percent focused on the object 50 percent of the maximum allowance.
- 40 percent focused on the object 25 percent of the maximum allowance.

Whereas the meaning code showed:

- 10 percent interacted with the object 100 percent of the maximum allowance.
- 50 percent interacted with the object 50 percent of the maximum allowance.
- 40 percent interacted with the object 25 percent of the maximum allowance.

Conversely, focus on characters, Aesthetic focus (life) and aesthetic focus(environment) did not have a set number of occurrences. Therefore, their frequencies and totals are of some importance at 120, 56, and 45 respectively. Interact with character only occurs a total of 13 times, however it is important to note that all participants attempted interaction with the character at least once, and that single interaction occurred at the same point during the story. Interact with other objects is wildly varied as far as frequencies go and holds a larger SD of 3.37. The final code is the follow character's gaze, which held an average of 2 per participant with a deviation of 1.8. With both sets of data presented, the following section will explore a deeper analysis of each, followed by a comparative analysis of the combined results.

Analysis

Self-Reporting Analysis

The Narrative Engagement Scale (NES) [14] which consisted of 4 separate subcategories:

- narrative understanding
- attentional focus
- emotional engagement
- narrative presence

The data from this scale demonstrated high averages and low deviations for all categories save for one, attentional focus. Although the mean was above average (3.60) the deviation was high (1.57). The following statements were used for this subcategory:

- I found my mind wandering while the during the story experience.
- While in the virtual world I found myself thinking about other things.
- I had a hard time keeping my mind on the story.

As demonstrated, these statements primarily focus on the mind: paying attention and not wandering from the subject. The discrepancy for this large deviation of the subcategory can be narrowed into two potential factors. The first possibility is the differences of cognitive capabilities and personalities of each participant. As no baseline was gathered before the experience on each participant's attention level or capabilities, it is difficult to have clarity on the efficacy of this category. Additionally, the other possibility for the large deviation is the manner in which the study needed to be performed. Since observations needed to be completed via video chat and on varying hardware, some individuals experienced technical issues, like stuttering during the experience. This may have been a potential factor in breaking the focus of a participant. However, since the averages in the other subcategories were high with low deviations and overall, the entire scale had a higher average (4.32), this subcategory may not hold as much weight at the others, and either may not be needed, or may need to be modified to eliminate potential discrepancies.

Likewise, the presence scale (IPQ) [25] indicated a similar trend. Although the average was above an acceptable range (3.92), like the attentional focus, it too suffered a high deviation of 1.25. Also, like attentional focus, it is likely that this large deviation was also a product of technical issues. Recall that the four statements used for this scale were:

- In the experience I had a sense of "being there".
- I felt present in the virtual space.
- The virtual world seemed more realistic than the real world.
- I was not aware of my real environment.

These statements are based on the physical presence the participant perceives in VR, and the lack of awareness of their real environment. As mentioned previously, one of the technical issues experienced by some participants was stuttering. This was likely due to participants using varying headsets and graphics cards, as well as having to live stream the experience. Regardless of cause, this would have an impact the user's perception of presence as it breaks the sense of "being there". Additionally, as the observations were conducted in the participants' homes, they had varying physical space in which to move. As this experience was created to move around in a large space, various participants had less room in which to explore; ultimately running out of room and thus become "aware" of their real environment's limitations. To lower the deviations in these scores, these environmental variables must be eliminated.

The suspense scale (SS) demonstrated both a lower average (3.35) and ahigh deviation (1.23). The high deviation of the scale may indicate that the scale may need to be modified further, or that there is a discrepancy in the actual wording of the scale. It is possible that some individuals may perceive the concept of suspense differently than others. Additionally, the use of the words “worry” and “anxious” may be a cause for confusion. Therefore, further research needs to be completed to assess the efficacy of this scale. However, the lower average of the scale indicates a problem with the project itself. The story and the project did not contain clear moments of suspense, and therefore it may have been difficult to identify them. As suspense is an important factor and is closely linked with the concept of curiosity [32], clearer moments of suspense need to be implemented in the project and storyline.

The flow scale (FFS-2) revealed an average of 3.64 and a deviation of 1.07. To review, the concept of flow [21] is the ease in which a user arrives at a pleasant optimal performance. Flow comprises eight specific factors: challenge activity; merging of acting and awareness; clear goals; direct immediate feedback; concentration; a sense of control; loss of subconsciousness; and altered sense of time.

From this perspective, the scale coincides with the eight factors quite well. However, the larger deviation and lower average indicate problems. In past studies, the flow scale was generally used for game-based interactive digital applications [33, 34] as the factors for flow were easier to implement and measure. As this project was a cinematic experience with a linear storyline, there were sufficient opportunities to create flow based on all of these factors. There was no direct instruction or clear task given during the experience for the user to be focused on, nor was there any gauge on which the user could evaluate their own performance. While participants were able to accurately report such statements as “I acted spontaneously and automatically without having to think”, the task orientated statements had the largest variation in answers. This is because there was no clear task, and there was no clear task because the participants’ actions were unable to affect the storyline in a linear story. This would indicate that either the flow scale is ill suited to cinematic experiences with linear stories, that it needs to be heavily modified to fit this genre, or that the project needs to find a better way to apply this scale without sacrificing its structure.

The curiosity scale (CS) performed well, with an average of 4.63 the low deviation of .60. However, it is important to note that the scale only had three statements that were simplified from the original 10. So, while it is an indication that the project did create curiosity and was able to accurately measure it, it might be pertinent to use the full-scale to get a more accurate view of the curiosity factors in the experience. Additionally, since curious types [8] were used in the project, expanding this scale to target those specific types may also prove beneficial to fine tune the results.

The enjoyment scale (ES) had the highest average of 4.75 and the lowest deviation of .43. Although it only consists of two statements, they were relatively simple, and the participants were able to answer them clearly and accurately. While it would be prudent to continue research to expand the scale, it was effective in relation to this project. This is because, in conjunction with the scale, enjoyment was also able to be observed during the experience. This enjoyment was observed objectively by the researcher in the form of participants smiling, chuckling, laughing, and some dancing.

The aesthetic pleasantness scale (APS) had an average of 4.43 with a deviation of .80. As Section 2.5 stated, this scale encompassed the elements of story-world, characters, and emotion. The high average and low deviation indicate that aesthetic pleasantness overall may play a more important role in narrative engagement than initially thought. To explain this assumption, this scale can be directly compared to the qualitative findings discussed in the next section.

Observational Analysis

First, consider the following codes: Aesthetic focus (life), aesthetic focus (environment), and focus on character. The aesthetic focus (life) was coded as such to include organic elements within the experience. These included objects such as wildlife, trees, grass, etc. Aesthetic focus (environment) included items such as the sky, the waves, and the weather. Combined, these elements make up the story-world, and part of the emotional element as stated in the APS. As mentioned in the previous section both codes had high frequencies throughout the experience, 56 and 45 respectively, with a combined total of 101. Additionally, focus on the character (which makes up the character element of the APS) also had high frequencies with a total of 120. This implies that focusing on the aesthetics of the story-world is nearly as important as focusing on the characters in story. As all of these codes are also part of the APS, this further indicates the importance of aesthetic pleasantness overall. Consider that the frequency of these codes combined equals to 221, whereas the rest of the codes combine equals to 99, with an overall total of 320.

Based on the number of frequencies for this study, participants spent nearly 70 percent of their time focusing on the aesthetics (character and story-world).

Another indication of its significance is that of verbal feedback received after completion of the story. Upon completion of the experience, each participant was asked which scenes they had an emotional connection to. With the exception of one outlier, all the other participants named the same two scenes having affected them the most. The first scene identified (Fig. 7) involved the participant standing on the edge of a lighthouse at night with northern lights in the sky, and the lights reflecting on the ocean water.

Fig.7. First Identified scene by participants

The second scene identified, involved the user being immersed in the ocean, physically flowing through it, with elements and ocean creatures becoming bioluminescent (Fig. 8). Both of these scenes had very strong visual attributes attached to them, which would lead to the possibility of investigating their visual attributes further.

Fig.8. Second scene identified by participants.

Additionally, the one participant that chose a different scene, chose a scene involving the characters gardening together (Fig. 9). The participant stated that this scene made them feel “nostalgic”. This coincides with the postulation that aesthetic content could relate to the personal background and previous experiences of the recipient, evoking congruent feelings in the participant [30].

Fig. 9. Outlier scene identified by participant

The next data to analyse is the interact with shell (meaningful) code. This code was attached to the specific interaction with an object (shell) during the experience. This object was the only object directly referenced in the experience's narration. Furthermore, it was also used as a physical representation for a "moment of unexpected change" [4] and as an ignition point for the story [4]. It was for these reasons that the shell was deemed a meaningful item [35]as meaning plays a dominant role in guiding attention in scenes of stories. As mentioned earlier, 100 percent of participants triggered this code. It is interesting to note that although some participants interacted with the shell more than once, all participants interacted with the shell at the same moment the story. This moment happened at the very end of the story when the character interacts with the participant. Conversely, the interact with other objects code had a more varied response. When comparing the two, while interact with shell (meaningful) had a deviation of .87, interact with other objects had a large variation of 3.37. This variation may be attributed to a few things. Firstly, this may connect directly to the sense of flow, as there was no clear direction, instruction, or task given to the participant at any time. Thus, the participant may have been unsure about what they could or should interact with. The exception of this, of course, being the shell, as this was directly used in the story. Personalities differences also may have influenced this variation, as some individuals may be more inclined to be tactile and want to touch and explore things while others may be of a more tentative nature. Although these items were used as curiosity types [8] and behavioural residue [7], it is unclear if they had any true bearing on the narrative engagement of the story as a whole and may need to be assessed individually. However, it can be postulated that the interaction with the shell had a more consistent response because it was a part of the story thus giving it more meaning, whereas the other objects were not. This may imply the that interactive objects require more meaning or purpose to the story in order to have consistent interaction and engagement.

Like the Interact with shell code, the interact with character code was largely initiated at the very end of the story at the same time for all participants. To clarify, in the final scene the character turns to the participant and gestures for them to come to them and sit down, where the interactable shell is also located. The significance of this is that although the participant had multiple opportunities to interact with the character, 90 percent of them only did so at the end when the character interacted with them first. This may signify that for a user to engage with an NPC (non-player character), the NPC must first engage with them.

Focus on crow and follow character's gaze were both diegetic devices within the experience to gain the attention of the participant and engage them. The crow was purposely made as a focusing diegetic device, while the gaze of the character was an accidental addition. The crow was first introduced in the first scene where the participant could interact with it, and it would appear throughout other scenes using a sound cue to direct the focus of the participant. This proved to be a semi-accurate way to direct focus, as all participants were able to focus on the crow at one point or another. However, the results were not very consistent, which may be because the crow is not a part of the story and holds no other significance.

The following character's gaze code was accidental, as it was a product of the character's natural personality. To clarify, the code was initiated whenever the character would point while looking at something, looked out to sea, or was otherwise searching for something. The participant would then follow the gaze and direction of the character. This signifies engagement and connection to the character as well as curiosity, as the user is trying to physically look where the NPC is looking. While the frequencies of this are varied, it appears to add to the engagement of the story,

as it is a more natural occurrence than a random appearance of a bird. If purposely controlled, it may prove a more effective device in gaining a keeping attention on the story.

Conclusion

Summary of Research Data

To review the quantitative data, the narrative engagement scale worked moderately well, however the subcategory of attentional focus must either be eliminated or modified to better adapt to cinematic VR experiences and eliminate possible discrepancies due to different cognitive abilities. The flow scale may also not be well suited to certain VR cinematic experiences that follow a linear storyline, as users do not have a specific task assigned to them or have the ability to influence the outcome of the story. The alternative to this is that the gameplay itself would have to change in order to adapt to the concept of flow. The curiosity scale worked successfully and with a reasonable degree of accuracy but was relatively simplistic. Further evaluation and research are needed to develop a more in-depth scale regarding narrative engagement. This also applies to the scale of suspense, with the addition of requiring further development and research on the relationship between curiosity and suspense, as well as to the practical implementation of opportunities to create suspense within the experience.

Regarding qualitative data, aesthetic pleasantness appears to play a significant role in narrative engagement, and therefore needs to be expanded and further explored in depth. Additionally, interactive items may need to hold more meaning for them to be interacted with consistently. Using a diegetic item to focus the attention of the user is potentially an effective way to assist with engagement, but the focus needs to be more purposeful. Finally, meaningful interactions with NPC characters may be dependent on the NPC character initiating interaction first, and that the user is more likely to engage in mirroring the behaviour of the NPC i.e., looking where they are looking.

Limitations

As this study was conducted via internet, participants needed to have access to their own headsets and VR compatible PCs. This greatly reduced the potential number of participants to only those who had a specific brand of headset. Additionally, although there was nearly double the number of people who expressed interest in the study, only half followed through. This is likely due to the observational requirement needed over Zoom, which some participants were unwilling to do. A small sample size is problematic as in increases the bias and lacks the statistical power to find significant effects in an overall population.

Recommendations

A larger sample size would give a more accurate representation of populous and eliminate many deviations in quantitative and qualitative data while increasing its validity. Additionally, the study needs to be performed in a more controlled environment. This means the environment needs to use the same hardware, headset, the same graphics card, and have the same room scale. It is also inadvisable to conduct such an experiment online as it introduces other technical issues, such as stuttering or prolonged delays, as well as the inability to accurately see the entirety of the participant's body during observation.

Furthermore, the VR project needs to have more opportunities for suspense, and more research should be explored on other suspense scales, creating suspense, and its definition. This was lacking in both the research and project, and as it is linked with curiosity [32] and since curiosity largely impacts narrative engagement [9, 5, 36], it would be beneficial to have a more in depth understanding of it. Along with suspense, the curiosity scale would also benefit from more exploration into its assessment, concepts, and the relationship of curiosity to narrative engagement as a whole. This would provide a well-rounded data set, increasing accuracy and validity. Finally, additional research should be conducted on the importance of aesthetics in cinematic VR experiences, and aesthetic scale needs to be modified and expanded based upon those recommendations.

The use of the flow scale is probably not appropriate for cinematic VR experience with the linear storyline, therefore either needs to be eliminated from the narrative engagement measurement or heavily modified to better fit with the genre. Likewise, the attentional focus aspect of the narrative engagement scale also either needs to be eliminated or heavily modified to eliminate discrepancies based upon potential cognitive differences, capabilities, or personalities.

References

1. Mateer, J. (2017). Directing for cinematic virtual reality: How the traditional film director's craft applies to immersive environments and notions of presence. Journal of Media Practice, 18(1), 14–25.
2. Wolfe, A. Louchart, S. and Loranger, B. (2022). The Impacts of Design Elements in Interactive Storytelling in VR on Emotion, Mood, and Self-reflection. 10.1007/978-3-031-22298-6_40.
3. Koenitz, H. et al. (2018) 'The Myth of `Universal' Narrative Models', in Rouse, R., Koenitz, H., and Haahr, M. (eds) Interactive Storytelling. Cham: Springer International Publishing, pp. 107–125
4. Storr, W. (2019) The Science of Storytelling. London, UK: William Collins.
5. Richardson, D. C. et al. (2018) 'Measuring narrative engagement: The heart tells the story', bioRxiv. doi: 10.1101/351148
6. McCrae, R. R., Gaines, J. F. and Wellington, M. A. (2012) 'The Five-Factor Model in Fact and Fiction', in Handbook of Psychology, Second Edition. doi: 10.1002/9781118133880.hop205004
7. Gosling, S. (2008) Snoop. London, UK: Bookmarque.
8. To, A. et al. (2016) 'Integrating Curiosity and Uncertainty in Game Design', Proceedings of 1st International Joint Conference of DiGRA and FDG, pp. 1–16
9. FEARGHAIL, C. O. et al. (2018) 'Director's Cut - Analysis of Aspects of Interactive Storytelling for VR Films', in Rouse, R., Koenitz, H., and Haahr, M. (eds) Interactive Storytelling. Cham: Springer International Publishing, pp. 308–322
10. Brown, S. A. et al. (2020) 'Capturing User Emotions in Interactive Stories: Comparing a Diegetic and a Non-diegetic Approach to Self-reporting Emotion', in Bosser, A.-G., Millard, D. E., and Hargood, C. (eds) Interactive Storytelling. Cham: Springer International Publishing, pp. 229–242
11. To, A. et al. (2016) 'Integrating Curiosity and Uncertainty in Game Design', Proceedings of 1st International Joint Conference of DiGRA and FDG, pp. 1–16
12. Bhide, S., Goins, E. and Geigel, J. (2019) 'Experimental Analysis of Spatial Sound for Storytelling in Virtual Reality', in Cardona-Rivera, R. E., Sullivan, A., and Young, R. M. (eds) Interactive Storytelling. Cham: Springer International Publishing, pp. 3–7
13. Busselle, R. and Bilandzic, H. (2008) 'Fictionality and perceived realism in experiencing stories: A model of narrative comprehension and engagement', Communication Theory, 18(2). doi: 10.1111/j.1468-2885.2008.00322.x
14. Bindman, S. W. et al. (2018) 'Am I a bunny? The impact of high and low immersion platforms and viewers' perceptions of role on presence, narrative engagement, and empathy during an animated 360° video', in Conference on Human Factors in Computing Systems - Proceedings. doi: 10.1145/3173574.3174031
15. Schoenau-Fog, H. (2011) 'Hooked! -- Evaluating Engagement as Continuation Desire in Interactive Narratives', in Si, M. et al. (eds) Interactive Storytelling. Berlin, Heidelberg: Springer Berlin Heidelberg, pp. 219–230
16. Knobloch, S. et al. (2004) 'Affective news: Effects of discourse structure in narratives on suspense, curiosity, and enjoyment while reading news and novels', Communication Research, 31(3). doi: 10.1177/0093650203261517
17. Hartmann, T., Stuke, D. and Daschmann, G. (2008) 'Positive Parasocial Relationships with Drivers Affect Suspense in Racing Sport Spectators', Journal of Media Psychology. Taylor & Francis Group, 20(1). doi: 10.1027/1864-1105.20.1.24
18. Roth, C. (2015) Experiencing Interactive Storytelling.
19. Spielberger, C. D. et al. (1979) 'Preliminary manual for the state-trait personality inventory (STPI)', Unpublished manuscript University of South Florida Tampa
20. Spielberger, C. D., Peters, R. A. and Frain, F. S. (1981) 'Curiosity and anxiety', in Curiosity research: Basic concepts and results
21. Csikszentmihalhi, M. (1997) 'Finding flow: the psychology of engagement with everyday life', Choice Reviews Online, 35(03). doi: 10.5860/choice.35-1828
22. Jackson, S. A. and Eklund, R. C. (2002) 'Assessing flow in physical activity: The flow state scale-2 and dispositional flow scale-2', Journal of Sport and Exercise Psychology, 24(2). doi: 10.1123/jsep.24.2.133
23. Jackson, S. A., Martin, A. J. and Eklund, R. C. (2008) 'Long and short measures of flow: The construct validity of the FSS-2, DFS-2, and new brief counterparts', Journal of Sport and Exercise Psychology, 30(5). doi: 10.1123/jsep.30.5.561
24. Slater, M., Usoh, M. and Steed, A. (1994) 'Depth of Presence in Virtual Environments', Presence: Teleoperators and Virtual Environments, 3(2). doi: 10.1162/pres.1994.3.2.130.
25. Schubert, T., Friedmann, F. and Regenbrecht, H. (2001) 'The experience of presence: Factor analytic insights', Presence: Teleoperators and Virtual Environments, 10(3). doi: 10.1162/105474601300343603.
26. Witmer, B. G., Jerome, C. J. and Singer, M. J. (2005) 'The factor structure of the Presence Questionnaire', Presence: Teleoperators and Virtual Environments. doi: 10.1162/105474605323384654.
27. Schwind, V. et al. (2019) 'Using presence questionnaires in virtual reality', in Conference on Human Factors in Computing Systems - Proceedings. doi: 10.1145/3290605.3300590.
28. Vorderer, P., Klimmt, C. and Ritterfeld, U. (2004) 'Enjoyment: At the heart of media entertainment', Communication Theory, 14(4). doi: 10.1111/j.1468-2885.2004.tb00321.x
29. Sweetser, P. and Wyeth, P. (2005) 'GameFlow: a model for evaluating player enjoyment in games', Computers in Entertainment (CIE), 3(3). doi: 10.1145/1077246.1077253
30. Cupchik
31. Rowold, J. (2008) 'Instrument Development for Esthetic Perception Assessment', Journal of Media Psychology. Taylor & Francis Group, 20(1). doi: 10.1027/1864-1105.20.1.35

32. Hoeken, H. and Sinkeldam, J. (2014) 'The Role of Identification and Perception of Just Outcome in Evoking Emotions in Narrative Persuasion', Journal of Communication. Blackwell Publishing Ltd, 64(5), pp. 935–955. doi: 10.1111/jcom.12114
33. Isbister, K. (2006) Better game characters by design: a psychological approach, Education
34. Isbister, K. (2018) How Games Move Us, How Games Move Us. doi: 10.7551/mitpress/9267.001.0001
35. Henderson, J. M. and Hayes, T. R. (2017) 'Meaning-based guidance of attention in scenes as revealed by meaning maps', Nature Human Behaviour, 1(10). doi: 10.1038/s41562-017-0208-0
36. Loewenstein, G. (1994) 'The Psychology of Curiosity: A Review and Reinterpretation', Psychological Bulletin, 116(1). doi: 10.1037//0033-2909.116.1.75

References

Andrew Perkis, Mattia Bellini, Valentina Nisi, M. *et al.* (2023) *(2) (PDF) INDCOR White Paper 2: Interactive Narrative Design for Representing Complexity*. Available at: https://www.researchgate.net/publication/370495133_INDCOR_White_Paper_2_Interactive_Narrative_Design_for_Representing_Complexity (Accessed: 3 February 2024).

Arnheim, R. (1954) *Art and Visual Perception*. University of California Press. pp.10-444

Appel, M. and Richter, T. (2007) 'Persuasive Effects of Fictional Narratives Increase Over Time', *Media Psychology*. Taylor & Francis Group, 10(1), pp. 113–134. doi: 10.1080/15213260701301194

Appel, M. *et al.* (2015) 'The Transportation Scale–Short Form (TS–SF)', *Media Psychology*. Routledge, 18(2), pp. 243–266. doi: 10.1080/15213269.2014.987400

Austin, T. R. and Chatman, S. (1979) 'Story and Discourse: Narrative Structure in Fiction and Film', *The Journal of Aesthetics and Art Criticism*, 38(2). doi: 10.2307/430732

Balkwill, L. L. and Thompson, W. F. (1999) 'A Cross-Cultural Investigation of the Perception of Emotion in Music: Psychophysical and Cultural Cues', *Music Perception*. University of California Press, 17(1), pp. 43–64. doi: 10.2307/40285811

Bhide, S., Goins, E. and Geigel, J. (2019) 'Experimental Analysis of Spatial Sound for Storytelling in Virtual Reality', in Cardona-Rivera, R. E., Sullivan, A., and Young, R. M. (eds) *Interactive Storytelling*. Cham: Springer International Publishing, pp. 3–7

Bilandzic, H. and Busselle, R. W. (2011) 'Enjoyment of films as a function of narrative experience, perceived realism and transportability', *Communications*. De Gruyter Mouton, 36(1), pp. 29–50. doi: 10.1515/COMM.2011.002/MACHINEREADABLECITATION/RIS.

Bindman, S. W. *et al.* (2018) 'Am I a bunny? The impact of high and low immersion platforms and viewers' perceptions of role on presence, narrative engagement, and empathy during an animated 360° video', in *Conference on Human Factors in Computing Systems - Proceedings*. doi: 10.1145/3173574.3174031

Bioware (2009-2014) *Dragonage.* [Video game] Electronic Arts.

Biocca, F. (2014) 'The evolution of interactive media towards "being there " in non-linear narrative worlds', *Sexual health*, 11(2)

Blijlevens, J. *et al.* (2017) 'The aesthetic pleasure in design scale: The development of a scale to measure aesthetic pleasure for designed artifacts', *Psychology of Aesthetics, Creativity, and the Arts*. American Psychological Association Inc., 11(1), pp. 86–98. doi: 10.1037/ACA0000098

Bockholt, N. (2017) *What does immersion actually mean?*, *ThinkwithGoogle*. Available at: https://www.thinkwithgoogle.com/intl/en-cee/future-of-marketing/emerging-technology/vr-ar-mr-and-what-does-immersion-actually-mean/ (Accessed: 4 September 2023).

Bound, K. R. (2016) 'Terror & tension' psychophysiological suspense: defining a framework to measure cinematic suspense in 21st century horror films. Available at: https://www.researchgate.net/publication/313438411_%27Terror_tension%27_psychophysiologic

al_suspense_defining_a_framework_to_measure_cinematic_suspense_in_21st_century_horror_films (Accessed: 17 April 2022).

Brewer, W. F. and Lichtenstein, E. H. (1982) 'Stories are to entertain: A structural-affect theory of stories', *Journal of Pragmatics*, 6(5–6). doi: 10.1016/0378-2166(82)90021-2

Brinkman, W. (2009). Design of a Questionnaire Instrument. Handbook of Mobile Technology Research Methods.

Brown, S. A. *et al.* (2020) 'Capturing User Emotions in Interactive Stories: Comparing a Diegetic and a Non-diegetic Approach to Self-reporting Emotion', in Bosser, A.-G., Millard, D. E., and Hargood, C. (eds) *Interactive Storytelling*. Cham: Springer International Publishing, pp. 229–242

Bucher, J. K. (2017) *Storytelling for virtual reality: Methods and principles for crafting immersive narratives*. 1st edn. Edited by Routledge. Available at: https://doi.org/10.4324/9781315210308 (Accessed: 17 April 2022)

Busselle, R. and Bilandzic, H. (2009) 'Measuring Narrative Engagement', *Media Psychology*. Taylor & Francis Group, 12(4). doi: 10.1080/15213260903287259

Busselle, R. and Bilandzic, H. (2008) 'Fictionality and perceived realism in experiencing stories: A model of narrative comprehension and engagement', *Communication Theory*, 18(2). doi: 10.1111/j.1468-2885.2008.00322.x

Campbell, J. (1991) *The Power of Myth*. First. New York: Anchor Books

Carbon, C. C. and Jakesch, M. (2013) 'A model for haptic aesthetic processing and its implications for design', *Proceedings of the IEEE*, 101(9). doi: 10.1109/JPROC.2012.2219831.

Cohen, J. (2001) 'Defining Identification: A Theoretical Look at the Identification of Audiences with Media Characters', *Mass Communication and Society*, 4(3). doi: 10.1207/s15327825mcs0403_01

Creswell, J. W. and Creswell, J. D. (2018) 'Research Design: Qualitative, Quantitative, and Mixed Methods Approaches - John W. Creswell, J. David Creswell - Google Books', *SAGE Publications, Inc.*

Cronbach, L. J. (1951). Coefficient α and the internal structure of tests. *Psychometrika, 16,* 297–334. https://doi.org/10.1007/BF02310555

Crotty, M. (1998) *The foundations of social research: Meaning and perspective in the research process*, *Sage*.

Crowther, W. (1976) *Adventure*. [Interactive fiction IDN]

Csikszentmihalyi, M. (1997) 'Finding flow: the psychology of engagement with everyday life', *Choice Reviews Online*, 35(03). doi: 10.5860/choice.35-1828

Dahlstrom, M. F. (2012) 'The Persuasive Influence of Narrative Causality: Psychological Mechanism, Strength in Overcoming Resistance, and Persistence Over Time', *Media Psychology*. Taylor & Francis Group, 15(3), pp. 303–326. doi: 10.1080/15213269.2012.702604

Demetriou, C., Ozer, B. U. and Essau, C. A. (2015) 'Self-Report Questionnaires'. doi: 10.1002/9781118625392.wbecp507.

Designing Interactivity into Game Play (2019) *University of Silicon Valley*. Available at: https://usv.edu/blog/designing-interactivity-into-game-play/ (Accessed: 6 December 2023).

Donnelly, J. (2015) *Experiencing 'Deep,' the Virtual Reality Game That Relieves Anxiety Attacks*, *Vice*. Available at: https://www.vice.com/en/article/xd5em3/experiencing-deep-the-virtual-reality-game-that-relieves-anxiety-attacks-142 (Accessed: 20 February 2021)

Ekman, P. (2016) 'What Scientists Who Study Emotion Agree About', *Perspectives on Psychological Science*. SAGE Publications Inc., 11(1), pp. 31–34. doi: 10.1177/1745691615596992

Fearghail, C. O. *et al.* (2018) 'Director's Cut - Analysis of Aspects of Interactive Storytelling for VR Films', in Rouse, R., Koenitz, H., and Haahr, M. (eds) *Interactive Storytelling*. Cham: Springer International Publishing, pp. 308–322

Folkman, S. *et al.* (1986) 'Dynamics of a Stressful Encounter. Cognitive Appraisal, Coping, and Encounter Outcomes', *Journal of Personality and Social Psychology*, 50(5), pp. 992–1003. doi: 10.1037/0022-3514.50.5.992

Gagné, P. and Hancock, G. R. (2006) 'Measurement model quality, sample size, and solution propriety in confirmatory factor models', *Multivariate Behavioural Research*, 41(1), pp. 65–83. doi: 10.1207/S15327906MBR4101_5

Garver, S., Adamo-Villani, N. and Dib, H. (2018) 'The Impact of Visual Style on User Experience in Games', *EAI Endorsed Transactions on Game-Based Learning*. Institute for Computer Sciences, Social Informatics and Telecommunications Engineering (ICST), 4(15), p. 153535. doi: 10.4108/EAI.5-1-2018.153535

Gosling, S. (2008) *Snoop*. London, UK: Bookmarque.

Green, M. C. and Brock, T. C. (2000) 'The role of transportation in the persuasiveness of public narratives', *Journal of Personality and Social Psychology*. American Psychological Association Inc., 79(5), pp. 701–721. doi: 10.1037/0022-3514.79.5.701

Green, M. C., Brock, T. C. and Kaufman, G. F. (2004) 'Understanding media enjoyment: The role of transportation into narrative worlds', *Communication Theory*, 14(4). doi: 10.1111/j.1468-2885.2004.tb00317.x

Hartmann, T., Stuke, D. and Daschmann, G. (2008) 'Positive Parasocial Relationships with Drivers Affect Suspense in Racing Sport Spectators', *Journal of Media Psychology*. Taylor & Francis Group, 20(1). doi: 10.1027/1864-1105.20.1.24

Henderson, J. M. and Hayes, T. R. (2017) 'Meaning-based guidance of attention in scenes as revealed by meaning maps', *Nature Human Behaviour*, 1(10). doi: 10.1038/s41562-017-0208-0

Hennebury, C. (2020) *Storytelling is not just entertainment. It's a fundamental part of being human | CBC News*, *CBC*. Available at: https://www.cbc.ca/news/canada/newfoundland-labrador/storytelling-is-human-1.5511027 (Accessed: 14 July 2023).

Hinton, P., McMurray, I., and Brownlow, C. (2004). SPSS Explained (1st ed.). Routledge. https://doi.org/10.4324/9780203642597

Hoffmann, D. L. *et al.* (2018) 'U-Th dating of carbonate crusts reveals Neandertal origin of Iberian cave art', *Science*. American Association for the Advancement of Science, 359(6378), pp. 912–915. doi: 10.1126/SCIENCE.AAP7778/SUPPL_FILE/AAP7778_HOFFMANN_SM.PDF.

Hoeken, H. and Van Vliet, M. (2000) 'Suspense, curiosity, and surprise: How discourse structure influences the affective and cognitive processing of a story', *Poetics*, 27(4). doi: 10.1016/S0304-422X (99)00021-2

Hoeken, H. and Sinkeldam, J. (2014) 'The Role of Identification and Perception of Just Outcome in Evoking Emotions in Narrative Persuasion', *Journal of Communication*. Blackwell Publishing Ltd, 64(5), pp. 935–955. doi: 10.1111/jcom.12114

Hood, B. (2012) *The Self Illusion: Why There is No 'You' Inside Your Head*. London, UK: Little, Brown Book Group

Isbister, K. (2006) *Better game characters by design: a psychological approach*, *Education*

Isbister, K. (2018) *How Games Move Us*, *How Games Move Us*. doi: 10.7551/mitpress/9267.001.0001

Jackson, S. A. and Eklund, R. C. (2002) 'Assessing flow in physical activity: The flow state scale-2 and dispositional flow scale-2', *Journal of Sport and Exercise Psychology*, 24(2). doi: 10.1123/jsep.24.2.133

Jackson, S. A., Martin, A. J. and Eklund, R. C. (2008) 'Long and short measures of flow: The construct validity of the FSS-2, DFS-2, and new brief counterparts', *Journal of Sport and Exercise Psychology*, 30(5). doi: 10.1123/jsep.30.5.561

Jaquet, L., Danuser, B. and Gomes, P. (2014) 'Music and felt emotions: How systematic pitch level variations affect the experience of pleasantness and arousal', *Psychology of Music*. SAGE Publications Ltd, 42(1), pp. 51–70. doi: 10.1177/0305735612456583

Jenkins, H. (2004) Game design as narrative architecture. *Computer 44*(3), pp. 118–130

Joyce, M. (1991) *Afternoon, a Story*. [Interactive fiction] Watertown: Eastgate Systems.

Karr, A. (2013). Colour and user experience. ACM Interactions, Retrieved from http://interactions.acm.org/blog/view/color-and-user- experience

Khalighy, S. *et al*. (2014) 'Measuring Aesthetic in Design', Proceedings of the DESIGN 2014 13th International Design Conference, pp. 2083–2094. Available at: https://www.designsociety.org/publication/35349/MEASURING+AESTHETIC+IN+DESIGN (Accessed: 15 April 2022)

Kilteni, K., Groten, R. and Slater, M. (2012) 'The Sense of Embodiment in virtual reality', *Presence: Teleoperators and Virtual Environments*. doi: 10.1162/PRES_a_00124

Kinoautomat (1967) Directed by Radús Činčera. Montreal, Quebec, Canada. Expo 67

Kirkpatrick, G. (2007) 'Between Art and Gameness: Critical Theory and Computer Game Aesthetics', *Thesis Eleven*, 89(1), pp. 74–93.doi: 10.1177/0725513607076134

Knobloch, S. *et al.* (2004) 'Affective news: Effects of discourse structure in narratives on suspense, curiosity, and enjoyment while reading news and novels', *Communication Research*, 31(3). doi: 10.1177/0093650203261517

Koenitz, H. *et al.* (2018) 'The Myth of `Universal' Narrative Models', in Rouse, R., Koenitz, H., and Haahr, M. (eds) *Interactive Storytelling*. Cham: Springer International Publishing, pp. 107–120

Koenitz, H. *et al.* (2015) *Interactive digital narrative: history, theory, and practice*, *Routledge Studies in European Communication Research and Education*

Kotlarek, J., Lin, I. C. and Ma, K. L. (2018) 'Improving spatial orientation in immersive environments', *SUI 2018 - Proceedings of the Symposium on Spatial User Interaction*. Association for Computing Machinery, Inc, pp. 79–88. doi: 10.1145/3267782.3267792

Kuijpers, M. M. *et al.* (2014) 'Exploring absorbing reading experiences', *Scientific Study of Literature*. John Benjamins Publishing Company, 4(1), pp. 89–122. doi: 10.1075/SSOL.4.1.05KUI

Laszlo, J. (1994) 'The Landscape of Time in Literary Reception: Character Experience and Narrative Action', *Cognition and Emotion*, 8(4). doi: 10.1080/02699939408408943

Lee, E. and Leets, L. (2004) 'Persuasive Storytelling by Hate Groups Online: Examining Its Effects on Adolescents', *American Behavioural Scientist*, 45(6), pp. 927–957. doi: 10.1177/000276420204500602

Loewenstein, G. (1994) 'The Psychology of Curiosity: A Review and Reinterpretation', *Psychological Bulletin*, 116(1). doi: 10.1037//0033-2909.116.1.75

Lucas Arts (1999-2010) *Monkey Island*. [Video game] Lucas Arts.

Malhotra N. K. and Dash S. (2011). Marketing Research an Applied Orientation. London: Pearson Publishing.

Mark, J. J. (2018) *Gilgamesh*, *World History Encyclopaedia*. Available at: https://www.worldhistory.org/gilgamesh/ (Accessed: 16 December 2022)

Mateer, J. (2017). Directing for cinematic virtual reality: How the traditional film director's craft applies to immersive environments and notions of presence. Journal of Media Practice, 18(1), 14–25.

McCrae, R. R., Gaines, J. F. and Wellington, M. A. (2012) 'The Five-Factor Model in Fact and Fiction', in *Handbook of Psychology, Second Edition*. doi: 10.1002/9781118133880.hop205004

McAuley, E. D., Duncan, T. and Tammen, V. V. (1987) 'Psychometric Properties of the Intrinsic Motivation Inventory in a Competitive Sport Setting: A Confirmatory Factor Analysis', *https://doi.org/10.1080/02701367.1989.10607413*. Taylor & Francis Group, 60(1), pp. 48–58. doi: 10.1080/02701367.1989.10607413.

Mendosa, M. (2015) 'The Evolution of Storytelling', *Reporter*. Available at: https://reporter.rit.edu/tech/evolution-storytelling (Accessed: 14 July 2023).

Miller, C. H. (2020) *Digital Storytelling: A creator's guide to interactive entertainment*. Fourth. Boca Raton: CRC Press

Naimark, M. (1998) Interactive art—Maybe it's a bad idea. In: Leopoldseder, H., and Schšpf, C. (eds.) *Cyber Arts 1998 International Compendium Prix. Ars Electronica*. Berlin, Heidelberg: Springer.

Naylor, F. D. (1981) 'A State-Trait Curiosity Inventory', *Australian Psychologist*, 16(2), pp. 172–183. doi: 10.1080/00050068108255893

Naughty Dog (2013) *The Last of Us*. [Video game] Sony Computer Entertainment.

Netflix (2018) *Black Mirror: Bandersnatch*. [Interactive Film] Netflix

Nielsen, L. T. *et al.* (2016) 'Missing the point: An exploration of how to guide users' attention during cinematic virtual reality', in *Proceedings of the ACM Symposium on Virtual Reality Software and Technology, VRST*. doi: 10.1145/2993369.2993405

Pentak, S. and Lauer, D. A. (2015) *Design Basics*. Nineth. Cengage Learning EMEA. pp. 27-288

Propp, V. J. (1928) *Morfologija Skaski*. Leningrad: Academia

Pruitt, S. (2014) *The Lumière Brothers, Pioneers of Cinema*, *History*. Available at: https://www.history.com/news/the-lumiere-brothers-pioneers-of-cinema (Accessed: 16 December 2022).

Richard, G. *et al.* (2021) 'Studying the Role of Haptic Feedback on Virtual Embodiment in a Drawing Task', *Frontiers in Virtual Reality*. Frontiers Media S.A., 1. doi: 10.3389/FRVIR.2020.573167.

Richardson, D. C. *et al.* (2018) 'Measuring narrative engagement: The heart tells the story', *bioRxiv*. doi: 10.1101/351148

Riedl, M. O. and Bulitko, V. (2013) 'Interactive narrative: An intelligent systems approach', in *AI Magazine*. doi: 10.1609/aimag.v34i1.2449

Roth, C. (2016). Experiencing Interactive Storytelling. PhD Thesis. Vrije Universiteit Amsterdam. Online: https://research.vu.nl/en/publications/experiencing-interactive-storytelling

Rowold, J. (2008) 'Instrument Development for Esthetic Perception Assessment', *Journal of Media Psychology*. Taylor & Francis Group, 20(1). doi: 10.1027/1864-1105.20.1.35

Ryan, M. L. (2002) 'Beyond myth and metaphor: Narrative in digital media', *Poetics Today*, 23(4), pp. 595–596. doi: 10.1215/03335372-23-4-581

Ryan, M. L. (2009) 'From Narrative Games to Playable Stories: Toward a Poetics of Interactive Narrative', *StoryWorlds: A Journal of Narrative Studies*, (1) 43-59. doi: 10.1353/stw.0.0003.

Ryan, M. L. (2015) *Narrative as Virtual Reality 2*, *Narrative as Virtual Reality 2*. doi: 10.1353/book.72246.

Ryan, R. M. and Deci, E. L. (2000) 'Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being', *American Psychologist*. American Psychological Association Inc., 55(1), pp. 68–78. doi: 10.1037/0003-066X.55.1.68

Sak, P. (2018) 'How Stories Change the Brain | Greater Good', *The Greater Good Website*, pp. 1–7. Available at: https://greatergood.berkeley.edu/article/item/how_stories_change_brain (Accessed: 10 February 2021)

Satorra, A., and Bentler, P.M. (2010). Ensuring positiveness of the scaled difference chi-square test statistic. Psychometrika, 75, 243-248.

Schoenau-Fog, H. (2011) 'Hooked! -- Evaluating Engagement as Continuation Desire in Interactive Narratives', in Si, M. *et al*. (eds) *Interactive Storytelling*. Berlin, Heidelberg: Springer Berlin Heidelberg, pp. 219–230

Schoenau-Fog, H. and Henrik, S.-F. (2011) 'The Player Engagement Process – An Exploration of Continuation Desire in Digital Games', *DiGRA 2011 Conference: Think Design Play.*, 6.

Schubert, T., Friedmann, F. and Regenbrecht, H. (2001) 'The experience of presence: Factor analytic insights', *Presence: Teleoperators and Virtual Environments*, 10(3). doi: 10.1162/105474601300343603.

Schwind, V. *et al.* (2019) 'Using presence questionnaires in virtual reality', in *Conference on Human Factors in Computing Systems - Proceedings*. doi: 10.1145/3290605.3300590.

Schindler, I. *et al.* (2017) 'Measuring aesthetic emotions: A review of the literature and a new assessment tool', *PLoS ONE*. Public Library of Science, 12(6). doi: 10.1371/JOURNAL.PONE.0178899.

Slater, M., Usoh, M. and Steed, A. (1994) 'Depth of Presence in Virtual Environments', *Presence: Teleoperators and Virtual Environments*, 3(2). doi: 10.1162/pres.1994.3.2.130.

Sloboda, J. A. and Juslin, P. N. (2001) 'Psychological Perspectives on Music and Emotion', *Music and emotion: Theory and research*, pp. 77–104

Spielberger, C. D. *et al.* (1979) 'Preliminary manual for the state-trait personality inventory (STPI)', *Unpublished manuscript University of South Florida Tampa*

Spielberger, C. D., Peters, R. A. and Frain, F. S. (1981) 'Curiosity and anxiety', in *Curiosity research: Basic concepts and results*

Solarski, C. (2017) *Interactive Stories and Video Game Art*. First. Boca Raton: CRC Press. pp. 13-16

Strange, J. J. and Leung, C. C. (2016) 'How Anecdotal Accounts in News and in Fiction Can Influence Judgments of a Social Problem's Urgency, Causes, and Cures', *Personality and Social Psychology Bulletin*, 25(4), pp. 436–449. doi: 10.1177/0146167299025004004

Storr, W. (2019) *The Science of Storytelling*. London, UK: William Collins.

Sweetser, P. and Wyeth, P. (2005) 'GameFlow: a model for evaluating player enjoyment in games', *Computers in Entertainment (CIE)*, 3(3). doi: 10.1145/1077246.1077253

Tavakol, M. and Dennick, R. (2011) 'Making sense of Cronbach's α', *International Journal of Medical Education*. IJME, 2, p. 53. doi: 10.5116/IJME.4DFB.8DFD

To, A. *et al.* (2016) 'Integrating Curiosity and Uncertainty in Game Design', *Proceedings of 1st International Joint Conference of DiGRA and FDG*, pp. 1–16

Västfjäll, D. (2001) 'Emotion induction through music: A review of the musical mood induction procedure', *Musicae Scientiae*. SAGE Publications, 5(1_suppl), pp. 173–211. doi: 10.1177/10298649020050S107

Vorderer, P., Klimmt, C. and Ritterfeld, U. (2004) 'Enjoyment: At the heart of media entertainment', *Communication Theory*, 14(4). doi: 10.1111/j.1468-2885.2004.tb00321.x

Vorderer, P. *et al.* (2004) *MEC spatial presence questionnaire (MEC-SPQ)*. Available at: https://www.researchgate.net/publication/318531435_MEC_spatial_presence_questionnaire_MEC-SPQ_Short_documentation_and_instructions_for_application (Accessed: 16 April 2022).

Wang, D. *et al.* (2019) 'Haptic display for virtual reality: progress and challenges', *Virtual Reality and Intelligent Hardware*. KeAi Communications Co., 1(2), pp. 136–162. doi: 10.3724/SP.J.2096-5796.2019.0008.

Weiberg, B. (2002) *Beyond Interactive Cinema*. Available at: http://keyframe.org/txt/interact/

Weisenbaum, J. (1966) ELISA—A computer program for the study of natural language communication between man and machine. *Communications of the ACM*. 9(1). pp. 36–45.

Wilms, L. and Oberfeld, D. (2018) 'Color and emotion: effects of hue, saturation, and brightness', *Psychological Research*. Springer Verlag, 82(5), pp. 896–914. doi: 10.1007/S00426-017-0880-8.

Witmer, B. G., Jerome, C. J. and Singer, M. J. (2005) 'The factor structure of the Presence Questionnaire', *Presence: Teleoperators and Virtual Environments*. doi: 10.1162/105474605323384654.

Wolfe, A., Louchart, S. and Loranger, B. (2022) 'The Impacts of Design Elements in Interactive Storytelling in VR on Emotion, Mood, and Self-reflection'. *ICIDS 2022.* Springer Science and Business Media Deutschland GmbH, 13762 LNCS, pp. 616–633. doi: 10.1007/978-3-031-22298-6_40.