A Discussion of Immersion in Human Computer Interaction: The Immersion Model of User Experience

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ABSTRACT

This document is a discussion of *Immersion* in *Human-Computer Interaction* which has been developed from observing and recording the experiences of participant's in studies exploring the use of, and engagement with, technology.

Within this Thesis, I present a model of *User-Experience* derived from my research which is termed the *Immersion Model of User-Experience*. I then explore how this model can be used to identify and foster the optimal form of *User-Experience* known as *Flow*. In addition, this Thesis includes an exploration of the prominent literature in *Immersion* and *Flow,* as well presenting a series of studies that were used to draw the conclusions of the Thesis.

Starting with an exploration of the topic of *Immersion* in *Human Computer Interaction,* I examine the common terms, descriptions and uses of *Immersion* across a variety of fields. I use this body of work to provide background and understanding to what it means to be immersed in activities. I then discuss how *Flow* experience can be identified as the optimal experience in an activity. I then present how this can be mapped to *User-Experience* by presenting the *Immersion Model of User-Experience*. In detail of this model I explore how different elements of an experience change the type of experience an individual has when engaged in an activity. Finally, I discuss how an antithesis to *Flow* can occur, the pessimal experience known as *Boredom*.

DEDICATION

In loving memory of Margaret Nixon (1924 – 2007)

All that I have achieved in my time in my post graduate studies is dedicated to the best Nana in the world. I'm glad I was with you at the end and I will never be able to say how much I miss and long to return to the times of being an endlessly loved grandson getting told bed time stories about magic buses.

The times I miss you most are in those brief moments where I forget that you are gone and can't wait to get home to tell you about something. I miss you every day and really wish you could have seen what I've become, the people I've met and the things I've done.

Acknowledgements

"My grandfather once told me that there were two kinds of people: those who do the work and those who take the credit. He told me to try to be in the first group; there was much less competition." – **Indira Ghandi**

Contributions to the thesis

Parts of this Thesis are composed from bodies of work performed in conjunction with other researchers. Below is a description of the contributions or roles of everyone involved, ordered surname alphabetically for each chapter.

Chapter 6: Study of gesture based interaction

John Dawson: Lead interviewer with participants during study-arrival and discharge. Primary investigator in the review and coding of recorded video of trials, additional investigator for conducting participant video trials.

Dr. Christian Kray: Study supervisor. Creator of basic annotation used in video coding. Team lead in statistical analysis and graphical presentation of photographic and statistical data.

Daniel Nesbitt: Lead investigator when performing video-trials, additional investigator in review and coding of recorded video trials.

Michael Rhos: Additional creator of basic annotation used for video coding and statistical analysis of participant questionnaires.

CHAPTER 7: STUDY OF SEVEN STORIES MUSEUM

Rachel Clarke: Lead investigator for recorded observations during facilitated and non-facilitated tours of the Seven Stories museum. Authorized photographer of museum gallery, lead interviewer during staff and public interviews.

John Dawson: Investigator of facilitated and non-facilitated sessions, second interviewer during staff interviews.

Dr. Areti Galani: Study supervisor and Newcastle University liaison with Seven Stories management staff.

Dr. Christian Kray: Responsible for design and planning of observation study.

John Shearer: Lead technical design, installation and support of hardware and software.

MESSAGE FROM THE AUTHOR

I would like to thank Dr. Christian Kray, formerly of Newcastle University. Currently with the Institute of Geoinformatics, University of Münster. Without his work ethic and, dare I say, stereotypical German approach; I would probably still be lost in the student lifestyle. It was he whom saw my potential and offered me this wonderful opportunity following a successful dissertation with him as my supervisor during my MSc degree.

Though our styles varied greatly, without his help I doubt that any of this would have been possible. Of note, allowing me to help organize, develop and take lead in (the exhaustingly time consuming I might add!), analysis of the hours of video footage for the gestures study was probably the turning point for me. I had never held any real responsibility until that point and for that I personally thank him.

In addition, to say my road to completing my post-graduate studies has been smooth would be thoroughly dishonest. Along the way, I was unfortunate to lose Dr. Kray as my supervisor, leading to a tumultuous period that could not have been negotiated as well as it was without the help of the academic team at Newcastle University. I'd like to pay special note to the massive contributions from Dr. Peter Andras, now at the School of Computing and Mathematics, Keele University. It was he who contributed and collaborated greatly in the various discussions and direction of the thesis towards the topic of immersion. I am most grateful for his willingness, patience, as well as ability to accommodate me as an additional research student on such short notice.

However, my rough academic endeavour did not end there, as Dr. Andras and I were forced to depart company less than a year later as he moved onward in his career. With his departure, I was very close to just giving up and admitting defeat. I had no supervisor, no guidance and no motivation to continue onward and thoroughly felt defeated. Therefore, it is with eternal gratitude and thanks, that I praise Dr. Phillip Lord and David Kirk of Newcastle University. Not only did they both pick up my development at such a late stage, but provided

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I've also been very lucky to have the love and support of an incredible set of friends. I'm sure on more than one occasion I lost the plot and my temper - yet they have stood by me in thick and thin. I am very appreciative of the trans-continental friendship of Alex Charnaud whose internet conferencing with an eight-hour time difference was certainly difficult to arrange, but key to maintaining my sanity. Also of mention is the stoic nature of Andrew Sinclair. University friend, housemate and I dare say surrogate brother. Your travels continue to be the cause of envy and the mysteries of your adventures known only to you. Credit also goes to Joseph Dowland and Tracy Zeng; a pair of truly unique individuals. I cannot ask for better people to meet in an introductory programming class in a master's degree so many years ago.

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During my time as a PhD student, I have been given opportunities and experiences I would never have thought possible. I give special mention to Jamie Allen who gave me the opportunity to work alongside the Culture Lab on the BBC Big-Screen project in Middlesbrough. I would further like to thank Dr. Aretti Galani for the opportunities engineered alongside Rachel Clarke in the Seven Stories museum, as well as her tutoring and guidance in going about learning the core skills of ethnography.

I would also like to acknowledge the massive contributions from my family. You have given me everything you could so that I have the best path to the opportunities of the world. I think now it's finally time I went down it. Words cannot describe my gratitude for putting up with my tantrums, my many despotic demands and for you always just being a phone call away.

Finally, the traditional courtesy goes out to those who fall into the list too long to mention in this section. Endless thanks go out to the various people I met in network events, my studies and especially online forums. To those I met playing games who provided insight and opinions on subjects far and wide well into the late hours of the morning. Under appreciated and undervalued, I hope your dreams come true. To the technical teams who assisted in setting up various activities, and especially to those who helped take them apart. Additional acknowledgements are made to the resources and expertise provided by the Newcastle University Culture Lab. I also wish to give special mention to all the Reception Staff, even though on more than one occasion red-tape has provided a source of headache, thanks for working diligently through faceless emails. To those at the Ministry of Defence who patiently waited as I sat in silence wearing headphones seemingly grumpy that a paragraph wasn't writing itself. Finally to every Ratty Pat that joined me on this ride and went to the Rainbow Bridge. I love you and I miss you forever and always.

It has been a long road, I have tested friendships, forged respect and have seen my world go from dizzy heights to pitfall lows. It has been a trek, a marathon, a sprint and a tough mudder rolled into one. Thank you everyone who's joined me along the way.

TABLE OF CONTENTS

Abstract I

Dedication II

Acknowledgements III

Contributions to the thesis III

Chapter 6: Study of gesture based interaction III

Chapter 7: Study of seven stories museum IV

Message from the author V

Table of contents VIII

List of tables and figures XIII

Figures XIII

Tables XV

Glossary of terms XVI

Chapter 1: Thesis background & motivation 1

1.0 Chapter overview 1

1.1 Background to the research – motivation 1

1.2 Development of the research 3

1.3 The immersion model of user experience 5

1.4 Aims and value of the research 6

1.5 Structure of the thesis 7

1.6 Chapter summary 8

Chapter 2: Immersion 9

2.0 Chapter overview 9

2.1 Common views of immersion 9

2.2 The value of immersion 11

2.3 Immersion in HCI and UX 14

2.4 Experiencing immersion 15

2.4.1 Deepening immersion 17

2.4.2 Diminishing immersion 18

2.4.3 Breaking immersion 19

2.5 Methods of quantifying immersion 21
2.6 Uses of immersion 22
2.6.1 Immersion & virtual environments 22
2.6.2 Presence and immersion 23
2.6.3 Presence as embodiment in virtual environments 24
2.6.4 Key points of virtual environments and presence 28
2.7 Immersion in art, theatre and political ideology 29
2.7.1 Immersion in art 29
2.7.2 Immersion in theatre 31
2.7.3 Immersion in political ideology 33
2.7.4 Discussion of Immersion in art, theatre and political ideology 35
2.7.5 Key points of Immersion in art, theatre and ideology 36
2.8 Chapter summary 37
Chapter 3: The Immersion Model 38
3.0 Chapter overview 38
3.1 The immersion model of user experience 38
3.2 Using the immersion model 40
3.3 Activity spaces 42
3.4 Negative features of an experience: frustration, disengagement and anxiety 43
3.5 Positive features of an experience: absorption, embodiment and enjoyment 44
3.6 Beyond the activity space, boredom and flow 46
3.7 Chapter summary 46
Chapter 4: Common experiences, Pessimal Experience and Optimal Experience in Activities 48
4.0 Chapter overview 48
4.1 The neutral state and common experiences 48
4.2 A Discussion of boredom 52
4.2.1 Experiencing boredom 52
4.2.2 Negative effects of experiencing boredom 53
4.2.3 Limiting occurrences boredom 53
4.2.4 Summary of boredom 56
4.3 A discussion of flow 56
4.3.1 Experiencing flow 58
4.3.2 The value of experiencing flow 61
4.3.3 Flow and user experience 62
4.3.4 Fostering flow 63

4.3.5 Summary of flow 65
4.4 Chapter summary 65
Chapter 5: Literature Review 67
5.0 Chapter overview 67
5.1 Literature relating to Human-Computer Interaction and User Experience 67
5.1.1 Literature regarding gestures 68
5.1.2 Gestures as an interaction tool 68
5.1.3 Examples of gesture based systems 69
5.1.4 Key points of gestures 78
5.2 Discussion of literature of embodiment in HCI 79
5.2 Discussion of literature regarding attention and space 86
5.3 Chapter summary 91
Chapter 6: Study 1 - Gestures as an interaction method 92
6.0 Chapter overview 92
6.1 Outcomes and discussion 92
6.2 Background of the study 94
6.2.1 Importance of existing none-gesture based connectivity in mobile phones 96
6.3 Study design 96
6.3.1 Participant recruitment and information 96
6.3.2 Apparatus and material 97
6.3.3 Procedure 98
6.4 Overview of results 100
6.4.1 Gesture analysis method 101
6.4.2 Basic annotation 104
6.4.3 Observations and example gestures 105
6.4.4 Participant feedback 111
6.5 Implications of using gestures for interactions 114
6.5.1 Implications for user interfaces 116
6.6 Application of the study in the immersion model 118
6.7 Conclusion and future direction 119
Chapter 7. Study 2 - User interaction with an interactive museum exhibition 122
7.0 Chapter overview 122
7.1 Outcomes and discussion 123
7.2 Background of the study 125
7.3 System design 126

7.3.1 Participant information 127
7.3.2 Apparatus and material 127
7.3.3 Video resources 129
7.3.4 Completed installation 130
7.3.5 Ethnographic study 135
7.3.6 Written observations 135
7.3.7 Unstructured interviews with staff members 137
7.3.8 Unstructured interviews with visitor groups 138
7.3.9 Overview of results 139
7.3.10 Observations of facilitated sessions 141
7.4.11 Unstructured interviews with staff and facilitators 142
7.3.12 Unstructured interviews with families 143
7.4 Application of the study in the immersion model 144
7.5 Conclusion and future direction 145
Chapter 8. Study 3 - User Experience in Videogame Playing 150
8.0 Chapter overview 150
8.1 Outcomes and discussion 151
8.2 Background of the study 152
8.2.1 Flow and boredom 152
8.2.2 Motivation of the study 154
8.3 Study design 155
8.3.1 Written observations 155
8.3.2 Video annotation 157
8.3.3 Unstructured interviews with Participants 158
8.3.4 Questionnaires 159
8.3.5 Participant recruitment and information 159
8.3.6 Apparatus and material 160
8.3.7 Overview of games 162
8.3.8 Candy Crush 162
8.3.9 Quake 163
8.3.10 Super Mario Crossover 164
8.3.11 Winnie the Pooh's Home Run Derby 166
8.3.12 Tangram Puzzle 167
8.3.13 Procedure 168
8.4 Overview of results 170

8.4.1 Written observations from video review 170
8.4.2 Participant interviews 174
8.4.3 Post game questionnaires 176
8.5 Application of the study in the immersion model 189
8.6 Conclusion and future direction 191
Chapter 9. General Discussion 194
9.0 Summary of findings 194
9.1 Limitations and future direction 196
9.2 Final words 199
Appendices 200
Appendix A. Gesture study information sheet and initial questionnaire 200
Appendix B. Gesture study final questionnaire 204
Appendix C. Basic video annotation schema for gesture study 207
Appendix D. Gesture study consent form and initial questionnaire 209
Appendix E. Post-game-play immersion review questionnaire 216
References 224

LIST OF TABLES AND FIGURES

FIGURES

Figure 1: The Immersion Model of User Experience.....6

Figure 2: The Immersion Model of User Experience.....39

Figure 3: Boredom on the Immersion Model of User Experience.....54

Figure 4: Mental States of Flow.....57

Figure 5: Flow on the Immersion Model of User Experience.....63

Figure 6: Visual example of Hyper Dragging.....71

Figure 7: Scoop and Spread.....73

Figure 8: Example of the NFC mesh of Touch Interact.....74

Figure 9: Example of interactions between devices in Stitching.....74

Figure 10: Touch and Interact sequence.....75

Figure 11: Bumping (a) and Tiling (b) content between devices.....75

Figure 12: Reaction Spaces in Proxemics.....88

Figure 13: Reaction Spaces as Concentration Zones.....89

Figure 14: Gesture Study apparatus setup.....98

Figure 15: Activities participants asked to generate (order of exposure randomised) 104

Figure 16: Results of basic annotation (%).....105

Figure 17: Example Gestures.....110

Figure 18: Responses to final questionnaire.....111

Figure 19: Most commonly reported feedback.....117

Figure 20: Borrowers exhibit layout.....129

Figure 21: Collated vignette shots.....130

Figure 22: Exhibit entrance information.....131

Figure 23: Reception Space.....131

Figure 24: Gallery perspective.....132
Figure 25: Borrower Entrance and investigator seating.....132
Figure 26: Additional apparatus in Borrowers space.....133
Figure 27: Example Interaction.....133
Figure 28: Collation of all vignette locations.....134
Figure 29: Example quality of vignette projection.....134
Figure 30: Example public observation.....137
Figure 31: Example facilitated observation.....137
Figure 32: Example of written observation in video game study.....156
Figure 33: Annotation schema used in video observations.....157
Figure 34: Video annotation example.....158
Figure 35: Apparatus set-up.....161
Figure 36: Candy Crush screenshot.....163
Figure 37: Quake screenshot.....164
Figure 38: Super Mario Crossover screenshot.....165
Figure 39: Winnie the Pooh's Home Run Derby screenshot.....166
Figure 40: Tangram puzzle screenshot.....167
Figure 41: Example of verbal frustration and aggression.....171
Figure 42: Example of physical disengagement.....171
Figure 43: Broken attention.....171
Figure 44: Enjoyment shown in smiling at screen.....172
Figure 45: Example of increased concentration.....172
Figure 46: Example of moving in to concentrate.....173
Figure 47: Broken concentration by looking at controls.....174
Figure 48: Broken concentration by turning to the investigator in protest after hitting the controls.....174
Figure 49: Reported participant immersion across game A and game B.....177
Figure 50: Estimated vs. actual time game A.....179
Figure 51: Estimated vs. actual time game B.....180

Figure 52: Correlation between reported immersion and awareness of controls game A.....181

Figure 53: Correlation between reported immersion and awareness of controls game B.....182

Figure 54: Correlation between reported immersion and awareness of environment game A.....183

Figure 55: Correlation between reported immersion and awareness of environment game B.....184

Figure 56: Correlation between reported enjoyment and desire to play longer game A.....185

Figure 57: Correlation between reported enjoyment and levels of immersion game A.....185

Figure 58: Correlation between desire to play longer and levels of immersion game A.....186

Figure 59: Correlation between reported enjoyment and desire to play longer game B.....187

Figure 60: Correlation between reported enjoyment and levels of immersion game B.....188

Figure 61: Correlation between desire to play longer and levels of immersion game A.....189

Figure 62: Initial framework of the immersion model.....190

TABLES

Table 1: Game Choice.....162

GLOSSARY OF TERMS

Throughout this thesis several terms are repeated. Below is a list of common terms and their meanings alphabetically.

Absorption: The feeling of focus and engagement with an activity. Higher levels of absorption represent greater levels of cognitive investment and emotional/physical engagement with an activity. It is developed as an individual experiences progress and reward in an activity space, and occurs as challenges and objectives by the individual are completed.

Activity: An event or action you can participate in.

Activity Space: The cognitive and physical space that an activity occurs in. For example, museums exhibitions occupy a real space you interact with in the museum. Whereas playing video-games the activity space consists of the individual, artefacts such as controllers as well as the virtual world and spaces presented to the player.

Anxiety: Anxiety is the feeling of nervousness caused by uncertainty or the desire for something to happen or occur. It can be considered as the sense of loss of control an individual feels they have over an activity. Greater levels of anxiety relate to greater loss of control and sense of control over an activity.

Boredom: The pessimal experience an individual can have in an activity. The state of Boredom is an undesirable state that is emotionally, cognitively and physically unhealthy for the individual. It is a state where anxiety, frustration and disengagement are at their peak.

Engagement: When you devote part of your cognitive and physical resources to an activity you become engaged in that activity. Engagement is marked by concentration and focus that can lead towards high levels of embodiment and absorption. Engagement can be conscious or unconscious. Conscious engagement is when you actively seek to focus and concentrate on the task at hand. Unconscious engagement is when cognitive resources are unintentionally focused onto a task or activity.

Enjoyment: Enjoyment is the process of taking pleasure from actions and achieving progress in the activity space. It is developed when individuals can experience reward and progression in an activity. Increasing levels of enjoyment represent that challenges are appropriate for the individual, in the sense that they cause an investment of cognitive and physical resources to increase and be overcome, but are within the capabilities of the individual to do so.

Embodiment: The interest in the range of ways in which people engage and experience the world. I consider embodiment in activities as the physical movement of the body, and the engagement of the human cognitive capacities and senses, that are the most relevant to the activity space. Embodiment is the process of making gestures, actions and using artefacts of an activity feel like natural extensions of the body, as well as representing a sense of control and mastery over an activity. It is the idea that gestures, actions and artefacts feel like they are a natural part of the individual.

Frustration: Frustration is the feeling of being upset or annoyed that results from being unable to achieve or fulfill goals in an activity. It is developed when an individual, through their actions, is unable to experience progress in an activity space. It is caused when challenges are too difficult to overcome, cause a sense of wasted cognitive and physical investment causing activities to cease.

Flow: The optimal form of experience an individual can have in an activity. Flow is when absorption promotes continued engagement, concentration and focus into an activity for positive emotional reward.

Gesture: Refers to the use of the natural movements of the limbs and body to express an idea or an intention. Using gestures can be considered a natural method of interaction on the grounds that gesturing is taught from an early age, have commonalities across culture and social boundaries, and do not require specialist equipment or technologies to teach.

Human-Computer Interaction (HCI): A field of Computing Science concerned with the design, evaluation and implementation of interactive computer systems. HCI is a broad, multi-disciplinary field of study. For this Thesis, I emphasize the focus of HCI as making complex computing systems easier to use and more functional for non-professional or technical users.

Immersion: The experience when a person is engaged in activity. Immersion is the spending of cognitive and physical resources into the activity space.

Neutral State: A physical and cognitive state where the individual is neither fully engaged nor disengaged with the world or activity around them.

Presence: The feeling of being a part of and being in a virtual environment. I consider presence to be embodiment in virtual environments.

Virtual Environment (VE): The virtual space or worlds created in a piece of work such as art, film, video games and virtual reality systems that an individual can interact with.

User Experience (UX): For this Thesis, I assume User Experience in a wider context than usability and efficiency of a product or system to fulfil user needs and desires. Instead User Experience is a broad term covering behaviour, attitudes and emotional responses to an activity, product or system by an individual. Positive user experiences are related to positive emotions such as enjoyment and happiness, as well as positive physical behaviour (such as smiling and laughing); as well as mental wellbeing (a sense of feeling good about oneself and actions). Negative user experiences are related to negative emotions such as frustration and

anxiety, as well as negative physical behaviour (shouting, aggressive motions) and mental negativity (disappointment about oneself and actions).

CHAPTER 1: THESIS BACKGROUND & MOTIVATION

1.0 CHAPTER OVERVIEW

This introduction chapter serves to explore the core objectives of the research, specifically the background and motivations of the research. This is then followed by a brief introduction into the core questions the research has been developed to address. The aims and value of the research are then introduced. The chapter ends with a review of the structure and content of the Thesis.

1.1 BACKGROUND TO THE RESEARCH – MOTIVATION

An expanding element of the *Human-Computer Interaction (HCI)* domain of Computing Science, as well as its related research fields, has been focused on finding and creating the optimal form of *User-Experience (UX)* with a system or technology. This has been marked by a reduced emphasis on the efficiency, functionality and complexity of a computer or system to fulfil a specific task; towards an emphasis on designing a system or technology to affect a person's emotions and attitudes about using a product, system or service.

Contemporary design of new technologies has therefore focused on developing and including elements that encourage an ‘experience’ of cognitive, emotional and physical interactions for the user to have when engaging with computers, technologies and their associated digital artefact's (McCarthy and Wright, 2004).

In search of understanding and crafting successful UX with technology, various aspects of human cognitive, emotional and physical experiences have been explored. Examples such as *Aesthetics* (Overbeeke, Hummels, Wensveenm Frens & Ross, 2010; Petersen, Iversen and

Krogh, 2004), *Affections* (Picard, 1997), *Emotions* (Norman, 2003), *Fun* (Blythe, Overbeeke, Monk and Wright, 2003) and *Embodiment* (Dourish, 2001), have all been used to describe, understand and promote various design considerations to influence the UX with a system.

Uniquely, despite this wide exploration of the cognitive and physical dimensions to UX, at present no common method to describe and create specific forms of experience across systems and devices has been developed; with interaction by users frequently viewed as being too heavily varied to easily standardize (Lee, Yeh and Ho, 2002. Garrett, 2010).

Furthermore, an examination of literature into UX shows that user interactions, both physical and cognitive, are frequently performed well beyond the original contexts, functions and designs of the devices and systems. In parallel to this technology is also becoming a pervasive, ubiquitous and personal part of our everyday lives. Traditional artefacts such as letters, personal organizers, calendars, calculators and communications are being replaced or concatenated into digital capabilities. With these condensed into single, powerful and multi-functional mobile devices. From this "technologisation" of every day activity, several industry leaders have emerged such as Apple, Google, Microsoft and Facebook providing both hardware and software to the user, each with their own 'brand' of user experience created through various design principles and branding. The importance of positive UX design therefore not only acts to promote positive use and uptake of competing devices in the market, but also as means of creating and developing product / brand identity.

The success of technologies or systems has therefore become dependent not only on their form and function, but how and what way users can purpose their devices and technologies into their everyday lives. Due to these trends, an understanding of the how and why users interact and favour particular technologies and devices is becoming critical to the success of not only new systems or devices, but the evolution and continuation of legacy devices and products. Questions are raised in regards to the why and how users can become engaged in the use of a particular technology or system. What aspects users find about their favourite computing devices and technologies positive and absorbing. What motivates user interactions to favour an experience or device when fulfilling functions, as well as questions as to why

these experiences are being sought with such intensity that they are being done so at the expense of other life-factors such as meaningful social relationships, as well as emotional and physical health.

1.2 Development of the research

The initial research of this thesis was directed to address the issues and problems raised from the previously mentioned trends and approaches in UX, with the aim to examine how users interact and experience different technologies to uncover what elements make a system or technology enjoyable and engaging for users.

This resulted in an initial research objective to capture and examine a broad range of UX with technologies, in doing so this lead to participation in an academic study, as described in Chapter 6, to investigate UX with interaction methods between devices. This study was aimed at specifically examining the use of gestures as an interaction method, investigating how using gesture-based interaction can be beneficial to UX by making activities involving connecting and interacting with two or more devices easier. Results showed that gestures were not only a beneficial form of interaction, but led to high levels of creative interaction and activity engagement.

Uniquely from this research a pattern emerged in post-study discussions and comments, with participants repeatedly mentioning that they felt ‘immersed’ or ‘absorbed’ by their engagement in the study and the technologies being used. Furthermore, interest into this feedback was created when participants remarked that such experiences were ‘normal’ for them when using their favoured or preferred technologies at home or work, or engaging in activities that they enjoyed. In contrast, participants also frequently remarked that had they not experienced such feelings during use or by engaging with the activities in the study, they would not have reported such high levels of enjoyment.

An additional study was developed to support this line of enquiry. This study, as described in Chapter 7, was an ethnographic observation of user interaction and experiences with a digitally enhanced museum exhibition. The aim of the study was to examine how interactions with a digital content system had on the UX of those visiting the gallery. Analysis of participant feedback from the study revealed that enjoyment, engagement and interaction were enhanced and influenced by the introduction of technology. What was evident from observations and interviews performed during this study was that similar reports that using technology was, again, an 'immersive' and 'absorbing' experience for those involved.

Following a review of the findings of this study, I began formulating initial questions regarding the direction of research into *Immersion*. Specifically;

- What is immersion?
- Why is it desirable?
- How do we encourage users to become immersed?

Considering these questions a third study was conducted. As described in Chapter 8, this study was an examination of UX in video-game playing, with the aim to explore what elements of a gaming experience help create or break the experience of *Immersion*. During review of the results of this study, it was discovered that different features encountered during an experience help shape and determine the type of experience a participant had. Participants who reported having a positive experience provided feedback that was focused on the design considerations (such as control methods), appearance (graphics and sounds) and enjoyable interactions (a sense of reward and accomplishment) that came from playing games. Comparatively, participants who reported having a negative experience reported that a range of different elements detracted from them enjoying the experience to its full potential. Specifically, this feedback included issues such as awkward interaction methods (poor controls), environmental distractions (noises, temperature) and the development of negative emotions such as *Boredom* and *Frustration* through repeated failure to progress.

In a review of these findings, I was also able to refine possible answers to the *Immersion* questions. Here I determined that *Immersion* is somehow a desirable experience that is part of

an ever-changing spectrum of cognitive and emotional UX during an activity. From this I discovered that when individuals are not engaged in activities, they reside in a cognitively and emotional *Neutral State*, where they are neither heavily engaged nor deeply distracted with the world or activities around them. I was then able to determine that individuals who desire to experience different emotional and cognitive states do so by investing and engaging their cognitive and physical energies into different activities. The aim of this engagement is to have a positive experience from the activity that rewards the individual, emotionally or physically, for their efforts; with the most rewarding experiences being those where the individual can experience an optimal experience known as *Flow*. Conversely, the most negative experiences are those which lead to experiencing a pessimal experience known as *Boredom*.

In research of what features of an experience caused *Flow* or *Boredom,* I discovered that a range of different factors, some positive, some negative, can be used to help identify and characterise a range of other types of experiences an individual can have when taking part in an activity. Collating all these findings I was then able to map them to a model that could be used to help determine what kind of experience an activity provides. I term this the *Immersion Model of User Experience*.

1.3 THE IMMERSION MODEL OF USER EXPERIENCE

For this Thesis, I present a model UX known as the *Immersion Model of User Experience*. This model is a means to evaluate different UX's by showing how a variety of different experience elements combine and create different types of experiences for an individual. I consider the pessimal experience, known as *Boredom*, and an optimal experience, known as *Flow* as the two extremes of experience which can occur from user engagement with activities. The *Immersion Model* and its elements are discussed in greater detail in Chapter 3 and Chapter 4, however to introduce the model, it can be graphically demonstrated as such:

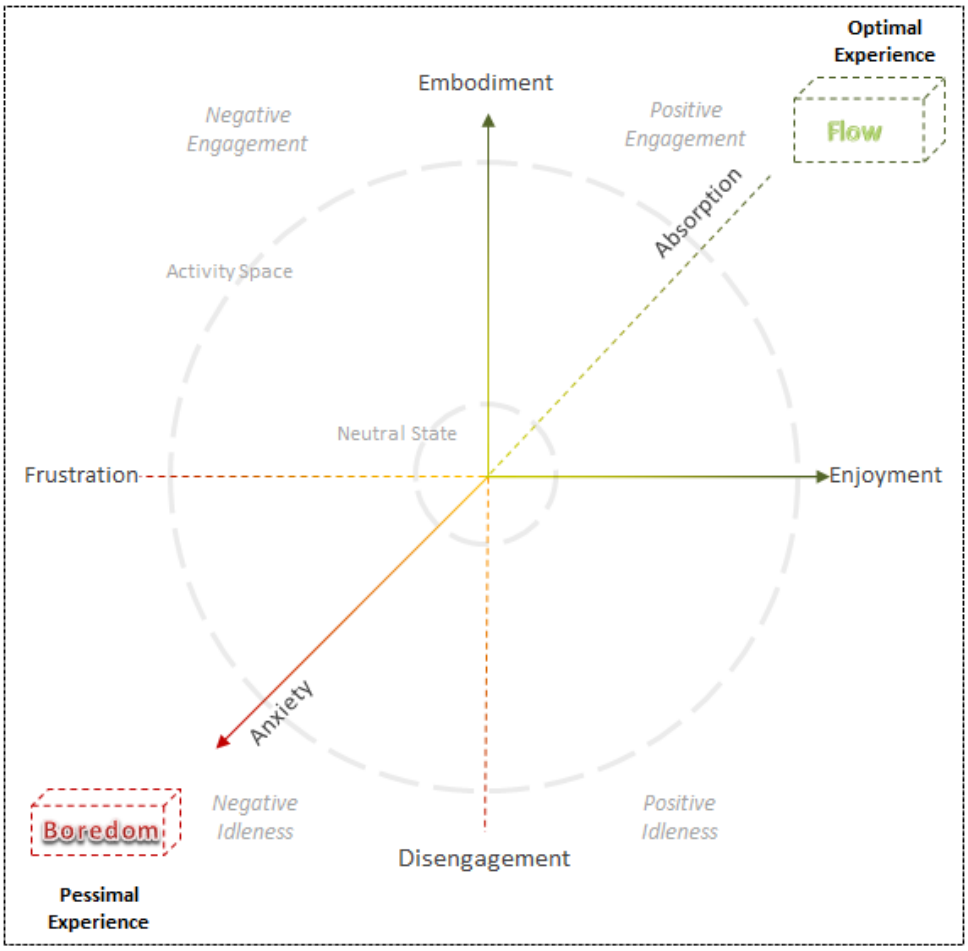


Figure 1: The Immersion Model of User Experience

1.4 Aims and Value of the Research

The aims of the Thesis are to address the questions about *Immersion* and contribute to the research of UX in HCI. In addition, this Thesis is used to introduce and discuss a model of UX, known as the *Immersion Model*. This model has been formed from an examination of a wide range of literature on *Immersion* and UX across a variety of different academic disciplines and fields of research, as well as from the observations and analysis of the various studies performed during the research.

Value of the research comes in its exploration of the topic of *Immersion* and the discussion of *Flow* as the optimal form of UX with different systems and technologies. This Thesis can also be considered as an introduction to the topic of *Immersion* in the context of HCI and UX, with the *Immersion Model of User Experience* an original contribution to the field of HCI. Specifically, for use in the evaluation of UX's with different technologies and activities. Uses

of the model range from helping to identify which elements of an activity inhibit or hamper positive interactions, to being a tool to identify how best to develop *Flow* and avoid *Boredom* in the design and use of new and existing devices.

1.5 STRUCTURE OF THE THESIS

The Thesis is divided into several chapters that each cover a different aspect of the research.

Chapter 1 is used to provide an outline to the motivations, development, aims and value of the Thesis and research that has been performed.

Chapter 2 introduces and discusses *Immersion*. In this chapter I explore the literature sources as well as the uses and meanings of *Immersion* across different activities and its role in creating positive and optimal UX's.

Chapter 3 examines the various elements that make up the Immersion Model of User Experience. In this chapter I discuss what *Activity Space* is, why we seek to engage in different activities, with the various elements that define the kind of experience an individual has.

Chapter 4 discusses four common types of UX. It discusses the pessimal form of UX known as *Boredom* and the optimal experience known as *Flow*. In this chapter I provide an overview and background to these experiences and discuss why it is important to avoid *Boredom* and promote *Flow* in activities.

Chapter 5 is a literature review of the key publications and sources reviewed during the research, providing an overview of the literature used in the creation and development of the studies discussed in chapters 5, 6 and 7.

Chapter 6 is a review of the initial study of UX in using gestures as an interaction method. Here I explore how the findings of this initial study encouraged the further investigation into *Immersion*, as well as how using gestures can serve to embody users in computing activities.

Chapter 7 is a review of the study in using a digital content system to promote interaction within a museum exhibition. This study highlights the influence that *Activity Space* has in encouraging engagement, attention and interest in activities by individuals, as well as how the environment of an activity can foster *Immersion* in participants.

Chapter 8 is a review of a study in video game playing. Here I highlight how different features can encourage or break a user's *Immersion*, as well as how attention is critical in the development and maintenance of *Immersion* in an activity.

In the final chapter of the thesis, Chapter 9, I discuss the limitations of the *Immersion Model of User Experience*, as well as the considerations and future work necessary to develop the research further.

1.6 CHAPTER SUMMARY

This introduction chapter has been used to introduce the background and motivations of the research discussed in this Thesis. It identifies that a growing area of HCI research is focused on UX. It then discusses how observations made during initial studies into UX prompted investigation into *Immersion* and *Flow* experience. The chapter then identified how the body of work of the Thesis provides a starting point for the study of *Immersion* and *Flow* for future research and ends with a summary of the structure of the thesis.

Chapter 2: Immersion

2.0 Chapter overview

In this chapter I explore the concept of *Immersion*. I introduce the predominant views on what *Immersion* is through exploring the key literature. I examine how *Immersion* is viewed as valuable across different activities and explore why investigating *Immersion* is valuable in the context of *User Experience*. The Chapter ends with an overlook of what attempts have been made to capture and understand *Immersion* and a summary of the findings.

2.1 Common views of immersion

There are several views on what constitutes *Immersion* in an activity. Although no formal classification of *Immersion* exists, there are several common views on what an immersive experience comprises of.

The first view of *Immersion* is that to be immersed is to be very heavily focused on an activity that the only concern of the mind is with that activity, to the exclusion of other concerns and actions. Examples of this type of *Immersion* typically point to engagement with books and games, or can be found by engaging with activities that require significant levels of concentration such as research and study. *Immersion,* in this sense, is what occurs when there are no distractions or external interferences to break the individual's attention or focus upon the activity. In addition, in this interpretation of *Immersion*, the physical body is not stressed significantly as it is the workings of the mind that drive the experience. For example, reading a book is not a significantly physically challenging activity. However, when reading a good book, it is very common for the reader to become embroiled with the content, characters and worlds; feeling bursts of emotion and deepening interest as they read further and further. As the reader continues to invest more and more focus into the world of the book, in doing so each page becomes an ever more rewarding experience as the events of the

story unfold and the narrative plays out in their imagination. In cases of researching and study, *Immersion* is the feeling that information is being processed and completed in seemingly compressed time-frames, where the individual feels that they have only worked for a short time despite the passage of significant amounts of time.

Another view of *Immersion* is that it is a social experience that occurs through participation in activities or actions. Examples of this form of *Immersion* focus on participation or engagement with a wider activity, such as political movements, religion and media. Here *Immersion* is fostered by a cycle of cognitive engagement and self-reflection about the participation and the role of the self within these activities. Examples of this include being a member of the audience to a performance piece, an individual in worship or an activist furthering an ideological cause. Here the body and mind may engage in a range of different levels of activity, ranging from stressful and intense engagement to a passive and reflective role. *Immersion* in this sense, comes from the individual's participation and self-perception in the activity. For example, the audience member becomes immersed when they view a performance, but are also immersed when they engage with others in discussion about the piece, its background and meaning, or simply revisit a performance they enjoy over and over. The religious worshipper may become immersed in religion by following the lessons and practices of her chosen scripture and dogma with greater belief, or joining orders and groups associated with that religion. The ideological activist becomes more immersed as he furthers his ideological goals in the political processes and wider society, deepening his *Immersion* as he engages more and more in actions such as votes, rallies and debate with others who share and conflict with his views.

A third view of *Immersion* is when the body and mind enter high levels of synchronous action in display and development of skills and ability. This form of *Immersion* emphasises the individual being in a 'zone' of intense concentration and physical coordination, and refers to activities of mind-body synchronicity such as sports and performance arts. Here moments where thought and action are synchronous, where the individual does not take pause to make a calculated action, characterizes the immersive experience. A motorsports driver for example is immersed does not pause as she strikes the corner apex at high speed, when she performs micro-corrections that saves her from a potential crash as back tires lose grip, or

when her split-second reactions allow her to capitalize on an opponent's error and over-take. The performer enthralled in the grips of his performance becomes immersed as he becomes one with his body as it flows with the activity. A dancer for example does not simply recite the foot movements like a machine. Instead he moves with passion and enjoyment to each beat and twist in the rhythm. To the observer his moves begin to predict and lead the music itself, as they become witness to the moment where the lines of hours of practice, ability and experience come together seamlessly. A further example is the musician as they play and lose themselves to the flow and emotion of the work, where their mind-body action is seamless as their instruments seemingly play themselves.

In review of these interpretations, I consider that *Immersion* is a form of mind-body engagement in activities. Whereby through the investment of physical and cognitive energies in an activity an individual experiences different physical and cognitive rewards such as positive feelings or physical satisfaction. As the level of *Immersion* in activity becomes deeper, so does the cognitive, physical and emotional investment required by an individual, while the rewards of their investment also increase respectively. Eventually by becoming deeply immersed the individual enters a state of optimal experience. Where doing the activity becomes satisfying in and of itself.

2.2 THE VALUE OF IMMERSION

A common theme across different views of *Immersion* is that it is a desirable aspect of an activity that occurs during or after an experience. This is reflected in how *Immersion* has been used to positively describe positive experiences in activities across a variety of different fields, and is associated with high levels of engagement, enjoyment, progress and learning. In this section I will explore a sample of the uses of the different uses of *Immersion* and what elements can be considered of value.

Traditionally the value of *Immersion* has been derived from its use as a learning method to develop lingual and literacy skills in foreign languages. Here, *Immersion* is a positive tool to learn new content or develop a skill. Genesee (1987) describes *Immersion* as an intensive teaching method whereby students are submerged into real world environment or culture

where the language being learnt is the first or native language. By throwing students into the deep end of the language learning environment (i.e. forcing real world application) this forces students to learn, use and adopt a language in a rapid and natural manner to function successfully. In doing so it is argued that the value of *Immersion* is that it improves the learning experience, as content is engaged in a more natural and complex manner than any academic institution or classroom environment can provide; as the content and context of learning is presented in its natural everyday format, rather than in formalized blocks of learning to be methodically consumed and regurgitated without context.

In film, *Immersion* is used synonymously with the *Diegetic Effect*, which relates to a conscious and sub-conscious belief the events told to the audience are fact rather than fiction (Burch ,1979 Tan, 1996). Here *Immersion* is used as a measurement to gauge how far an audience has suspended their disbelief of inconsistent or audacious elements of a narrative (Ryan, 2001); with high levels of *Immersion* linked to the quality of the actor's performance, styling of sets and effects of the cinematography. In this interpretation, *Immersion* represents elements of a performance that are of a high quality due to how well they are able to distort the audience's views between what is real and what is not.

Stage and Theatre have attached similar value to *Immersion* to quantify the quality of actor performance and narrative design. Methods to promote high levels of fidelity, such as the *Stanislavski System* (Stanislavski, 1936), have been developed to guide actors to produce and re-enact genuine experiences of emotion during performances. The intent of these techniques has been to enhance the fidelity of the unfolding events in the narrative. Other methods such as those proposed by Agusto Boal (1993) seek to break the audience-stage barrier by bringing the audience into the piece as *spect-actors*. Here the lines of story and events are blurred by forcing the spectators to become part of the actual performance knowingly or not. In both cases the value of *Immersion* is to encourage greater cognitive and physical engagement with the work.

Art has also explored the term *Immersion* in its descriptive of classical and contemporary pieces. The styles of *Trompe-L'oeil* and *Frescoes* have long been used to create the sense of virtual spaces the observer can enter; though not physically, but through emotion and

imagination. *Immersion* in this sense is one of transportation from the real world to that of the ones depicted by the artists. Modern technologies and styles of art have also allowed the artist to bridge the space-observer gap, with *Immersion* having come to describe the engagement of the audience into the *space of illusion* (Grau, 2003). Here *Immersion* is considered in how the user becomes mentally invested in the piece through their exploration of the emotional and physical levels the works present to them. The value of *Immersion* in this sense is to explore how to foster and deepen audience mental engagement with the content or encourage greater interaction.

Finally, the construction of story narratives have explored how *Immersion* can be used to create content and direct a works structure. Murray (1997) examines how the properties of computers and virtual spaces can be used to develop narrative concepts and designs by how immersed the individual is. Here the value of *Immersion* is that it can influence content direction or encourage alternative design perspectives to bring the narrative from role-playing to complex interactive scenarios for the audience to actively engage and absorb themselves within.

In review, we can summarize how *Immersion* is a valuable aspect of any experience as:

- It encourages high levels of cognitive and physical engagement.
- It creates and enhances enjoyment.
- It fosters learning and exploration.
- It promotes unique design considerations.
- It encourages high levels of quality and fidelity.

2.3 IMMERSION IN HCI AND UX

Increasingly new systems, applications and devices are being marketed and developed with *Immersion* as a desirable and positive element of their design and function. Despite this growing use of the term *Immersion* in computing activities and products, the Oxford dictionary of Computing does not formally recognize the term (Dantith, 2004). Nor has the use of *Immersion* been consistent or formalized in regards to computing activities.

From a content design perspective, *Immersion* has been explored in the development of the content of *Virtual Environments* (VE) for wearable computers and *Virtual Reality Systems* (Slater, Usoh & Steed, 1994; Witmer & Singer, 1998). Here *Immersion* has been used to describe how well technology can create fidelity of elements within a virtual experience; with the emphasis being that the most immersive features are those that create the most realistic elements (Brown and Cairns, 2004). Comparatively Coomans and Timmermans (1997) argue that *Immersion* is not a single element of VR interaction and that a combination of natural interaction, sensory engagement, telepresence, simulation of environments (visual, acoustic and haptic) and visualization of important information are required to qualify VR experiences as being immersive. Others such as Newman (2004) have attempted to simplify what *Immersion* is regarding computing; arguing that the most immersive experiences are created using systems that can utilize the largest display spaces possible and produce the highest quality audio.

In application design *Immersion,* has been used to describe the HCI methods between systems. Pasch, Bianchi-Berthouze, Van Djik and Nijholt (2009) emphasize the differences in immersive experiences in movement based interactions using controls such as the Nintendo Wii hand controller and Sony Playstation Eye Toy. Here *Immersion* is the ability to break away from traditional control restrictions of a machine, with more immersive designs being those which allow the user to interact in a more free and natural manner.

Alternatively, Sweester and Wyeth (2005) have used *Immersion* as a means of adapting *Flow* (Czikzentmihalyi, 1975) into a computing context. Here they present the *Game-flow model*, where *Immersion* is a positive effect of developing flow-experience within games.

Alternatively, Chen, Wigand & Nilan (1998) explore the possibility of *Flow* as indicative of *Immersion* into web-users activities on the internet. Frasca (2001) explores the use of *Immersion* as tool in video game design in the context of producing games that allow players to reflect personal opinions on different subject matters, allowing critical discussion of real life issues and flaws in a safe environment. Players are 'immersed' in the sense that the characters of the game are themselves.

I consider that within the context of HCI/UX, *Immersion* is a design tool, interaction method and an experience product that allow the user to achieve the highest levels of engagement and satisfaction from technology and systems. *Immersion* is therefore the means to develop the optimal form of experience between a user and technology as well as promote systems and devices to produce other valuable aspects, such as fostering learning of technologies or to drive the quality and fidelity of technology.

2.4 EXPERIENCING IMMERSION

I consider that individuals exist in a neutral cognitive and physical state when not engaged in an activity. Within this state the individual is as equally engaged in the activity of being idle as they are disengaged with the world and activities around them. Emotionally they are neither frustrated nor excited, aroused or relaxed. They have a mental focus on nothingness, a disassociated awareness of the world around them, yet remain mentally aware of themselves and sub-conscious of their immediate environment. This *Neutral State* persists until they engage in an activity.

Once the individual engages in activity, they begin to move beyond the *Neutral State* and enters the *Activity Space*. Consider *Activity Spaces* somewhat like a bubble encompassing the elements of a given activity. This could be the geographical space or physical boundaries that an activity is performed in such as a sports field. Alternatively, it can be the sensory and cognitive realms such as artefacts that the individual can see, feel and engage with or the images formed in the imagination.

As the individual engages more and more, they begin to become immersed and begin to focus solely on the activity to the exclusion of others. As they do so the 'depth' of their *Immersion* is affected by different elements of the experience. Elements such as *Embodiment, Absorption* and *Enjoyment* create a deeper, more positive experience of *Immersion*. Whereas others such as *Frustration, Disengagement* and *Anxiety* can break *Immersion* and create a negative experience.

When the positive aspects of the experience are at their highest the individual experiences the optimal experience known as *Flow*. This is where doing the activity for the sake of the activity is enjoyable, which drives the individual to do everything they can to continue to extend the experience. In doing so the individual begins to invest even greater and greater levels of mental energy. Concentrating deeper and focusing only on actions and behaviours that are relevant to progress further in that activity. At this point the individual is at the deepest level of *Immersion,* focusing only on the activity as they draw satisfaction and reward from their engagement. Eventually however distractions will overpower the individual such as fatigue, stress or challenges in the activity that are too great to overcome. In doing so the *Immersion* of the individual begins to wane and the begins to revert to the *Neutral State*.

A pessimal experience also exists. This experience is known as *Boredom* and occurs when the negative aspects collate to form an unbearable and undesirable experience that the individual seeks to escape. Uninteresting, laborious and over-challenging tasks and is produced from high levels of *Frustration, Anxiety* and *Disengagement* between the individual and *Activity Space*. In the state of *Boredom,* the only desire of the individual becomes to alleviate themselves of the experience by either returning to the neutral state or finding relief in a different activity. How the individual escapes *Boredom* can be through choice, such as focusing on specific activities to do or from transitioning from one activity to another. For example, someone bored using a computer to browse the internet, may instead choose to focus on reading a book or watch a TV show, alternatively they can transition from the activity of browsing to playing a video game to try and alleviate their feelings of being bored.

2.4.1 Deepening immersion

The optimal experience, *Flow*, is created at the deepest levels of *Immersion* and is created when *Embodiment*, *Absorption* and *Enjoyment* are at their peak.

Embodiment is the process of making gestures, actions and using artefacts of an activity feel like natural extensions of the body. As the more natural the artefacts and actions of the activity feel, the less mental and physical effort the individual needs to invest in them. This allows physical and mental resources available to then be used to create more engagement with through deeper engagement and *Immersion* into the *Activity Space*. Eventually as *Immersion* deepens, *Embodiment* develops to the point where the individual no longer separates their awareness and action; and they move and engage with the *Activity Space* in a completely fluid and natural manner.

Further as the individual becomes immersed in an activity, they also begin to become absorbed within it. Being absorbed can be thought as a deep level of concentration where all the cognitive focus of the individual is directed at into the *Activity Space*. At this level of *Immersion*, awareness of the environment beyond the boundaries of the *Activity Space* become ignored as more and more mental energy is focused onto the activity. Greater *Absorption* is also accompanied by greater effort to progress in the activity. As if progression is inhibited, such as from a lack of skill or too difficult a challenge, then concentration and focus on the activity begins to fade and the individual starts to return to the *Neutral State*. However, if the challenge is appropriate to the abilities or skills of the individual, progression and reward continue in a cycle of action-reward, requiring even greater concentration on the activity and therefore deepening *Immersion*.

As the mind-body act in unison, the activity then becomes a truly enjoyable experience in of itself, where the individual is rewarded the more they invest into the activity. *Enjoyment* can be in many forms such as feelings of accomplishment or satisfaction, or by generating positive emotions such as happiness, elation and fun. At the point where the individual is completely embodied, absorbed and enjoying the activity for the sake of doing the activity they have become immersed enough to reach the point of optimal experience.

2.4.2 Diminishing immersion

The pessimal form of experience, *Boredom*, is created when the *Frustration*, *Anxiety* and *Disengagement* in an activity are at their most severe. In this state, all the individual does is seek to alleviate their *Boredom* by either finding a means to return to the *Neutral State*, or engaging in other activities.

A key element that leads to the pessimal state is *Frustration*. I consider that *Frustration* is where the reward for investment of cognitive and physical energy is not adequately returned in an activity. *Frustration* usually occurs when Individuals encounter challenges that are too difficult to overcome with their level of skill or ability, or when they encounter opposition that makes their actions ineffective. When this occurs, physical and cognitive resources that could be spent on becoming immersed in an activity are instead wasted on trying different actions to overcome the difficulty, or wasted determining why actions are not effective. Progression in an activity therefore begins to stall or cease entirely until the individual develops the skills and ability needed to proceed. In doing so *Immersion* is diminished as concentration and progress are blocked.

As *Frustration* increases so can the level of *Anxiety* the individual has. Challenges that cause *Frustration* may also cause individuals to doubt and concern over their ability to control and overcome the challenge. Although overcoming frustrating challenges can be a very rewarding experience, generally where individuals encounter repeated *Frustration* the levels of *Anxiety* can raise quickly causing expenditure of significant cognitive and physical energy. In doing so this leads to further doubt, introduction of error and cognitive and physical exhaustion, making deeper *Immersion* in the activity too taxing for the individual.

Increasing levels of *Frustration* and *Anxiety* in an activity can also lead to a lack of progress and reward. As this occurs, the ability of the individual to remain interested and absorbed in an activity also diminishes. The highest levels of *Disengagement* in an activity marks the point where the chances of becoming immersed in an activity is at its weakest, as if an

activity is not interesting to the individual, the likelihood of them committing high levels of mental and physical energy to engage with the activity is unlikely as the cognitive and physical energies can be better spent on other activities.

2.4.3 Breaking immersion

Eventually individuals will return to the *Neutral State*. This may be a natural process that follows the conclusion of activities, such as the end of a sports game, finishing a chapter in a book or completing tasks and objectives so that the activity no longer holds any interest or meaning to the individual. In other cases, an individual may wish to return to an activity but first requires a winding down period to reflect and review their progress and development to see how to proceed further. For example, artists and writers may pausing in creating works, either to seek out inspiration and ideas, or simply to consider the next element to develop. Others who have hit a wall of difficulty, to spare themselves from growing frustrated, may stop an activity to reassess what they must first work on to progress onward.

However, the *Neutral State* may also be forced upon the individual due to distractions and needs that can breach and break an individual's engagement with activities. Distractions are elements of the activity and environment that divert and consume an individual's mental and physical energies; or reduce the capability of the individual to commit high levels of concentration. A distraction could for example be unanticipated information such as notifications or messages sent to the individual during interactions, interrupting the primary activity with other, minor and unrelated concerns or issues. For example, a sports player may receive instructions from their coaches that tell them to change tactics or actions, breaking the *Immersion* of the player at least momentarily as they adjust. Another form of distraction could be environmental such as poor quality surfaces or ineffective equipment. A damaged and waterlogged pitch for example may force the individual to have to pay attention to each move they make to avoid making errors, whilst a loosely strung tennis racquet may force an individual to use the item in abnormal ways to be effective.

Needs are also elements of an activity that breach and break an individual's engagement with activities. However, needs must be addressed before concentration or progress can be made

in the activity. An example of a need can be found in the biological requirements of the body like hunger or fatigue. Other needs may be formed from various conditions or requirements such as chronological conditions, such as having to wait the passage of time until evening to stargaze or the need for suitable sized tidal waves to occur before they can be surfed upon.

Distractions may resolve themselves upon the passage of time, by actions in an activity, by own accord or worked around and ignored by the individual once they have been identified. Distractions may also develop in severity into needs. For example, a video game player may find himself becoming hungry as he games. He does not immediately have to cease playing the game and address this distraction, however the longer he games the more and more his hunger grows until eventually all progress ceases as he must satisfy the need to eat. A distinction therefore exists in that needs cannot be ignored indefinitely and cannot be resolved without intervention from the individual. For example, a game controller that has no power needs to be charged first before it can be used, whilst vehicles need fuel before they can be driven.

Addressing needs and distractions may itself become or lead to an immersive activity. Pre-empting the need for hunger can lead the individual to undertake activities such as shopping or cooking. Distractions like faulty equipment may lead to intensive time spent repairing or replacing the item. The key point however is that in any activity needs and distractions will emerge that return the individual back to the *Neutral State*.

2.5 METHODS OF QUANTIFYING IMMERSION

In trying to capture and understand *Immersion* one approach has been using quantitative methods of recording and defining *User Experience* (UX), with focus placed on usability, interface design and device ergonomics. Attempts to capture UX has largely been through personal questionnaires to measure how far a user has been a part of an experience, with emphasis on documenting user physical, mental and biological responses to place user interaction on a measurable scale. Witmer and Singer (1998), as well as Jennett, Cox, Cairns, Dhoparee, Epps, Tijs and Walton (2006) are examples of work which use examples of measurement of experience to attempt to capture Immersion and UX. Furthermore, the use of likert type scales has focused on user reactions and responses to an activity (Mirza-babaei, Long, Foley and McAllister, 2011). Bio-metric measurements such as physical movement, vision-hot spots, and bio-chemical response activity have also been used to measure of individual *Immersion* within an interaction experience (Norris, Chen, Xhu, Small & Cacioppo, 2004. Pace, 2008). Witmer and Singer (1998), as well as Jennett et al. (2006) also employ experience-focus analysis with an emphasis on attention focus during an immersive experience. However, such approaches only tell us the how of UX not the why. By this what is meant is that a purely quantitative approach leaves little room to explain what motivates and engages users beyond the individual's responses to particular design and layouts of a system.

In redress of this, qualitative measures such as those employed by Csikszentmihalyi (1975, 1990 and 2002) and the *Experience Sampling Method* have been explored. Here focus is on taking a snapshot of an individual's feelings and perceptions during engagement in an activity with the individual self-recording their feelings and experiences as they happen rather than as a reflection upon an experience or activity. This affords a recording of the moment of the event of *Immersion*. The underpinning focus of such methodologies however is on finding the features of an experience to create an ad-hoc definition of *Immersion* relative to the experience perceived at the time, rather than produce a wider understanding of the term. In doing so what we see is that self-reporting during the moment is counter intuitive to the act of experiencing *Immersion*. As by being immersed in an activity and then breaking that *Immersion* to record it are counter active to one another.

2.6 USES OF IMMERSION

A great variety of literature on what *Immersion* is across different uses and contexts exist. In this section I discuss the content and themes of the dominant literature I have explored across a variety of different academic and artistic fields in the research of *Immersion*.

2.6.1 IMMERSION & VIRTUAL ENVIRONMENTS

Immersion in HCI/UX has received considerable investigation in the case of *Virtual Environments* (VE's), with the study of VE closely tied to the study of *Virtual Reality Systems*. Ellis (1994), helped define VE's as a new medium for potential human-machine interactions and explores the potential of *Immersion* in VE as powerful training and educational systems in the coming decade. In addition, Ellis (1994) examines the scientific, psychophysical, physiological and perceptual implications the design of VE's can have on UX. Here the emphasis is that *Immersion* is a valuable means of determining how engaging and effective such VE systems are. Similarly, Seymour, Gallagher, Roman, O'Brien, Bansal, Andersen and Satava (2002) also explore VE systems for teaching medical surgeon teaching and examine the suitability of such systems to teach and develop skills for use in real-world applications, examining how systems that are highly immersive reduce skill training times and promote best practice. Success of the use of highly immersive simulators is covered in Satava (2006), where rules for best-practices incorporated into the design of such systems help increase learning productivity. For example, in surgery simulators it is often possible to 'kill' the virtual patient caused by errors, where as in flight simulators the ability to reproduce harm or damage to passengers and vehicles serves as an effective manner to teach individuals relative best practices and principles effectively without risk to real world assets or individuals.

Engagement in virtual spaces can take many forms, such as through observation via a head-mounted displays, or by using a screen or monitor to obscure the observers field of view to only that presented by the VE. Other interaction methods include motion tracking or direct interaction through control artefacts such as keyboards, controllers, joysticks or a combination of each. In regards to *Immersion* Perdue (2003) examines VE's in the context of

the individual's self-interpretation of metaphors and images through the users engagement with content such as that presented through mediums like books, film and television. Here Perdue (2003) equates *Immersion* as a means of encouraging high levels engagement between the individual and VE content in a natural and instinctual manner; and argues that for a VE be truly immersive, any boundaries or separation between the user and the VE must first be addressed.

2.6.2 Presence and immersion

Immersion is also explored in literature through its relation to the phenomenon of experiencing the self within a VE. This is known as *Presence* and is described as a sense of 'being there' in a VE even though the user may be physically situated in another. Witmer and Singer (1994) examine presence in the context of being a natural phenomenon of awareness by users in *Virtual Environments*. Linking environmental factors and sensory stimulation as key in developing an individual's self-identity. Heeter (1992), also identifies the need of the individual to discern and validate their existence within virtual worlds through sensory stimulation and input. Mean whilst Insko (2003) furthers the analysis of the self-validation experience by exploring possible means used to measure *Presence*.

Lombard and Ditton (1997) is a comprehensive attempt to define presence. In the work the authors outline the "perceptual illusion of non-mediation" in which a user or participant experiences presence when they no longer perceive or acknowledge that the *Virtual Environment* is being presented through a medium. Additional attempts to unify differing definitions of *Presence* are seen in Slater, Usoh and Steed (1994) which elaborates upon the idea of a *Presence/Immersion* relationship as the act of becoming immersed into the VE, rather than *Immersion* being the result of having presence in a VE.

Presence can be thought as the focusing of the mind energy into a virtual space for the creation of identity within the virtual space. This is because within any VE, there is need to self-identify by users as they need to discern and validate their existence and actions within the order of the virtual world they are engaging with, so that they may understand their position and role within it (Heeter, 1992).

Presence is fostered when users can identify elements of a VE and interact with them. In addition, *Presence* is fostered when a VE reacts with the user through their interactions (for example, blocks move when pushed, footprints are left behind as the user walks across sand). From this process of reaction and interaction, the user develops their sense of self within the VE, in the sense that they learn what they can and cannot do, how the virtual world acts and reacts to them and their actions; as well as how they may or may not behave to achieve results. Self-identity is then further reinforced through the reactions of others in the virtual world such as other users or virtual avatars. The more of the VE the user engages, the more of which behaviours and actions are valid are learnt. In doing so, the user learns how their body-mind can act and react in this virtual world.

Presence is valuable in our examination of *Immersion* as it creates an understanding of how an individual experiences the world. By understanding self-identity, *Presence* allows a user to comprehend and focus their actions in a VE per which actions they know will produce results. In doing so *Presence* helps focus the mind and activities of the individual into the VE and in doing so helps foster and create *Immersion* into the activity by the individual.

2.6.3 Presence as embodiment in virtual environments

I consider the experience of developing self-identity through presence in a *Virtual Environment* to be akin to the experience of *Embodiment* of the individual in the real world. As the more the individual creates presence in a VE, the more natural a VE feels to engage and become immersed within.

In support of this Heeter (1992) identifies that;

> *"A sense of presence in a virtual world derives from feeling like you exist within but as a separate entity from a virtual world that also exists. The differentiation and experience of self may be enhanced if other beings exist in the virtual world and if*

> *they appear to recognize that you exist. It may be enhanced if the virtual environment itself seems to acknowledge your existence.* (p.262)

The consideration of *Presence* as a form of *Embodiment* in a VE is an important one as though presence and *Embodiment* are linked through the mind-body experience of the individual, they can be separate to one another. I therefore consider that *Presence* is concerned with the body's experience of virtual or imaginary spaces; whilst *Embodiment* is concerned with the body's experiencing reality. Due to this there is the possibility of a wide degree of separation between the two despite both having common links. In turn this means it is possible to have a strong presence in a virtual world, even though physical *Embodiment* within the virtual world may not be strong and vice versa.

An example of this phenomenon can be seen when taking part in a video-conferencing call (Gunawardena & Zittle, 2009. Hauber, Regenbrecht, Hills, Cockburn & Billinghurst, 2005). Here users will, by the nature of the system, have a high degree of presence as they use the video-conferencing system to create a virtual space to offset the physical distances between the parties involved. In this virtual space, they can talk, interact, as well as share files and information in a manner akin to a real-world exchange; which can give the illusion of compressed time and distance between the participants. At the same time users don't have a strong degree of *Embodiment* in the activity as they are largely limited in how they can physically sense and interact with the virtual space. Users are reliant upon the senses of sight and sound and touch to experience the call and perform the actions needed to manipulate the virtual space. Though they may be heavily embodied in the *Activity Space* around the call, such as wearing headsets to hear and transmit voice or using input artefacts like keyboards and mice, the virtual space where the participants are connected remains disconnected and disembodied from them.

A contrast of this is the process of driving a car. Driving is a heavily embodied activity, involving complex coordination of the body and mind to operate a vehicle to navigate to and from a destination. However, the environments that exist when driving a car are often (and quite literally) few and far between. With everything occurring in the act of driving situated in the immediate physical reality of the user, such as the controls in the driver's seat and the

activities occurring on the road outside the vehicle. It can be argued that in some manner the destination of a car journey is akin to a *Virtual Environment* until the individual arrives at their destination. It is virtual in the sense that the mind may wander to think about activities they need to do once they arrive, or may lead to imaginations of possible scenarios and activities of what will occur soon once they arrive. Despite this the user won't have a strong sense of *Presence* in the process of driving the car as it is very much a physically embodied experience in reality than any other sense.

The emphasis here is the identification and representation of the self in a VE. This stems from the act of focusing the attention and activities of the user into the VE. This experience of the 'experiencing of the virtual space' is mediated by the interaction methods of the user, but ultimately must pass from this medium into the mind of the user. In doing so *Presence* represents the psychological *Embodiment* and subsequent *Immersion* of a user as they exist and act within a VE despite being in the real world. *Presence* in turn serves to create and foster an immersive experience by bridging the virtual space and physical realm of the user.

In support of this link, Slater, Usoh and Steed (1994) elaborate upon the idea of a presence-embodiment-immersion relationship. Here they argue that self-representation of the body within a virtual world is immersive because of the way the represented body can interact with the virtual world. Sensors placed on the human body can map movements in virtual worlds and the more the virtual body can interact with the virtual world, the more the physical realm and virtual realm are bridged and physical action becomes virtual interaction. This then leads to *Presence* and *Immersion* into the virtual world.

Other explorations of presence found in the works of Lombard and Ditton (1997), who expand on the idea of a presence-embodiment-immersion relationship. The work focuses on user perception of the VE as the key factor in developing *Presence*, where in the most compelling experiences the senses are immersed in the virtual world and the body is entrusted to a virtual-reality generating engine. Here senses are manipulated to fully submerse the body into the *Virtual Environment*, the eyes are covered by a head mounted display to make the real world invisible, ears are covered by headphones so that ambient sound is muffled; whilst the hands are covered by gloves or props so that the user can interact with insubstantial

elements of the VE. The emphasis of these highly immersive virtual systems is therefore to create a sense of fidelity of the VE to the user. Literature to support this can be found in Witmer and Singer (1998) who identify that VE's which produce a greater sense of sensory illusion produce higher levels of Presence. Witmer and Singer also explored the factors that affect *Immersion* including isolation from the physical environment, perception of self-inclusion in the VE, natural modes of interaction and control and perception of self-movement. In doing so, they argue that any VE that effectively isolates users from their physical reality increases the degree to which the user will feel immersed.

The link between the physical senses, *Presence* and *Immersion* shows how within a virtual user perceives the virtual world. Perceptual *Presence* is the sensory feedback to the actions and reactions by the user and the *Virtual Environment*. As user's sense and experience what the VE has through the interaction methods available to them, this creates *Presence* for themselves and the elements in the virtual space. Referring to Slater, Usoh and Steed (1994) this supports the importance of the physical-virtual link, suggesting that there is correlation between physical realm actions and virtual world interaction to give meaning to the actions and in turn help foster and promote *Immersion*.

The most common example of this physical-virtual body link can be seen in a user involved in walking through a virtually created maze using a virtual reality system. Imagine within the system walls prohibit movement around the virtual space. When a user tries to move through a wall the controls used to move appear to stop responding and the user will perceive that the virtual walls are impassable barriers and in turn modify their future behaviours to avoid them. What occurs is the development of presence of the user and the wall, as although the walls and the space they occupy are not physical-world entities, a user will know by looking at the wall in the virtual space that they cannot proceed. The virtual selves of the user are stopped by the wall as they perceive their virtual selves to be facing the virtual wall whilst the physical bodies are stopped because the user knows that doing additional action won't provide meaningful interaction. In doing so the user perceives where their virtual selves currently fit-in the VE and by understanding their place in the VE become further immersed within it as the lines between reality and virtual become blurred.

2.6.4 KEY POINTS OF VIRTUAL ENVIRONMENTS AND PRESENCE

I consider VE to be a fictions space in which a user can engage within. Engagement in this virtual space can take many forms with *Immersion* a form of mental *Absorption* created from this engagement. I aim to emphasise that virtual space of a VE affects how a user will behave and act during interaction and that virtual environments shape and focus the attention and absorb the user's attention into an activity.

I consider presence as a sense of 'being there' in a VE though the user may be physically situated in another, and argue that presence is akin to *Embodiment* in *Virtual Environments* through the development of a user's self-identity within a VE. As the experience of developing self-identity through *Presence* in a VE is akin the experience of *Embodiment* of the individual in the real world.

Together VE and Presence highlight the role of space and its influence in user interactions, which I consider to be a foundation in developing the optimal form of experience. In doing so, I consider that:

1. *Virtual Environments* are a virtual or physical space in which a user can engage themselves within. Engagement in this virtual space can take many forms with *Immersion* a form of mental *Absorption* created from this engagement.

2. The design and fidelity of the virtual space of VE's affects how a user will behave and act during interaction, in turn absorbing the user's attention into the VE.

3. The phenomenon of experiencing the self within a virtual space of a VE is known as *Presence*. *Presence* is described as a sense of 'being there' in a VE even though the user may be physically situated in another. I consider the experience of *Presence* akin the experience of *Embodiment* of the individual in the real world and is a favourable experience to create fosters *Immersion* which can lead to positive experience.

2.7 IMMERSION IN ART, THEATRE AND POLITICAL IDEOLOGY

In this section I explore the role of *Immersion* and its use across art and theatre. I consider that art and theatre create *Immersion* by encouraging a focus of attention into the spaces and stories that they portray, and highlight that *Immersion* in the context of art and theatre is driven by a sense of participation and mental-absorption into the works.

2.7.1 IMMERSION IN ART

In the context of art, *Immersion* is the illusion of being physically present in the world portrayed by the art piece. Art attempts to create *Immersion* by 'drawing in' the observer into the worlds and virtual spaces of the piece. This may seem strange as by their nature many forms of art are not interactive and rarely involve the observer being a part of the piece. For example, there is no interaction with the Mona Lisa or the Last Supper through touch or via any input device. Instead engagement is based on observation and mental consideration of what the piece is interpreting. Artwork also does not typically respond or interact to the audience observing, Mona Lisa does not change her smile nor do the members of the Last Supper move or respond to onlookers. Put simply it is not a common feature of traditional art to involve the individual observer directly as a participant. Instead it is the individuals own investment into the piece that determines their level of engagement and subsequent *Immersion* into the piece, as by simply dismissing Mona Lisa's smile or the Last Supper as simply 'pictures on canvas' means that one has failed to engage in the greater scene and messages these pieces have set out to convey.

Grau (1993) examines the methods of art to create *Immersion* in detail, and argues that due to the pre-dominantly non-interactive nature of the medium, artists are forced to employ a variety of different styles and techniques to try and produce a given effect or provoke a mental and emotional response in an individual. Artists use these techniques to engage the senses and mind of the user about the piece and attempts to immerse the observer through by absorbing their attention into the *Virtual Environment* and spaces of the work.

Immersion in art is therefore to present a snapshot of the narrative the piece is set in to engage the imagination and focus the mind of the individual. For example styles, such as *Trompe-l'œil* (Trick of the Eye) employ realistic imagery and tricks of perspective in order to create optical illusions of spaces and three-dimensionality. Mean whilst other visual styles such as panoramic frescos use motifs that address the observer from all sides in a unity of time and place, thereby enclosing the observer hermetically in the work (Grau, 1993). This creates an illusion of being in the picture looking outward into the world and the events portrayed.

Other literature explores how art aims to induce *Immersion* by creating an emotional engagement of the individual. Art uses this emotional induction to capture the attention of the engaged individual to draw focus onto the ideas and concepts the piece portrays. Matravers (2001), for example, explores the relatively complex emotional and intellectual understanding that great art pieces require and highlights how it can be both challenging for both novice and professional alike. This challenge in interpreting art is further explored in the works of Fichner-Rathus (2013). Here Fichner-Rathus explores how art covers a broad range of topics and themes at a visual and emotional level, and observers must focus their concentration and absorption into the world per the piece to discover and understand the themes presented. In turn this emotional and mental interaction with the art piece, and the desire the fully understand it, engages the individual and provides an enjoyable and immersive experience as it is shared with others or provokes deeper thought in the observer.

Art also encourages *Immersion* through the *Embodiment* of the observer. In earlier sections the idea of presence as *Embodiment* in a VE was explored and can be summarized as being the act of self-identification within a virtual space. Art attempts to achieve a similar effect of *Embodiment* through new forms of interactive installation art pieces being developed and deployed in galleries and public spaces (Paul, 2003). These pieces typically involve the use of computer technologies in promoting audience participation within the works themselves (Edmonds, Turner and Candy, 2004) and some form of feedback is given (Cornock and Edmonds, 1973). The feedback can be graphical, audible, haptic, or a combination of features that in some way augments or changes the piece. In doing so audience participation interacts and modifies the piece in relation to their behaviour. The piece and audience therefore share a

unique and intertwined relationship of response and action and are immersive through this bond. Such systems have been explored in the works of Rose (2012) which explores new technologies and narrative platforms such as the internet. Other exploration is in Dyson (2009) which emphasises the importance of audio and environmental sounds in enhancing such engagement. Such artworks therefore intrinsically generate presence of the user within them as presence is created as the audience interacts and reacts to the changing artwork.

2.7.2 Immersion in theatre

Immersion has also been explored in theatrical performances, both on stage and on screen. Here immersion is the process of creating fidelity to a scene, where the actors and stage effects are used to produce genuine performances or portrayals of the events occurring. By creating scenes and emotions of high-fidelity, the audience is drawn within the performance and able to relate to what occurs. In doing so they begin to feel a part of the performance, either through indirect means such as observation, or direct means such as participation, becoming embodied within the performance and subsequently immersed.

Literature on theatre techniques and methodologies has also been developed to document and examine different techniques to produce this immersive effect to the audience. In particular, the *Stanislavski System* (Stanislavski, 1936), and its derivative works of method acting, aims to produce and recreate genuine human emotion into scenes of a performance by using the performers past and previous emotional experience. The aim being that by creating fidelity of emotion and environment from experience, the performance can be considered genuine. From this fidelity, the audience are drawn into and subsequently immersed into the world of the scene.

The fidelity of a performance is also enhanced using environmental factors. Reany (2010) examines the importance types of environmental elements such as scenery or thematic design that encourage audience participation in a performance. Literature also examines other elements that are employed in theatre to produce *Immersion* such as costume design, lighting, props and back-drops; which all contribute in portraying the scene to the audience and subsequently focuses the attention of the audience into the virtual worlds presented to them.

Environmental factors in creating *Immersion* also examine how audience members are closed off to the real world through the design of theatres and performance space. An example of this is how in many theatres are lights are dimmed, silence is required and the stage is angled to provide the maximum centre of focus. In addition, theatres are typically open-spaces or large buildings with seating to allow comfortable viewing whilst outside distractions are kept to a minimum. Even in open air amphitheatres, the physical environment is used to ensure that such focus to the stage is maximized and external distractions beyond the stage are kept to a minimum. This can be seen in the design of open-air theatres such as the Arles Amphitheatre of France, or the more contemporary Hollywood Bowl in Los Angeles California (Grau, 1993).

This makes the physical space and environment of a performance an important mechanism to encompass the audience and focus their attention onto themes or elements. White (2013) explores the use of architecture layout in successful London based production companies, where performances require the audience to navigate and explore the spaces of the performance either prior to or during the performance. The aim of this is to help the audience become a part of the production as well as encourage the focusing their attention onto the themes of the performance. Theatres therefore seek to encompass and engage the audience to become a part of the piece direct or indirect, fostering their embodiment into the performance and subsequently immersing the audience in the experience of the worlds and emotions being portrayed.

Augusto Boal (1993) focuses upon techniques and theatre styles designed on drawing in spectators into becoming participants in each performance whether willingly or not. Here Boal explores the idea of impromptu performances in public spaces where the audience don't realize it’s a performance and become engaged in the scene as actors improvise around them. In doing so the audience move from being passive into an active level of engagement in the performance, as their emotion and mental attentions focused on the scene at the time though unaware of it being fictional. Audiences then become immersed in that they become a part of the performance in a literal sense where the audience’s role is blurred so that they are not so much a spectator to events as they are *spect-actors* in the performance i.e. they are in the

performance as it unfolds and become immersed because of their inability to make the direct connection to how they relate to how the piece plays out.

2.7.3 Immersion in political ideology

Literature in the role of politics in human activity and political participation is extensive, stemming from the formations of the first great empires to the modern day. Aristotle noted that man by nature is a political animal (Aristotle, d. 332 BC), where the natural preference of an individual is to take part in communities of political activity. The aim of these political communities, in Aristotle's view, is to enhance the virtues (i.e. benefits) of the community rather than those of individual private wants. The individual's role within politics is therefore akin to being part of an organic being rather than a cog in the political machine of government.

In a modern context, Aristotle's comment of man's political appetite glimpses upon the idea that individuals seek to be a part of a greater whole to benefit themselves and their community. In fact, it is commonly seen that belonging to a group is one of the basic needs of humanity. Anthropologists such as Maslow (1943) prioritize belonging as one of the core necessities of a content life. In support of Maslow's view, psychologists and social commentators have also accepted the need of belonging within the individual. Baumeister and Leary (1995) as well as Kenrick, Neuberg and Cialdini (2010) comment that such basic human needs as belongingness and a search for happiness are hard-wired into human psychology from an evolutionary and sociological perspective. From this evidence, it would suggest that belonging to a group or unit is a natural extension of the behaviour of self, i.e. to want to belong is to be human.

In fulfilment of this need technology and societal developments have allowed people to become more connected than in previous generations. The shrinking of time and space across the globe due to the development of internet, mobile telecommunications and social media have meant that individuals have access to a far wider variety of social and common interest communities than ever before. Danah Boyd (2008) for example identifies increased use and changing methods of online-identities in online social-networks used by American teens over

recent years. Whilst a contemporary and far more extreme example of group-activity and event participation through digital mediums can be seen through the organisation of the London 2011 riots and social protests using social-network sites (Halliday, 2011).

Traditional methods of association and activity also remain strong, if not stronger, in wake of this digital unification. If we can assume that belonging to like-minded groups is a desired state by the individual, then we can safely state that the various ideological groups that exist in the modern era serve as a mean to fulfil these needs. Ideological alignment serves good grounding to analyse belonging in the sense that those who choose to be a part of an ideology will inevitably be drawn to it out of like-minded principles or circumstances (Rosenberg, 1956. Jost and Napier, 2008).

Edward Schatz (2009) supports the idea that *Immersion* in ideologies is tied to the individual's engagement within them. Though Schatz focuses primarily on the value of using *Immersion* in political groups for academic study, the work highlights an important aspect of what immersion in ideologies entails. In particular, the shared views and circumstance of the ideology serve to act as an influence on the behaviour of the individual. Engaging in activities that serve to promote and strengthen the ideology such as attending rallies, engaging in debate or furthering the cause, allows the individual to develop and reinforce their sense of sense of belonging and being within the group. Individuals immerse themselves in the sense that their ideologies encompass their interactions with the world around them, and the more they engage in them, the stronger their *Immersion* becomes. Subsequently removing oneself from the group or engaging in behaviour and activities in opposition to the ideology serve to weaken an individual's association and their immersion within.

O'Shaughnessy (2004) explores the use of propaganda to create and influence mass opinion and emotion or to redirect the attentions of the public to view failures into victories. O'Shaughnessy work highlights how being immersed in ideology leads to an individual to exclude the need to question the assumed ground truths of the ideology and this leads to the elimination of alternative interpretations of that may challenge the ideology aligned interpretations. Through this ideologically encapsulated view there are clear answers as well as defined and justified actions for dealing with the perceived environment of the individual.

In doing so engaging in political activity focuses the attention of the individual on the ideological interpretation of the surrounding world, which is achieved over a broad spectrum of time and activities that further perpetuates their ideological views. Individuals are therefore immersed in the ideology in the sense that it directs influences and encompasses their actions in the world.

2.7.4 Discussion of Immersion in art, theatre and political ideology

In the context of art, *Immersion* is the illusion of being physically present in the piece. The use of optical trickery or artistic technique is used to invoke emotional engagement or interest of the observer, to draw them into the virtual environments presented in the art work. This engagement, metal or emotional, subsequently encourages mental investment and *Embodiment* in the form of presence leading them to be immersed.

In the context of theatre, *Immersion* is the process in creating fidelity to a scene, to create emotional and mental-absorption by the audience akin to that of works of art. In this case, techniques focusing on acting methodologies, environmental factors and the design of performance spaces encourage the focusing and engagement of the audience onto the performance. In doing so, these factors and techniques are used to encourage engagement and investment of the audience's energies to lead them to become immersed within the performance.

Finally, *Immersion* in political ideology, explores the way that ideology fulfils a need of belonging in the individual. *Immersion* represents the engagement into political-motivated activities by an individual, and how through these activities they become more engaged and immersed in the activities and practices of the ideology.

This section has introduced a wide variety of themes and literature related to *Immersion* and its use in art, theatre and political ideology. The key points in consideration of *Immersion* in art, theatre and political ideology are as follows;

2.7.5 KEY POINTS OF IMMERSION IN ART, THEATRE AND IDEOLOGY

1. In the context of Art, *Immersion* is the illusion of being physically present in the piece. Artistic techniques create perspectives to invoke emotional engagement or interest of the observer into the VE's presented in the art work. Much like presence in VE's, art attempts to draw in the observer into the worlds and virtual spaces of the piece. This engagement is based on invoking observation and mental consideration of what the piece is interpreting. Art also aims to induce *Immersion* by creating emotional engagement of the individual into the piece and encourages *Immersion* through the *Embodiment* of the observer by fostering presence in the piece.

2. *Immersion* in theatrical performances is the process of creating fidelity to a scene; where the actors and stage effects are used to produce genuine performances or portrayals of the events occurring. Scenes and emotions of high-fidelity allow the audience to be drawn within the performance and able to relate to what occurs, in doing so they begin to feel a part of the performance. Environment and space of a performance are important mechanisms to encompass the audience and focus their attention onto themes or elements.

3. *Immersion* in ideology is created by engaging in activities that further the goals and beliefs of the ideology. Ideologies encompass the interactions of the individual. *Immersion* in ideology is akin to immersion into a virtual environment requiring a great deal of psychological *Immersion*.

2.8 CHAPTER SUMMARY

In this chapter I explored the concept of *Immersion*. I argue that *Immersion* is a valuable part of any experience as it encourages high levels of cognitive and physical engagement, creates and enhances enjoyment, as well as fosters learning and exploration of an activity. I also argue that it promotes unique design considerations and encourages that focus in design should be on creating high levels of quality and fidelity to produce positive UX.

I also consider that individuals exist in a neutral cognitive and physical state when not engaged in an activity and that within activities a pessimal and optimal experience exists. *Immersion* is the key to developing the optimal experience, known as *Flow*, as without *Immersion* a pessimal experience known as *Boredom* may be experienced. I also identify that a variety of elements either deepen, diminish or break *Immersion* in activities and in the subsequent chapter I shall explore each of these elements in greater detail.

Finally, I explored the core literature and uses of *Immersion* across a variety of different fields and disciplines. Here I discussed what *Immersion* is considered across the field of VE's, art, theatre and ideology to promote a wider understanding of the term *Immersion* and its application.

CHAPTER 3: THE IMMERSION MODEL

3.0 CHAPTER OVERVIEW

In the previous chapters I explored how *Immersion* occurs in different activities. In this exploration, I determined that *Immersion* is part of a need to engage in activities to experience the optimal form of UX known as *Flow* and to avoid a pessimal experience known as *Boredom*. In addition, I also introduced how different elements promote, diminish and break *Immersion* and that different elements affect the type of experience for the individual. I also introduced how it was possible to map user experiences in an activity known as the *Immersion Model of User Experience*.

In this chapter I shall now discuss the various elements that make up this mapping. I begin by introducing how the model should be used to explore UX. I then discuss the *Activity Space*, describing the cognitive and physical boundaries of an activity. I then move on to describe each feature of the model, explaining the role each element plays in defining a UX. I then end the chapter with a discussion of how the optimal and pessimal experiences exist outside the *Activity Space* and summarize the findings of the chapter.

3.1 THE IMMERSION MODEL OF USER EXPERIENCE

Previously I discussed that a wide variety of different aspects promote, diminish and break *Immersion*. I also discussed that the value of being immersed in an activity is that when a deep level of *Immersion* occurs this helps foster an optimal form of experience known as *Flow*. *Flow* can be thought as the best form of experience an individual can have in a task or activity as it is the experience of happiness in performing the task or activity for the sake of performing the activity. *Flow* is created when *Embodiment*, *Enjoyment* and *Absorption* into an activity are at their peak for an individual. In contrast to this, I also consider that *Boredom* is the pessimal experience of an individual to have when engaging in an activity. I consider

that *Boredom* is developed when an activity is uninteresting, laborious and over-challenging, and it occurs where the levels of *Anxiety*, *Frustration*, and *Disengagement* in the activity are at their peak.

Between these two extreme experiences there exists a *Neutral State* that can be considered a period of subconscious perspective by the individual, where they exist in simultaneous state of idleness and activity, engagement and disassociation. In this *Neutral State* the individual has no purpose or goal to focus their mental and physical energies into but are neither experiencing negative or positive effects from doing so.

Individuals leave the *Neutral State* as they engage in activities. Activities themselves have both cognitive and physical boundaries which I term the *Activity Space* and within this space the actions and abilities of the individual are used to engage, develop and progress the type of experience they have. The overall type of UX an individual has from this engagement is determined by the levels of different elements experienced in the *Activity Space*. Positive elements of an experience are *Enjoyment*, *Absorption* and *Embodiment*. Negative elements of an experience are *Disengagement*, *Anxiety* and *Frustration*. I model this as such:

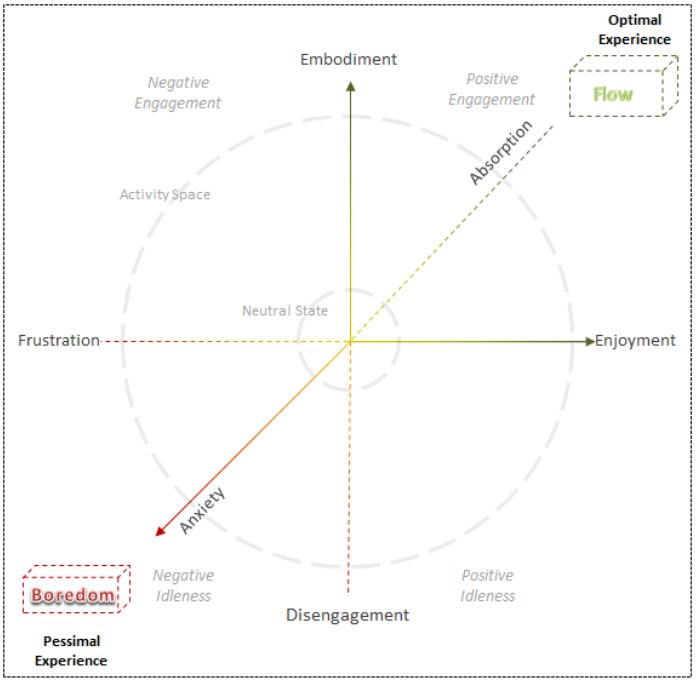


Figure 2: The Immersion Model of User Experience

3.2 USING THE IMMERSION MODEL

Today it is taken for granted that most users can take advantage of the convenience and usability of modern technologies. No longer do modern electronics or computing devices carry the mystique of being magical devices that require extensive education to use and operate. Much to the relief of many average users, once seemingly complex activities such setting the clock on a modern video device is now a largely automated process if an internet connection is possible. Indeed, simply walking into any electronics store or browsing online gives a wide range of thousands of different devices, software and systems that offer a 'simple to use' solution to a range of problems or activities the customer may have.

It is easy to forget however that our understanding of *User Experience* (UX) is a recent phenomenon. Indeed, as Kunivasky (2010) notes, only at the turn of the millennia was device interconnectivity and usability even really considered by designers and manufacturers, as prior to this the complexity of the technology was paramount - often leading to very difficult interoperability between what should be two or more complimentary devices. Only then was it in the early 2000's that the fruits of these considerations began to bear fruit when a swathe of ubiquitous and interconnected devices began appearing on the open market.

What has emerged from this design shift has been what many consider as the traditional usability frameworks employed of UX. These traditional frameworks have typically focused on the performance and user cognition aspects of technological interactions - i.e. how fast the technology does something and how easy it is to get it to do it. Or they have focused upon the non-utilitarian aspects of UX such as user perceptions of an experience, sensations experienced and the meaning and value of user behaviours to determine best design principles (Law, Roto, Vermeeren, Kort and Hassenzahl, 2009. Law, Roto, Hassenzahl, Vermeeren and Kort, 2009. Roto, Law, Vermeeren and Hoonhout 2011).

Within these frameworks, it is seen that positive UX is a desirable aspect of technological systems simply because positive experiences are preferred to negative experiences. Greater consideration to the benefit of positive experience with systems has argued that new systems

or tools that provide a better experience are more quickly and easily integrated for use in the everyday by a user; and has been explored in how users who report having more positive experiences have been seen to be able to memorize functions more consistently and perform them with fewer errors. In addition, because users find enjoyment in using a system or technology, it is argued that overall effectiveness and efficiency improves and in turn productivity rises (Oracle, 2011).

Why positive UX occurs remains largely unclear. To address this I argue that the *Immersion Model of User Experience* encourages exploration and answers to this paradigm by exploring optimal UX as the experience of *Flow*. Through the *Immersion Model* I argue that designers and users are better able to identify which elements are generating positive elements such as embodiment, absorption and enjoyment in a system. In addition, as the model tries to capture and represent common experiences of the individual, the *Immersion Model* can be used to inform and guide designers on what type of experience that general use of a system or technology generates for a typical user.

The model also has value as a contribution to the wider field of HCI and UX respectively. Increasingly modern societies seek to adopt and adapt the use of technology to improve various aspects of everyday life. Studies into positive experience have demonstrated that happy individuals are successful across a multiple of professional and personal domains (Lyubomirsky, King and Diener 2005). In doing so the *Immersion Model* contributes to HCI as through its use we can make wider observations of happiness in everyday technology activities and how they can be improved to produce the optimal experience for users.

Finally, the *Immersion Model* can be used to help create a wider range of UX. By examining features that generate positive elements as well as negative elements, systems can be designed to provide a range of different experiences at different points of use. Designs can therefore be intentionally made ways to cause the user to experience a range of different micro-experiences, with the intention of creating a wider overall UX. In doing so the design of systems and technologies need no longer focus on just performance and technical considerations, but instead on generating a UX sandbox where a wider UX is crafted and developed.

3.3 Activity spaces

Every activity occurs in some form of space. This can be the physical real world space that an activity occurs in, such as the dimensions of a sports field or it may be a more conceptual area. For example, museums exhibitions occupy a real space within a physical building, but each segment may use activity spaces to provide imaginary boundaries between where you interact with them in the museum. *Activity Space* may also be quite personal; for example, when playing a virtual reality game, the *Activity Space* consists of the space around the individual and controllers as well as the space presented on the screen.

Understanding how we interact with space has been explored in the works of Rudolf Laban (1966) and the ideas of *Kinesiology*, specifically *Space Harmony*. Here physical movement and mental attentions are directed by the limitations of the space a person can engage with in combination with the limits of the human body. Space therefore greatly influences interaction with an activity as all interaction is dictated by how we can physically and cognitively move and interact within the space. We must be aware of our movements and understand which movements prohibit or expand interaction in these spaces which in turn leads to greater awareness and engagement into the activity. This is further reflected in the works of Edward Hall (1963, 1966) and his discussion of personal space zones in human communication known as *Proxemics*. Hall divides the geographical areas around an individual into various zones of social interaction. These spaces then influence an individual's interaction and communication with the world, where the closer an event or activity is to the individual, the more intimate the interaction is and the more the individual must be aware of and interact with whatever is within their personal space.

In the context of the *Immersion Model* I consider that the *Activity Space* to be the area where an experience develops, as it is within this space the individual fosters, diminishes and engages with the different elements that create an experience. The *Activity Space* is also the physical and cognitive arena that focus the attention and awareness of the individual and makes an activity an activity. What is meant by this is that any activity is contained within its own space that has different actions and elements that make up that activity, the user then invests their mental and physical resources into the *Activity Space* when they wish to have an

experience. Take for example rock climbing. A surface just a surface until the individual decides to engage in the activity of climbing. They then perform actions and focus their attention into the activity space of climbing and then begin to have an experience in that activity. The *Activity Space* around an individual then influences how and what elements of an activity they concentrate upon. In doing so attention is focused on what exists in an activity space at a given time and the individual engages in the activity.

3.4 NEGATIVE FEATURES OF AN EXPERIENCE: FRUSTRATION, DISENGAGEMENT AND ANXIETY

There are three dominant negative features that mark an experience within an *Activity Space*. These are *Frustration*, *Disengagement* and *Anxiety*.

In the context of the *Immersion Model*, *Frustration* is the feeling of being upset or annoyed that results from being unable to achieve or fulfill goals in an activity. It is developed when an individual, through their actions, is unable to experience progress in an *Activity Space*. It is caused when challenges are too difficult to overcome cause progression in activities to begin to cease. Challenges are important in an activity, as without challenges to overcome the individual does not need to invest significant cognitive and physical resources, therefore without challenge there is no experience to have. Increasing levels of *Frustration* serves as a marker that the current challenges are beyond the abilities of the individual to overcome now. In doing so investment of physical and cognitive resources loses meaning, leading to a negative experience as they individual realizes such resources can be spent elsewhere to build a more rewarding experience. At its peak, *Frustration* serves as a marker where the individual is in a heavily emotional and physically stressed state and desires to leave the activity space to recover.

Related to *Frustration* is *Disengagement*. *Disengagement* is the process of withdrawing involvement from an activity or becoming detached from immediate concerns. It is tied heavily to levels the levels of concentration that the individual wishes to commit to an activity, with greater levels of disengagement representing lower levels of mental investment. *Disengagement* occurs when interest in and the meaningfulness of continuing an activity are

lost by the individual. As they become more uninterested and disengaged the individual experiences a desire to change or leave the activity space to focus their resources into something else. At its peak, *Disengagement* shifts from a desire to a need to change to any other *Activity Space*, at this point the individual is thoroughly disinterested in the activity and is not motivated or have any intention of continuing i.e. they are on the verge or experiencing the most pessimal experience known as *Boredom*.

Anxiety is the third dominant element of any experience. *Anxiety* is the feeling of nervousness caused by uncertainty or the desire for something to happen or occur. In the context of the *Immersion Model* it can be considered as the sense of loss of control an individual feels they have over an activity. Greater levels of *Anxiety* relate to greater loss of control and sense of control over an activity. When at its peak the individual feels that their efforts are meaningless and don't contribute to or influence their progression in the activity.

The negative elements of an experience can combine with each other as well as the positive elements to create different user experiences. These common experiences are discussed in the subsequent chapter. However, it should be noted that when these negative elements are at their peak, the user experiences the pessimal state known as *Boredom*.

3.5 Positive features of an experience: absorption, embodiment and enjoyment

In conjunction with the negative elements, there are also three dominant positive features that affect the type of experience within an activity space. These are *Absorption*, *Embodiment* and *Enjoyment*.

Absorption in the context of the *Immersion Model* is the feeling of focus and engagement with an activity. With higher levels of *Absorption* representing greater levels of cognitive investment and engagement with an activity. It is developed as an individual experiences progress and reward in an *Activity Space*, and occurs as challenges and objectives by the individual are completed. *Absorption* also relates to the level of *Immersion* in an activity,

with high levels of *Absorption* synonymous with high levels of *Immersion* in the experience. At its peak, *Absorption* represents a complete cognitive and physical resource investment into the activity space by the individual, representing that the individual is fully engaged with the activity space and ignoring other activities or distractions that threaten to break this high level of concentration.

Embodiment in the context of the *Immersion Model* is the physical movement of the body and the engagement of the human senses that are the most relative to the *Activity Space*. *Embodiment* is the process of making gestures, actions and using artefacts of an activity feel like natural extensions of the body and represents a sense of control and mastery over an activity. It is the idea that these gestures, actions and artefacts feel like they are a natural part of the individual and through their use greater control and mastery of the activity space occurs. At its peak, *Embodiment* represents the merging of action and awareness in the individual in the activity, in a sense they become a part of the *Activity Space* and feel as though the dictate and direct the progress of an activity.

Enjoyment is the process of taking pleasure from actions and progress in the *Activity Space*. It is related to both *Embodiment* and *Absorption* and is developed when individuals can experience reward and progress in an activity. Increasing levels of enjoyment represents that challenges are appropriate for the individual, in the sense that they cause an investment of cognitive and physical resources to overcome them, but are within the capabilities of the individual to do so. At its peak the individual no longer needs rewards from progression in an activity, instead performing the activity itself becomes enjoyable. At this point the individual is close to experiencing the optimal experience they can have in any activity known as *Flow*.

3.6 Beyond the activity space, boredom and flow

As the above elements combine during an individual's interaction in the *Activity Space* they create different types of experiences. These common experiences are discussed in greater detail in the following chapter. However, beyond the activity space two extreme experiences can occur. When the negative features of an experience are all at their peak, this is known as the pessimal state known as *Boredom*, whilst in contrast, when all the positive features of an experience are at their peak, this is the optimal experience known as *Flow*.

In the context of the *Immersion Model* these experiences seemingly exist outside the *Activity Space* as they are significant experiences in and of themselves. *Boredom* represents the need and desire to escape the activity space. It is a level of the highest desire and focus of the individual to do anything other than what they are currently doing, as well as the point where the preference for change of activity is at its highest. Due to this I consider that *Boredom* represents the point where the individual is involved in an activity but thoroughly disengaged from it and are instead seeking something else to engage themselves with. Comparatively *Flow* is the point where the individual has gone beyond the need for the *Activity Space* to feel engaged and have an experience within, instead simply engaging with the activity is more than enough to continue to motivate the individual to continue their engagement. At this point the desire to change is at its lowest, as the individual has entered a 'zone' where they are happily to simply take part in what they are currently doing at the expense of anything else. In the following chapter I describe the experience of *Flow* and *Boredom* in greater detail.

3.7 Chapter summary

In this chapter I begin by introducing how the model should be used to explore UX. Here I argued that the *Immersion Model* can be used to direct the design and overall experiences and that it can be used to help identify what produces a positive experience. I then moved on to discuss the different elements of the *Immersion Model*. I began by discussing the *Activity Space*, describing that an activity is determined by the cognitive and physical boundaries that an individual can engage with. I then move on to describe each feature of the model, explaining that there are six dominant features which define a UX in an activity. Here I

identified three dominant negative features; *Frustration*, *Anxiety* and *Disengagement*. I then identified three dominant positive features as *Embodiment*, *Enjoyment* and *Absorption*. When the negative or positive features are at their peak, I then argued that the individual can experience one of either extreme experience. When the negative features are at their highest, this is the pessimal experience known as *Boredom*, which is the point where the individual seeks to escape the activity space to do anything other than the current activity. In contrast, when all the positive features are at their peak, the individual is in the optimal experience of the activity known as *Flow*. Here simply engaging with the activity is enough to provide enjoyment and motivation to continue to engage with an activity.

Chapter 4: Common experiences, Pessimal Experience and Optimal Experience in Activities

4.0 Chapter overview

In the previous chapter I discussed the various elements that make up the *Immersion Model*. In the following section I delve deeper into the model to introduce and explore the different forms of experiences users can have in activities. Describing the most common types of experience before highlighting the most pessimal and optimal forms of experience known as *Boredom* and *Flow*. I begin by introducing the types of common cognitive and emotional experiences in an activity that individuals have, exploring how a neutral cognitive experience exists that allows an individual to take part in activities or idleness without becoming bored or highly engaged. I then examine four common experiences that occur as differing levels of cognitive and emotional engagement are experienced by the individual. I then move on to introduce the concepts of *Boredom* and *Flow* experience and highlight why *Boredom* is the pessimal experience that can occur in an activity and why it should be avoided when possible. Finally, I comment on how *Flow* is the optimal experience of an activity, what it is to experience flow, and why individuals should strive to achieve the conditions necessary for it to occur.

4.1 The neutral state and common experiences

In this chapter I shall discuss that in any activity *Boredom* can be the least rewarding and most emotionally unsettling state to be in, I term this the pessimal experience. In comparison *Flow,* can be regarded as the optimal experience of enjoyment and engagement with an activity.

Human emotion and engagement does not function in a state of extremes, instead phases of various emotional and mental activities will occur when engaged in an activity, or may occur

as a precursor to other experiences and activities. In simplest terms individuals have a cognitive and emotional *Neutral State* during their day to day engagement. This *Neutral State* can be considered a period of subconscious perspective by the individual; where they exist in simultaneous state of idleness and activity, engagement and disassociation. They may for example experience a state of mental activity, organising thoughts and ideas for later, or they could be experiencing a mental blankness where the body and mind (though connected through nerves and senses) simply interact only at the subconscious biological level. In this state, they are neither bored nor anxious, nor are they enraptured and cognitively engaged. Entering this *Neutral State* is easier for adults and older children, as the neutral state requires a degree of discipline and control of one's cognitive energies, a feature than most young individuals are unable to manage over long time periods.

From this *Neutral State* when an individual engages with an activity, different emotional and cognitive experiences that are neither *Flow* nor *Boredom* may occur as levels of different features of an experience increase and decrease. Broadly we can divide these experiences into four categories *Negative Engagement*, *Positive Engagement*, *Negative Idleness* and *Positive Idleness* within an activity. These experiences can be described as such:

1. *Negative Engagement*: As an individual is taking part in an activity they may be forcibly disengaged from starting or progressing in the activity they want to do, as they must first address other activities before they can begin. I term this experience *Negative Engagement*. In this experience an individual may be fully embodied in an activity but frustrated that they are unable progress, as the individual may be very aware of what they must do to complete or progress an activity but are frustrated that they are unable to engage in the desired activity until the necessary preparation tasks are completed. An example of this can be seen in activities where the individual must expend physical energies to complete a task, but are not mentally rewarded or engaged from doing so. Simple examples of this could be the act of having to clean a messy sink of dishes before engaging in cooking activities, or preparation maintenance before riding a bike on a course. The individual is aware of the movements and features needed to complete the task; the dishes must be scrubbed and rinsed and left to dry, or the necessary tools and mechanisms of the bike tightened and

greased. However, until the pots and cutlery are available, or the pre-ride maintenance complete they won't be able to cook as effectively or cycle enjoyably as they could otherwise do so – as these issues will continue to weigh or interfere with further engagement. Once the individual has performed the necessary preparation however they may then become more and more absorbed and engaged in their desired activity, eventually taking enjoyment out of it and beginning to take steps towards experiencing *Flow*. Alternatively, the preparation may drain them of too much cognitive and physical energy that they instead become disengaged and anxious about undertaking their originally desired task, and may become bored or disinterested in pursuing the desired activity until another time.

2. *Negative Idleness*: Individuals may also experience activities where they are cognitively 'elsewhere' by having their mind focused on other things or activities they would rather be doing. Doing so however is frustrating and mentally draining. The individual may be anxious that they are unable to control the situation and from this a high degree of *Frustration* and *Disengagement* occurs. An example of this may be at engagements or activities where the individual isn't actively involved, such as waiting by the side-lines of a sporting activity, or the activity itself is disinteresting to the individual such as watching a performance that neither engages nor entertains. During this lull-period the mind may begin to wander to other issues or topics the individual feels is of greater significance or importance. Alternatively, those waiting may grow anxious as they become frustrated at how they can't engage with the activity, or begin to cast their minds on how this delay will impact on their pre-planned activities or their schedule. As the levels of *Frustration*, *Disengagement* and *Anxiety* are nearing their peak, the desire to do anything else may begin to become overwhelming. In this state the individual is very close to experience *Boredom*, or may begin to grow tired and fall into a resting state of sleep as nothing else can be done to pass the time. In the worst cases the individual is trapped in idleness – they can't engage or get aroused by the activity but they can't simply fall asleep to wait the activity out, at this point the individual is forced into boredom and has the most uncomfortable of experiences.

3. *Positive Idleness:* In contrast to negative idleness there is an experience where levels of interest in the activity at hand may be low, but allowing the mind to wander and explore itself may be enjoyable in and of itself. Take for example the individual who has been heavily loaded with mundane tasks and activities. No single item may be interesting enough to raise their levels of engagement or arousal to require deep concentration and engagement; but instead they may begin to day dream or imagine themselves elsewhere, creating complex and exciting scenarios or simply enjoy the planning of alternative activities and goals for later. In doing so a unique experience arises in that the individual is simply enjoying doing nothing of importance or note as they go about their day to day business. As the uninteresting tasks complete however they may begin to become more engaged or invested in the activities they have been planning, and once free from their burden begin to become more engaged and immersed in achieving other activities.

4. *Positive Engagement:* In contrast to negative engagement, positive engagement is when the individual begins to become more and more absorbed and engaged in their activities, investing greater amounts of emotional and cognitive energy and enjoying doing so. In this state the individual sees that the more they invest, the more they progress and the more rewarding the activity becomes. As levels of *Embodiment*, *Absorption* and *Enjoyment* peak the individual becomes close to entering *Flow*. As they begin to enter *Flow* more emotional and cognitive energy are invested and in return the individual experiences greater progression and greater reward until simply doing the activity is enjoyable, engaging and rewarding. When reaching this level of engagement, the individual has the most optimal experience of the activity they are engaging with.

It should be noted that the common experiences described are not pre-determined during an individual's engagement with an activity. An individual may go from one experience to the other as different levels of engagement and reward occur within an activity. What may start out as a fun and engaging experience may become a frustrating and uncomfortable experience, whilst some activities that may seem unbearably mundane and unexciting can turn out to be the most engaging and arousing for the individual.

In the following sections I will now explore in greater detail the two extremes of experience in an activity; the pessimal experience of *Boredom* and the optimal experience of *Flow*.

4.2 A Discussion of boredom

Pleasure and *Enjoyment* are features that any individual strives for in an activity. The idea of undertaking tasks that we perceive as uninteresting, laborious or over-challenging is not met with grins and enthusiasm, but rather resistance, reluctance and in some cases stress and anxiety. Most would rather procrastinate hours away with minor distractions than must commit time and effort to the things they perceive as boring or unenjoyable. It is therefore natural to seek enjoyment and happiness in all the things we do and engage with. However, before we explore how to achieve this optimal state it is necessary to understand the negative experience we all seek to avoid.

4.2.1 Experiencing boredom

The definition and experience of *Boredom* often differs between scholars and commentators depending on the circumstances and context of when and how those experience it. For some such as Fisher (1993) boredom is a psychologically centric experience of "an unpleasant, transient affective state in which the individual feels a pervasive lack of interest and difficulty concentrating on the current activity." Others such as Leary, Rodgers, Canfield and Coe (1986) describe *Boredom* as a derivative of misplaced or unfocused attention stating it as "an affective experience associated with cognitive attentional processes." Alternatively, contemporary psychologists such as Csikszentmihalyi (1997) attribute *Boredom* as a response to a lack of a consistent challenge or personal skill development in activities.

Common to all interpretations of *Boredom* however are the issues of *Engagement*, *Enjoyment* and attention. James, Cheyne, Carriere and Smilek (2006) identify that disinterest, anxiety and a lack of control are common across all instances of boredom. They highlight that a proneness to experiencing *Boredom* stems from being unable to engage in desirable activity, from being forced to engage in unwanted activity, or when there exists no apparent reason for the individual to maintain their *Engagement* in an activity. In doing so *Boredom* can be

considered as the least desirable of experiences in an activity as by being bored one is either being consigned to do something they do not wish to do, or are unable to escape from their current circumstances until something beyond their control is completed.

4.2.2 Negative effects of experiencing boredom

Boredom carries a significant risk to the emotional, cognitive and physical wellbeing of the individual. Sunberg and Farmer's (1986) development of the *Boredom Proneness Scale* and subsequent research has identified that boredom proneness is clearly and consistently associated with failures of attention and empirically linked to negative cognitive and emotional states such as depression, anxiety and physical health issues. Smith, Cohen and Stammerjohn (1981) for example identified that individuals forced to engage in monotonous or repetitive tasks reported higher incidences of health disorders such as muscle and joint pain; whilst others such as Sommers and Vondanovich (2000) as well as Vodanovich, Verner and Gilbride (1991) have identified strong correlation between *Boredom* and neurological disorders such as depression, hostility, anxiety and reduced impulse control. Evidence further suggests that *Boredom* also correlates to reduced productivity and effectiveness in individuals, as illustrated in research into the *Job Boredomness Scale* (Grubb, 1975) which identified that increased proneness to *Boredom* is caused by un-stimulating and repetitive tasks.

As these reviews demonstrate, *Boredom* is not pleasurable or desirable as it is inherently restrictive to an individual's creativity, engagement and overall well-being. It is the pessimal state of an activity and its mitigation and avoidance should be paramount.

4.2.3 Limiting occurrences boredom

Referring to the *Immersion Model* as discussed at the beginning of the chapter we can see *Boredom* represented as such:

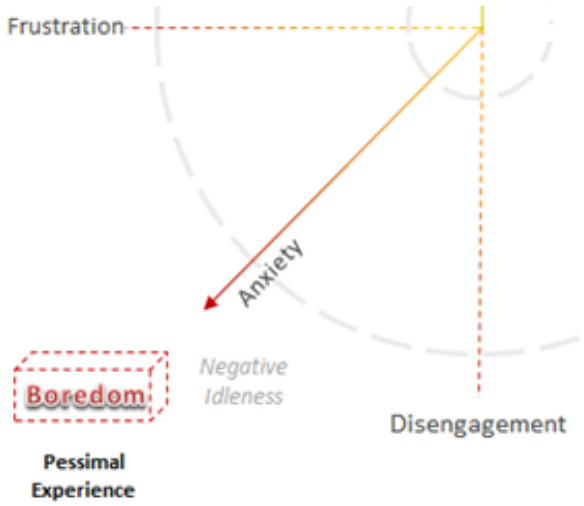


Figure 3: Boredom on the Immersion Model of User Experience

Boredom occurs when *Frustration*, *Anxiety* and *Disengagement* towards an activity are at their peak. In addition, due to having such negative and detrimental effects on the individual, avoiding *Boredom* is not only a desirable aspect within an activity, but also a necessity to ensure the overall wellbeing of an individual. Despite this, developing proven methods in preventing and avoiding *Boredom* in activities is a far from simple matter, as due to the diversity of interests and experiences of the individual, no single method can be applied to ensure that all individuals won't become bored of activities. In some cases, a defining aspect of an activity may simply be that it is inherently boring, yet the task itself necessary to be completed before any further progression or developments be made. In other cases, *Boredom,* can be argued to be a natural aspect of human goal pursuits (Bench and Lench, 2013) where the experience of being bored is a natural psychological mechanism to inform the individual that new goals and activities should be pursued.

If we consider *Boredom* as a natural aspect of any activity, questions arise over how the occurrence of this *Boredom* developing can be limited. In address of this, meaningfulness of activities is most frequently attributed to why individuals become disengaged from activities, with activities that individuals perceive as having a lack of meaningfulness leading to greater levels of *Disengagement*. Frankl (1992) for example identifies that individuals naturally seek meaningfulness in their work and activities, in the sense that individuals working towards a goal or purpose find them more rewarding than activities which do not; with a lack of

meaning in doing an activity leading to a sense of alienation from a task or activity by the individual (Aktouf 1992). In doing so activities that engage individuals are those where they can either create or identify clear purpose and response from their actions, wherein the individual feels that through their contributions they can produce tangible results and outcomes that in turn motivate greater engagement and enthusiasm towards the activity.

Humans by nature are incredibly expressive creatures with a range of physical, emotional and cognitive resources brought to bear when an individual engage themselves in an activity. As most activities require some level of physical exertion and cognitive engagement (with some demanding intense physical or intellectual challenges that can put enormous stress on the mind and body), individuals inevitably vary in their abilities to meet these challenges.

Despite this individual are, by and large, rewarded equally when they can achieve and develop within an activity. With happiness and enjoyment generated the most when an activity is both challenging yet within the realms of success for the individual (Csikszentmihalyi, 1997). By pairing and individual's abilities up with suitably challenging activities, the overall level of satisfaction and enjoyment can be maximized. Suggesting that early identification of what an individual finds enjoyable and engaging can help identify and limit the aspects that they find boring or laborious thereby limiting the scope of *Boredom* in an activity.

The attention demands of activities also vary in type and scope. Some activities for example require a great deal of emotional and cognitive labour (Hochschild, 1983; Sutton, 1991), and the ability to address such cognitive demands and invest mental resources varies by activity and individual respectively. For example, researchers have explored the 'need for cognition' that some people have for complex activities (Thompson, Chaiken, & Hazlewood, 1993). However, some roles require more cognitive processing than others, meaning some individuals can become overwhelmed at the amount of information that must be processed to think and act clearly. In cases where excessive cognitive dissonance occurs, this leads to depletion of cognitive resources (i.e. attention) quicker leading back again to a loss of meaningfulness and enjoyment in an activity. What this means is that to some degree the activity needs to be 'right' for the individual to succeed within, meaning that to limit

Boredom, individuals should pursue activities that suite their emotional and cognitive capacities.

4.2.4 Summary of boredom

Boredom is the pessimal experience in an activity. It is a physically and cognitively unhealthy state for an individual to experience. It is associated with negative emotional states and physical health degradation as well as being highly cognitively restrictive. We can consider *Boredom* as the point of an activity where human expression and skill development have stalled, as well as the point where the expenditure of cognitive and physical energy does not result in progress or reward. To avoid *Boredom* the level of cognitive and physical energy investment must not be too exhausting for the individual and the activity itself stimulating and rewarding enough to warrant further investment. As discussed below, when these conditions occur, it can allow the individual to experience the positive states in an activity, as well as allow them to attain the optimal experience known as *Flow*.

4.3 A discussion of flow

Philosophers have long pondered what it is that makes individuals happy. Ancient commentators such as Aristotle for example, emphasised that happiness and well-being are the optimum goals of any human activity (Aristotle, d. 332 BC). During the Enlightenment 17th Century and subsequent Romantic 18th Century period, thinkers such as Jeremy Bentham (1789) and John Stuart Mills (1861) concluded that quality of life (to which was meant happiness) related directly to the experience of greatest level pleasure at the least level of harm to the greatest number (known as utility). 20th Century commentators have continued in this vein of thinking emphasising that happiness is born from the fulfilment of constant physiological and emotional needs (Maslow, 1943) or individual self-reflection and development through our experiences (Sartre, 1946).

Contemporary writers of the late 20th and early 21st century have combined elements of these views to produce the argument that meaningful experiences are those that produce positive emotions whilst limiting negative emotion in our actions and activities. The most

comprehensive discussion on this view on happiness can be found in the works by Mihaly Csikzentmihalyi (1975, 1990, 1997 and 2002). Here the development of enjoyment in an activity, which is termed as *Flow*, is the optimal experience for any activity and should be sought after in preference to anything else.

Flow is described as "...the state in which people as so involved in an activity that nothing else seems to matter, the experience itself is so enjoyable that people do it even at great cost, for the sheer sake of doing it." (Csikzentmihaly 2002). Subsequently Csikzentmihalyi models *Flow* as a series of conditions where individual's skill level and the challenges posed to them by the activity align and produce positive experiences. Negative emotions such as apathy, *Boredom* and *Anxiety* are seen to block and inhibit *Flow* experience as they actively deny happiness from occurring. On the other hand, positive emotions such as relaxation, a sense of control and enjoyment were factors that contributed towards developing and perpetuating *Flow* experience. The interaction between skill, mental states and challenge is modelled as such:

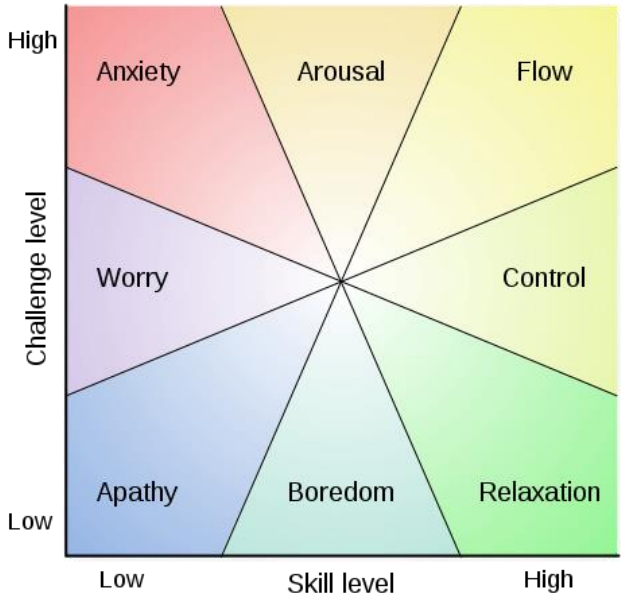


Figure 4: Mental States of Flow

4.3.1 Experiencing flow

At the beginning of this chapter I discussed the common cognitive states that an individual can experience. Within this it was identified that states of high concentration and focus typically result in greater and more rewarding experiences in activities, with the optimal experience of *Flow* occurring when the investment of these resources and rewards from the activity are in alignment.

Csikszentmihalyi (1975, 1990, and 2002) describes methods to foster the conditions necessary for *Flow* to occur and the aspects that define *Flow*. To produce *Flow* requires these aspects should be encourage or facilitated to occur as the result is that individuals engage and enjoy themselves in an activity so much that they continue to participate simply for the sake of doing so.

In experiencing *Flow*, the first aspect Czikszenmihalyi characterises is the merging of action and awareness. What is meant by this is that as an individual becomes more engaged within an activity, they become more mentally absorbed to the point where all their mental resources are focused purely on the activity. When this level of mental investment occurs, awareness of events and activities outside the experience become subconsciously filtered out. Individuals then begin to act and react in accordance solely with what is going on in the activity and not what is happening in the world around them. The merging of action and awareness is therefore the point where an individual loses the need to reflect upon their surroundings to act, and they effectively encapsulate their own experiences from the rest of their surroundings. Participants may reflect upon their immediate surroundings as they perform actions, but all reflection stays encapsulated and isolated from things that are outside of the activity. Take for example the Rock-climber scaling a surface. As they do so, they are focused not on what is occurring at the summit of their climb, nor are they focused on what occurs below them. Instead they are focused solely on the climb before them, which handholds they should next grip and how to continue to progress upwards in their ascent. In doing so the climber does not ‘think’ about the numerous possibility of what the next hand-hold may entail, instead they simply see and act to continue onwards and upwards.

The second aspect of *Flow* is developed through the setting and completion of goals that produce reward and feedback for the individual. This need not be a simple goals/feedback relationship, as simply fulfilling a set-list of targets may not produce a *Flow* experience. Instead goals and feedback can be derived from an individual's mental investment into the activity. To illustrate this, take the example of the video game player who receives his goals in two forms; his own goals of playing the game to be entertained; and those directly given to him from the game itself. His feedback is produced from the rewards of play as well as completion of the tasks he is given by the game. However, his feedback can also be derived from events and stimuli produced during play and the fulfilment of goals. He may see colours; hear sounds or progress in a narrative storyline during play. The goal/feedback relationship then becomes a complex system of receiving tasks or goals, fulfilling them through various feedback methods, to only then develop more or existing goals. *Flow* experience is fostered when the goals/feedback absorb and reflect the individual's cognitive investment, as if an individual would have to divide their attention they would limit their attention and mental investment in the activity thereby prohibiting *Flow*.

The third aspect of *Flow* is that it occurs when an individual enters a paradoxical sense of control over the activity. By challenging and developing skills in the fulfilment of goals, the individual learns to reduce the risk of failure in an activity to a minimum whilst maximizing their successes and rewards. By limiting failure this produces a sense of control in the participant, as they are continuously filled with a sense of dominion over the activity. In doing so they begin to feel as though they can direct their own course of action in an activity regardless of the external factors of reality. The individual also begins to feel that they can choose to continue their *Engagement* or end their *Engagement* in an activity at will and that it is they, and not the external factors that dictate when this occurs. In paradox to this, the control exerted is not true control; but rather just a false sense of the possibility of total control (Csikszentmihalyi 1990). This is because the events of reality will eventually enter conflict with that of the individual. In example of this, take the cyclist speeding downhill. The reality of the situation is that forces such as momentum and gravity are really what control the speed and descent of the rider. He or she is not truly in control as the bike gains more and more speed and despite the ability to control this momentum to some degree through braking; however, overall, they are limited in what they can do. However, as the cyclist picks up speed, the paradox of control occurs. They begin to 'enter the zone' as they gain speed, with

each successful turn further enhancing their confidence and sense of control over the activity where, at its peak, the rider believes they are fully in control of their actions and the activity.

The fourth aspect of *Flow* experience is the loss of self-reflection or constant scrutiny of the ego. To experience *Flow* the individual must forget temporarily who they are as individuals and instead develop an expanded state of being into the activity. The individual therefore becomes a part of the activity, with the tools and interactions they engage with becoming extensions of themselves rather than as separate entities. Consider the musician practising an instrument. They may start with warm up exercises or techniques that have them concentrate on the intricacies of their finger movement across the instrument, or focus themselves into ensuring they have correct form or posture, or perhaps breathing correctly. Regardless, at this point they are very aware of the separations between themselves and the instrument. However, as they begin to play they become more and more engaged with the activity of playing, whilst their awareness of themselves and their separation from the instrument diminishes. When fully concentrating and in a state of *Flow* as the instrument seemingly plays itself, with it becoming a natural extension of the musician, as seemingly each rhythm and note flows freely from one to the next.

The fifth aspect of *Flow* is a diminished sense of the passing of time. It is not a complete dulling of the sense of time but rather its mechanical passage on a clock. Often this is experienced as sudden realization of the perceived amount of time that has past compared to the actual time that has past. However, it is also possible to be aware of time accurately during such as the passage of seconds, minutes and hours. The difference being that during *Flow* experience time becomes a two-form entity. On one hand, it becomes a measurement of the duration of involvement in a *Flow* experience, whilst 'time' and its limitations (fatigue, lack of time available) becomes an external factor will eventually break a *Flow* experience.

The sixth aspect of *Flow* experience is that it is an autoletic experience. By this what is meant is that *Flow* is a self-rewarding experience that is enjoyable in and of itself (Csikszentmihalyi 2002). The activity that creates *Flow* therefore does not therefore necessarily matter as *Flow* can occur in any activity if the other aspects of *Flow* are facilitated. Indeed, Csikszentmihalyi hypothesizes that an individual's personality traits assist in creating Flow. These personality

traits include curiosity, persistence, low self-centeredness and a high rate of performing activities for intrinsic reasons. In ensuring that these traits are enabled low is a self-rewarding experience for those who enter it as it is as enjoyable to get to a state of *Flow* as it is to enter it.

4.3.2 The value of experiencing flow

Flow can be thought as the optimal form of experience an individual can have in a task or activity, as it is the experience of happiness in performing the task or activity for the sake of performing the activity. *Flow* is therefore an intensely rewarding state of participation in an activity which provides a great deal of value to the individual.

By creating *Flow*, *Boredom* can be delayed or avoided in the individual. As explored previously the state of *Boredom* is the pessimal state of experience and should be avoided whenever possible. By fostering *Flow* in an activity even the most seemingly mundane of activities can help avoid this pessimal state.

Flow also requires a deep level of mental engagement into an activity. As explored earlier humans are expressive creatures with physical and mental capacities to engage and interact with the world around them. When these energies are undirected, negative emotion and unsatisfying experiences occur, with physical and emotional health put at risk. By enabling and encouraging *Flow*, these resources can be directed towards creating rewarding engagement in activities helping to ensure that cognitive and physical health are not put at risk.

As we can consider *Boredom* as the point of an activity where human expression and skill development have stalled, as well as the point where the expenditure of cognitive and physical energy does not result in progress or reward. *Flow* can be considered the point where human expression and skill development are at their peak, as is the reward from the expenditure or cognitive and physical energies, attaining this state should therefore be paramount in any activity.

4.3.3 Flow and user experience

Technology is everywhere in the modern world. So much so that increasingly computing research and leading industries have placed emphasis on using technology to uncover and develop *Enjoyment* and pleasure from computing experiences (Monk, Hassenzahl, Blythe and Reed, 2002). It is also now accepted that human emotions are critical in activities such as decision making, perception and learning of tasks by users. Picard (1997) for example, discussed the idea of Affective Computing were computing applications could identify and interpret human emotional states and respond accordingly to facilitate interaction. Others such as Cowie, Douglas Cowie, Savvidou, McMahon, Sawey and Schroder (2000) examine the importance of identifying and reacting to user emotion the challenges posed in doing so.

Regardless of the influence of computers on human emotion, if we assume we seek enjoyment and pleasure in activity, by which we mean *Flow*, then computing activities and the user experiences they provide also apply to this generalization. There already exists an attempt to incorporate *Flow* into the realm of computer activity (Sweester & Wyeth, 2005), with *Flow* being a culmination of positive experiences by the user in computing activity. Other developments of exploring *Flow* in computing can be seen in the attempts to identify the role of *Flow* in virtual and augmented reality entertainment systems (Chou & Ting, 2003), whilst the growth of the video games industry, has seen exploration of the role of *Flow* in promoting pleasure and *Enjoyment* in computing such as video games (Weibel & Wissmath, 2011).

Within these domains of computing activities, *Immersion* is the valued aspect of promoting *Flow*, with the emphasis being that *Immersion* is a product in creating *Flow* and subsequently creating an enjoyable experience. We therefore can assume that promoting *Immersion* into any computing activities is more likely to result in a *Flow* and thusly create positive and enjoyable experiences for the user. In support of this assumption Jordan (1998) commented on the apparent lack of accounting for pleasure in products as a major factor to be considered in future application and product design. In his work, he highlighted that un-enjoyable products were associated with negative emotion such as annoyance, anxiety, contempt and frustration; thereby leading users to view such products and applications to be things to be

avoided despite their purpose and function. These negative effects would then linger after use, leading to apprehension and rejection of future use if they could be avoided (Jordan, 1998). Comparatively, enjoyable products were associated with positive emotions such as security, confidence, pride, excitement and entertainment; which encouraged the products and applications to be used repeatedly, with users becoming excited when anticipating their use. In comparing the discoveries of Jordan to the concept of *Flow* and HCI, we see strong links between the two: more use of a well-designed computing product (for example a popular video game) leads to pleasure and enjoyment for the user, where as poor design leads to negative feelings and product rejection (such as the unpopularity of new operating systems). Design of computing systems therefore benefits when considerations of features that promote *Immersion* are explored, as by incorporating features that lead to *Immersion* can also lead to overall more positive computing experience.

4.3.4 Fostering flow

Having such positive effects for the individual, promoting *Flow* is an intrinsically desirable aspect to promote in an activity. Referring to the *Immersion Model of User Experience* we can see *Flow* occurs when *Embodiment*, *Absorption* and *Enjoyment* into an activity are at their peak in an activity. This is represented as such:

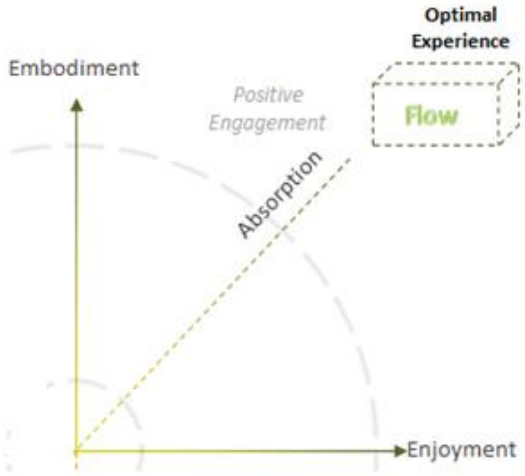


Figure 5: Flow on The Immersion Model of User Experience

Difficulty in promoting *Flow* in an activity arises from how tastes and attitudes towards different activities varies between individuals. Put simply not every individual will find the same activity as stimulating or enjoyable as the other, and as previously alluded in some cases a defining aspect of an activity may simply be that it is inherently boring. Despite this, there are several methods to developing *Flow* in an activity.

The setting of goals or objectives that can be achieved is a key aspect of *Flow*. Although some activities naturally have a goal or objective to them (for example physical activities such as sports), it is possible for an individual to create their own goals and objectives in nearly any activity (for example mastering a section of a musical performance). Setting these goals is an important first step to fostering *Flow* for the individual as successfully completing these goals and objectives is an enjoyable experience. The more goals and objectives that can be fulfilled, the more the individual derives a sense of enjoyment from the activity and in turn helps to foster *Flow*.

Next cognitive resources must be heavily invested into the activity if *Flow* is to occur. By first immersing themselves into an activity, it is only when an individual's attention is at its most intense do they experience *Flow*. Due to this elements which may divert or redirect these mental resources need to be reduced or eliminated when possible. Distractions such as awkward controls or environmental and design influences for example, environmental noise or excessive information, can divide and interrupt individual’s attention to the task at hand. In doing so this means that even though an individual may be highly engaged and immersed in an activity, their ability to experience complete focus, and in turn *Flow*, will be inhibited.

In addition, an individual should feel that the actions and movements they perform in an activity feel as though they are natural extensions of the individuals body, as the merging of action and awareness is a key aspect of *Flow*. In the previous chapter I explored the role of *Embodiment* in user activities, describing *Embodiment* as the process of making gestures, actions and using artefacts of an activity feel like natural extensions of the body. Creating *Embodiment* is achieved by making actions and movements of an activity as simple and un-taxing as possible to allow the individual to interact freely between their use and other actions necessary to engage in an activity. Due to this, complex movements or actions in an activity

should limited or simplified where possible, as in doing so the overall cognitive and physical burden of an activity is reduced and the individual can incorporate them into their natural movements, making them extensions of themselves rather than having to excessively focus or be interrupted.

4.3.5 Summary of flow

Flow is considered the optimal experience in an activity, and we seek to experience *Flow* to escape a pessimal state of *Boredom* that is both physically and cognitively harmful. To experience *Flow* a high level of *Immersion* is required, as by being immersed, one experiences a greater sense of engagement and investment into the activity. Eventually the individual reaches a level of satisfaction and enjoyment within that activity by becoming fully absorbed into it and this absorption then leads to *Flow*.

4.4 Chapter summary

In this chapter I begin by introducing the types of common cognitive and emotional experiences in an activity that individuals have, exploring how a *Neutral State* exists that allows an individual to take part in activities or idleness without becoming bored or highly engaged. In this state the individual is neither engaged nor disengaged, but instead is searching for an activity to invest their mental and physical resources to have an experience.

I then examined the four common experiences that occur as differing levels of the features of an experience occur. These were *Negative Engagement*, *Negative Idleness*, *Positive Idleness* and *Positive Engagement*. *Negative Engagement* is characterised by high levels of *Embodiment* and *Frustration*. *Negative Idleness* is characterised by high levels of *Anxiety* and *Disengagement* and is the precursor experience to the pessimal experience known as *Boredom*. I then characterised positive idleness as experiences of high *Enjoyment* but also high levels of *Disengagement* in the activity. Finally, I characterised *Positive Engagement* when individuals experience a high level of *Embodiment*, *Absorption* and *Enjoyment* in an activity and acts as the precursor to the optimal experience of *Flow*. I then move on to discuss the concepts of *Boredom* and *Flow*. Here I identified that *Boredom* is not only an emotionally

unsettling state, but also a physical risk to the individual. Comparatively I explored what it is to experience *Flow*, suggesting that it is the means to prolong avoiding *Boredom* and highlighting the features necessary for a *Flow* to occur.

Chapter 5: Literature Review

5.0 Chapter overview

In this chapter I review the literature that prompted and directed the studies of chapters 6, 7 and 8. I begin with an exploration of gesture based interaction, *Embodiment* and attention in user experiences; as well as the importance of space and movement are also discussed. In the last section of this chapter I summarize the conclusions drawn from the review of the literature.

5.1 Literature relating to Human-Computer Interaction and User Experience

Human Computer Interaction (HCI) is a multi-disciplinary topic that does not belong to a specific philosophical tradition or theoretical background. Instead the majority contributions to the HCI field date from its start in the 1980s, and have primarily held a historical basis in computer science and cognitive sciences.

A recent emphasis of these developments in HCI has been focused on *User Experience (UX)*, with focus ranging from interface design to theoretical methods and modelling techniques of user interactions with areas such as psychology; computing science; as well as art and media studies contributing to a growing awareness of audience perceptions and interactions while using computational devices.

The research presented in this thesis reflects this multi-disciplinary approach to the study of *Immersion* in the context of HCI. Within this thesis theories and methods from several disciplines and knowledge domains have been used and combined to produce the *Immersion Model of User Experience*. With works from areas such as cyber psychology, digital art,

Embodiment, interaction methodologies, *Flow*, spatial perception and *Virtual Environments* have been explored to produce the outcomes and discussions presented in this thesis.

5.1.1 Literature regarding gestures

In chapter 6 I review a study in the use of gestures as an interaction method. From this review, I could develop an understanding the role and importance of *Embodiment* in UX. Below is a review of literature used in the creation of the study.

5.1.2 Gestures as an interaction tool

The human body is equipped with a range of powerful expressive tools. On one hand, we can convey a wide variety of emotion, desire and intent when we express ourselves verbally. We use pitch, tone and volume in our voice to express what we want. In addition, the human body can move in and around space and assume a wide variety of geometric shapes with the limbs. Through our bodies, we provide dimensionality to our communications, as we strike poses to assert and reinforce the points we make, use micro-expressions of the face and body to emphasize our thoughts visually, or use gestures and movement of limbs to non-verbally communicate.

To use our bodies in our communications is a natural part of being human. Even in instances where we can't understand another individual, such as through a language barrier, we immediately call upon a vast repository of universal gestures and culturally common expressions to create a baseline communication level between one another. In activities we aren't familiar with, such as interactive art or using a touch-based device, we fall back upon familiar movements and gestures on a best-fit nature until we learn or are instructed otherwise. Gestures are therefore both a powerful tool of communication and learning for individuals.

If we consider *Gesture* as using the natural movements of the limbs and body to express an idea or an intention, then using gestures can be considered a natural method of interaction. This is based on the notion that gesturing is taught from an early age, gestures have commonalities across culture and social boundaries and gestures do not require specialist equipment or technologies to teach.

There are, however, multiple schemes for classifying human gestures. A brief overview of work on gesture classification is given in Wobbrock, Morris and Wilson (2009) whose study was based on user interactions with table top surfaces. This work highlights the primary flaws of traditional mouse and keyboard inputs: that interaction is limited by the inherent restrictions of the methods of input. A mouse for example can only allow input in the X and Y axis, as well as provide input through the available buttons on the device. Keyboards are limited by their format (QWERTY, Dvorak etc) as well as their size (standard, laptop, duplicated keys such as number pads and handheld devices) and thus restrict input through their design. Interactive surfaces however are typically operated via multi-touch free-handed gestures where meaningful gestures are constrained only in the creativity of the gestures used, thereby giving a far larger vocabulary of possible inputs than these traditional methods.

5.1.3 Examples of gesture based systems

Initial work into using gestures as an interaction method can be seen in Wobbrock, Morris and Wilson (2009) who examine how users produce gestures to interact with devices. In the study, users are presented the 'effect' that a gesture should produce, known as *referents*, and then have them perform the actions that they think would produce the given effects on the device. The recorded gestures for each referent are in turn known as *signs*. While the focus of the work is for surface computing, the potential for coupling mobile phones to other devices, such as other mobile phones, large displays and interactive table tops also presents itself.

Further exploration of *Gesture* as an input method between devices is performed in Buxton, Billinghurst, Guiard, Sellen and Zhai (2011) who examine the importance of gestures in the design of applications and computing systems. Particularly, Buxton et.al equates the

importance of defining gestures alongside that of speech; as the qualities and intent that gestures convey are closely related and categorized per their relationships with speech. In turn gestures are subdivided into the following classifications;

1. *Symbolic*: Gestures within cultures that have come to have singular meaning in a given context, such as waving the hand to symbolize hello (upon greeting) or goodbye (upon departure), or creating an 'O' with index and thumb to represent "okay".

2. *Deictic*: Gestures of pointing or direction. The intent of these gestures is to focus an observer's attention to specific events or objects in the surrounding environment. Typically pointing and line tracing fall into this category.

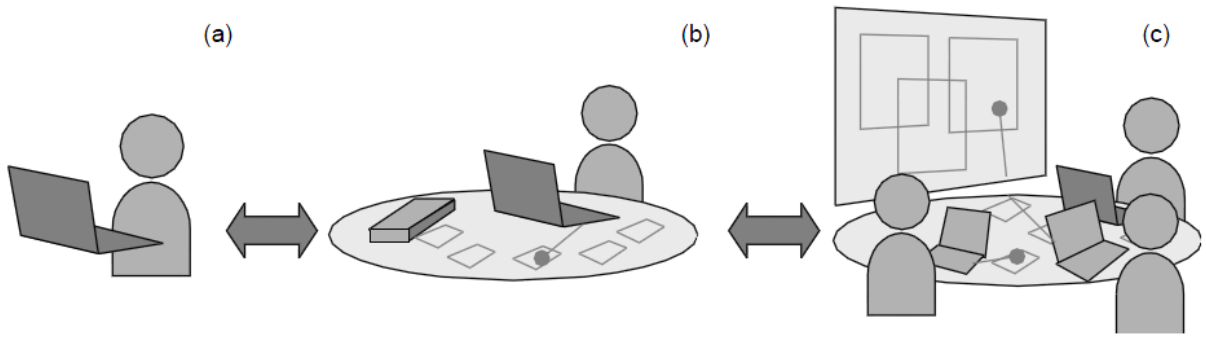
3. *Iconic*: Gestures used to convey information such as size, shape or orientation of an object. These gestures are used to convey information and characteristics visually, for example making flapping motions with the hand to represent a see-saw effect of a ship in waves.

4. *Pantomimic*: Gestures used in showing the use of movement of invisible tools or objects in the speaker's hand. For example, making the action of turning a 'wheel' using both hands.

Only one category of *Gesture*, symbolic gestures, can be interpreted alone without the need for contextual information. In the context of device to device interaction, knowing which gestures require contextual information is a necessity for effective design of such systems. As this contextual information is required to ensure that appropriate and consistent behaviours can be incorporated or achieved by a system. In support of this McNeil (1992) argues that;

> *"…gestures are an integral part of language as much as words, phrases, and sentences… gesture and language are one system… and the value of categorizing gestures in such a manner in the context of device to device interactions is invaluable*." (pg. 2)

Related studies in *Gesture* have also examined 3D spatial gestures which as seen in the works of Rekimoto and Saitoh (1999). This work, known as Augmented Surfaces, was a project with the goal of exchanging information between mobile devices, interactive surfaces and physical objects in a seamless and natural manner. It introduces the concept of "hyper-dragging" virtual objects from a mobile device display onto a projected surface thereby moving information across the boundary of devices. The system works by recognizing when a user places a portable computing device on an interactive table surface. By using marker tracking software connected to a video camera mounted upon the table, each surface can then identify which user has established a connection with a device to the table. When a user wishes to share data to others around the table they can use input devices such as mice to select and drag items from the mobile device. By dragging the chosen item to the edge of the screen, the item is then migrated ("hyper-dragged") to the table surface for interaction, whereas dragging items to other devices results in the upload of the item between devices. Further interaction across the 3D planes via hyper-dragging gestures can be demonstrated using wall-mounted devices, below is a figurative example of this process:



A: User can perform independent tasks on mobile device. B: User can drag items to work surface via hyper-dragging. C: Multi-user engagement with data items with incorporated Wall-display for additional interactivity.

Figure 6: Visual example of Hyper Dragging

Further work exploring *Gesture* can be seen in BlueTable (Wilson and Sarin, 2007). This work focuses on an infrared camera and infrared illuminated vision based system, which enables the association of a mobile device with an interactive surface. The camera detects objects placed on the table as connected components and then displays graphics that are registered with the object of a certain size and shape. To check whether the connected

component is a mobile device the system sends a hand-shake request over Bluetooth to each device in range and waits for the device to blink its IRDA port. By examining the shape of the object connected it is possible using such vision based systems to track the orientation and movement of attached devices, thereby allowing gesture input to be interpreted through the direction and orientation of the artefacts used.

Additional 3D plane gesture interactions can be seen in *Pick and Drop* (Rekimoto, 1997) which extends direct gesture-based manipulation to interactions across devices. One application example is that of creating text and graphical items on a personal digital assistant (PDA) and then copying them to a nearby interactive whiteboard. The PDA is used like a painter's tool in this case to give the impression of seamless transition from device to device. The aim of *Pick and Drop* is to provide a natural approach to transference of data items between devices rather than the traditional methods of drag-and-drop files sharing on larger systems. The reason for this is that PDA's are often limited in screen capacity so by using a traditional drag-and-drop system, where users must use select files and transfer them to a shared folder space before transferring to the required device, is unwieldy for multiple or large transfer transactions.

An extension of *Gesture* research in 3D spaces is seen in 'Hyper Palette' (Ayatsuka, Matsushita and Rekimoto, 2000) which presents the idea of using a PDA as an input device for an interactive table using the interaction metaphors of "scoop" and "spread". The technique combines device/user movement across the table with tilting the PDA relative to the movement direction. Interaction is then achieved by using two gestures for the deposit and acquisition of data items. Tilting the front edge (in movement direction) downward is termed a *"*scoop" and is used for transferring digital items from the table to the PDA. This gesture implements the metaphor of using the PDA as a scooping tool, such as a spade or shovel, for the "picking up" of digital content on the table as if lifting data items from a bucket. Tilting the front edge (in movement direction) upward and swiping the PDA across the table is termed a *"*spread" and implements the reverse operation, i.e. transferring content from the PDA to the table as though digital items are being thrown back into the bucket. Digital items are then deposited onto the surface in reverse order of collection to allow the

ability to ‘undo’ unintentional scooping of items. Figure 7 is taken from Ayatsuka, Matsushita and Rekimoto (2000) and demonstrates these gestures graphically.

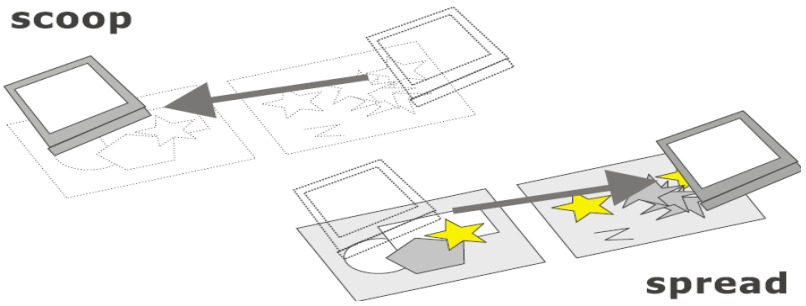


Figure 7: Scoop and Spread

Touch & Interact (Hardy and Rukzio, 2008), explores connecting mobile phones to positions on a large display. The system is implemented using Near Field Communication (NFC) and Radio-frequency Identification (RFID) capabilities integrated into a mobile phone. The reader capabilities are then used to interact with RFID tags integrated into a large display. This allows the device to be able to pick up items and drop them on a screen at the RFID locations. The selection accuracy is limited by the granularity of the RFID tag arrangement, where the more RFID tags available the greater accuracy and range of selection of items can be achieved. Comparatively, Stitching (Hinckley, Ramos, Guimbretiere, Baudisch and Smith, 2004), removes the PDA element in favour of the inputting capabilities of stylus-pen gestures. The aim of the stitching system is to use the inherent gestures of stylus-pen artefacts to span two or more devices for the transfer and manipulation of data items. Pen input on one screen is dragged across the screen and bezels of the devices to the second screen. Background systems are used to then interpret user actions and intent such as data item deposit or copy and pasting. Figure 8 and Figure 9 demonstrate these systems:

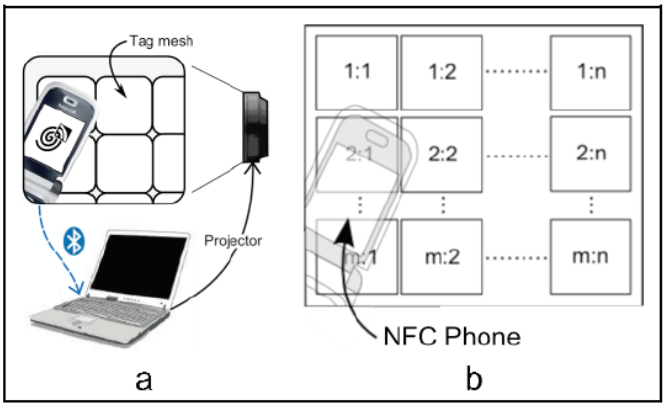


Figure 8: Example of the NFC mesh of Touch and Interact

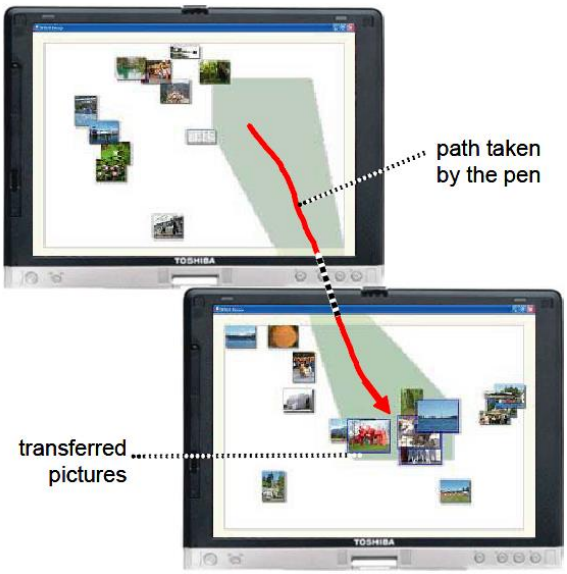


Figure 9: Example of interactions between devices in Stitching

Unlike other methods discussed that don't necessarily require device to device contact, Hinckley (2003) assumes the integral portability of both devices. In this case, the act of bumping of two or more devices together is seen as a valid method for connecting displays, mobile phones (Figure 8), or between portable devices such as tablet PCs (Figure 9). In this case gestures are made with the devices and incorporate the accelerometers attached to the devices. By setting devices to pick up the event as simultaneous sensor readings and associate the devices accordingly this removes hands-on input of network addresses or machine id's and allows for near instantaneous and seamless connection.

Application of synchronous gestures includes sharing information or dynamically tiling together displays to show an image across multiple devices (Figure 11). Woo and Lim (2009), and their work Contact-and-Connect, further investigate device interaction through device to device touch. Here they explore how gestures that are based on intuitive metaphors such as lighting a candle (tilting one device to touch another vertically aligned device), or tipping water from a bottle to a glass (making a pouring motion with one device above another to initiate file transfer) can be used to facilitate interactions in a more natural and seamless manner.

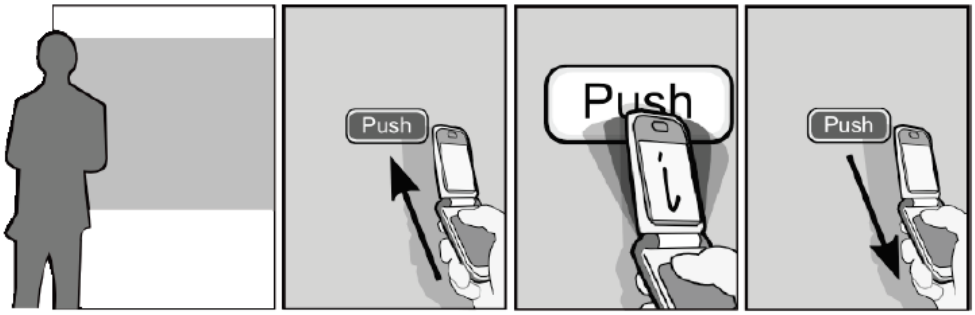


Figure 10: Touch and Interact sequence

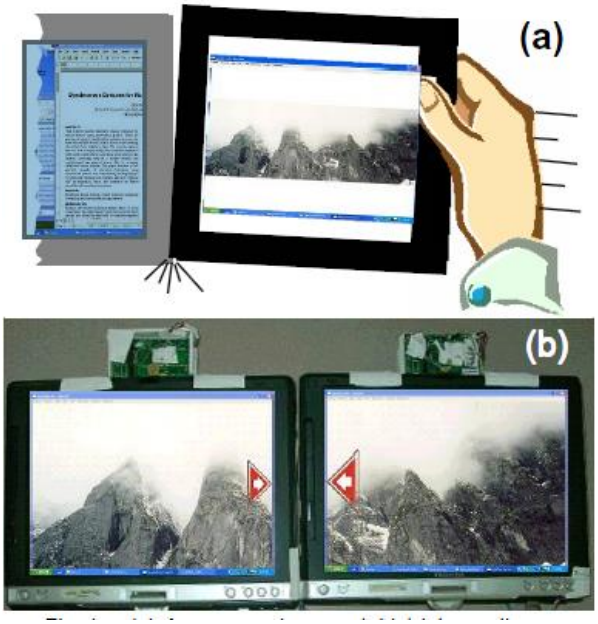


Figure 11: Bumping (a) and Tiling (b) content between devices

That one there! *(*Swindels, Inkpen, Dill & Tory, 2002), explores the use of device artefacts as gesture aids. Here, infrared pens are used to make pointing actions and transfer device identities between multiple devices. Interaction between devices is made on the assumption

of short-range communication between devices at a level where users can clearly point out which device they wish to connect to. Gestures are then used to emphasize seamless connectivity between devices, rather than using traditional network synching actions. Tandler, Prante, Muller-Tomfelde, Streitz and Steinmetz (2001) explore devices as gesture aids through the connection of multiple pen-operated devices to shared workspaces, as well as the exchange of items between them. Once again the use of built-in RFID tags and readers allow for the detection and interaction between devices by establishing ad-hoc connections.

Gesture Connect (Pering, Anokwa & Want, 2007), is a combination of device to device connection and *Gesture* based interaction for connecting and controlling devices. Here, Near Field Communication protocols (NFC) and a custom Phone System Interface (PSI) module enable command input by detecting user gestures with an inbuilt accelerometer. Users can then scan NFC tags attached to the devices they wish to interact with and control them through physical gesturing depending on the interaction they desire. Example gestures include 'wrist flicks' to change the currently playing music track on a stereo or raising and lowering the device to control volume. Additional systems requiring the use of custom-modules for device-device interaction can be seen in RELATE (Gellersen, Fischer, Guinard, Gostner, Kortuem, Kray, Rukzio & Streng, 2009), which uses a hardware dongle to exchange radio and ultrasound signals between nearby devices to infer their relative spatial relationship to one another. In doing so it is possible to track devices with a high accuracy in regards to the relative location and orientation of each device and in turn associate gestures with devices or users attempting specific interactions.

Due to the capabilities of modern phone and PDA devices, many works focus on using integrated systems such as accelerometers and NFC readers. Although such features are greatly beneficial in gesture-based interaction, BeepBeep (Peng, Shen, Zhang, Li and Tan, 2007) attempts device connectivity using features universally inherent in almost all devices: microphone, speaker and inter device communication in order to remove the necessity for specialist hardware such as those in Gesture Connect and RELATE. BeepBeep uses acoustic range sensing that sends and receives sound signals between two devices in order to infer the distance between them. In order to avoid inaccuracies in measuring the signal travel time, each device sends a signal and simultaneously listens for the arrival of its own signal at its

microphone. According to the authors indoor interactions are more accurate than outdoor cases. With indoor use cases accurate to within 2cm³ and Outdoor use cases accurate between -2cm³ and 4cm³ and places emphasis on the effects of the surrounding activity space when using gestures as an interaction medium.

Gestures related to device proximity as a method of device-device interaction can be seen in Peng, Shen, Zhang and Lu (2009) which elaborates the idea that a perception gap between devices exists. What is meant by this is that devices do not necessarily know which nearby device is the intended target to be paired with, even though the user may have clear perceptions on which the intended partner is to be. Here they explore pointing and moving one device towards another in order to enable spontaneous device pairing. By using a pointing gesture at the device intended for pairing, the device can interpret the gestures as an intention of pairing and connect the devices.

Using *Gesture* does not require expensive or specialist hardware and working systems can be achieved using current off-the-shelf hardware to support ad-hoc device connections based on intuitive spatial gestures due to the wide range of inbuilt capabilities such hardware typically incorporates. However, Kray, Nesbitt, Dawson and Rohs (2010) note several instances of impulsive gestures with relatively large movement amplitude, such as moving the entire body of the user whilst making gestures. In these cases full body movement was accompanied with outstretched motions or using the whole limb to infer meaning, which suggests that robust and powerful equipment is required for fully accurate spatial recognition of gestures in interaction.

An example of an investigation of more coarse-grained gestures can be found in Dachseelt and Buchholz (2009) Natural Throw, which examines using hand movements to align the device on the X, Y and Z axis and using the outstretched arm to make throwing gestures to transfer data items from a mobile device onto a large display. Estimated trajectory of swings using accelerometers are used to determine target location and device. Similar movements and gestures are then used to gather data items from displays by using pulling gestures to remove them from the screens. The intent is to provide a visual metaphor to aid transfer between smaller to larger displays and vice versa removing the need for higher technical

knowledge in how to pair devices together thereby opening up a wider audience for device use.

The focus on the non-technical user is also echoed in the works of Moen (2007) who argues that movement and *Gesture* based interactions are worthy of greater focus as it allows and encourages a far wider form of engagement than high-expertise devices. The focus of this design, for Moen, is on wearable computing in order to explore full body motions as an interaction modality. Klemmer, Hartmann and Takayama (2006) provide a vivid and wide approach in highlighting the possible design paradigms that can be addressed through the consideration of human movement as an interaction method.

5.1.4 KEY POINTS OF GESTURES

I consider that gestures are a natural form of interaction and expression of the individual in world around them and would benefit from further investigation in addressing traditional HCI paradigms of input and interaction methods. Using gestures can be considered a natural method of interaction on the grounds that gestures are taught from an early age, can have commonalities across culture and social boundaries and do not require specialist equipment or technologies to teach. From the review of the literature I am able to state the following key points of gestures as an interaction method.

1. Gestures are a natural tool of human communication and interactions. As a tool of communication and interaction, gestures are powerful in that they can express intent, emotion and action simultaneously without the need for verbal prompting.
2. The range of gestures is varied, and many different possible schema and methods to examine them exist. With gestures already seeing use as a possible method of human-computer interaction and computer-computer interactions as systems and sensors grow more powerful.
3. The use of gestures is based on creating a more natural interaction method for inexperienced users, but also as means to address existing limitations of using artefacts such as keyboards and mice.

5.2 Discussion of literature of embodiment in HCI

The leading examination of *Embodiment* in HCI is the work of Paul Dourish (2001) and his study of the value of *Embodiment* in HCI. Here Dourish argues that the HCI design of tangible and social computing would be bettered with a wider knowledge of everyday human activity, understanding and interaction, specifically through an analysis of *Embodiment* in computing activities.

Dourish (2001) argues that contemporary HCI has focused on a variety of techniques and technologies as well as historical background to how technology has developed over recent decades. Despite this, HCI has been criticized for offering little developed theory that addresses the emergence of increasingly complex and collaborative systems. Specifically, struggle has arisen in how such emerging systems are best structured and how they are best used and the majority of HCI research seemingly does not see theory as one of the key components of HCI. Instead emphasis has continued upon traditional approaches to HCI such as mental modelling, reduction of cognitive loads and the use of metaphors in interface design. In doing so HCI has focused on the technological innovations or ethno-methodological detail of new devices, rather than engaging in theoretical abstractions and social-contexts of device design and use. Part of this limitation of HCI is caused by several of its adopted subject areas such as sociology and semiotics, which deliberately keep theorizing and generalization at a distance in order to provide more quantitative rather qualitative analysis of emerging technological and design trends.

In address to this gap of knowledge, Dourish attempts to make theoretical discussion more relevant and accessible to a computing audience. Drawing upon established philosophy of language and phenomenology, particularly to the monist schools of philosophy. Dourish then uses this philosophical background to ground a conceptual framework and a corresponding set of principles for system design practice, noting that the ideal system design is a balance of "the ability to develop systems that resonate with, rather than restrict (or, worse, refute), the social organization of action" (Dourish, 2001). In particular, Dourish goes on to emphasize the emergence of tangible computing and ubiquitous computing as the fore-front fields to explore and develop such design methods.

The proliferation of mobile and highly-sensory devices over the past decade contrasts starkly with the legacy of older systems that use or possess very few features as integrated functions. Parallel to this, HCI has continued to focus on the more traditional design route to treat devices and device owners as isolated systems and system users, where devices are considered to stand alone from one another rather than parts of a wider interconnected system. HCI design of tangible and social computing can therefore benefit from a wider knowledge of everyday human activity, understanding and interaction.

Being aware of how a user is practically engaged and non–rationalising in everyday activity is rarely used in HCI but is familiar to other academic disciplines such as psychology and art. In turn HCI is, in many ways, repeating the lessons that philosophy, linguistics, sociology, architecture and many other fields have already explored over the past centuries. Therefore there is need from the mobile/ubiquitous conceptual shifts in computing to look at the lessons of old to provide direction; and to be aware that understanding interaction is critical to the effective design and use of current and future technologies.

Embodiment provides a possible answer to this lapse of knowledge in HCI in two ways. The first is in developing a better understanding of human activity, in particular the way that people's interaction with systems are a fundamentally embodied phenomenon (Dourish 2001, p. 145). The second use of embodied interaction is to view embodied interaction as a critical element when discussing the design of existing technologies. Dourish presents six points to consider in the use of *Embodiment* in system design as such:

1. Computation is a medium

When considering *Embodiment* in system design it is important to consider that computation is a medium where embodied interaction manifests. Social studies of computer use have shown that systems are most successful when technology is made to fit into the working setting and activities rather than being the central focus of said settings or activities. Mean whilst, the practices and methods of the working environment are in a continual flux and transition, evolving and developing as time passes by and capabilities and requirements are

realized and created. The focus of HCI then should not be to create a technological snap-shot of a working environment to fit a system into, but rather create and design systems to facilitate this evolution and development of the working environment.

Dourish (2001) compares this to the 'tool paradigm' for interactive systems, with the idea that a system should present itself to users as a tool without overly constraining how the tool is to be used. Traditional interpretation of this tool paradigm has normally been realized at the level of applications, where design of applications has centred on providing features that allow reading, writing and communicating information to and from a particular application to the user through various features and functions. However it is now not enough to just mimic existing tools or to create new assortments of features in HCI design, but instead to recognize that the computer itself is a tool.

Directness has therefore become a key property of user interaction. Rather than respond to the requests of the system, users instead seek to understand how their direction (control) is achieved through the actions and feedback the system provides. Such feedback can be found in examination of embodied interaction, as it is through embodied interaction that we can understand how information can be made directly available and perceptible to the user; without requiring indirect manipulation or interpretation. What this means is that how the computation of actions are achieved becomes the tools in which we can design and foster the expected outcomes and experiences users desire.

2. The User manages meaning

Embodiment is inevitably a user-centric experience when it comes to system design. If we must consider computation as a medium, then we must in turn consider that the user is the agent to give meaning to the computations made. What is meant by this is that through *Embodiment* of the world, the user gives and creates meaning to their actions and through embodied interaction in computing, similar meaning is created in for the actions performed. In turn our use of *Embodiment* in system design must understand how these meanings are created by the user.

Meaning is created through experience and taught behaviour. An icon of a pair of scissors, for example, can indicate a cutting function or perhaps removal of a selected area or element. Working practices and conventions also inform user meaning. Take for example the README file of system. No standard requires the presence of README files as part of a systems documentation nor is it set they are mandatory reading before system use. However convention and practice will typically have the README file give the user a summary of what the system can do or instructions on how to configure and setup the system; whilst access to the file may be offered prior to or after installation of a program.

As users will be the central operators of a system as well as influenced by particular working practices and trends of the working environment, users are therefore best able to determine what features should be inhibited or hidden in the craft of system design. Designers can add as many features as they can design but the practicality or the actual use of features is ultimately up to what users find meaningful in achieving specific actions. Designers must therefore be more aware of the communicative significance of systems and the features contained within them through the user. Through an awareness of embodied interaction, designers are therefore able to understand how their users intend to use a system at both a physical and social level and can design them appropriately to demands and requirements of the user, rather than just the requirements of the system.

3. The User manages coupling

If users manage the meaning of features and use of a system, then they must also be the central focus on the coupling between different features of a system. Coupling refers to the degree of coordination of two elements of a system and how coordination between those elements and the system is maintained. A classic example of coupling in HCI is the use of a mouse to manipulate a pointer in a graphical user interface. In normal use the mouse moves directly with the user's hand and the cursor on the screen moves directly with the movement of the mouse; with each of these elements coupling the connection between the hand-mouse-pointer. The effect of this coupling means that activities in the system can be organized in terms of high-level interaction concepts. For example "dragging and dropping" in terms of

higher-level actions infers a process of selection and moving items on screen using the action of the mouse.

Coupling is broken in several different ways. Physically there may not enough space to complete an all-in-one action. Take for example the edge of the mouse pad or length of the operator's arm which poses problems for the coupling between hand movement and mouse movement to be unlimited. In addition a broken mouse might introduce troubles for the coupling between mouse movement and cursor movement, whereas broken buttons on the mouse limit the manipulation capabilities of the system by the user. From a technical standpoint coupling can be broken by issues such as system workload, which may mean that the computer is so busy that responding to user interface events may be delayed or outright discarded.

The critical point to understand about coupling is that it occurs at different levels of a user's interaction and *Embodiment* in a system. At these different degrees of coupling, the entities with which the user interacts and their meaning are also different. Take the prior example of meaning in the system. The "cut and paste" option is represented through set of pixels as a display artefact; as a button; or as the system function accessed through right-click commands and keyboard shortcuts. The meanings assigned to the objects in the interface change as actions are performed.

It is also important to understand that coupling and intentionality are directly related. Cutting a body of text would imply it is being removed for later use, whilst cutting another body of text immediately after leads to questions what to do with the last stored cut. Most simple editing systems only store the last cut section for pasting, is the user then wanting to "cut away" the first piece of text in the meaning of "cut and remove" or do they still see the "cut" option as having "removed for later use"? By implication if we emphasize that users manage meaning, users must also be able to manage coupling in system design. Designers of systems thus need to understand how users engage and disengage from the system; with coupling being the heart of a user's ability to work with and control the system. Examining user embodiment in interactions allows designers to tease out these complex requirements by uncovering the various layers and coupling links by exploring how actions in a system are

performed and embodied, allowing a far more natural system to be designed for the intended users.

4. Embodied interaction participates in the world it represents

Embodied interaction rejects the notion that artefacts used in a system and the system itself are separate entities. Instead we must consider that both are entities that participate in a single coextensive reality and within this coextensive reality the artefacts and systems not only represent information about their activities, but also about the activities surrounding that information.

An example of coextensive reality is the example of a medical record of a patient in hospital. Here the medical cards held in the record not only represent information about the patient, but information about wider activities performed on behalf of the patient. The card thus gives the reader information about the patient, but also about itself and the activities it was used for. For example a blood-screening card can contain information of toxins and adulterants in a patient's blood; it is a physical artefact of the hospitals patient care system. However the blood screening card also infers non-physical entities such as the conceptual organization of patient files of the hospital, the processes of patient care and treatment, as well representing the work performed in the hospital. The card is thus an output of the system, but it also participated in its own production and when used by the user (in this case a doctor) becomes an embodied artefact that summarizes the results of all the background activities and interactions required to produce the card. The key point to take away here is that artefacts that act as representations in a system work on multiple levels that may not be obvious to users but are taken for granted. From a design perspective capturing such interactions is extremely difficult without examining how and what artefacts users are engaged and embodied in activities within the system.

5. Embodied interaction turns action into meaning

How embodied technologies and subsequently embodied interaction turns user actions into meaning is also important to consider. In the previous points it was noted that computation is a medium like any other, and a computational representation of an action is often in the form of symbols and icons. Like any symbol features gain meaning from their combination with other features and their function and role-of-use within the system. By using these features users give meaning to the system.

This meaning is created through *Embodiment* as users perform actions in the system through their understanding of its processes, tools and the symbols used to represent functions within. In addition control methods such as audible utterances, physical gestures; and manipulation of artefacts collectively constitute the modern users computing activity. When combining features and control methods, the activities performed using these tools and features are used to convey and create meaning for the user's intentions and the functions of the system as a whole. For example using the copy feature infers the replication of information or styling. When using cutting features, such as cropping tools, meaningful manipulation and organization of information is inferred. In turn using a series of cutting and copy features infers an editing or formatting activity being performed by the user whilst through these actions infer that the system is an editing suite of sorts.

Since meaning is created through the user's actions and activities *Embodiment* becomes the manner in which the user translates their intents and actions into meaningful activity. Through the users interaction with the features and artefacts of the system they fulfil the activities and goals they wish to achieve. Thereby giving meaning to the system and actions as whole. Design of systems benefit from understanding how this meaning is created because it helps understanding the activities and conditions a system is used within. We explored in earlier chapters that modern devices are increasingly being used in manners and activities far beyond their original function. By understanding the possible activities and contexts users may use a system, design can focus into which features create or hinder positive experiences of use.

6. Embodied interaction relies on the manipulation of meaning on multiple levels

Much like coupling, meaning within the system can occur on different levels for the user. Meaning also changes within each area of a system a user is engaged within. Take the example of an editing suite where the user is editing a video clip. Using the cutting command they edit and crop scenes of video into the order they wish. Cutting in this sense obtains many different meanings. It can in an overview of the entire video, mean to shorten the video by removing content, but also can mean extending the video by cutting other elements and adding them to the video. At levels of sound editing cutting may mean removal of sections such as sound; or perhaps the order that sounds appear between scene to scene (such as voice over's or sound effects). The critical point of this is that the design of any system should account for the fact that users assign meaning to the computational systems at different levels of use.

System design needs to account for this diversity of meanings and how meaning transforms during use by the user. The benefit to understanding these different levels of meaning can allow designers to understand how to make systems 'natural' to use. By understanding how meaning changes level to level, the design of features can be catered to ensure that the expected behaviour of a feature occurs at the appropriate level; and that supporting features added or removed depending on which level of meaning is desired.

5.2 Discussion of literature regarding attention and space

Attention and space are integral in the fostering of *Immersion* in activities. I consider that *Attention* is greatly influenced by the environment that an activity occurs in as how we move and interact with that space serves to focus the mind and focus of the individual into that activity.

The role of space and *Attention* can be seen in the topic of *Proxemics*. *Proxemics* is the use of space in communication and organization of human activities. Hall (1963, 1966), for example, explores the importance of proximity and space in defining and shaping an

individual's actions and reactions to a given situation. Earlier in this chapter I examined the philosophical foundations of experience and perception, with an implicit notion that all experiences are shared. Hall (1966) strengthens this implicit belief that experience of events and activities is a shared experience by emphasising that individuals of different cultures occupy different sensory worlds but experience the world similarly. Hall (1966), argues that different cultures and peoples have a selective screening of sensory data where, due to cultural influences, some information is retained while filtering out others. Due to this, experience as it is perceived through one set of culturally patterned sensory screens is quite different from experience perceived through another – however the experience is collectively shared between the native and non-native cultures. For example, a Japanese traveller may be accustomed to close proximity with others on public transport, whilst American individuals consider such close proximity an invasion of privacy. Regardless the experience of proximity is universal even though the interpretation of its meaning and the spatial boundaries may not. Hall and Hall (1975) argue that this sensory screening is linked to environmental and architectural design choices across different cultures. Here they comment that the architectural and urban environments are expressions of this sensory screening process and that it is possible to learn how different peoples use their senses based off these choices. By understanding these sensory implications, design of systems and devices can be greater catered to practices and acceptable use to the user or audience.

Hall (1966) argues that even though cultures may differ in their use and interpretation of space there are commonalities across all cultures. Here he highlights what are termed Reaction Spaces, a geographical spherical perception of personal space around an individual. Four different spaces exist which are:

1. The *Intimate Space:* The immediate reaction space around the close proximity of the body.

2. The *Personal Space:* The distance of space that an organism maintains between others without involuntary bodily contact.

3. The *Social Space:* The socially and physically conditioned boundary line between the area where an individual does not touch or expects to be touched by another without concerted or special effort.
4. The *Public Space:* The Where environmental and personal interaction is almost entirely observational and navigational.

Graphically these spaces are represented as such:

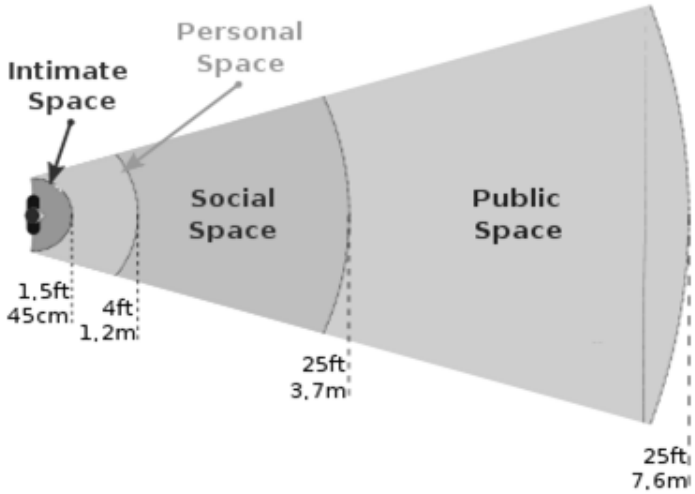


Figure 12: Reaction Spaces in Proxemics

Within each of these differing spaces, Hall (1966) examines how user activity and behaviour differs, noting that the closer and more intimate the activity is in terms of which space it occurs within, the greater and more intimate the personal interaction and attention is given to the activity. Proxemics therefore provides a basic spatial frame work of where *Attention* is most focused by an individual in an activity or item in a given environment. I model this as such:

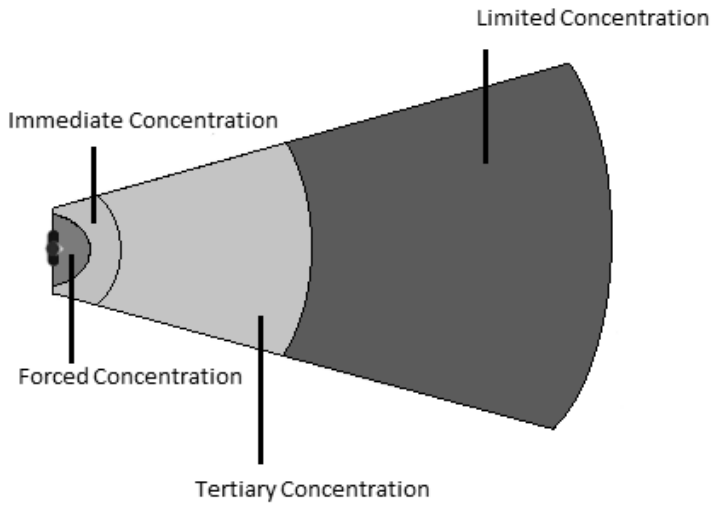


Figure 13: Reaction Spaces as Concentration Zones

Subsequent research into the role of space and attention can be seen in works of Space Harmony and Laban Movement Analysis put forward by Rudolf Laban (1966). Here, Laban discusses the range of human movements in physical spaces are diverse and vast whilst at the same time a powerful communicative and interactive tool. Laban establishes a systematic approach to human movement, presenting these theories of movement in his model of Laban Movement Analysis (LMA). LMA explores the role of movement and space harmony (Laban, 1966) noting that motion is achieved in connection with the environment, the spatial patterns of moving the human body and the lines of spatial tension that these movements require. By this, what is meant is that the geometry of human movement is spatially harmonious in that awareness of space and movement of the body influence one another.

Laban concludes that all human movement is divided into four categories. These categories are as such:

1. *Body*: Movements of separate body parts and their relationship to one another. Laban considers that movement is influenced by the body's structure and organization. Laban used theories of platonic solids and geometric foundations to represent the interplay of different body parts to achieve a particular form.

2. *Effort*: Effort represents the characteristics of different movements based off four sub-categories, weight, flow (i.e. continuity), space and time. These are the dynamic qualities of a movement that distinguish similar movements from one another. An example of this can be seen in the differences between an individual punching their fists straight ahead of themselves, and reaching for a glass.

3. *Shape*: Shape represents the changing directions and forms the human body changes in relation to it and its surroundings as movements are made. By observing the shape aspect of movement, one aims to describe the process of the body's shape change in space. In particular Laban emphasised that shape represents how human movement allows an individual to become in contact with or withdraw from the environment by changing the body's shape.

4. *Space*: The space category involves motion in connection with the environment, spatial patterns, pathways, and lines of spatial tension. Here Laban argued that space is divided between the general space, the environment around the individual, and the Kinesphere; the space around us within reaching possibilities of the limbs without changing one's place.

The value of Laban's work is that it provides a framework of analysis to see the forms of how humans can be embodied in space. If we treat Proxemics as how *Attention* is managed in space, then Laban's work represents a method into analysing the forms that individuals can take to interact and embody themselves in that space. In particular Laban's views on space harmony are relevant because of the way in which it emphasises a relationship between the individual and environment around them. In previous chapters I explored the idea that *Immersion, Activity Space* and *Embodiment* are tied together in fostering *Flow* in activity. Due to this I also consider that Laban's view on the link between human and environment contributes towards how *Embodiment* is important in natural human activity, with the key point being that human interaction is tied to both influencing and being influenced by the environment of the activity.

5.3 CHAPTER SUMMARY

The research presented in this discussion of the literature reviewed during the study has aimed to reflect the wide and multi-disciplinary approach used to direct and influence the studies presented in Chapters 6, 7 and 8.

In this review I explored the in the use of gestures as an interaction method. This research prompted the study found in Chapter 6 and Chapter 8 as well as providing an understanding of movement and embodiment in UX. Following this I explored the role of *Embodiment* in HCI. Here I discussed the work of Paul Dourish (2001) and examined how *Embodiment* occurs as a natural forms of interaction and expression of the individual in the world around them. Related to this exploration of movement, I then explored how attention and space are related in fostering *Immersion* and *Flow*. In particular I consider *Proxemics* as a useful spatial framework where attention is most focused by an individual in an activity. The influence of the space, our awareness of what is in a space and how the individual acts and interacts with an activity space were considered in this review. This body of literature formed the basis of the study discussed in Chapter 7 regarding the importance of space and its effect on user experiences.

CHAPTER 6: STUDY 1 - GESTURES AS AN INTERACTION METHOD

6.0 CHAPTER OVERVIEW

This chapter explores and summarizes a study in using gestures for device to device interactions performed during January 2010 at the Culture Lab of Newcastle University. The study was originally an attempt to address a gap of knowledge which exists in current gesture based interaction research with mobile devices. Specifically the study aimed to elicit knowledge of what gestures are naturally produced by users when using mobile devices to interact with other devices. The study was also aimed at assessing the potential of *Gesture* as an interaction method; as well as to probe initial information from users about which gestures they would produce naturally when using mobile devices. The study was also intended to gather some initial feedback about these gestures in the context of a number of activities.[1]

During the investigation, it was discovered that *Gesture* was not only a beneficial form of interaction, but led to high levels of creative interaction and activity *Engagement* by the user. I examine how using this gesture based interaction has the potential to be beneficial in fostering interaction, by making activities involving two or more devices easier for the user. I seek to emphasize the use of gestures as an interaction method that fosters embodied interaction due the user's inherent natural proficiency and vocabulary of gestures

6.1 OUTCOMES AND DISCUSSION

The outcome of the study was over eleven hours of comprehensive video of 23 participants engaging in the task-based activity. From this video a basic annotation schema was drawn up

[1] A shorter version of this chapter is published as a paper: KRAY, C. NESBITT, D., DAWSON, J. and ROHS, M. (2010). User-defined gestures for connecting mobile phones, public displays, and tabletops, *Proceedings of the 12th international conference on human computer interaction with mobile devices and services*, Lisbon, pp. 239 – 248.

to record the key elements of the gestures that were made. In addition participants provided verbal and written feedback about their experience during the study, this was captured in the form of verbal discussion with the investigators during the final feedback, as well as completing review questionnaires related to the study. From this feedback I gained an understanding of commonly used gestures for interaction activities by users as well as user feedback on which gestures were suitable for specific tasks and activities.

An unintentional aspect of this feedback was the reported level of *Engagement* in the activity that occurred by participants. Overall the range of gestures was wide and varied, and several participants mentioned during the review stage of the investigation about how engaged and involved they felt they had become in the activity. Particular emphasis was reflected in the review of how appropriate certain gestures were in activities. Despite having completed the task and feedback section of the study, participants felt motivated to consider, justify and develop their answers outside of the formally recorded setting. Uniquely users did not differentiate that no true interaction was performed between devices, as all artefacts used during the study were deactivated or switched off to prevent distraction. Users were therefore self-reporting high levels of *Engagement* and *Enjoyment* in what we would consider being an inherently non-interactive activity and were continuing to perform and review elements of the study outside of the original intended discussion boundaries.

In review of this feedback, I considered which aspects of the activity could have fostered such experience and encouraged such feedback. From this consideration I was able to postulate that through *Gesture* users were becoming embodied into the activity and in doing so becoming immersed and experiencing *Flow*. I theorized that this occurred as participants were being tasked to develop and determine which gestures would be appropriate for each action, and that their *Embodiment* into the task through *Gesture* was also providing a positive feedback to fulfilling the tasks and goals of the activity. As the goals and rewards were also quite clear to participants i.e. the more questions they answered the more questions were asked, and the closer to their financial reward for participation they became, the foundations of *Flow* were created.

As the boundaries of the activity were limited to the field of view of the camera, so was the *Activity Space* for the participants to engage within. Though I shall discuss the importance of *Activity Space* in the subsequent chapter, I feel that the environment set up for the study was unintentionally contributing to fostering *Immersion* and *Flow*. I consider that due to the setup of the room, the mental energies and concentration of the user were being focused into the physical spaces between themselves and the artefacts being used. From this I consider that the combination of these factors fostered *Immersion* into the activity by the participant and I consider that unintentionally, *Flow* was fostered and experienced. To evidence this in a retrospective view, the goals and objectives of the activity were clear, feedback was immediate and responsive and the challenge of the task varied from question to question. In doing so *Enjoyment* in performing the activity was developed resulting in *Flow* and accounting for the feedback received.

6.2 BACKGROUND OF THE STUDY

In background to the work presented there exists a broad range of available devices to research and study for suitability, capability and commonality of using gestures for interactions. For the purposes of this research however I have chosen to focus on the increasingly prevalent adoption of mobile phones and smart-phone devices, as this provides a suitable area to explore gesture-based device-to-device interactions. The reasoning for this is that mobile phones include a variety of powerful sensors such as cameras, Near Field Communication (NFC) readers, compasses and accelerometers. In principle these sensor suites could be used to detect gestures whilst at the same time remain a portable, familiar, frequently used and easily obtainable technology for users. The aim of the work is to highlight what natural gestures are created using portable devices when users are presented with questions of what expected gestures will create certain outcomes and fulfil different tasks between device-device interactions.

Gesture based interaction has the potential to be beneficial in terms of making activities involving two or more devices easier to use. However a gap of knowledge exists in what gestures a user produces when using gestures for interaction. In order to address this gap of knowledge it is necessary to query and engage users about which gestures they would

produce naturally when presented with specific referents involving device-to-device interactions. The aim of the following work was, at the time, to highlight research undertaken to gather some initial feedback about these gestures in the context of a number of device- to-device interactions using gestures made with mobile phones.

As explored in the discussion of literature in Chapter 5, research in HCI has been focused on facilitating and simplifying the connectivity and interaction between devices using gestures, artefacts or physical touching devices. Also shown in this related literature is that the array of possible mediums and methods to explore to address the issue of interconnectivity between portable devices is varied. Hand held devices, static devices, sound based devices and artefact dependant examples are all plausible systems and technologies that encourage further study and solutions to existing connectivity paradigms. The drawback to this has been that the study of interactions between mobile phones and other devices have been on a per-case basis. Rather than create a wider knowledge of the general use of *Gesture* as an interaction method, this has instead created a body of specialist research that focuses on these use cases; with the methods of creating interactivity aimed at a specific per-device case rather than generalised level. In doing so, little attempt into what gestures users produce naturally when posed with activities and tasks has been made creating a gap of knowledge which exists within the study of using *Gesture* as an interaction method.

In order to address this gap in knowledge, the study performed in January 2010 aimed at examining the following research questions:

1. Which gestures do users produce naturally to trigger various activities involving a mobile device and another device?

2. Which of these activities do lend themselves well to being triggered by gestures, and which ones do not?

3. What is the impact of different types of content and devices on the gestures being generated?

6.2.1 Importance of existing none-gesture based connectivity in mobile phones

Current mobile technology possesses a great deal of in-built and customizable connectivity techniques to allow portable devices to interact with others. Typical wireless connectivity solutions can be seen in the form of Wi-Fi which uses existing wireless local area network (WLAN) technologies as intermediaries to establish connections between devices. Other connectivity can come in the form of Bluetooth which uses short-range radio transmissions to establish Personal Area Networks (PAN's) between users and nearby devices. However other standards have also been incorporated in mobile devices. The Groupe Spécial Mobile / Global System for Mobile Communications (GSM) are the European telecommunications Standards Institute responsible for connectivity between mobile phones of older generations. Other systems also include using features such as Infared Data Association (IRDA) ports for communication between devices and direct-cable connections using standards such as the Universal Serial Bus (USB) technologies. These methods provide existing and background support for gesture based interaction as it is through these protocols that gesture based commands can be transferred between devices.

6.3 Study design

This study is an observation study to examine human computer interaction using mobile phones as a method of device-device interaction. In this section I explore the setup of this study.

6.3.1 Participant recruitment and information

Participants were recruited through the use of publicly handed-out flyers, posters positioned in high-foot traffic areas of Newcastle and Northumbria University, as well as agreed upon public spaces such as windows in local businesses. Additional effort for recruiting participants was through various internal cross-department electronic mailing lists at Newcastle University, as well as word of mouth from investigators to friends and family. Social media was also used to recruit participants using the Facebook platform. Recruitment began one week before the first study was run in order to establish time-slots and scheduling

for participants. Participants were then staggered so that interaction between individuals was kept to a minimum so as to limit the possibility of participants who had completed the experiment to provide information to influence pre-meditated gestures or prompts for others.

Response to the study was limited despite efforts. In the end the study ran for a total of three days with a total of 23 participants, of which eight were female. The age range between participants was 18 and >60 years old, with the majority (N = 20) being less than 35 years (SD = 8.61 years). Ethical consideration was sought with Newcastle University and granted approval. This study was given favourable opinion due to the considerations of management of participant information, participant video and the publishing of results.

6.3.2 Apparatus and material

The study took place in Culture Lab, a media laboratory located on the campus of Newcastle University. Participants were each assigned a time slot to attend the study and were greeted at reception. Once information packs had been given out participants were then taken to a limited access media-room where an installed video camera was situated for recording the study. Alongside this video camera was other apparatus necessary for the study. The additional apparatus within the work space were an interactive tabletop system (Microsoft Surface) and a large plasma screen representing public displays (the size used was 42” mounted upon a stand). In order to prevent distraction and possible interference, all devices had been deployed in their standard forms, but were turned off whilst the trials were being performed. To limit cross-participant exposure and communication, only the investigator and the subject were present in the media room during each of the trials. As time slots were staggered in the event of a participant over-running the expected time slot other participants were placed in a waiting area in the entrance area of the media lab. Contact between waiting and leaving participants was monitored to prevent interference.

As the trials required use of a mobile phone, participants were free to use their own handheld devices during the study. However if unable or unwilling to use their own devices participants were provided with a Nokia N95 Smartphone. Again to avoid distraction and interference this device was turned off. If the participant chose to use their own device they

were instructed to turn their own device off and the study would not begin until they had done so.

For the phone-to-phone condition, the investigator held out a mobile phone at about arm's length so that participants would have a point of reference when performing their gestures. To facilitate this, investigator and participant were spaced apart roughly 1.5 meters. Distances between each of the apparatus for the trials were set up so that a participant could easily reach either device without having to walk or move about in the room any more than necessary. The study followed a within-subject design where the order of exposure was counterbalanced between the three conditions. For each condition there were twenty questions and the order in which they were asked was randomized across conditions and participants. Figure 14 below demonstrates the apparatus set up**:**

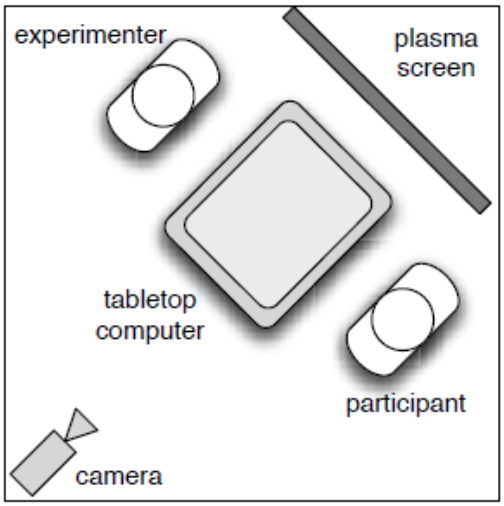


Figure 14: Gesture Study apparatus setup

6.3.3 PROCEDURE

Upon arrival participants received a randomly selected information package. The content of all packages was the same but each contained the counter balanced questions for the investigator to use. Contained within the pack was the initial information sheet (Appendix A) which provided them with a short overview of the study, its aims and an initial questionnaire that contained a small number of questions about their background, age, gender and

experience in using the devices used in the study. Once completed this initial questionnaire was then returned to the information packet for collection by the investigator. To keep confidentiality for participants rather than names or contact details, each information package was numbered.

After participants had read the information sheet and completed the questionnaire, the investigator then provided them with a verbal briefing that detailed information about the study, participants were then briefed of what was involved in each trial. Participants were then informed that there would be three sections to the study covering different device to device interactions. After finishing the explanation, the investigator provided subjects with the opportunity to ask any questions they might have. Investigators explicitly discouraged questions during the study to avoid situations where a participant would engage in a dialogue about their gestures.

The participants were then asked which device they would like to use, their own hand-held devices or the Nokia N95 Smartphone provided by the investigator. If a participant chose to use their own device, they were instructed to turn it off before proceeding. After this the main study began after all questions of the participant were answered.

Three conditions, phone to phone, phone to screen and phone to table were to be studied. For each condition the investigator would first read out a brief explanation to the subject, which highlighted the device configuration that pertained to the condition. Additionally the investigator instructed participants to clearly indicate once they felt they had finished a gesture through a verbal signal, for example saying “done”, once a gesture had been completed. The investigator did not demonstrate or provide verbal information about how gestures should be made with regards to each condition by participants so as to avoid influencing or prompting them into particular gestures.

Due to the nature of the apparatus involved in the study, in the case of the interactive table top, the investigator also provided a verbal explanation and brief description of what a table top system is. This was based on the assumption not every participant would be familiar with

such technologies. The order of questions related to the three conditions was then counter-balanced between participants. For each of the conditions, subjects had to answer twenty questions in the form of gesture 'signs' relating to 'referents' posed by the investigator.

For each question, the investigator first read out the question to the participant. The participant then performed a gesture or indicated that they were unable to do so. Once they indicated that they had finished, the investigator asked them to rate how well their gesture matched the device configuration and the activity described in the question. After participants had responded, the investigator would then move on to the next question. At the end of the third condition, subjects were returned reception and provided a final questionnaire (Appendix B), this contained questions about their general attitude towards using gestures with a mobile phone device to trigger activities, as well as some further questions relating to their technology experience and proficiency. Upon completion of this final questionnaire participants received a small payment of £5 (Sterling) to compensate them for their time. They were then discharged from the study.

6.4 Overview of results

Of the 23 participants 22 owned a mobile phone device. During the study, the majority (N = 19) preference of participants was to use their own hand held devices rather than the Nokia N95 provided. The investigators attributed device familiarity as the reasoning for this choice by participants.

All participants that took part in the study reported that they had prior experience in using or engaging with a public display of some kind. Under half (N = 11) of the participants had not used or come across a table-top touch surface computer system before the study. This result was higher than expected due to the specialist nature of the apparatus, but can be attributed to its common deployment in public spaces. If participants had used any of the apparatus devices beforehand, they were asked to rate their level of expertise in using and interacting with the devices on a five point Likert type scale, where 1 corresponded to "very inexperienced" and 5 to "very experienced."

The purpose of this scale was to gain an assessment of the technological "savviness" of participants i.e. how well each believed they were able to interact and use the capabilities of the devices without instruction or demonstration, so as to judge their level of expertise with interacting with the different apparatus. Results of this assessment showed that the average self-reported rating for expertise with a device was highest in the case of mobile phones (M = 3.91) followed by public displays (M = 3.59). The table-top computer received the lowest average rating (M = 3.00).

Each participant completed 20 questions per condition and experienced all three conditions, with the order of these conditions randomized between packs. In total investigators collected video footage of the experiment recording more than 300 individual gestures. On average it took participants about 27.5 minutes to complete the study, with the longest time taken being 45.5 minutes (SD = 4.13 minutes) and the fastest being a little less than 20 minutes. Variation in time was attributed to types of gesture made, for example waving gestures typically took 2-3 seconds longer than pointing gestures. Contact gestures between devices had the longest duration, lasting between 4 to 6 seconds with short 1-2 second pauses to emphasize particular actions or intended effects. Variation in completion times was also attributed to participant response times to questions, i.e. the time it took before the participant made a *Gesture* after being given the question. In several instances participants exceeded two minutes before responding. Subjects took on average about nine minutes per condition, which included the time taken by the investigator to read out the initial instructions and the questions preceding and following each *Gesture*. In total approximately eleven hours of video material was recorded during the study.

6.4.1 Gesture analysis method

A detailed analysis of all the gestures would require a thorough annotation according to a well-defined set of criteria to accurately capture all aspects of each gesture made by the participants. Such information as the 3D trajectory of the gesture or changes in velocity during the gesture would also need to be documented in order to help distinguish the context of the gesture. For example, it was noted that gestures relating to 'referents' of rewinding or aborting interactions were made at greater pace than those for moving or scrolling

interactions; comparatively manipulating gestures such as pausing or stopping material on other devices were often slower to represent greater levels of accuracy.

In order to assess whether such detailed analysis would be worthwhile, the investigators screened the recorded footage for some basic gestural properties (Appendix C). All footage for each of the three conditions was divided between investigators and annotated. Since the properties were very basic and of factual nature rather than of interpretative nature, such as labelling a gesture as 'pointing' or 'flicking', it was deemed unnecessary to have several annotators work through the entire set simultaneously in order to be able to perform a cross-validation between individual judgements afterwards.

Each *Gesture* was attributed six properties. Four of which were binary attributes, where a property of the gesture was either true or false. The remaining two properties were time measures recorded in full seconds based off their duration on the video-playback software.

The binary attributes were concerned with the distance between the mobile phone held by the subject. These attributes recoded changes in distance whilst the gesture was performed by the participant. Cases where devices touched or were placed upon one another were also noted. In addition, rotation of the participant's hand-held device along any axis was recorded as well, if the participant's device location remained constant this was also noted. For example if the participant's phone was moved in front of the public display while maintaining the same distance to it, I would record a location change but no change in the relative distance.

The time based measures were the delay before producing a *Gesture* and the duration of the *Gesture* itself. The former was recorded as the time interval (in full seconds) between the investigator finishing reading out a question, which asked the subject to perform a *Gesture*, and the time when subjects started to physically move or make a *Gesture* with the mobile phone in any way.

The duration of a *Gesture* was specified as the time in seconds between the start point of the *Gesture* (when movements were first made) as well as the end point of the *Gesture* (when the

participant indicated completion). However it is important to note that although part of the instructions read by the investigator at the beginning of each condition asked participants to clearly indicate when they were done with performing a *Gesture*, i.e. by saying "done," many of the participants did not do so during the study. Due to this the annotation team defined the end of a gesture either being marked by the subject indicating it explicitly (verbally) or by them providing a rating for the quality of the match. In many cases participants would perform a *Gesture* and then immediately provide a verbal quality of match. In such cases the annotation used this to mark the end of a gesture. In cases where participants did not indicate ending or quality of match for a *Gesture*, the annotation marked the end of a gesture as the point in time when the investigator started reading out the question about the quality of the match. Due to these circumstances duration measure of the gestures is not very precise and provides only an indication of the upper bound of how long gestures took.

The investigators did not explicitly instruct participants to keep quiet during the study in between questions or gestures other than to request questions be kept to the end. Due to this several subjects complicated annotation of gestures by explaining the gestures or quality of match as they performed them, or engaged in think-aloud activities. Several incidents of ambiguous situations arose in cases where participants would comment aloud what *Gesture* they would make for an activity but then perform a different *Gesture* or none at all. In several cases participants would verbally communicate their use of previous gestures for other activities in order to fulfil the current one. For example, a participant would comment "I would perform the same gesture as I did for activity 5." Once again the participant would then either not do anything or perform a different *Gesture* than the one indicated. In order to address such phenomenon, annotation in such cases focused on noting physical movements of the mobile phone held by the subjects.

6.4.2 BASIC ANNOTATION

The activities participants were asked to generate gestures for are as such:

	What gesture would you perform with your phone ...
1	... to send an item that is visible on your phone screen to the other device?
2	... to send a phone number or contact from your phone to the other device?
3	... to send an application (e.g. a game) from your phone to the other device?
4	... to send a media file (e.g. photo, video, music) from your phone to the other device?
5	... to download an item that is visible on the other device's screen to your phone?
6	... to download a phone number or contact from the other device to your phone?
7	... to download an application (e.g. a game) from the other device to your phone?
8	... to download a media file (e.g. photo, video, music) from the other device to your phone?
9	... to stream a media file (e.g. video, music) from your phone to the other device?
10	... to stream a media file (e.g. video, music) from the other device to your phone?
11	... to synchronise your phone with the other device (e.g. time, calendar, contacts)?
12	... to select the other device (e.g. among a number of devices)?
13	... to authenticate your phone with the other device (e.g. to make a payment)?
14	... to scroll the screen content of the other device to the left?
15	... to abort the current interaction between your phone and the other device?
16	... to pause the current interaction between your phone and the other device?
17	... to rewind the current interaction between your phone and the other device?
18	... to move the current interaction between your phone and the other device forward?
19	... to mirror the content of your phone's screen on the other device?
20	... to vote for the content being displayed on the other device?

Figure 15: Activities participants asked to generate (order of exposure randomised)

The results of the basic video annotation showed the following:

Changes in the absolute location of the phone were the most common form of *Gesture* performed by participant across all three conditions. More than 70% of all gestures in all three conditions incurred a change in relative distance between devices whilst more than 70% of them resulted in a change in the (absolute) location of the mobile phone.

Rotation of the device, as well as touching of devices occurred considerably less across all conditions. Despite all target devices being roughly at the same distance to the participants, only 20% of all gestures targeting the public display involved the two devices touching. However touch between devices occurred in equal measure between Phone-to-phone conditions and phone to table-top conditions. Rotation of device occurred within 47% to 59%

of all gestures depending on condition and played a greater role in phone to table-top and phone to public display than phone to phone conditions.

The average delay between the investigator asking a question and subjects starting to produce gestures as well as the overall duration of a gesture also differed between conditions. In the phone to phone condition the average delay across all participants was approximately 4s, with the average duration of a gesture being 5.0s. In cases of gestures targeting the table-top, participants took approximately 5.0s until they started to perform a *Gesture*, while the actual *Gesture* took approximately 6.0s to complete. In the phone to public display condition, the average delay was 3.5s and the average duration of a gesture 4.5s. Due to difficulties in exactly pinpointing the start and end of gestures (see earlier), these times should be considered as estimates of the upper boundary. Times also varied considerably both between subjects and within conditions, with some subjects taking up to 2.5 minutes before starting to produce a gesture. Figure 16 shows the results of the basic annotation of the recorded gestures.

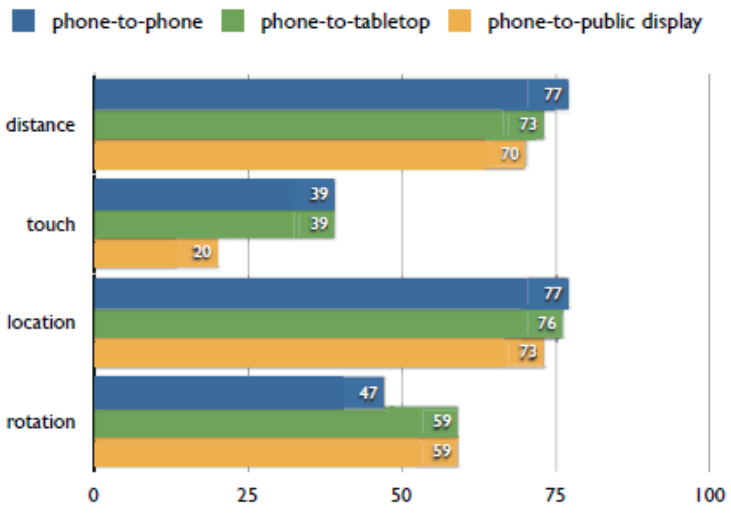


Figure 16: Results of basic annotation (%)

6.4.3 Observations and example gestures

Overall impressions of the study suggested that the concept of phone gestures was very easy to understand and to put in practice for users of a wide degree of technology experience. In

particular, it was observed that participants seemed unfazed about interacting with technologies they may have been unfamiliar with – so long as a familiar technology (in this case a mobile phone) was used as an intermediary control device.

For the two larger devices (table-top and the public display), participants frequently talked about different regions that could be displayed on their mobile device screen and that differing regions (for example the top corner of the screen) could be associated with certain functions or activities. Participants also reported that they felt that they "could interact more" with the public display through rotation of the phone than any of the other apparatus. Interestingly a concern of damage to the public displays was the reported reason that put participants off touch-based interaction between devices, despite the table top surface being of greater fiscal value and recipient of a greater number of 'touch' interactions. This perception however is attributed lack of knowledge by participants about table-top systems and if such knowledge was made explicit by investigators, it is assumed a different overall result of touch-based interactions with the table-top would occur.

Participants also commented that rotation between phone to phone interactions was unnecessary because "it was right there in front of me" preferring instead touch interactions. In some cases a user would touch devices together physically and then use their free hand to touch the other device to perform the action. This suggested that other devices held out at one another were best interacted via distance, location and touching one another; rather than rotating devices relative to one another. Indeed, participants commented that making rotations and gestures with phones would appear "silly" and "embarrassing" in a public setting. This in turn suggested that the social-context and setting of gestures are important considerations for users and to be highlighted for further study.

With changes to absolute location and changing distances between devices the most common forms of *Gesture* made, this suggests that movement of the user's device in relation to the device to be interacted with is critical to establishing a perceived connection by the user. In addition to measuring various aspects and requesting direct feedback from participants, the investigators also noted down some qualitative observations during and after the study. One such observation relates to the ease with which the majority of the participants took to

producing gestures with their mobile phones. There was little confusion about what was asked of them and they were able to quickly perform gestures. In cases where confusion did seemingly occur, particularly in cases where participants took a long time to produce a *Gesture*, the participants took a "best-guess" approach that was adequate to provide feedback and information for annotation.

The investigators observed a variety of different gestures with the forms of gestures varying between different device configurations. However further analysis of the video data is needed to quantify this aspect exactly. In terms of the gestures participants performed throughout the study, the variations in gesture occurred both within and between subjects. Again, additional analysis of video will be required to gain quantitative data on the types of gestures made. Some common gestures where captured and typically included pointing the mobile phone at another device (often prior to touching), pulling gestures (where the phone was pulled away from the other device) and flicking gestures (where the phone was moved along a short trajectory with a considerable acceleration/ deceleration component).

Gestures people would perform less frequently were pouring gestures (where the phone was held at an angle with respect to the target device and then moved as if pouring liquid from it onto the other device), as well as directional touching (where the phone touched the other device at non-obvious angles or from the side). Uncommon gestures included placing the mobile phone on the top edge of the public display and then performing hand gestures over the display, or using the second hand in a scooping motion to move data from the target device to the mobile phone, which was then held at a consistent distance from the target device.

Figure 17 shows four example gestures. The photos shown in the figure are taken from the video footage used for the basic annotation. Each example is shown in three steps demonstrating how the participant performed a particular form of gesture. On the figure, time advances from left to right so (a) occurs before (b) and (b) occurs before (c).

The first *Gesture* is a typical occurrence of a 'pull away' gesture. Participants would hold their mobile device in close proximity of the target device (here: another mobile phone) and is then pulled back towards the user in a smooth motion increasing the distance between the two devices. This *Gesture* was performed in response to question number 15 in Figure 15. Pulling gestures were a frequent occurrence when questions related to selecting, stopping or acquiring items between devices suggesting that the motion of the "pull" represented terms such as "stop" and "copy." This suggests that a vocabulary is shared between like for like gestures, but with very different meanings depending on context or activity of use.

The second *Gesture* (labelled d-f) shows a 'pointing' *Gesture*. The mobile phone is initially held in a default position by the user, and is typically orientated so the buttons and controls of the device are correctly orientated towards the user. The phone is then moved slightly and rotated so that a particular side of it (here: the top) is pointing in the direction of the target device (here: the table-top). The phone is then held in this position for a period of time (without touching the other device) before being moved back to the original (default) position. This *Gesture* was performed in response to question 1 in Figure 15. Pointing gestures were often used in a "commanding" manner in the sense of direct commands such as "send" and "select" type actions. This suggests that pointing acts as a confirmation of a particular direct action for users.

The third *Gesture* is an example of 'touch' between two devices. The mobile phone is moved from the start position towards the target device (here the public display) until physical contact is established. This *Gesture* was a response to question 11 in Figure 15. Rotation of devices was also observed by users. Typically connections were made with the phone orientated so controls were the "correct way up" to the user. In several cases however the device was rotated so that the screen faced away from a user. This suggests that touch and rotation can be used to provide context for particular actions. For example in the given example of "synchronisation" the face of the mobile phone was rotated so it faced the public display. This suggested that showing screens to one another was the expected gesture to establish synchronisation connections between devices.

This context created by rotation can further be seen in the fourth example, which shows what was termed a ‘facing gesture’. The participant moves his phone from the start location towards the target device (here: another mobile phone) while rotating it so that the phone screen is pointing downwards however contact is not made between the two devices. He then brings his phone very close to the other phone so that their screens are facing still without establishing physical contact. This was in response to question 13 of Figure 15. Again connection was implied via the facing of screens. This suggests that mobile devices themselves possess a form of context based on rotation. For example, presenting a screen suggests “connection” whilst drawing the device away suggests “stop.”

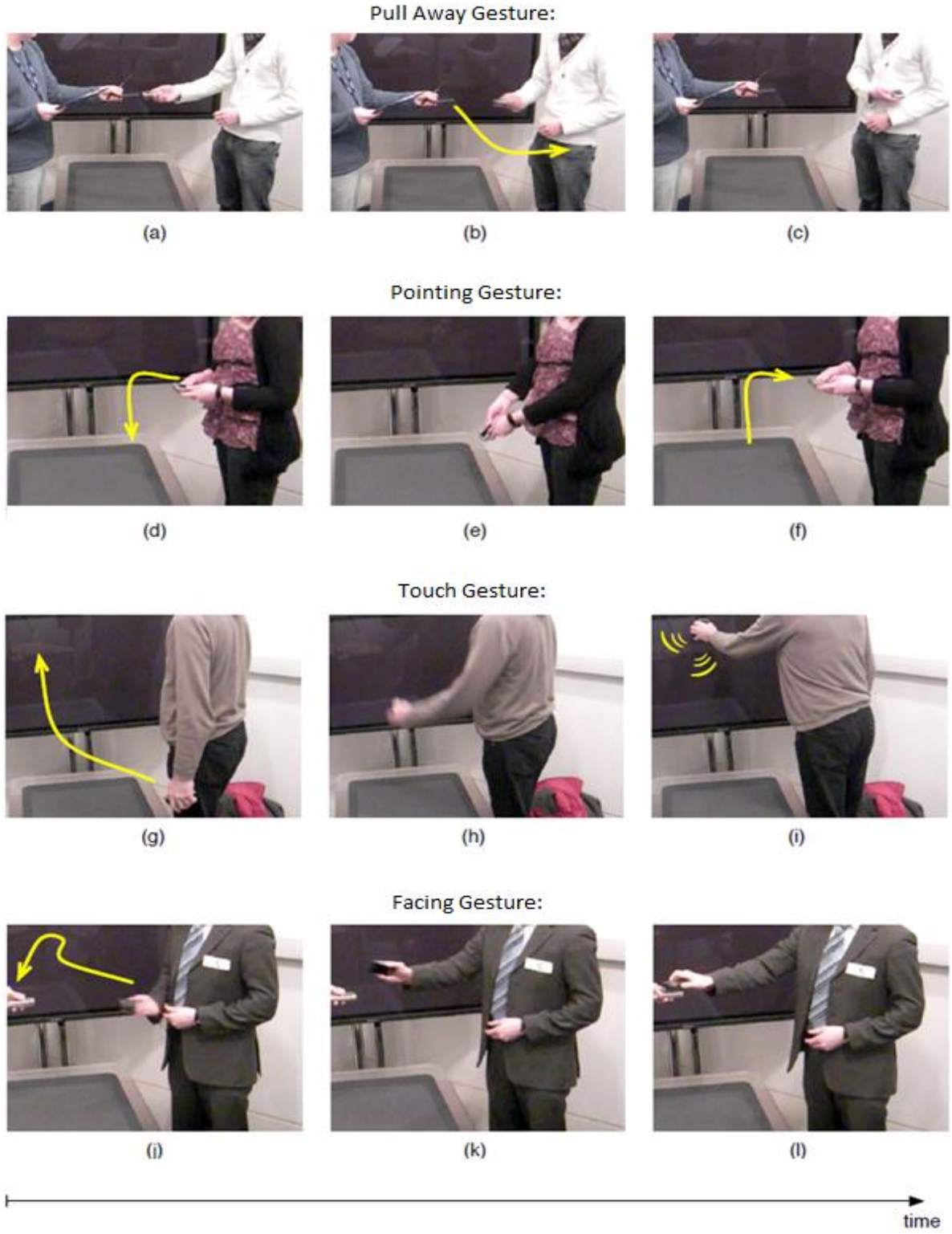


Figure 17: Example Gestures

6.4.4 PARTICIPANT FEEDBACK

After completion of all the conditions and questions participants were given a final questionnaire (Appendix C) which contained questions probing whether or not subjects could imagine using phone gestures to interact with another device, as well as which activities and devices they thought would work well in this context.

The first section of the questionnaire used a seven-point Likert-type scale to measure how far participants were in agreement with a number of statements relating to the use of mobile phones and gestures as an interaction method (where 1 corresponded to strong disagreement and 7 to strong agreement). Figure 18 below summarises these responses.

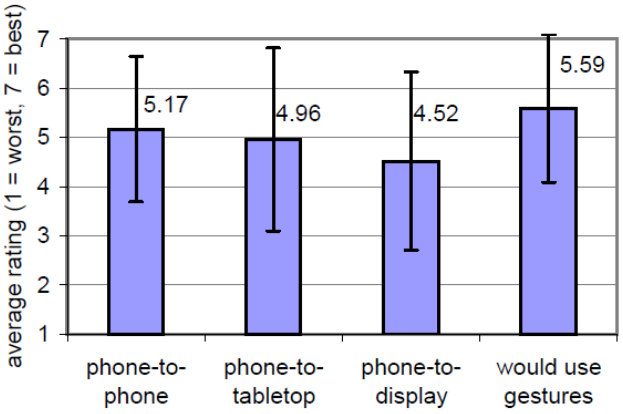


Figure 18: Responses to final questionnaire

Participant response when asked if they would agree that phone gestures work well with a particular target device was positive in all three cases. Phone to phone interactions received the highest average score (M = 5.17, SD=1.48). As participants attributed the familiarity of devices as the reason gesture interaction was the most suitable condition, this was further supported when participants were asked whether they would use phone gestures if they were an available features of their phone, to which the majority agreed (M = 5.59, SD=1.5).

Phone to table-top scenarios were the second most popular form of interactions with positive results of (4.96, SD=1.86). Of particular comment, participants responded that mobile

devices seemed “like sensible tools to use” for interactions with table-top devices. The investigators also observed that touch between devices and the user played an important role in table-top interactions. The Phone to public display configuration received the lowest overall rating (4.52, SD=1.82). Participants cited that distance played a factor when interacting with public displays, with several commenting that displays are “typically out of reach” or “mounted up high on a wall” as well as citing the possibility of damage (“I wouldn’t want to crack or scratch it”) to the display as factors which discouraged *Gesture* interaction.

Overall qualitative feedback from participants was informative. Feedback about the three most negative and positive aspects of using phone gestures was gathered in order to determine which activities subjects thought would work well, and which three they thought would not work well.

The three most commonly mentioned negative aspects of using phone gestures were possible misinterpretation of gestures by a system. For example using a wave to “rewind” but a raised hand to “stop” content could be interpreted incorrectly, or that a pulling motion for “copy” actions may be interpreted as “disconnect”. Participants also noted that social embarrassment and feeling awkward when performing phone gestures in public were particularly negative features. The environmental context of gestures was also briefly explored, with participants commenting that gestures would be “good in small loud areas such as clubs, but not in wide open spaces with lots of people” concern about individual identification, with personal and device security in crowds also mentioned. Finally, the third most common negative aspect was the difficulty to learn to correctly perform gestures. Additional negative comments mentioned included concerns of impact on device battery life, the danger presented to bystanders while performing gestures (such as accidently releasing the phone) as well as concerns about costs incurred by adding gesture support to mobile phones and compatibility between devices.

The most positive aspect reported by participants was the speed of interaction between different devices. Specifically connection times between devices were commented on (“Feels quicker than normal methods like Bluetooth”). This was followed by “ease of use” as the

second most common positive aspect; with additional comments about connections between devices being “made easy” using gestures compared to traditional connection technologies such as configuring networking settings. One unexpected positive recorded by participants was the enjoyment of using gestures. Several participants reported that gestures felt “Fun and modern” as an interaction method and that using gestures, as a whole, was an entertaining experience. Less frequently mentioned comments about positive aspects of using phone gestures related to aspects such as increased hygiene (due to not having to touch anything but one’s own phone), not having to flick through menus on the phone (suggesting interface design limitations can be overcome using gestures) and the benefit of physical activity resulting from performing gestures (with one individual commenting on the possibility of mobile gesture health orientated gaming).

Participants also listed which activities they felt were most suitable for using gestures. The most commonly mentioned activity was sending information to other devices, with pointing gestures commented as the most suitable. Transferral of information was either mentioned in a generalized way “To send files to another device” or specific transfer actions such as “Sending pictures” or “Give MP3’s to other people”. Participants also mentioned receiving items and information as the second most frequent activity of use. In particular participants reported that “authenticating” files i.e. accepting or rejecting files to be transferred to them, was a useful feature of gesture interaction. A unique viewpoint was that accepting payment actions was a popular form of authentication using gestures, however giving payments via gestures was unfavourable.

Synchronization between devices was also commented upon, synchronization for participants was in the form of diary and calendar features (“Sync calendar from device to phone”) rather than back-ups of phone data (“I’d prefer to plug the device into my PC”). This suggested that users preferred traditional means of backing up contents on devices rather than using gestures. Additional activities suitable for using gestures given by participants were playing games, especially multi-player games, watching television and remotely controlling other devices such as media players or other mobile devices such as tablets.

Two activities were mentioned frequently as unsuitable for using gestures. As mentioned above, making payments was seen as an unfavourable activity by participants. Especially in regard to possible misinterpretation of gestures by systems ("It may take payment twice"). Certain activities of authentication were also mentioned repeatedly. Participants commented that "Trying to make first time connection to other unknown devices means security issues," emphasising that any high security transaction was an unsuitable activity, with participants preferring some kind of visual interaction with the intended pairing device, so that they could see what device they were actually connected too.

Participants also stressed the need to be able to "trust" what they were interacting with before using a *Gesture* to establish a connection. Concerns of misinterpretation of gestures were again the reported reason for this and suggested that security issues of accidental connection to un-trusted devices was the primary concern. Finally voting, browsing the internet and entering phone numbers were activities mentioned less frequently by participants as being suitable for use with phone gestures. Participant reported that such activities were easier and quicker to do using the built-in features of the device. Several also expressed dislike of being unable to look at the screen clearly when making a gesture, with others reiterating social awkwardness in performing gestures in public to perform actions that were easier to access and more discrete through built-in controls ("If I'm on the train I don't want to wave my hands about to look at my email").

6.5 Implications of using gestures for interactions

The results of the study show that the reaction to using phone gestures to trigger activities involving another device was quite positive. This positive feedback is a combination of both quantitative data (through assessment of the Likert Scales questions) as well as informal feedback during and after the study. Participant activity during the experiment was eventful, with a variety of different gestures produced and used over the three conditions. The investigators also note that all participants were able to produce gestures quickly and effortlessly (without need for assistance) and that it did not take long for them to understand the concept of using gestures to produce a particular activity. The investigators also note that

even though all devices were switched off during the experiment, all participants were able to perform and put in to practice the concepts presented to them.

Due to this feedback, as well as the results of the basic coding of the recorded video, using gestures as an interaction method appears to be worthwhile and pursuing further investigation. In particular the creativity of the participants that generated a large number of different gestures in a short amount of time, presents interesting issues with regards to developing a vocabulary of gestures. In particular the issues of generating "context" with like-type gestures appears worthy of independent investigation. While some gestures did re-occur frequently both within conditions and between conditions, there were also gestures that were quite innovative - such as writing one's signature in the air while holding the phone as a means of authenticating oneself. This indicates not only is there much to explore in terms of possible gestures, but also highlights the need to involve users in the design process. Furthermore, it is of the investigator's opinion that examining the impact on environmental and social context of using gestures for interactions is also of value for further study, if only to examine the range of creative gestures in given social and environmental contexts (such as in confined spaces or in public spaces with strangers). Additionally culturally symbolic gestures can be explored (for example, the use of religious gestures).

Overall the majority of gestures involve changing the relative distance between the mobile phone held by the user and the target device, as Figure 18 previously shows. In doing so it would seem important that recognizing such gestures requires technologies that can estimate relative distances between devices. As seen in the earlier discussed literature of the Thesis, this can be realized by technologies measuring signal strengths or runtime differences between signals (such as Beep Beep or Point and Connect). Furthermore, many of the distance related gestures could be examined in greater detail using existing technologies such as accelerometers. As accelerometers are increasingly becoming standard features of Smart-Phones (to check for rotations of the device), as well as magnetometers and gyroscopes, this suggests that the potential of using gestures in mobile devices has only begun to be uncovered.

Moreover, absolute location in space was a component of some gestures. Except for pointing towards a target, which was used in a "commanding" or "confirmation" format. This property is difficult to implement with high precision and low latency, but can be achieved by using camera-based techniques using either natural features or special markers such as those explored in Swindels, Inkpen, Dill and Tory (2002). Existing on-the-shelf technologies such as the Wii controller for example, uses an embedded infrared camera that detects external infrared LEDs as special markers. Additional study of the "tonality" of gestures is can also be considered i.e. the tone of gestures such as how aggressive or passive the intent they are meant to convey, though such research has yet to be explored.

Finally, direct contact in which two devices physically touch during the gesture have been observed least often. Although efforts such as those by Hinckley (2003) have been explored, additional research is warranted into the suitability of touching devices together, especially in the context of concerns of damage to devices, as well as the physical location of devices such as public displays as brought up by participants in the experiment.

6.5.1 Implications for user interfaces

Figure 19 summarizes qualitative feedback from the participants, which can have some implications for the design of interfaces based on phone gestures. The most frequently listed negative aspect was the fear of gestures being misinterpreted. From a design perspective this can be interpreted as the need to make sure recognition works reliably, or the need to provide means to users to easily abort accidental interactions. Fear of "double actions" such as making payments twice were emphasized as a primary concern. Such issues may require the use of a user-interface to confirm a repeated action once a gesture has been completed or require a confirmation prompt or gesture on the "receiving" device before actions can continue. However it is arguable that in doing so this would undermine the use of gestures to begin with (affecting speed and necessity of use).

The second most frequently named negative aspect was feeling awkward in public contrasted with the positive aspects "fun to use" and "looking good/cool". This conflict may be attributed to the matter of context i.e. performing gestures in public is "cool" in one location

but “awkward” in another one. Indeed participants expressed concern about gesturing in differing social settings (clubs, public transport and public spaces). This was emphasised in that physical space for gestures was also a concern, alongside concern for bystanders. What this infers in terms of requirements of interfaces is that *Gesture* based systems should be useable without the need for a lot of interaction space on the part of the user. Gestures should be useable both discreetly (in confined spaces) and extravagantly (in open spaces). How much space required for each of these conditions however requires further exploration.

Making payments and authentication with un-trusted devices stood out as highly unsuitable activities for use with phone gestures. This is attributed to the high visibility of gestures, which may be an undesirable side-effect when performing activities with security/privacy implications. Entering a pin code via a gesture was seen as undesirable as devices do not “know” who is making the gesture, thereby undermining the security of pin-based protection. Arguably design of interfaces could rely on face and speaker recognition of users, such as those explored in Hazen, Weinstein and Park (2003) or other methods of user authentication such as graphical solutions discussed by Chang, Tsai and Lin (2012). Sending and receiving data was listed as being well-suited for phone gestures. It may well be that in this case, the visibility of gestures is a desirable feature as it can make it obvious to others what is going, in particular to the recipient or sender of the information. A key implication of this is that gestures are common to nearly all languages, with many gestures extending across linguistic boundaries.

	negative aspects	positive aspects	well-suited activities	unsuitable activities
1	misinterpretation	speed	sending data	payments
2	feeling awkward in public	ease of use	receiving data	authentication
3	difficult to learn	fun to use	synchronizing devices	rewinding/forwarding
4	privacy	simplicity	rewinding/forwarding	placing a call
5	having to remember gestures	universal use	scrolling	entering text
6	damaging phone	looking good/cool		

Figure 19: Most commonly reported feedback

6.6 Application of the study in the immersion model

This study into gestures was the first hands-on encounter with *Immersion* by the author. In particular the study served to invoke several questions beyond its original scope about how users become absorbed into an activity. It was noted that, unintentionally, the level of engagement in the activity that occurred by participants was very high, with several participants mentioning during the review stage of the investigation about how engaged and involved they felt they had become in the activity. Particular emphasis of this was reflected in how participants felt motivated to consider, justify and develop their answers outside of the formally recorded setting. In doing so this led me to consider what aspects the experience of the activity could have fostered and encouraged such feedback.

Following the study my literature based research began to focus on aspects of how *Immersion*, space and movement influenced human engagement. In particular I focused upon *Flow*, Proxemics and Kinesiology as possible explanations of why user *Engagement* was so high. As I developed my understanding of space and human attention, I originally assumed that because the boundaries of the activity were limited to the field of view of the camera, so was the *Activity Space* for the participants to engage within. Due to this I considered that the setup of the room served to direct the mental energies and concentration of the users into the personal space between themselves and the artefacts being used. I then considered that the setup of the study had unintentionally fostered *Immersion* into the activity by the participant, as they had become more engaged and absorbed into the activity than they normally would have and had unintentionally entered into *Flow*.

Later review of literature into *Embodiment* would lead me to revise these considerations. In particular I began to consider that the act of performing a *Gesture* could contribute to fostering *Flow*. We do so based on the view that gestures are a form of *Embodiment* of the world. My exploration of the philosophical origins of *Embodiment* also helped further encourage this view. I consider that as gestures were being made, the participants were becoming embodied in the activity of the study. In doing so, along with the other factors I have mentioned, they became engaged, immersed and absorbed in the *Activity Space* which lead to *Flow*.

6.7 Conclusion and future direction

This chapter has presented a study that was performed for the purpose of addressing a gap in knowledge about which gestures are naturally produced by individuals in different contexts and activities. For the purpose of research, gestures using mobile phones was studied. As mentioned at the beginning of this chapter, three research questions were posed:

1. Which gestures do users produce naturally to trigger various activities involving a mobile device and another device?

2. Which of these activities do lend themselves well to being triggered by gestures, and which ones do not?

3. What is the impact of different types of content and devices on the gestures being generated?

In the study the investigators present an investigation into eliciting gestures from users for combining mobile phones with other devices i.e. other mobile phones, interactive table-tops and large public displays. The results are encouraging, in that users generally liked gestures as a way to use their mobile phones to intuitively interact with other devices. This in turn presents several questions in development of seamless device to device interactions. Among the device types tested in the study, using phone gestures to connect to other phones received the highest rating, followed by phone to table-top and finally phone to public display scenarios. Logical expansion of this investigation is to test interaction between other devices, such as mobile phones and tablet computers, as well as examining interaction with gestures beyond the use of mobile phones; such as using device artefacts such as IR scanners or Stylus pens to aid gestural interaction.

Additional observations also provide some initial insights and pose interesting questions about implementation and design of phone *Gesture* systems. Overall the degree of novelty

and diversity of gestures that users invented provides interesting questions relating to the cultural and social contexts of use of gestures. Furthermore, the ability to spontaneously produce meaningful gestures by participants suggests that a vocabulary of gesture based interactions is as diverse and adaptable as other methods of communication. This was seen in a number of gestures which occurred frequently (such as pulling the phone back or flicking it in a particular direction), as well as stand out examples of novelty, for example; placing a phone on another phone so that their screens were facing, or placing a phone on top of the frame of the public display. The exploration of space in which gestures are made has also been highlighted. This warrants further investigation into what is an appropriate "gesture space" for using and designing gesture based systems.

In addition to this, the study helped prompt and develop initial findings into the value of *Gesture* as a method of embodied interaction that promotes *Immersion* in an activity and contributes to fostering *Flow*. Cataloguing and categorizing gestures in more detail is another logical next step in this line of research, in order to see which particular kind or form of gestures contribute towards developing and fostering *Embodiment, Immersion* and *Flow*.

A subsequent contribution of this cataloguing can inform the design of future mobile phones in terms of which sensors to include in order enabling the recognition of common gestures. As the research shows, a large number of gestures involve a change in the location of the phone and/or a change in the relative distance to the target device, whilst physical contact occurred less often. In particular Public Displays received less device to device contact whilst phones and table-tops received contact in equal measure. The use of a combination of contact and gestures is warrant of further exploration, if only to further expand the knowledge of the subject. To aid this, consolidating the observed gestures into a coherent gesture set based on the gestures that resulted from the study would be beneficial, though this would require research to look for gestures with a high degree accuracy and description with agreement on the definition, context and description of particular gestures between participants. A starting point for this, as mentioned previously, could be focused on gestures which transcend linguistic boundaries.

Finally the current study only investigates interactions that span two devices, one of which is a mobile device. It would be interesting to explore group interactions in which media items are exchanged from one sender to multiple receivers at once or in which input is collected from multiple sources. Moreover gesture interaction between two non-mobile devices by single and multiple users can be considered for further exploration. Furthermore in the study the number of devices was limited and all devices were deactivated for the duration of the study. Consequently future areas of research to establish the influence of graphical content gestures is worthy of exploration. Moreover, in order to validate the approach of using gestures for multi-device interaction, a comparison study with other technologies would be beneficial.

Chapter 7. Study 2 - User interaction with an interactive museum exhibition

7.0 Chapter overview

In the previous chapter I explored and discussed the idea of using *Gesture* as a method of interaction between devices. During this study I found that gestures could be used to aid in developing embodiment and *Immersion* in activities. It was discussed that the use of gestures could provide a natural and simple method to facilitate embodied interaction and in turn help promote *Immersion* and *Flow*. In relation to this I introduced the *Immersion Model of User Experience* in Chapter 3. Within this model it was noted that the *Activity Space* contributes to developing both *Embodiment* and *Immersion* into an activity. Here I consider that the *Activity Space* is the physical world around to be experienced and interpreted by the body (such as through the use of *Gesture*) during an activity.

This chapter summarizes the work performed during 4th and 6th of December 2010 at the Seven Stories museum in Newcastle upon Tyne, United Kingdom. The study was an ethnographic observation of both public and organized groups interacting with the "Nuffin like a Puffin" exhibit, specifically focusing upon "The Borrowers" exhibit which had been enhanced with a digital content system designed and installed by Culture Lab of Newcastle. The original aim of this study was to examine how public and facilitated visitors experienced and interacted with the Borrowers exhibition, as well as assess the value of the digital content system to enhance the interactivity of the exhibition.

During the observation I discovered and developed my knowledge of *Activity Space* and its contribution of focusing attention in an activity. This would then assist in my understanding of *Immersion* and *Embodiment* in fostering *Flow*. From the observations made, I consider that *Activity Space* are areas where *Embodiment* occurs when a user performs actions relevant to the activity within them. In doing so, user *Engagement* and attention increases in these spaces

the more embodied an individual becomes. Through this engagement, I consider that activity spaces foster *Immersion* and *Embodiment* in an activity.

7.1 Outcomes and discussion

The outcome of the study was approximately two and a half hours of audio recorded interviews with staff and visitors to the exhibit. Of these approximately twenty minutes of verbal descriptions of interactions and observations by staff and the public were recorded by Rachel Clarke and John Dawson of Culture Lab. In addition to these recorded observations each investigator produced a written observation of several full-day (12-hour) visits to the museum, these were then concatenated together. Photographs of an example facilitated interaction were also taken. Due to the vulnerable nature of the participants in the study, ethical approval was sought with Newcastle University and Seven Stories museum. The study received favourable opinion for approval. As part of this approval only approved photographs of facilitated interaction and the museum exhibit were allowed and these were performed by Rachel Clarke.

During the study it was noted that space and environment played an important part in engaging and subsequently immersing individuals into the Borrowers exhibit. In particular the attention of visitors during facilitated actions was drawn to finding and spotting the Borrowers across the space. Once a Borrower vignette had been spotted visitors would comment that the characters of the Borrowers story occupied the space of the exhibit to other visitors, leading to further attention and focus into the exhibit space by others. Due to this visitors would return several times to the exhibit to try and 'catch' the borrowers in action.

During times where Borrower vignettes were not being played, older visitors would engage more with content displayed on the walls such as manuscripts and information about the book. The activity of finding Borrowers between reading and engaging with other content was seemingly enjoyable based off the reactions of visitors, especially when they were able to 'catch' a Borrower by being witness to a vignette of a borrower in action. This suggested to the investigators that the space of the Borrower exhibit helped focus the attention of the visitors onto the content of the activity of spotting Borrowers and were subsequently becoming immersed in the activity.

Further observations gave evidence that the activity space of the Borrowers exhibit was influential in encouraging engagement with the exhibit. This aspect was seen during facilitated sessions where groups of children were shown around by a museum guide. Here what was apparent from our observations was the notion that the Borrower characters occupied the exhibit space and could be interacted with such as visitors attempting to get the borrowers walk across their hands and arms. What was unique about this was that this influenced further interactions not only in the Borrowers exhibit, but across other exhibits in the gallery. Across the gallery visitors would disregard the possibility that borrowers could be in the space with them, contrary to the themes of the Borrowers book. Although this was true due to the limitations of the system and the capabilities of the equipment, it was interesting to note that visitors only considered that the Borrowers were within the boundaries of the Borrowers exhibit. Due to this consideration, visitors would return to the Borrowers space and then begin searching for them in within the space - moving curtains, touching the paintings and features of the rooms; as well as waiting at locations where the borrowers had been spotted. After leaving visitors would not engage with adjacent or opposite exhibits in a similar manner, with several expressing dismissal that “the borrowers don't live here” when entering different exhibits.

It was also noted that behaviour of visitors was influenced by the Borrowers space. For example, visitors would disregard the content of other exhibits in favour of the Borrowers and in several cases, individuals would spot Borrowers vignettes playing whilst outside the room and run in to try and apprehend them. Other visitors in groups would split off individually and revisit the Borrowers space and begin searching for the Borrower vignettes. Upon discovery, visitors would proclaim that they had spotted them and would take enjoyment at the fact they had achieved this on their own, in doing so they would return consistently to the exhibit space to try and spot all the Borrowers in the room. Facilitators and staff noted that visitor behaviour in the borrowers was less aggressive than other interactive exhibits due to the confines of the space, the technology used and the design of the Borrowers exhibit further suggesting the influence the space had on visitor behaviour.

7.2 BACKGROUND OF THE STUDY

The Borrowers interactive exhibit was developed as part of a Collaborative Innovative Partnership between Culture Lab of Newcastle University, the International Centre for Cultural and Heritage Studies and Seven Stories the national centre for children's books. The exhibition lasted for public access for a total of nine calendar months and was funded by ONE North East. The focus of the project was to support the development and implementation of a digital strategy for Seven Stories through the creation and implementation of new digital technologies for the "Nuffin like a Puffin" exhibition, a celebration of 70 years of Puffin books.

The digital system aimed to provide a working digital solution to address the lack of interactivity that existed across the gallery exhibitions. The solution provided was to develop and implement a system which projected small video vignettes of characters from "The Borrowers" books throughout the Borrowers exhibit space in order to promote and facilitate interaction in the activity space of the exhibit. The program opened in June 2010 and continued throughout the 2010/2011 period ending in September 2011.

The purpose of the installation was to create a sense of *Immersion* and *Engagement* for visitors into the space that "The Borrowers" would occupy. Design was intended to make visitors feel as though they were making a visit to the Borrowers' home and catching the "Clocks family" (characters from the original book) going about their daily business. The nature of the interaction was intended to be playful and engaging due to the nature of the intended target audience. Allowing a visitor a series of different possible experiences with the Borrowers and activity from the reaction of audience was also to be captured and reflected in particular elements of the delivered content. A key part of the implementation was also to keep the key themes of the content and its delivery in-line with that of Seven Stories expectations and Puffin Publications. Additional thematic considerations were required in regard to the Borrowers books, specifically the theme of the Borrowers only being active when threats of discovery are at a minimum.

After installation a study was performed on the direction of Dr Areti Galani, School of Arts and Cultures, Newcastle University. The principal investigators were John Dawson and Rachel Clarke of Culture Lab Newcastle University. The study was performed between December 4th 2010 and December 22nd 2010.

The focus of the study was on gathering ethnographic information about visitors to The Borrowers exhibition. This ethnographic information came in the form of visual observations of the interactions of the general public visiting the facility during Saturday 4th December 2010 and an organized school visit and facilitated tour to Seven Stories on Monday 6th December 2010. Recorded Interviews with guests and staff were also performed between the 6th and 22nd of December 2010 to further elicit information about the success and user experiences of the exhibit.

Two core aims were created to help facilitate and direct the ethnographic data collection. Specifically the core aims of the study were to:

1. To explore the application of digital technologies to enhance the experience and engagement of Seven Stories' exhibitions and how such technologies facilitated interaction in the exhibit.

2. To evaluate any of the differences between general public user interaction with the exhibit and organized school trip user interaction with the exhibit.

7.3 System design

This study is an observation study to examine *Human Computer Interaction* (HCI) with a digital interaction within a museum gallery. In this section we explore the setup of this study.

7.3.1 Participant information

According to visitor data collected by Seven Stories the facility is host to approximately 70,000 visitors a year, 17% of which are aged 5 years and under. This means for many visiting it is their first visit to the gallery and interactive exhibits in general. Of the 70,000 visits, there are approximately 12,000 organized school visitors both to the building as day trips and through educational outreach programs to interested parties across the North East of England. 85% of all Newcastle schools and 50% of all North East Schools have worked with Seven Stories in this manner. Although efforts are made to market the centre to all age groups in education, the main audience of Seven Stories is children who are at Foundation and Key Stage 1 and 2 levels of learning. Therefore the majority of visits are drawn from preschools and preparatory schools.

Typically those who are non-school visitors come in the form of family group visits. Due to the target audience and visitor age restrictions, at least one adult (qualified as an individual aged 17 or more years) is required to attend with any visitor aged 16 and below. Groups of visitors typically commute to Seven Stories from within a 30 minute car drive of the Seven Stories facility – covering the majority of the Newcastle and Gateshead area. Typically these group visits are by families of, on average, a group of 4 persons with mixed aged children.

The primary motivators for visiting are that visitors are looking for “an enjoyable day out”, followed by “wanting to see an exhibition or event” with solo-individual visits motivated by “self-interest” or “educational” purposes. Seven stories do not collect socio-economic background information on its visitors, and it is less of a factor in terms of their research on visitors than the attitude of the visitors towards books and the exhibits presented.

7.3.2 Apparatus and material

The apparatus used in "The Borrowers" room includes illustrations, original manuscripts, letters, props, a writing desk, a throw projector and a curtain. Dressings and props were used to decorate the space with a ledge and two small brown stools situated to the left of the

entrance. Paper and some pencil crayons were placed on the ledge to provide and promote interest and interactivity for younger visitors. In addition a copy of "The Borrowers" book was also provided on the table so visitors are able to read the book or review the synopsis if they were unfamiliar.

In front of the table a large magnetic board was installed and edged with plastic trim to make it appear akin to a picture frame. An Information panel was then mounted to the side of the picture frames explaining who the Borrowers are and invited the visitor to leave a message for the Borrowers. To the right of the message board there was a large black and white illustration and three panels with paragraphs about how the Borrowers story began. Above this black and white graphic were framed original manuscripts of segments of the original text.

On the main wall were three mounted and framed original illustrations of original artwork for the book, next to these in the centre of the wall was a faux-grandfather clock prop mounted to the wall. Within the clock the main camera used to track visitor activity within the Borrowers room was fitted. This provided a convenient casing for the majority of the electronics and digital equipment without interfering with the theme of the room. Additional framed illustrations and a skirting board of 15cms high were attached to the wall to the right of this housing. To the right hand side of the room was a blue curtain tied back, this marked the end of the back wall but was used as an interactive prop to promote investigation and activity within the Borrowers room. The adjacent wall came out at 45 degrees towards the entrance with the design of the room aimed to draw the attention of visitors to the back and side walls where content the major content and the projections were being displayed. This angled wall was also used to mount additional exhibit information such as pictures, original manuscripts, as well as the original letters and telegram communications between the author and publisher.

The digital interaction of the room was designed to be projected on to the large wall where the clock was mounted, this throw projector was mounted on the ceiling just off-centre to the clock. This then meant that projections faced the entrance to the space whilst the projector was kept out of view due to how high it was affixed. The system used the openFrameworks

system as the platform to support the programming of the system. openFramewoks is an open-source C++ package toolkit designed to allow rapid content prototyping and experimentation. This was chosen on the grounds of cost, flexibility and record to work well with artistic and visual interactions. In order to track activity within the exhibit space, a digital camera was used to capture user movement and trigger interactions by those entering and engaging in the space. The final installation layout of the projection system in the Borrowers space was as such:

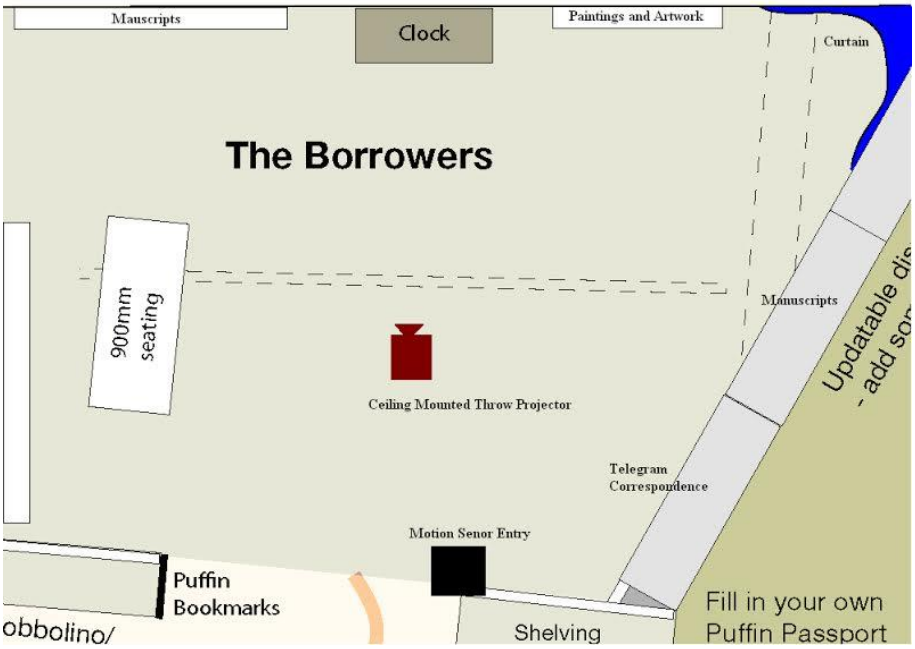


Figure 20: Borrowers exhibit layout

7.3.3 VIDEO RESOURCES

Initial vignettes were filmed in Culture Lab where sequence length was established. This was followed by a final shoot in collaboration with MagicIF Ltd, where a series of shots lasting between five and thirty seconds were filmed with performers playing the book characters of Arrietty and Pod. This was filmed in a green screen studio at Teesside University Middlesbrough. The following image is a collation of the shot vignettes:

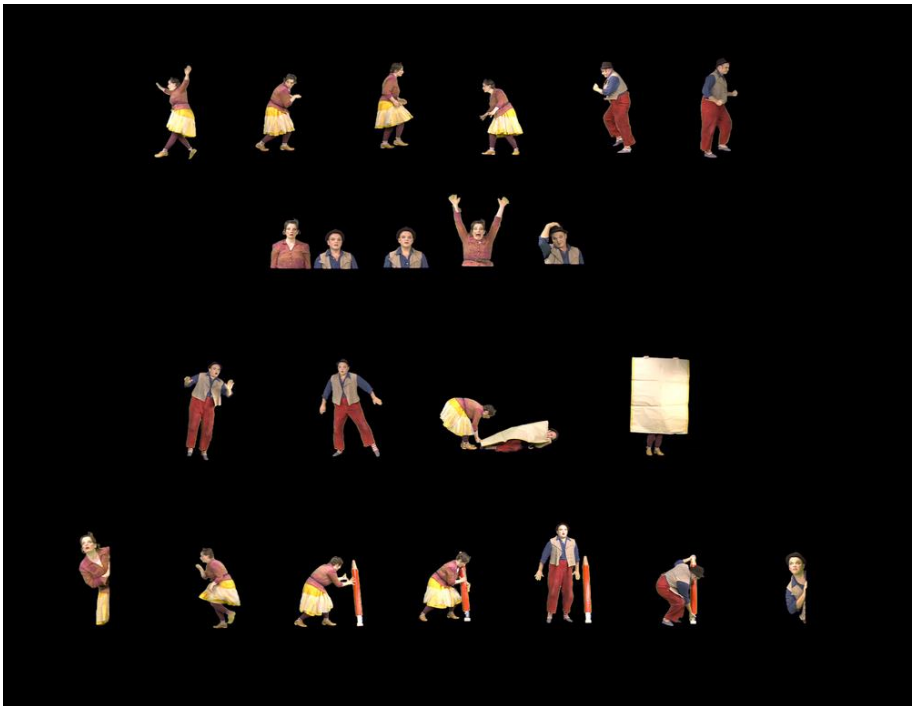


Figure 21: Collated vignette shots

7.3.4 Completed installation

The Borrowers interactive installation formed a part of the “Nuffin like a Puffin” exhibition that ran for a total of 9 months from June 2010 to September 2011, and celebrated the seventy year anniversary of Puffin books. The exhibition was housed in the main building of Seven Stories the national centre of children’s book. The layout and overall design was bright; colorful; and multi-sensory which combined traditional museum exhibits; manuscripts; and illustrations from a selection of Puffin books with animation, audio-recordings, installations and props based on delivering educational content depending on the themes and characters of the books. The main body of the exhibition was organized chronologically of Puffin publications starting from 1941 and preceded chronological up to publications in 2009. A graphic panel ran all the way around the room with information on books from each era to provide a chronological history of publications by Puffin. The exhibit was then divided into dedicated rooms that focused upon aspects of particular books each of which contained different types of activities related to the themes of the book for visitors to explore. Each of these rooms were linked via coloured tape that ran across the main floor and walls and acted as a pathway to lead visitors to the various sections of the exhibit as well as to draw attention to related information each book/room. Below are photographs of the final gallery setup.

Figure 22: Exhibit entrance information

Figure 23: Reception Space

Figure 24: Gallery perspective

Figure 25: Borrower entrance and investigator seating

Figure 26: Additional apparatus in Borrowers space

Figure 27: Example Interaction

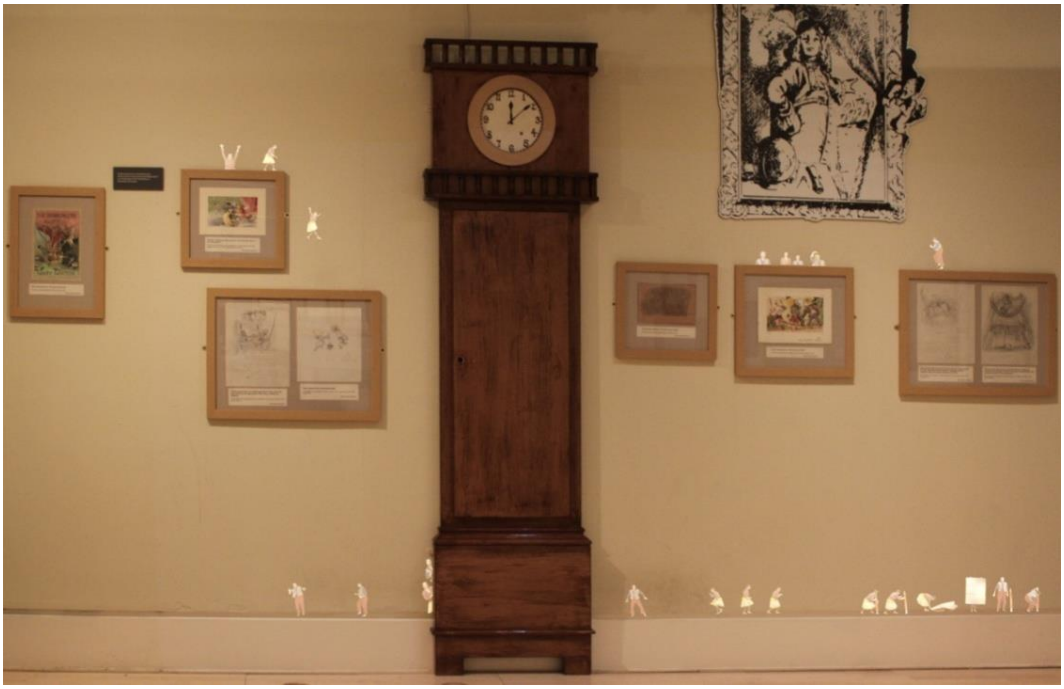


Figure 28: Collation of all vignette locations

Figure 29: Example quality of vignette projection

7.3.5 Ethnographic study

The methodologies employed in the study were discussed between the investigators and project supervisor. A key aspect of the study was to view visitor interactions with the exhibit in its natural setting and operation in order to capture user experiences. This meant that investigators were not to prompt or interfere with visitors to the gallery and avoid drawing attention away from or to particular aspects of the gallery whilst visitors were going around.

In order to fulfil this aim, the agreed upon methods were:

1. Written observations of visitor activity in the exhibit and gallery
2. Unstructured interviews with staff and facilitator guides
3. Unstructured interviews visitors to the gallery after they had exited the gallery

7.3.6 Written observations

Written observations were performed by investigators from the nearby seating near the entrance of the Borrowers room in Figure 24. This allowed a full view of activity in the exhibit space without drawing attention from the Borrowers to the investigators. This vantage point also allowed a wide view of the entire gallery, but only a limited view of the main activity area at the far end of the gallery. Observations focused primarily on interactions with the Borrowers, however investigators also moved throughout the room during the day to observe interactions in other areas such as the carpeted activity area that could not be seen from the seating. Both Rachel Clarke and John Dawson were present for these observations, during which each observer took turns to observe interactions from different locations in the gallery each hour. Investigators did not enter the exhibits so as to avoid drawing attention to particular aspects or content.

The written observations were divided into two types, public and facilitated. Public observations were to see how the general public interacted with the Borrowers exhibit in a

non-facilitated way. These observations occurred on Saturday 4th December 2010 and consisted of short hand notes about different aspects of visitor activity in the Borrowers space. The Saturday was chosen as it is when Seven Stories has the highest traffic of its intended target audiences.

Facilitated observations were observation made during a school visit to the seven stories. This visit occurred on Monday 6th December 2010 and also included short hand notes on the activity and behaviour of the visiting group. This Monday was chosen as Seven Stories only hosts school visits during weekdays. An additional facilitated session occurred on Thursday 9th December 2010 which was performed solely by Rachel Clarke.

Observations were divided into two elements.

1. The first element was the visitor demographics such as the number of visitors in a group and the gender of the individuals. Gender was gathered to help differentiate parties, such as those in multiple adult-child groups or when multiple groups where in the space together. As investigators were to avoid interference or contact with the visitors whilst the visitors explored the gallery, socio-economic information was not collected.

2. The second element of an observation was the notes of visitor activity in the Borrowers exhibit or in the gallery as a whole. Recording the number of visitors was important as the interactive system was designed to react to the number of visitors in the room at a given time, the fewer individuals present the increased chance of a vignette being played. Subsequently the best time to 'catch' a Vignette for the visitors was as they entered the room. Notes on activity focused on capturing the most apparent behaviours (talking, standing still) and actions (touching, moving objects) of visitors whilst in the Borrowers space were also made. Where necessary, when multiple groups of visitors were in the Borrowers space, they were numerically divided into separate parties (party 1, party 2).

Below is an example of a public and facilitated observation:

Number of Individuals: 4: 2 Parties: Party 1 (P1) 1 Woman, 1 Child (female). Party 2: 1 Women 1 Child (Male).
Activity:

Party 1 – Woman and Child (female) enter room, both turn right. Woman makes a sweeping observation of the room from right to left. Interaction in progress – Borrower jumping from picture frame Left hand side of the clock.

Woman comments "Oh look its the borrowers." Pointing towards interaction. Child turns to look but interaction already complete / ended. Woman walks from right side of the exhibit to painting on left hand wall before stopping at message board. Both look at pencils and message board before walking out of exhibit.

Party 2 – Both woman and Child (male) enter from left hand side and look at message board. Interaction ending (Borrower jumping from picture). Male child stands in centre of room and spins around on heel in counter-clockwise motion 3 times. No interaction occurring as he does so. Mother speaks to child and both leave exhibit heading towards main entrance / seating area.

Figure 30: Example public observation

Facilitator Interaction:

Parents and children guided into main seating area by facilitator. Some stand, some sit on the stools facilitator stands in front of group and presents. Showing and directing to exhibits on the floor.

Facilitator using hand gestures to point and direct to points of interest. Children and Parents looking in direction of gestures.

Children given props to facilitate interactions – Spyglasses / Magnifying glasses. Parents standing around / seated discussing with one another exhibits and off-topic.

Group lead to Borrowers exhibit. Facilitator poses question 'Can you spot the borrowers?'

Children notice interaction of borrower climbing / jumping down painting frames LHS of GFC.

Children holding up magnifying glasses to 'investigate' borrower.

"Oh look!" is exclaimed from children at front.

Crowding in begins to occur – those at the back begin to try work their way to front.

Activity and noise in borrowers exhibit causing interest as other children in other exhibits begin to walk and run over to see borrowers interactions.

Figure 31: Example facilitated observation

7.3.7 UNSTRUCTURED INTERVIEWS WITH STAFF MEMBERS

Rachel Clarke of Culture Lab Newcastle University was lead investigator in organizing and running the interviews with members of staff and facilitators of seven stories. These interviews were performed across a two and a half week period between the 4th December 2010 and 22nd December 2010 and involved unstructured conversations with the staff after

delivery of their facilitated sessions. John Dawson was present for interviews on the 6th of December 2010. Unstructured Interviews were chosen as it was felt that performing surveys with staff and guests would not accurately capture how visitors were experiencing the gallery and exhibit.

Due to limitations of space, as well as the need to avoid influencing other visitors by the investigators, interviews were held in the cafeteria and staff offices of Seven Stories away from visiting patrons. Questions were performed in an unstructured manner, but divided into two areas of interest. The first area was related to the technical aspects of the system. Questions from this category included the level of knowledge the staff possessed in how the system operated, how far the staff understood the limitations of the system and how the system could be expanded across the whole gallery. The second area were questions related to interactions with the system within the Borrowers exhibit. Questions of this type also included what facilitators had observed in visitor interactions with the Borrowers exhibit, how the facilitators used the system during the delivery of their sessions, as well as open-ended questions intent to provide opportunities for staff to give feedback on the positive and negative aspects of the system. Assistant Curator Alison Copes was also interviewed. This interview focused on the design process of the exhibition and the interactive aspect of the exhibit. This provided perspective to the original expectations of the system as well as how well the existing system had fulfilled these expectations.

7.3.8 Unstructured interviews with visitor groups

Unstructured interviews with visitor groups were also performed. Rachel Clarke of Culture Lab Newcastle University was lead investigator. These interviews were performed between the 5th and 22nd of December 2010. Groups of visitors were selected at random to be approached as they left the gallery and asked if they would take part in a brief interview about their experiences in the gallery. These interviews were performed in the cafeteria and stairwell outside the gallery.

Questions were presented in an unstructured manner but focused into two areas. The first area was related to the knowledge and awareness of the exhibition by visitors. Questions from this category included how the visitors learned about the exhibit, how often they visited Seven Stories, if they had visited the Puffin exhibition before, as well as their knowledge about the themes of the exhibit. Other questions included familiarity with Puffin books and if Puffin books were read by the visitors outside the exhibition. The second area was related to visitor experiences in the gallery. Questions from this category included a summary of what visitors experienced in the gallery, if they had noticed the Borrowers exhibit, as well as open ended questions relating to what they had noticed during their time in the gallery. Questions in this category were also directed at which areas of the exhibit had drawn a visitor's *Attention* and which exhibits they found to be the most engaging.

7.3.9 Overview of results

The majority of families observed were couples with two children estimated to be under the age of seven years old. Of those interviewed, the majority were familiar with Seven Stories and the exhibition. Those observed and interviewed did not appear to fully engage with the interactive as a result of two self-reported factors. First engagement in the gallery by adults was limited by parental commitments. Many of the adult visitors reported not engaging with the content of the exhibit as they were "too busy watching the children." Families with two or more children spent less time in the Borrowers space as children would enter and leave. Second, engagement in the Borrowers space was limited based on how far families were interested in spending time in exploring the space, as well as how intermittent and briefly the Borrower vignettes were visible.

The Family groups reported that they were drawn more to the lively and immediate aspects of the gallery. Colours, sounds, dens, caves, carpeted spaces, physical objects, crayons, costumes and small tables were set up throughout the exhibits in the gallery and meant that family audiences were drawn by their children to those spaces much more readily and quickly. Spaces such as the "Stig of the Dump" room and "Mr Big" and his piano provided space where groups could either hide or comfortably play together with a number of activities to keep them engaged and attentive to one area.

The intermittent nature of the Borrower vignettes often meant no interactions were occurring when visitors entered the space. Although a level of subtlety was part of the overall design, the vignettes of Borrowers in action were short in length. In many cases visitors often looked at other features of the room that faced away from the interaction and so did not see the Borrowers. In other cases visitors would only catch the final frames of a vignette interaction and would appear to dismiss them. However, when Borrower vignettes were noticed in full, they were a shared experience with a high level of shared excitement. Adults responded by either pointing out the interaction physically with a finger, or verbally announcing them such as “Look I see a Borrower” or “There is one there.” This would then lead visitors to change their behaviour from observing the space to actively investigating the exhibit in greater detail. This was then evidenced by family discussions within the group where friends or family, copied or repeated what each other did in attempt to invoke the Borrower vignette. This was also further evidenced by visitors who had already left the Borrowers space who would return to try and find the vignettes others had noticed.

Finally it was observed that visitors would comment about the purposes of each of the different exhibit spaces. In particular adults and children would declare that each space represented a different activity area of the characters from the books. Examples of this included comments such as “This is the house of Stig” “This is where Mr. Big plays his piano” and “The Borrowers live here.” This provided interesting observations into the influence that each space had on visitor behaviour. For example, visitors were much more aggressive in their interactions with the "Stig of the Dump" and "Mr. Big Plays Piano" exhibits than that of the Borrowers. Interactions would involve touching, drawing, and interacting with the mounted information and interactive sections of these zones. In comparison the Borrower space, activity tended to be sedate and observational. However when the Borrower vignettes were spotted, visitor interaction with the space would become more aggressive. Actions such as pulling back the curtain, looking around the room, slapping the walls where Borrowers had run across; and attempts to try to see behind the mounted picture frames and clock, were the most common forms of this investigation. It was observed that by engaging in the space visitors created a sense of "being inside the Borrowers house." This was evidenced by how many visitors would proclaim "Hello Borrowers!" when entering or returning to the room or would wave their hand around the room and say "Good bye Borrowers!" even when no vignettes were playing.

7.3.10 Observations of facilitated sessions

Facilitated sessions differed from the public observations. Each session was adapted for the age group and their particular interest. Some of the facilitated sessions included family learning groups, whilst others were made entirely of school groups. Facilitators would give different introductions to the exhibit depending on which group they were guiding at the time. Across all groups facilitators included an introduction to the exhibition and an introduction to the Borrowers to help frame people's expectation and experience.

When available to the facilitators, groups were given props to aid in their interaction with the Borrower space. These artefacts were spyglasses and magnifying glasses that were meant to help the groups examine the space in greater detail. When groups noticed the interaction of the Borrowers climbing, running and jumping, visitors would hold up their artefacts to 'investigate' the Borrower and the area that they had run from/towards. Of particular interest, facilitated groups who had magnifying glasses spent observably longer times in the Borrowers area than those who did not. In addition it was noted that a perception amongst the facilitated groups was that the magnifying glasses were only to be used inside the Borrowers space.

In addition it was observed that in facilitated groups, interest and engagement in the Borrowers space was more repetitive by visitors than that of the public observations. In particular, individuals and smaller groups of the facilitated session would break away from the main group to return to the Borrowers room repeatedly whilst the rest of the groups were engaged in other exhibits. During this time these groups would inform others by shouting to the other groups when borrowers had been spotted, which would elicit more individuals to come back to the Borrowers space.

It was consistently observed in these sessions how animated, engaged and intrigued children and adults appeared to be when they were aware of the Borrowers. This was illustrated by children of different ages trying to look behind the picture frames, the clock and floorboards as well as knocking on the wall to see if the Borrowers would respond and mimicry of some

of the Borrowers movements. There was a large amount of bodily interaction through pointing, running, moving from frame to frame, trying to make Borrowers jump onto hands and playing with the projected light. As children engaged in searching for the Borrowers, adults would join in searching for them.

Finally it was observed that framing the space to visitors helped in stimulating imagination of the visitors by providing a narrative context to the visitors. These narratives were continued into the room where support for shared social interaction between individuals in the groups was provided. Evidence of this *Embodiment* came through the visitor's verbal and physical anticipation and expectation of the Borrowers appearing. Several adults and children were observed asking each other questions such as "Where are borrowers?" and "Where are they likely to appear?" as well as direct instructions to one another such as "Keep an eye for the borrowers" and well as being aware and engaged with the other features of the space in anticipation a Borrower may appear (for example "Wait by the clock for one to pop out").

7.4.11 Unstructured interviews with staff and facilitators

From interviews with facilitators after delivery of their sessions the following feedback emerged.

During the interviews, staff and facilitators of Seven Stories were excited by the possibilities the system provided for them. They described how it enabled a different kind of interaction that was not possible within the rest of the gallery. In particular staff commented that the space and interaction provided a more "magical", "unexpected"; and "surprising" experience for them which they could transfer to their visitors. In addition facilitators commented that the interactive aspect of the space gave a sense of belief that the Borrowers were real.

Facilitators found that the interaction provided different methods to encourage engagement into the Borrowers space. This was largely a result of their personal backgrounds and strengths they bring to the interpretation of the exhibitions and to the sessions. However facilitators commented that the more time they spent with the exhibition, the more they were able to adapt and their focus their sessions depending on the group such as using other

elements; such as abstracts from the Borrowers Book or to encourage visitors to spot and find the interactions. Facilitators also noted that an initial lack of their own understanding of the interactive inhibited them delivering sessions, such as being unaware that the system was sensitive to motion causing vignettes to freeze in place, this was initially interpreted as the system being broken. However facilitators commented that once they were familiar with the systems behaviour they could use it to enhance audience *Embodiment* as their own sense of uncertainty and excitement about when and where the Borrowers would appear could be transferred to the audience.

Finally facilitators and staff discussed that within the interactions there was a “sense of magic” about the Borrowers exhibit and noted that the exhibit was a much more passive exhibit compared to others in the gallery. They noted that the Borrowers space was much quieter than other spaces, which lead visitors to whisper and be more subdued in their interactions. Facilitators commented that this helped immerse visitors into the space by encouraging them to behave in particular ways, such as being quiet or 'making themselves smaller' such as curling into a ball on the floor or by being motionless or to focus their attention on particular props in the room such as the clock or curtain. In doing so facilitators commented that this helped visitors “get into the world of the Borrowers” whilst they were in the Borrowers space.

7.3.12 Unstructured interviews with families

From interviews with facilitators after delivery of their sessions the following feedback emerged.

During the interviews families repeatedly reported that they were not fully aware of the Borrowers exhibit or of the interaction aspects that were in the Borrowers space. This was especially interesting as several of the families interviewed had visited the “Nuffin like a Puffin” gallery on previous occasions. Reasons given for missing the interaction by adult visitors was having their attentions elsewhere, such as watching over the children or by not being informed that there was an interactive aspect to the exhibit.

Families also commented that they spent the most time with the interactive aspects of the different exhibits. In regards to the Borrowers, families reported that they had left messages on the Borrowers message board that directly referenced aspects of the interactive. This suggests that people have engaged with the interactive, reflecting and responding to what they have seen and further suggests co-operation and discussion between groups. Furthermore some visitors left small gifts such as trinkets (match boxes, buttons) and gifts (flowers) with messages attached for the Borrowers in the installation space, which suggests that the interactive aspect of the space influenced the behaviour of family groups to engage with other aspects of the exhibit.

7.4 Application of the study in the immersion model

Following the study at Seven Stories I was left with additional questions about what individuals were experiencing. At first exploration into literature on *Immersion* and *Virtual Environments* appeared to provide the answer. Here I considered that the Borrowers exhibit was acting as a *Virtual Environment* to those that were engaged within it and that much like the Gesture study of Chapter 6, the confines of space had served to focus visitor attention into the interactive aspects and subsequently fostered *Absorption* and *Flow*. In addition I considered that the encompassing nature of the exhibit had further assisted visitors to become absorbed in the themes and narrative of the Borrowers.

Following this study, review of literature into presence as well as art and theatre provoked further considerations. Here I considered that the interactive aspect and props used to decorate the room had created a sense of fidelity to the world and themes of the Borrowers book. In doing so I considered that these factors were leading visitors to develop a sense of *Presence* in the exhibit, which was being reflected in how visitors perceived the Borrowers as actual entities that occupied the exhibit; and was reinforced by the ways they tried to interact with them. I then considered that *Immersion* into the Borrowers exhibit was due to a combination of the use of space, *Presence* generated by the interactive and the way that attention and *Engagement* was being focused by the environment.

Later I would revise these views in consideration of *Embodiment*. After review of literature into *Embodiment* I considered that visitors experiences were embodied in the way that they engaged with the props and interactive of the exhibit. At this time I considered that *Presence* was a form of *Embodiment* in the narrative of the Borrowers. However users we also becoming physically embodied in the exhibit space. This was reflected after observing how the Borrowers visitors would behave and interact differently with the exhibit once a vignette had been discovered. Moving from a passive interaction to actively physically exploring and engaging with the props and features within it. In doing so I consider that the visitors were becoming embodied within the Borrowers space and through the combination of the other factors discussed becoming engaged, immersed, absorbed and experienced *Flow*. I therefore consider that the *Activity Spaces* are integral to the development of *Flow* in an activity, on the grounds that environment and space play important roles in influencing user behaviour and interaction with an activity.

7.5 Conclusion and future direction

This chapter summarizes the work performed during 4th and 6th of December 2010 at the Seven Stories museum in Newcastle upon Tyne, as well as subsequent observations and interviews performed from the 6th- 22nd December 2010. The study was an ethnographic observation of both public and organized groups interacting with the "Nuffin like a Puffin" exhibit, specifically focusing upon "The Borrowers" interactive exhibit which had been designed and installed by Culture Lab Newcastle University. During the observation we discovered and developed our knowledge of activity spaces and their contribution of focusing attention in an activity which would later be used in developing our understanding of *Immersion*, *Embodiment* and fostering *Flow*.

The core aims of the study were to:

1. To explore the application of digital technologies to enhance the experience and engagement of Seven Stories' exhibitions and how such technologies facilitated interaction in the exhibit.

2. To evaluate any of the differences between general public user interaction with the exhibit and organized school trip user interaction with the exhibit.

The ethnographic study provided a visitor-orientated look at the application of digital technologies in the Seven Stories gallery. Overall the results were positive with the majority of staff, facilitators and families commenting that the technology enhanced the experience and engagement of audiences with Seven Stories' exhibitions and learning programs. In particular the technology was especially useful to encourage *Engagement* with young people within facilitated sessions, as it provided a greater embodied experience and understanding of "The Borrowers" story and concept; increasing social and shared interaction amongst visitors.

Visitors and staff also provided positive feedback on how the system enhanced the exhibit, with the majority of comments focusing on how the interactive enhanced the 'feel' and 'enchantment' of the exhibit space in the gallery. This suggested that through using such interactive technologies, exhibit spaces are enhanced compared to those which did not employ similar technology. This was further reflected by facilitators who were interviewed showed a preference for wanting to incorporate similar technologies across the gallery to help audience *Engagement* with the material in their sessions.

The study also highlighted several differences between facilitated sessions and public visitor experiences. The greatest difference between these two groups was the level of *Engagement* and frequency of spotting interactions within the space. Public groups also lacked awareness of the interactions going on in the space around them. This lack of awareness was due to two main factors, having their attention committed elsewhere - such as looking after children and other features in the gallery; or from ignorance about there being an interactive element to the Borrowers space. Due to these factors, none facilitated groups spent observably less time in the exhibit space than those of facilitated sessions, as well as being far more passive in their interactions compared to other exhibits in the gallery. Comparatively, during facilitated sessions, visitors to the exhibit would spend longer trying to spot interactions within the Borrowers space and would do so in preference to engaging in other exhibits. Here it was

observed repeat visits to the Borrowers space were common by individuals and groups who would actively break away from the main group to return to the Borrowers space. What was unique about this was such behaviour was contagious as the more these individuals and groups spotted Borrowers, the more others in the group would return to the space to find these interactions.

The study also helped highlight several limitations with the deployed system. In particular interviews with families and staff highlighted that in none facilitated visits many of the interactions were missed due to the subtlety of the interactive; or due to a lack of awareness of the interactive. From this several recommendations were made by families and staff in how these limitations could be addressed, with emphasis that making visitors aware of the interaction, either through direct action such as signs or staff informing visitors to the gallery.

Additional limitations were commented on by facilitators who noted that the behaviour of the system was often too unpredictable. Facilitators commented that a lack of their own understanding of the technology of the interactive, such as being unaware that the system was sensitive to motion and audience numbers, was often misleading. In several cases facilitators would bring in audiences unaware that their presence was reducing the chance of a vignette being played. Also when groups spotted a vignette and the system would freeze it in place this was interpreted as the system being broken. To address this, facilitators and staff recommended increasing the frequency or duration of the Borrower vignettes so that visitors could spot them more frequently.

A third limitation and recommendation was also exposed through the study. It was observed that young audiences had the most enthusiastic response to the interaction, but do not necessarily have a good understanding of the context or content that is being displayed. In support of this, staff and facilitators commented that although the system helped enhance the Borrowers space, it required considerable context and understanding on the part of the audience member to appreciate. In addressing this it was recommended that additional props, such as features that help explain who and what the Borrowers are, could be integrated with

the installation to help inform and prompt younger audiences of the narrative themes the interactive is trying to convey.

In the study I presented an investigation into eliciting what aspects that interactive technologies created in an exhibit space and how this affected visitor interaction and behaviour. The results are encouraging in that users generally liked the various aspects of the exhibit and felt that the experiences were enhanced because of it, with the majority feeling that once the interactions were understood by visitors, the opportunities to engage and interact were greater than that of other exhibits which did not use similar technology. This in turn presents several questions in how space and technology can be used to enhance the experience and *Engagement*.

Additional observations also provide some initial insights and pose interesting questions about how engagement in the space was important in creating an enjoyable visit. During the study it was noted that space and environment played an important part in engaging and subsequently immersing individuals into the Borrowers exhibit. The *Activity Space* of the interactive was a critical factor in focusing the attention of visitors to the content around the room (providing context and narrative), as well as being a part of the interactive aspect of finding and spotting the Borrowers (such as looking behind the curtain). Once a Borrower vignette had been spotted, visitors would demonstrate different to behaviours in the space. Visitors would return several times to the exhibit to try and 'catch' the borrowers in action and during the period where Borrower vignettes were not being played, older visitors would engage more with content displayed on the walls such as manuscripts and information about the book.

A subsequent contribution of this study can inform the design of future exhibits incorporating similar technologies and interaction methods. In particular I observed that the activity of finding Borrowers between reading and engaging with other content was enjoyable based off the reactions of visitors when they were able to 'catch' a Borrower. Further observations gave evidence that visitors developed the notion that the Borrower characters occupied the exhibit space and could be interacted with, with several individuals attempting to get the Borrowers

to walk across their hands and arms. What was unique about this was that such behaviour influenced further interactions not only in the Borrowers exhibit, but across other exhibits in the gallery. Visitors only considered that the Borrowers were within the boundaries of the Borrowers exhibit and would dismiss the possibility that the Borrowers could also be in other exhibits in the Gallery, suggesting a potential avenue to expand the content. However, in doing so it was common for visitors aware of the interaction to return to the Borrowers space and then begin far more aggressive interactions with the exhibit, moving curtains, touching the paintings and features of the room as well as waiting at locations where the Borrowers had been spotted. Such behaviour suggests that a gallery-wide system would promote greater engagement across different exhibits and provide another layer to engaging visitors with the content. This would require a system of much greater capabilities than that used in this study, however due to the relatively uncoupled nature of the apparatus and technology such a system is not beyond reasonable consideration.

Finally the current study only investigates interactions in the setting of the Seven Stories where the audience is primarily families and children below the age of seven years. However the "Nuffin like a Puffin" exhibition is a nation-wide event that celebrates 70 years of Puffin Books. This means that for many of today's pre-internet adults, their childhood books were Puffin titles with their parents also influenced by the titles. It would be interesting to explore how interactions with the Borrowers interactive differs between these different, older groups as our observations showed that behaviour of visitors was influenced by this interactive. For example, visitors would spot Borrowers vignettes playing whilst outside the room and run in to try and apprehend them. Other visitors in groups would split off individually and revisit the Borrowers space to begin scanning around and then loudly proclaim that they had spotted them by themselves. It was evident that this was enjoyable as they would return consistently to the exhibit space to try and spot all the borrowers in the room. It would therefore be interesting to see if comparative behaviours are performed by different groups familiar with the Borrowers and Puffin themes.

Chapter 8. Study 3 - User Experience in Videogame Playing

8.0 Chapter overview

In the previous chapter I explored the importance of space and environment in human activity, focusing on a study performed on visitor experiences in an interactive museum exhibit. During this study we found that visitor engagement was influenced by the space of the exhibit and that visitor behaviour changed depending on the level of interaction they perceived. In relation to this I introduced the *Immersion Model of User Experience* in Chapter 3. Within this model it was noted that individuals desire to have positive experiences when engaged in activity. This desire is derived from wanting to avoid the *Neutral State* of the individual when not engaged and the pessimal experience of an activity known as *Boredom*.

This chapter summarizes a body of work performed from 1st August 2014 to 28th January 2015. This work was a study to elicit what aspects can help foster or inhibit *Immersion* and subsequently *Flow* into an activity. The aim was to compare *User Experience* of playing video games and observe participant behaviour during game play. After playing, participants were then interviewed to gather information about what they had experienced. These interviews were to elicit what participants felt helped or hindered them in becoming immersed as well as to see if they had experienced *Flow* during game play.

It was observed during the study that participants repeatedly reported that they would play video games in their spare time as they "wanted something to do" or did not want to experience being bored. Participants then stated that they played the games because they felt that it was typically a rewarding experience. This suggested that there exists a *Neutral State* of activity by individuals as well as an undesirable state of experience known as *Boredom* from which we seek to escape by becoming immersed into activities.

8.1 Outcomes and discussion

The outcome of the study was approximately twenty hours of recorded video footage of participants playing two different video games, this footage was shot from two view angles creating approximately forty hours of footage in total. In addition to this footage, written observations were also made by the investigator of how participants behaved during playing. After playing each game, participants provided feedback in the form of questionnaires and took part in an unstructured interview about their experiences.

Results and observations from the study showed that different elements caused participants to experience different levels of *Immersion* in playing the games, with some elements leading to higher *Immersion* and others either breaking or reducing *Immersion* by the participants. Progression and reward were associated with players feeling more immersed, whilst *Frustration, Anxiety* and loss of interest in the game resulted in players feeling less immersed. Levels of *Immersion* were also noted to be strongly linked with *Enjoyment* and a desire to continue playing for longer to continue experiencing this *Enjoyment*.

This study highlighted that *Immersion* and *Flow* are linked experiences and I consider that when *Flow* occurred in participants, it was when they were most engaged (immersed), focused and experiencing *Enjoyment* during play. I consider that players became immersed by becoming engaged and rewarded as they progressed during play, and that the participants only experienced *Flow* at the point where they were fully absorbed into the activity. I consider *Absorption* the point where the individual commits all mental energies and focus into an activity and in doing so they experienced *Enjoyment* from simply doing the activity. From this I consider the point an individual becomes absorbed into an activity marks the deepest levels of *Immersion* - where the individual begins experiencing *Flow*.

As I consider *Flow* to be the optimal experience in an activity, I also consider that there exists a pessimal experience known as the state of *Boredom*. During the study, the state of *Boredom* was demonstrated by negative behaviour and displays as *Frustration, Anxiety* and *Disengagement*. These features were then linked to reduced *Attention, Immersion* and *Embodiment* with the activity. Participants would often display negative behaviours caused

by errors or distractions around them, and such displays would accompany their decision to cease play. As all participants experienced *Frustration*, *Anxiety* or *Disengagement* and I consider that a *Neutral State* exists when an individual when not engaged an activity.

I consider the *Neutral State* as although *Boredom* is an undesirable state, *Flow* is a difficult state to attain without significant physical and cognitive investment. Therefore a 'middle ground' must exist between the extreme experience states. In addition the type of experience must differ, as not all experiences exist purely as an experience of *Flow* and *Boredom*. Due to this I then considered that different common experiences must exist depending on what the individual encounters during engagement within an *Activity Space*.

8.2 Background of the study

8.2.1 Flow and boredom

Csikszentmihalyi has made an extensive study of positive experiences that people have when engaged in activity (Czikszentmihalyi, 1975; Csikzentmihalyi, 1990). In this body of research he concludes that the optimal form of experience is known as *Flow*. *Flow* is described as "the state in which individuals are so involved in an activity that nothing else seems to matter" (Csikzentmihalyi, 1990) and is marked by complete engagement and focus of the individual into an activity. Eight features then mark *Flow* which are - clear goals, high levels of concentration, feelings of serenity, distorted senses of time, direct and immediate feedback within the activity, balance between skill and challenge, a sense of control over the activity and feelings that the activity intrinsically rewarding.

Prior to *Flow* is the experience of *Immersion* into an activity. *Immersion* is the sense of engaging and becoming involved in an activity by engaging and focusing mental energy into it. It would reason that *Flow* and *Immersion* overlap with one another due to these similarities, although this is true, *Immersion* differs from *Flow* in that it is not always the ideal or optimal experience to have. Activities can still be highly engaging for the individual, however they may still be aware of things like biological demands such as hunger or sleep, or

time-pressing concerns such as needing to leave the game to drive to school or go to work. Individuals can therefore be immersed in an activity but not necessarily experience *Flow*.

Immersion in an activity can occur without the complete exclusion of all else. In doing so it may seem that *Flow* is simply the extreme end of *Immersion*, however there are a plethora of activities that could be considered to provide highly immersive experiences but which do not lead to *Flow*. For instance, playing video games can be a fully immersive experience with full psychological and physical engagement on the part of the player. Some games are open ended in such a way that a player can do what they want and wish in the game world. However such open ended games lack objectives and goals, so until a player creates such goals and objectives, it is unlikely for *Flow* to occur as with no object and nothing to achieve there is nothing to enjoy. An alternative example to this is that individuals may be challenged beyond their abilities, such as encountering a difficult opponent or boss monster whilst playing the game and subsequently be defeated. It may be an immersive experience but hardly a rewarding one if all that results is defeat over and over again.

Engagement and focus are required to become immersed in activity, however to enter *Flow* total commitment of these features must be made by the individual. This total commitment we term absorption and it is the point where the individual considers nothing else to be important in the activity. Just engaging in the activity is enough to provide reward. At this level of *Immersion*, instances where negatives such as a lack of goals or repetitive defeat are ignored because simply doing them is enjoyable.

It is suggested by Csikszentmihalyi (1990) that the negative experience in an activity is one of *Anxiety* and *Frustration*. This experience, known as *Boredom,* is marked by a lack of interest and *Engagement* by the individual in an activity. I consider that it is not possible to be immersed in activities all the time, since doing so would suggest we could never become bored and being perpetually in *Boredom* suggests the opposite. It then reasons that a *Neutral State* exists that is the natural 'middle ground' of the individual which they return to when not engaged in activities.

8.2.2 MOTIVATION OF THE STUDY

The key inspirations for the study were Eggen, Feijs, de Graaf and Peters (2003) and Jennet, Cox, Cairns, Dhoparee, Epps, Tijs and Walton (2008) in measuring and defining the experience of *Immersion* in games.

Eggen et al. (2003) focuses on a study performed to examine how physical agents can be developed to aid in limiting video game use in young players. Here they highlighted how external distractions can limit and draw the attention of players away from videogame screens by forcing attention and physical interaction outside the game. They formulated the success of their intervention in terms of action space noting that when the player is a state of *Immersion*, his or her attention is focused upon the action space related to the activity that is immersing them. By forcing players to switch their attentions from one space to another then *Immersion* is forcibly broken. Of particular interest, Eggen et al. (2003) considered the aspects of *Flow* to be interchangeable with that of *Immersion*.

Jennet et al. (2008) however explores *Immersion* further. Here they consider that *Immersion* is a natural aspect of activities such as video game playing and explore how *Immersion* can be measured subjectively through questionnaires as well as objectively based on task completion time and physical indicators such as user eye movements. *Immersion* differed to *Flow* as it is an emotionally charged experience of both positive and negative feelings during an activity. *Immersion* was linked to the several key features of *Flow* such as temporal dissociation, reduced awareness of surroundings and high mental focus as indicators of high levels of *Engagement*. However *Immersion* may be divorced from the actual activity in the sense that *Immersion* can occur but not necessarily because of what is occurring in the activity.

For the study discussed in this chapter, the idea that *Immersion* could exist naturally in activities such as video game playing but differed to *Flow* was of considerable interest and that further investigation into understanding the differences between *Immersion* and *Flow* was warranted. In particular if *Flow* is the result of intense *Immersion* into activity,

examination into what features foster or hinder *Immersion* is of value. In addition if *Flow* is the desirable state of becoming immersed, I considered that there must also be an undesirable state that exists which I consider to be *Boredom*.

In order to address this gap in knowledge, the study aimed at examining the following research questions:

1. Which features create or break *Immersion* in activities?

2. What is the undesirable experience and what features lead to this experience?

8.3 STUDY DESIGN

This study is an observation study designed to examine the overall experiences of participants playing video games. Participants would be observed and interviewed to capture information about what they had felt and experienced during play, with questionnaires used to elicit further information about what helped create or break *Immersion* in playing videogame. In addition a correlation methodology was also employed to examine the links between the observed and reported behaviours from participants with the answers of the questionnaires.

8.3.1 WRITTEN OBSERVATIONS

Written observations were performed by investigators from approximately one and a half meters behind and to the left of the participant. This allowed the investigator a full 'side view' of the left hand side of the participant whilst remaining outside their field of view.

Observations focused on three aspects of participant behaviour during play. These aspects were as such:

1. *Movement*: Any movements made by the participant were noted down and described. Examples of observed movement included personal attention such as scratching or pushing back hair, reorientation in the chair or stretching limbs.

2. *Sound*: Any sounds or noise by the participant was noted down during play. Examples of this included tutting, whistling, sighing and mumbling / speaking.

3. *Attention*: The attention of the participant was also noted down whenever they switched their attention from outside the space of playing video games. Such examples of this included looking out windows, looking behind shoulders or focusing on other features in the room.

Aspects were kept intentionally open so that they could be combined together to capture complex behaviours. For example, behaviour such as tapping on the desk whilst humming would be recorded as a Movement + Sound behaviour. This allowed the investigator to capture complex actions quickly which could late be reviewed using the recorded footage of participants. Below is an example of a written observation:

Participant: 4 **Game**: 2 - Tangram Puzzle

M - #4 Leans Backwards, scratching / rubbing face with left hand.

S - Deep sighing

M+S - Leans back towards screen, tutting sound

A+S - Sighing at screen.

M - Leans head over to scratch back of neck.

M+A - Head looks down to keyboard, left hand goes down to keyboard.

Figure 32: Example of written observation in video game study

8.3.2 VIDEO ANNOTATION

Participants were filmed during game play. This footage was then used to help elicit further observations of user behaviour whilst playing the games. Videos were reviewed and observations were recorded in a similar fashion to the written observations described above. As the video footage could be reviewed multiple times a basic annotation was used in the videos to try and help capture and highlight recurring phenomena or behaviours. The annotation aimed to build upon the different aspects of written observations. In doing so the following schema was created to help in this annotation:

Code	Long Title	Description
A/A	Awarness or Attention Shift	Used where participant focuses on something other than the screen. Example - Keyboard, Outside window, Overshoulder etc
AAC	Action and Awareness Combination	Used where an example of Action and Awareness appears. Example - Participant performs several complex moves in the game without looking at controls
CON	Concentration / Focus	Used where participant appears to be concentrating or focusing intensely. Example - long pauses in game play
FR	Frustration	Used where participant display frustration. Could be outbursts, hitting the screen, slamming table etc
INQ	Inquiry	Used where participant inquires about something in or outside the game. Example - "What time is it?"
ND	Negative Display	Used where the participant makes a negative display. Example - Gritting Teet, Frowning
NV	Negative Vocalization	Used where participant makes a negative vocalization. Example - Profanity, Grunting, Growling etc
OD	Other Display	Used where participant performs anything that doesn't fit in other codes. Example - moving equipment.
PA	Personal Attention	Used when the participant gives themselves personal attention. Examples - Shifting seat, touching hair, reorganizing clothing etc
PD	Positive Display	Used when participant makes a positive display. Example - Clapping, Smiling, Dancing
PV	Positive Vocalization	Used when participant makes a positive vocalization. Example - Singing, cheering, woo-hooing

Figure 33: Annotation schema used in video observations

The result of this basic annotation was a more comprehensive view of how participants behaved. The alternative camera angles of video footage also provided a wider field of view of the body posture and positioning of the participants. On the follow page is a sample of how observations and the annotation were used.

Time Index	Video Type (Face / Side)	Notes	CODE		
0.12	Face	Touching / Rearranging hair	PA		
0.27	Face	Waving hand around	OD		
0.54	Face	Tilting head around in puzzlement	ND		
1.01	Face	Scrunching of face / Lips, Leaning Forward	ND	CON?	
1.29	Face	Deeping Inhalation / Sigh, Shifting body back, Coughing	PA	NV	FR
1.53	Face	Rearranging hair, Face on hand, swaying in chair	PA	CON?	PD
2.21	Face	Frowning, pointing at screen	ND	FR	
3.12	Face	Shifting in chair, rearranging self	PA	CON?	FR?
3.32	Face	Head dipping, Frowning	ND	FR	
3.47	Face	Scratching back of head, moving head forward / shifting, mouthing.	ND	FR	CON

Figure 34: Video annotation example

8.3.3 Unstructured interviews with Participants

A core aim of the study was to elicit feedback from participants about what they had experienced during game play. Unstructured interviews were held with participants after each game was played. Questions were performed in an unstructured manner but divided into several areas of interest. The first area was related to what users had experienced during playing. In the case of the participant chosen game participants were asked what motivated them to pick the particular title. Questions from this category included if the participant felt happy whilst playing the game, what they thought and felt about during game play and if they were aware of what was going on in the environment around them. The second area was to find what aspects the participants felt positive about during playing. Questions from this category included what features or aspects of the game encouraged participants to continue playing and if they would play the game again at a later time beyond the study. Finally the third area was related to what aspects the participants felt negative about during playing. Questions from this category included reasons why participants wanted to stop playing, what features they found hindered or obstructed their enjoyment of the game; as well as if anything interrupted or drew their attention away from playing.

Unstructured interviews also served a second purpose in the study. As Participants were given as much time necessary to consider answers to questions this forced them to engage with investigator and not with the game. In doing so this helped ensure that any *Immersion*

experienced from playing the first game was broken and therefore not carried over into the second game.

8.3.4 Questionnaires

Before starting the study, participants were given an information pack that contained a consent form describing the study and an initial questionnaire (Appendix D). This questionnaire contained information about age, gender, if and how often participants played video games, their experience playing video games as well as information such as what features of games they find the most immersing as well as what features they would like to see in future games. For participants who did not play video games, the questionnaire also included questions relating to what features could be included to attract them to play.

Between each game participant were given a questionnaire to fill out (Appendix E). This questionnaire was based on that of Jennett et al. (2008) but included additional questions about participants environmental awareness, attention, their views of the game and what they had experienced playing. This questionnaire also served as another means to break any residual *Immersion* between games in participants.

8.3.5 Participant recruitment and information

Participants were recruited through the use of publicly handed-out flyers, posters positioned in high-foot traffic areas of Newcastle University, as well as agreed-upon public spaces such as windows in local businesses. Additional effort for recruiting participants was through various internal cross-department electronic mailing lists at Newcastle University, as well as word of mouth from investigators to friends and family. Social media and email was used to arrange the date and time slots for each participant.

Recruitment ran continuously from the 1st August 2014 to 28th January 2015. In doing so participants were organized so that interaction between individuals was kept to a minimum

limiting the possibility of participants who had completed the experiment could provide information to influence or prepare pre-meditated answers for others taking part.

Response to the study was limited with a total of 21 participants, with ten males and eleven females taking part. Participants were aged 18-60 with an average age of 31 years (SD = 12.81 years). As there was no financial incentive to take part in the study and many had chosen office-hours, I attribute these as the primary reasons for low participation.

The majority of participants (N = 13) were active video game players playing video-games at least once a week. The experience of video-game playing was high amongst this group, with an approximate average of 10.84 (SD = 0.375 years) years gaming experience per participant. The most common reported devices used for playing video games by these participants were personal computers and consoles. The main motivations to play video games listed by participants was interest in the game story / lore, the challenges of game-play, or finding enjoyment / fun in playing video games.

Of those that did not play video games (N = 8), the main motivations for not playing were a combination of lack of interest in video games (N = 5), time restrictions that prevented playing (N = 3) or a lack of skill at playing video games (N = 1). Features most commonly reported that would attract this group to take up video game playing were options to personalize the game (such as adding photographs or self-insertion into the game world), the ability to socially interact with other users (such as multiplayer or social media) and problem solving or educational features added to the game.

8.3.6 Apparatus and material

Participants used a desktop PC located in Office 6.45 of Claremont tower, this was a Dell i7 870 with attached Viglen EZ-9920 Keyboard, Microsoft Basic Optical Mouse Model: 1094 and a 20 Inch Display Monitor model Iiyama PL2409HD.

Two video cameras were also required to record the participant during play. These were the following;

1. *Camera 1*: Sony Cyber-Shot DSC-W80 mounted atop of the PC Monitor and was aligned so that it captured the face, upper body and hands of the participant.

2. *Camera 2*: Samsung Galaxy Tab 10.1 2Mp was positioned approximately 1 meter away to the right hand side of the participant. This was to allow a full side view of the participant's body.

The investigator sat behind out of view from the participant in order to avoid influencing or distracting the attention of the participant. This also gave the investigator full sight of the left hand side of the participant. Since view of the front and right side of the participant were blocked by the apparatus the video footage of each participant was used to supplement gathered observations. Figure 35 demonstrates the apparatus setup.

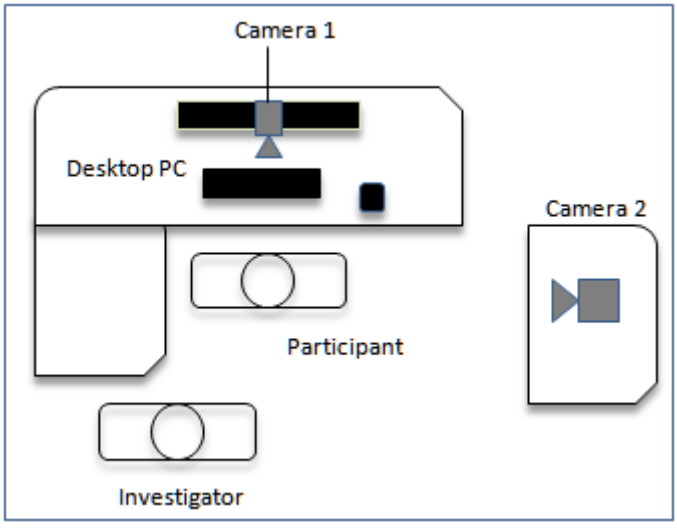


Figure 35: Apparatus set-up

8.3.7 Overview of games

The games that participants could play in the study were selected as they represented broad variety of different game genres. This was chosen as it was expected that participants would have different familiarity and gaming experiences.

Selecting suitable games was difficult as the variety and diversity of game types that are available is broad. In addition certain games types appeal to different skill sets and interests in players; meaning that regardless of which games were chosen particular participants would not find certain games as interesting or immersive as others. In consideration of Jeannette et al. (2008) who argue that *Immersion* is an aspect of all video games, it was decided that games covering broad categories would be chosen so that individuals could indicate which one they would expected to become immersed in. The list of games available and the number of times they were selected for play was as such:

Game	Genre	Times Selected
Candy Crush	Puzzle	7
Quake	Shooter	4
Super Mario Crossover	Action Platformer	10
Winnie the Pooh Baseball	Sports	0

Table 1: Game choice

8.3.8 Candy Crush

Candy Crush is a match-three puzzle video game released by King publishing. It is an internet browser based game where players must connect three or more matching 'candies' together to score points. During play "special" candies can be formed by matching a combination of 4 or 5 in a certain formation, which produce varying effects and score higher points. As players score points the game increases in difficulty by going up in levels. As each new level is reached, the combination of different types of candies increases as new colours and candies are added. Extra challenge is also added by new elements of difficulty such as

special obstacles like jelly; which must first be broken before a player can use and score points for the candy inside. The objective is to score as high a point total as possible until either a timer runs out or no more moves can be made. Candy Crush can be played in 2-modes. "Original" mode which were games are limited by a 5 minute timer or an advanced "Marathon" mode which removes the timer meaning games can only ends when no more possible moves can be made. For this study "Original" mode was chosen as it was felt that a marathon game would be discouraging to players unfamiliar with the game. Figure 36 is a screenshot of the Candy Crush game participants played.

Figure 36: Candy Crush screenshot

8.3.9 QUAKE

Quake is a first-person shooter video game by idSoftware and runs as a web browser plug-in. The game play of Quake consists of players fighting in different arenas attempting to kill (known as "frag") more of their opponents than any other player or team in a given match. This is achieved by navigating a 3D environment and shooting other players with a variety of weapons whilst collecting different power-ups such as health; armour; extra weapons and ammo. Victory is achieved when a player either reaches a certain score (called Frag limit) or

the level timer expires (Default: 30 minutes). Players can play in two formats, against live human opponents, or against the artificial intelligences of the game known as "bots" that adapt to the players performance. For this study the artificial intelligence opponents were selected. The reason for this is that to play against real human opponents players must register their own unique profile which attempts to match opponents against equal skilled players by evaluating player performance over 30 matches whilst AI opponents adapt dynamically based on player performance during a match. Figure 37 is a screenshot of the game of Quake participants played:

Figure 37: Quake Screenshot

8.3.10 Super Mario Crossover

Super Mario Bros. Crossover is a flash browser-based action-platform game developed by Exploding Rabbit. The game's levels and graphics are duplicates of those found in the original Nintendo Entertainment System game Super Mario Bros. Players progress through different "worlds" divided into four levels. Three of these levels involve the player getting to the end of the level, whilst at the end of the fourth level players must defeat a 'boss' called Bowser in hopes of rescuing a Princess known as Peach. During each level enemies will attempt to block the player. The player can jump on enemies to kill them and acquire power ups from special blocks that serve to boost health, shoot fireballs, or remain

invincible for a short period of time. Besides completing the level, the player can also earn coins and points, attempting to achieve a high score. Crossover varies this formula by adding in several additional main characters in addition to Mario that the player can play. The player selects one of the additional characters at the start of each level. Each character is based on other classic Nintendo Entertainment System games, uses different attacks and movements that are related to their original game, as well as their own signature music. The game has two modes, original mode and advanced mode. Advanced mode adds additional levels from another Mario-brothers title aimed at expert level players, for this reason this study chose to use the original mode as the skill level of advanced mode would be unsuitable for new or unfamiliar players. Figure 38 is a screen shot from Super Mario Crossover participants played.

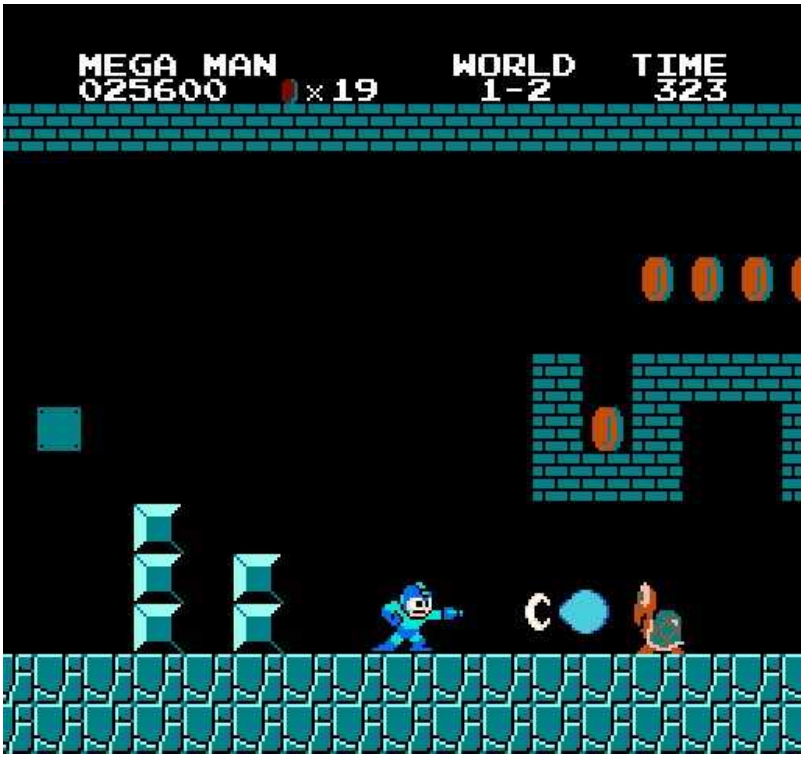


Figure 38: Super Mario Crossover screenshot

8.3.11 Winnie the Pooh's Home Run Derby

Winnie the Pooh's Home Run is a flash browser-based baseball video game published by Walt Disney Pictures. The player controls the Character Winnie the Pooh in order to defeat his friends in a baseball match. In each stage players face off against one of the other characters of the Winnie the Pooh franchise and are given a target number of home-runs they must successfully hit. The player must hit this target number of home runs within a limited number of pitched balls to achieve victory or they must replay the stage until they succeed. As players progress the difficulty of each opponent increases represented by each opponents unique method of pitching the ball to the player. During the game players acquire experience points to spend to increase their abilities such as swing speed, swing strength and movement speed. The game only has a single game mode where players progress sequentially from opponent to opponent as they complete each stage but may visit previous stages in order to acquire more experience points to increase their abilities to help make progression against harder opponents easier. Figure 39 is a screenshot of the Winnie the Pooh's Home Run Derby.

Figure 39: Winnie the Pooh's Home Run Derby screenshot

8.3.12 TANGRAM PUZZLE

All participants would play another video-game after their chosen game from the options listed previously. This second game was a video-game version of a Tangram puzzle.

The Tangram is a dissection puzzle consisting of seven flat shapes, called tans, which are put together to form shapes. The objective of the puzzle is to form a specific shape using all seven pieces which may not overlap. Tans can be rotated and flipped by the player to help them make the desired shape of the puzzle which is usually presented in the form of a silhouette. In the study the Tangram game was chosen as it is a virtual version of a real-world puzzle. Unlike Jennette et al. (2008) who wished to use a real-world Tangram puzzles to examine the transition of immersion to real-world engagement in participants, this study wanted to see what features broke or fostered *Immersion* and *Flow* in game playing activities. Due to this it was felt that a video game version of the Tangram puzzle would serve as suitable choice to contrast with the other games being both a video game but at the same time a real-world puzzle. This would allow us to investigate participant experience in the sense that participants were still playing a 'video-game' but a form of video game in strong contrast to the larger than life scenarios of the others available. Figure 40 is a screenshot from the Tangram puzzle video game used in the study.

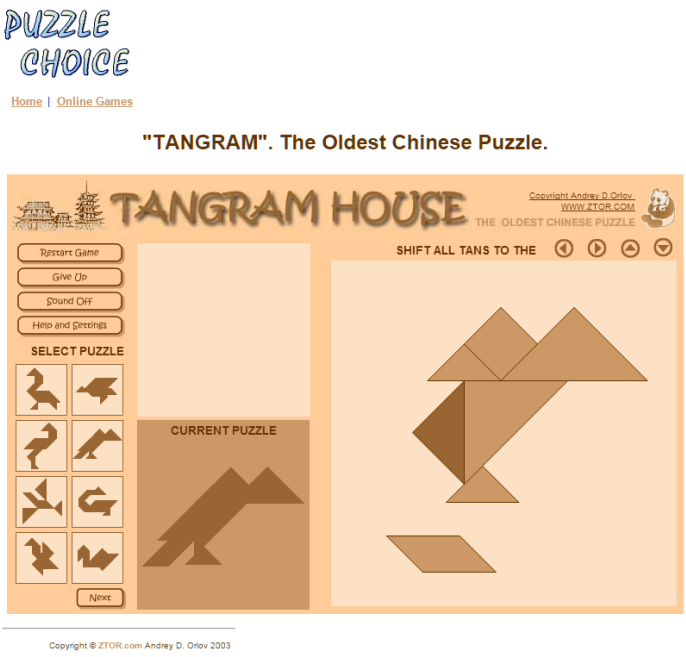


Figure 40: Tangram Puzzle screenshot

8.3.13 PROCEDURE

The study took place in office room 6.45 of Claremont Tower located on the campus of Newcastle University. Participants were greeted at reception by the investigator and lead up to the office.

Upon arrival participants received a randomly selected information package. The content of all packages was the same but each pack was numbered. This helped ensure names of the participants remained anonymous. Contained within the pack was the initial information sheet, which provided them with a short overview over the study and its aims and an initial questionnaire that contained a small number of questions about their background, age, gender, and experience in playing videogames. Once completed this initial questionnaire was then returned to the information packet for collection by the investigator.

After participants had read the information sheet and filled in the questionnaire, the investigator then provided them with a verbal briefing that detailed information about the study and what would be expected of them in each trial. Participants were then instructed about what would occur in each section of the study.

Following the outline of each section of the study, section 2 began. Participants were then told of the choices of games available to them to play for this section. Due to the nature of the games involved in the study, the investigator provided a verbal explanation and brief description of the type of game each game was, this was performed as it was expected that not all participants would be familiar with the games available. Once participants had selected a game, they were then given a brief verbal description of the basic controls of the game and directions in how to start the game. This was again based on the assumption that not every participant would be familiar with the basic controls or know how to start a new game.

At this point the investigator provided subjects with the opportunity to ask any questions they might have prior to starting the game. Participants were instructed that they may ask

questions about the game (such as controls or how to change the game settings) but off-topic questions were discouraged. Once the participant was ready each camera was activated and the participant instructed to commence playing.

Once the participant had begun playing, the time of when play commenced was noted. Observations of how users behaved during play were then recorded. These observations were made to see when and where participants would switch focus from the activity space of the game to elsewhere, as well as any other behaviour participants performed during game play. These observations were then supplemented by the video recordings of the face and upper body, and right hand side view of the participant which were reviewed at a later date.

Once participants had ceased play the game was turned off. The unstructured post-game interview was then performed to elicit information about what the participant had experienced. The purpose of these interviews was to see what features had encouraged or inhibited participant *Immersion* and *Enjoyment* during play. Interview questions were left intentionally open to allow participants to express what they had experienced and how they had felt during game play as well as to provide as verbose descriptions of which features helped or inhibited their *Enjoyment* and *Immersion* into the game.

Once the interview was completed participants were provided a copy of a questionnaire (Appendix E), which contained questions about their experience of playing the game, as well as some further questions relating to how far they felt they had been immersed in playing. In addition participants were asked to provide an estimation of how long they believed they had been playing the game which was noted down for comparison to the recorded actual game time. Once participants had finished the questionnaire the third section of the study then began.

The third section was a repeat of the procedure described above, however participants were not given the option to choose which game they would play. Instead all participants would play the video-game version of the Tangram puzzle. Once participants had ceased playing this game they were then interviewed and provided another copy of the questionnaire this

time to review the second game. Upon completion of this final questionnaire, participants were then discharged from the study.

8.4 Overview of results

8.4.1 Written observations from video review

Several written observations were made during the study. These observations were then further enhanced through review of the recorded video footage. I shall now discuss these observations.

It was observed that participants would often, quite explicitly, express *Frustration* through negative displays. Such displays were either verbal (profanity, shouting), or physical (movements of the limbs or body). It was observed that *Frustration* and negative displays would precede participants stopping play or would interrupt and disengage participants from the game activity. It was observed that participants would disengage from the game activity during displays in several ways. The most common way this was observed was that participants would distance themselves from the controls of the game, either physically moving away from the controls, or pushing the controls away from themselves. The second way *Disengagement* would occur was by switching attention away from the game activity to other features in the environment, such as moving attention from the screen to looking at other features in the room, looking to features outside the room or 'hiding' the view of the screen such as by putting hands over faces or putting heads onto the desk. Figure 41, Figure 42 and Figure 43 are examples of these behaviours.

Figure 41: Example of verbal frustration and aggression

Figure 42: Example of physical disengagement

Figure 43: Broken attention

In contrast to *Frustration* it was observed that participants would also express *Enjoyment* and concentration in the form of positive displays. Such displays were either verbal (cheering, celebration), or physical (nodding, dancing, smiling). It was observed that the more positive displays performed, the longer the participant played the game for. It was also observed that participants would focus on the game activity more following a positive display. The most common way this was observed was that participants would lean in closer to the game space, perform personal attention such as shifting in the seat to rearrange themselves, or increase their level of concentration on the screen, such as focusing and resting their head into the palm of the hand. Figure 44, Figure 45 and Figure 46 are examples of these behaviours.

Figure 44: Enjoyment shown in smiling at the screen

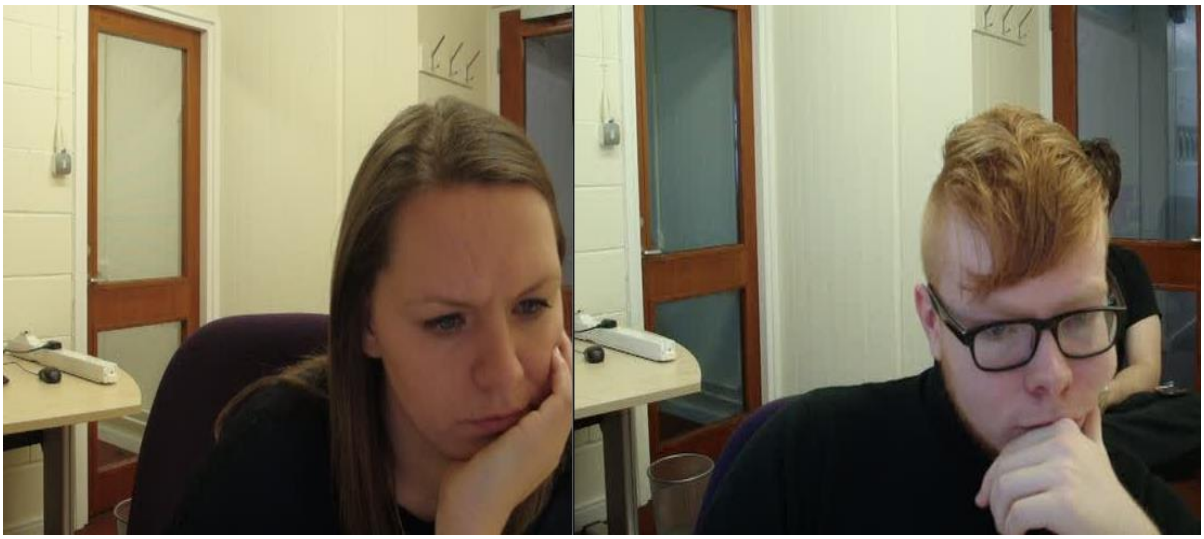


Figure 45: Example of increased concentration.

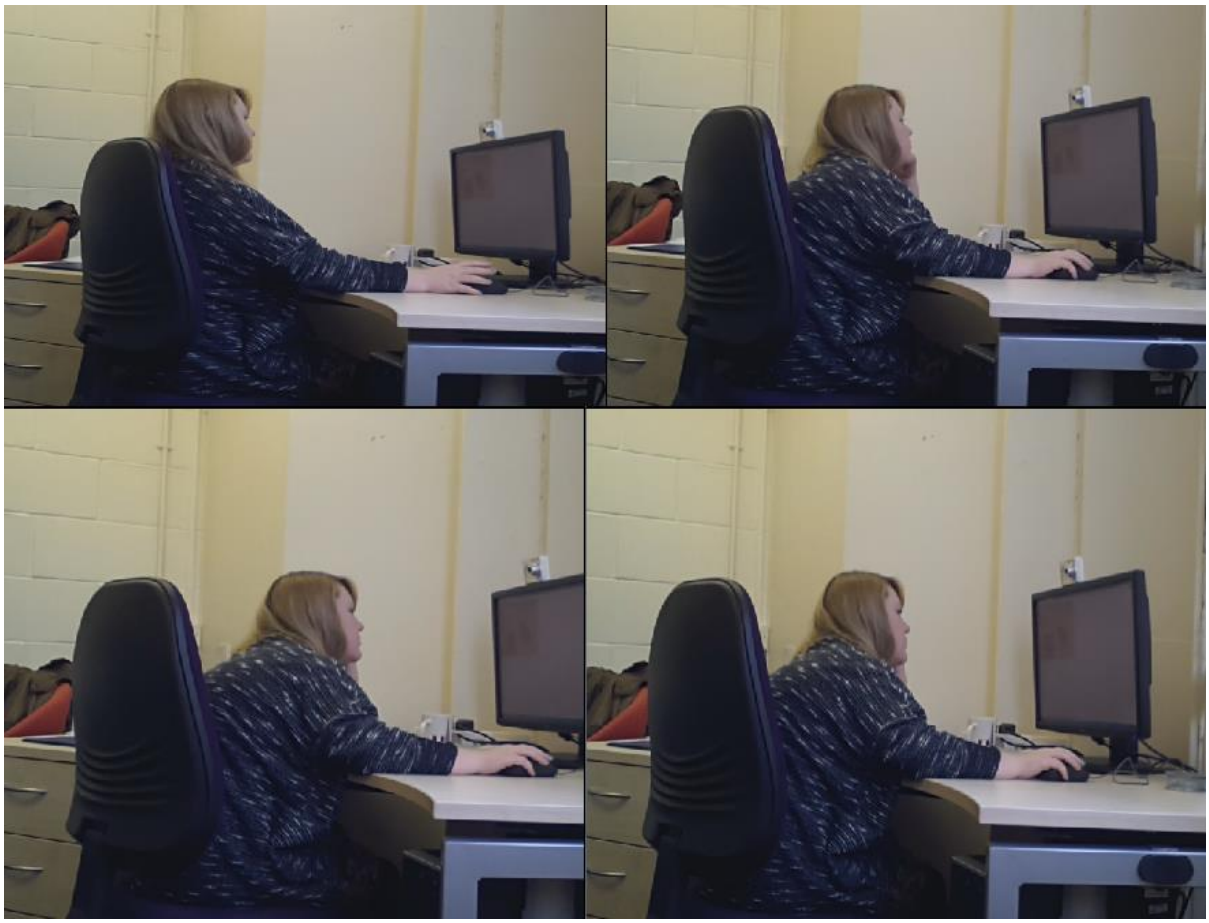


Figure 46: Example of moving in to concentrate

It was observed that players switched attention away from the screen to the controls more than any other distracting features during play. These moments of broken concentration were brief, with longer breaks from the controls usually to complain to the investigator or inform the investigator that participants wanted to cease play. It was also observed that these times of broken attention would occur after a participant had failed or made an error during game play, with the breaking of attention to ensure that correct position of the hands were on the controls. Participants would also look at controls or rearrange themselves if a chain of errors was made during play, when this occurred it was also observed that participants would gesture at or 'hit' the controls more aggressively; either raising hands and slapping the desk; clicking repeatedly to quickly return to the game or rapidly tapping keys such as the spacebar. Figure 47 and Figure 48 are examples of these behaviours.

Figure 47: Broken concentration by looking at controls

Figure 48: Broken concentration by turning to the investigator in protest after hitting the controls.

8.4.2 PARTICIPANT INTERVIEWS

Following the playing of each game by participants unstructured interviews were performed to try and elicit information about what users had experienced during their experience playing video games. In this section we highlight the most common feedback from these interviews.

Participants reported that they had an enjoyable experience playing games. This feedback was either about changing emotional states that had occurred from playing the games ("I was nervous but felt better after playing the games") or direct statements about their *Enjoyment* of

playing the games ("That was really fun, I'd play that again"). When asked which aspects participants had the most *Enjoyment* from, participants focused on positive aspects of the games they played such as graphics ("They really caught the classic graphics"), music ("It was good that all the characters had their own music"), or game play features ("I liked it when I popped a chain of candies and the screen went crazy"). Participants also reported that they would have liked to play the games for longer ("We could be here all night") or play the games at times other than the study ("I'll be playing that when I get home").

In addition participants were given a maximum of two hours to play each of the games. During the study none of the participants reached this time limit. When participants stopped playing, the interview questions were directed to what reasons had led them to do so. The most common reasons given for stopping play was due to a loss of interest in the game ("After a few levels it wasn't interesting anymore"), *Boredom* ("The game was boring") and *Frustration* ("It was too hard, I couldn't do it"). Loss of interest was the most commonly reported reason to stop playing (N = 12) and was attributed to players becoming used to the challenges of the game. Participants reported that after playing several levels there was little motivation to continue playing - as they lost interest in the goals of the game or were not interested to see how the events of the game played out. A loss of interest was also strongly tied with the participant reporting that playing video games was a time consuming activity and that because there wasn't anything being achieved, they were thinking about other concerns which influenced them to stop playing.

The next commonly reported reason to cease play was *Boredom* (N = 6). Here participants reported that the games were or had become boring during play. Reasons for games becoming boring were a lack of progress in the game, repetitive game play, or the player feeling they had explored everything the game had to offer them. Lack of progress was linked with either having to restart the game after failing or becoming 'stuck' at certain points between levels that were too difficult to progress through. Repetitive game play was linked to participants having to do the same thing over and over between levels or the reported feeling that the game had no end. Finally players reported that once they had explored the features of the game they grew bored of the game, by this players reported that after they had played as different characters, changed settings in the game options, or tried to play the games in a

different way (for example, only using a single weapon to win a match in quake), they felt they had completed everything the game had to offer them and therefore grew bored of playing.

The final reported reason for ceasing game play was *Frustration* (N = 3) at the game. Participants reported that having to restart levels or not understanding how to achieve success in the game caused them to stop playing. Difficulty of the game was reported by participants as the reason for their *Frustration*. Participants also linked *Anxiety* with this *Frustration*, commenting that they would become stressed and anxious each time they could not overcome certain elements of the games despite several different approaches.

8.4.3 POST GAME QUESTIONNAIRES

Following each game, participants completed a questionnaire based on the *Immersion* review questionnaire of Jennette et al. (2008) (Appendix E). This questionnaire served as a means of gathering further participant feedback but also as a means to force the participant to engage outside of the game activity space to reduce residual *Immersion* from one game being carried over to another game. It should be noted however that the effectiveness of this could not be clearly determined.

All statistical analyses of the questionnaires were performed using IBM SPSS Statistics v21.0. The questionnaire consisted of 40 questions divided into three sections about their experiences of playing the game. Each question was a survey-type question with a Likert type scale with a range of 1 (Strongly Disagree) to 5 (Strongly Agree) for each questions about UX in playing video-games. An alternative scaling of 1 (Not very Immersed) to 10 (Very Immersed) was also used to find the level participants felt they were immersed in either game. Questions also included space to allow participants to expand on their answers if necessary. Finally participants were asked at the beginning of each questionnaire to give an estimation of how long they thought they had been playing the game for to see if any perception of time was seriously distorted.

As participants got to choose which game they felt they would be most immersed in, it was hypothesized that players would be more immersed into playing Game A than the mandatory game of Game B. However from analysis of the questionnaire feedback of participants of Game A and Game B this proved to not be the case. Figure 49 is a chart of reported *Immersion* in Game A and Game B grouped by participant.

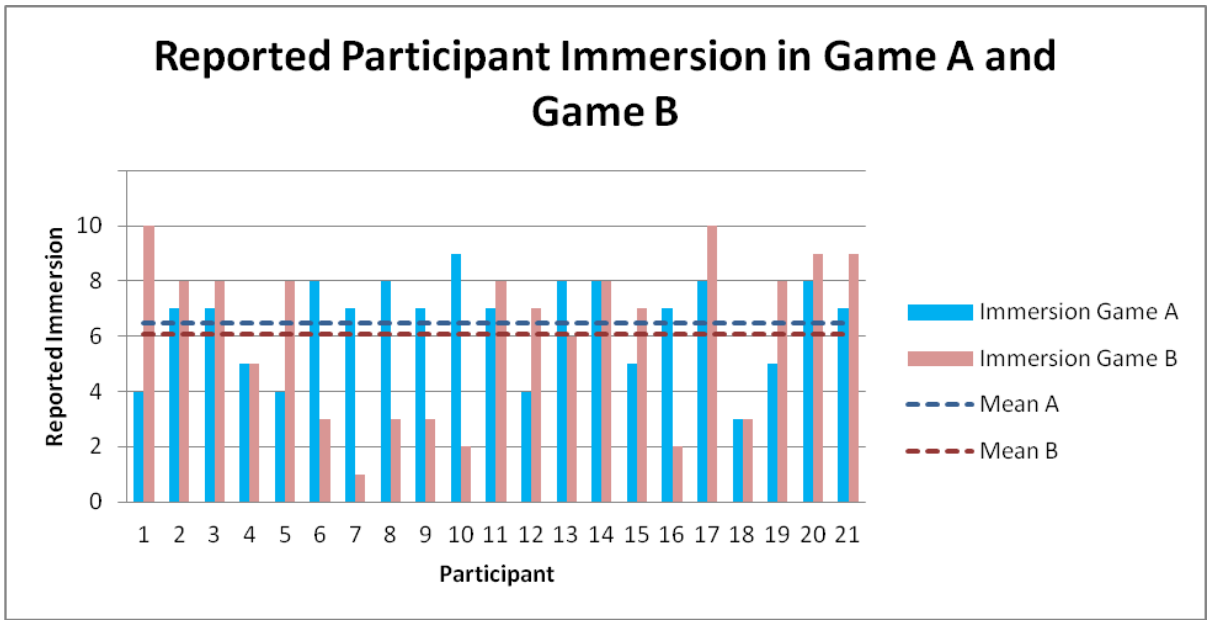


Figure 49: Reported participant immersion across game A and game B

Overall participants (N=21) were associated with a mean *Immersion* score in Game A of 6.47 (SD = 1.72), in addition participants were associated with a mean *Immersion* score in Game B or 6.10 (SD = 2.91). These results inferred that participants were slightly immersed in both games during play. In addition distribution of these results was sufficiently normal to perform a comparison. To test the hypothesis *Immersion* was higher for participants in Game A compared to Game B; a paired-sample T-test was used. Results of this test showed no significant difference (t (20) = 0.481, p = .635) between reported *Immersion* between the two games. This suggests that players were not any more immersed in Game A than that of Game B despite being able to choose which title they thought they would become immersed playing. We consider from these results that the video-games were naturally immersive however other factors may contribute to determining what depth of *Immersion* was attained by players.

Players were allowed up to a maximum of two hours to play each game. This time limit was set to allow management of participant commitments that may have been forgotten about from being immersed in the study. None of the participants exceeded this time limit. When game play started the time participants began playing each video game was noted. After participants had ceased playing each game the time they stopped playing was also recorded. Participants were then asked to estimate how many minutes they had spent playing the game. It was hypothesized that participants would experience time distortion during game play as they would become immersed. Participants (N = 21) were associated with an actual game time in Game A of 24.81 minutes (SD = 11.73). Participants were also associated with an estimated game time in Game A of 21.81 minutes (SD = 10.69). These results initially inferred that minor time distortion had occurred by participants. Distribution of these results was sufficiently normal to perform a comparison. To test to see if there was significant difference between the estimated game time and actual game time by participants for Game A.

A paired sample t-test was used. Results then showed that there was no significant evidence ($t(20) = -1.56$, $p = .136$) to suggest that the estimated time by participants and the actual game time played in Game A strongly differed. This suggested that the time distortion experienced by participants during play was not significant. In support of this the percentage discrepancy between estimated and actual game time was then calculated to examine how accurate participant's estimations were to actual game time. Here results showed that the mean accuracy of participants (N=21) estimations of time for Game A was 99.75% (SD = 53.69), this suggested that participants were able to estimate the passage of time accurately to that of actual time passed and therefore this suggests they were not experiencing significant time distortion which suggested that participants were not becoming heavily immersed in playing the game. Figure 50 demonstrates these results.

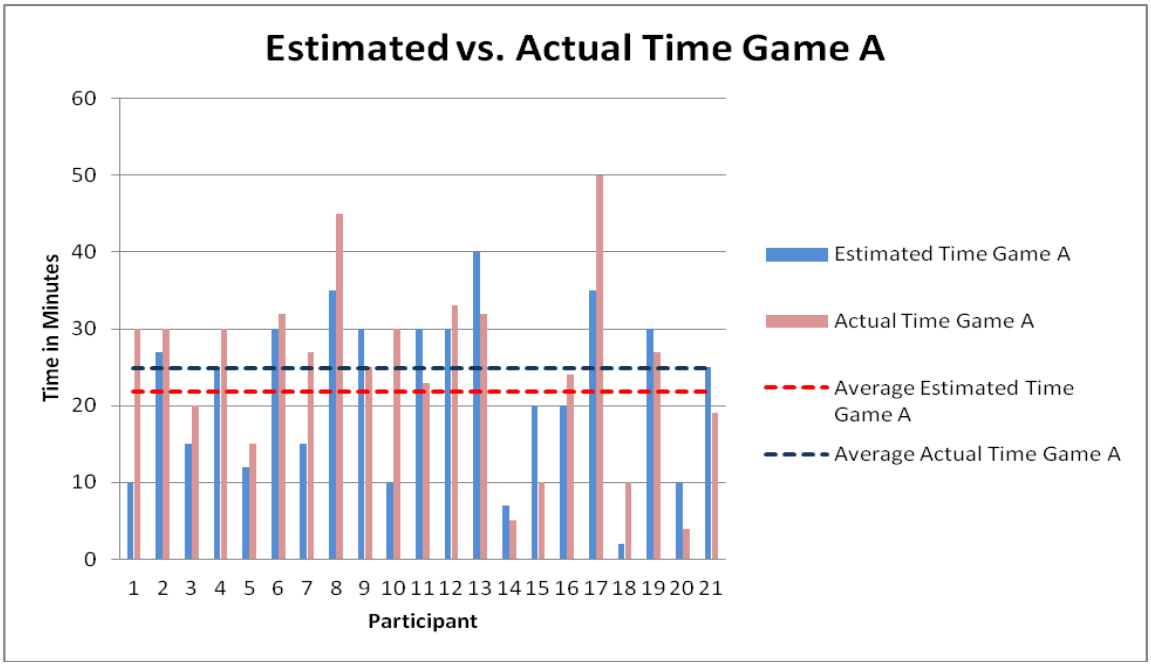


Figure 50: Estimated vs. actual time game A

In addition, participants (N = 21) were associated with an actual game time in Game B of 24.29 minutes (SD = 10.85). Participants were also associated with an estimated game time in Game B of 21.52 minutes (SD = 10.05). Much like Game A these results initially inferred that minor time distortion had occurred by participants. Distribution of these results was also sufficiently normal to perform a comparison. To test to see if there was significant difference between the estimated game time and actual game time by participants for Game B (Figure 51); a paired sample t-test was used. Results then showed that there was no significant evidence ($t(20) = -1.77$, $p = .093$) to suggest that the estimated time by participants and the actual game time played in Game B strongly differed. This suggested that the time distortion experienced by participants during play was not significant. In support of this, the percentage discrepancy between estimated and actual game time was then calculated to examine how accurate participant's estimations were to actual game time. Here results showed that the mean accuracy of participants (N = 21) estimations of time for Game B was 91.28% (SD = 27.84). This suggested participants were able to estimate the passage of time accurately to that of actual time passed and therefore this suggests they were not experiencing significant time distortion and becoming heavily immersed in Game B. Figure 51 demonstrates these results.

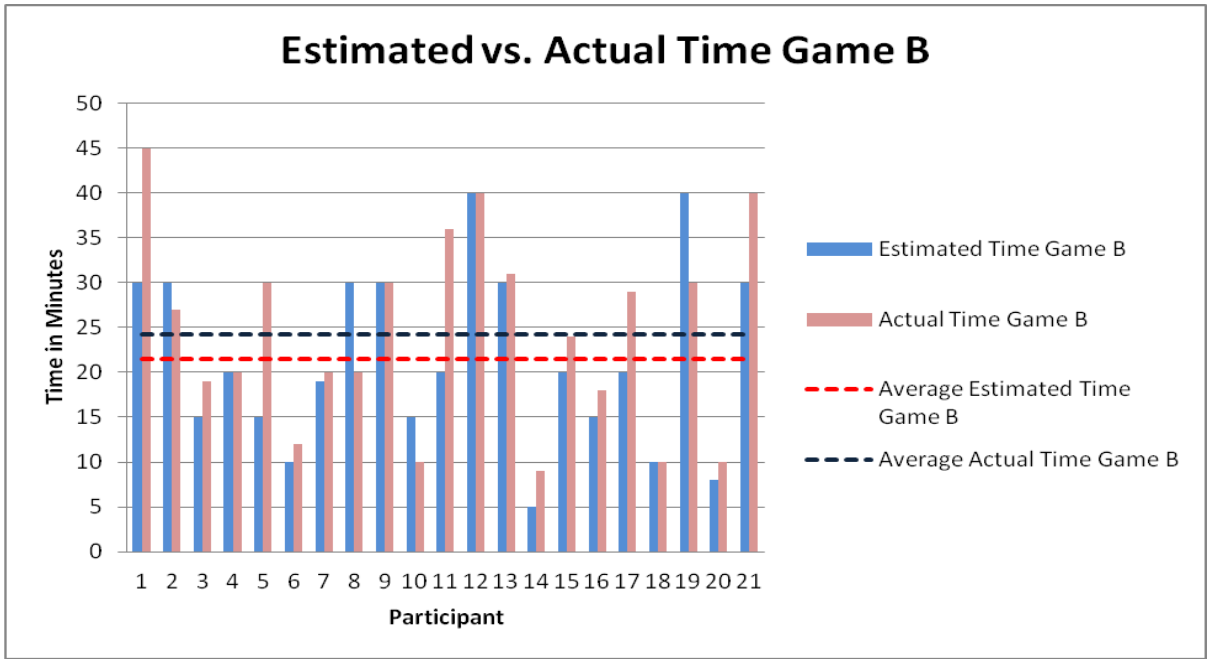


Figure 51: Estimated vs. actual time game B

Additional observations made during participant play also suggested that attention and awareness of the participants was frequently divided between the controls and the game space. Due to this it was hypothesized that awareness of the controls subsequently reduced the *Immersion* of participants during game play. To see if a correlation between awareness of controls and levels of *Immersion* was present a Pearson's Correlation test was performed. Distribution of the results of recorded immersion and awareness of controls were sufficiently normal to perform this correlation. Participants (N = 21) were surveyed about the level of *Immersion* they experienced during game play in Game A (M = 6.48, SD = 1.72) and their awareness of using the controls during game play during Game A (M = 2.71, SD = 1.45). A Pearsons R analysis of this data revealed a moderate negative correlation between awareness of the controls and reported *Immersion*. (r = -.502) this correlation proved to be significant (p = 0.20). In turn this suggested that the more aware of controls participants reported the lower overall *Immersion* was experienced during play in Game A, and that this awareness contributed to reducing *Immersion* during game play. Figure 52 are the results of this correlation test in Game A.

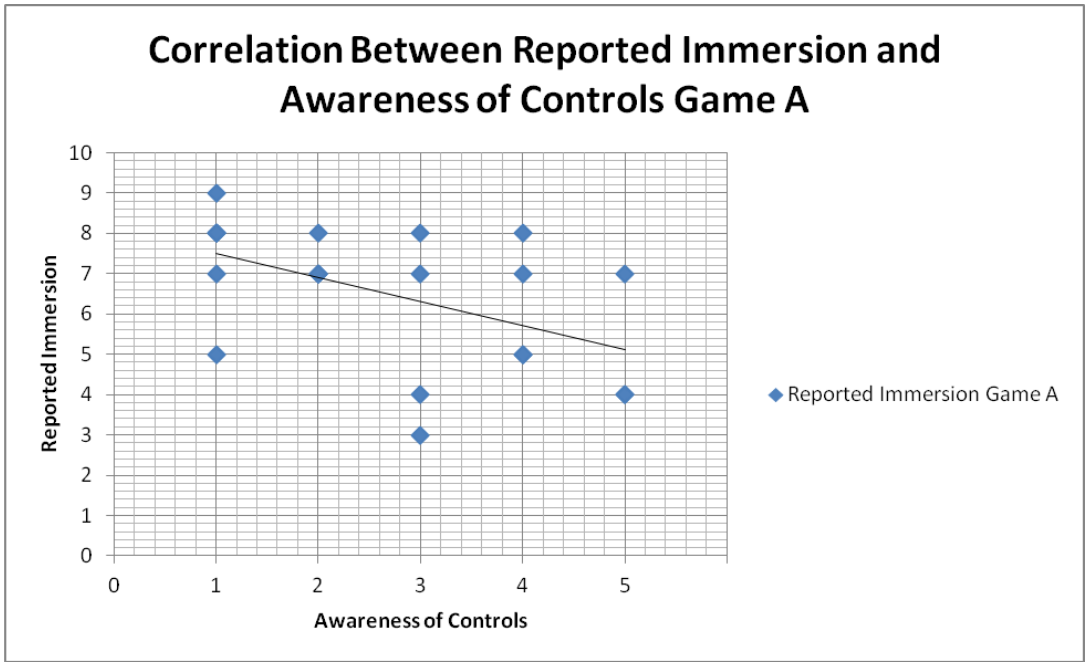


Figure 52: Correlation between reported immersion and awareness of controls game A

The test was then repeated for Game B. Participants (N = 21) were surveyed about the level of *Immersion* they experienced during game play in Game B (M = 6.10, SD = 2.91) and their awareness of using the controls during game play in Game B (M = 2.52, SD = 1.17). A Pearsons R analysis of this data revealed a weak negative correlation between awareness of the controls and reported *Immersion* (r = -.207) in addition this correlation was not significant (p = .369). In turn this suggested that the more awareness of controls participants experienced the lower overall *Immersion* was experienced during play in Game B, however it also suggested that this awareness of controls was not significant in lowering *Immersion* during game play in game B. Figure 53 is the results of this correlation test in Game B:

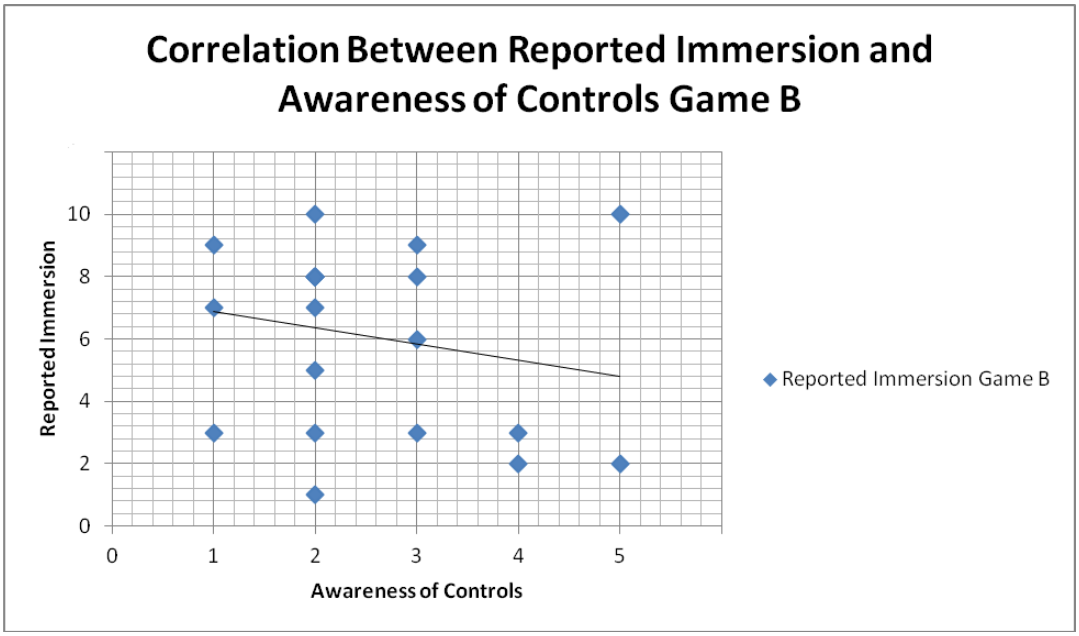


Figure 53: Correlation between reported immersion and awareness of controls game B

Observations made during participant play suggested that attention and awareness of the participants was frequently divided between the surrounding environment and the game space. Due to this it was hypothesized that awareness of the environment subsequently reduced the *Immersion* of participants during game play.

Distribution of the results of recorded *Immersion* and awareness of environment were sufficiently normal to perform this correlation. To see if a correlation between awareness of environment and levels of *Immersion* a Pearsons Correlation test was performed. Figure 54 describes the results of this correlation test in Game A. Participants (N = 21) were surveyed about the level of *Immersion* they experienced during game play in Game A (M = 6.48, SD = 1.72) and their awareness the surrounding environment during game play during Game A (M = 3.00, SD = 0.89). A Pearsons R analysis of this data revealed a moderate negative correlation between awareness of the environment and reported *Immersion*. (r = -.357) this correlation proved to be insignificant (p = 0.112). In turn this suggested that the more aware of the environment participants experienced the lower overall *Immersion* was experienced during play in Game A. However it also suggested that this awareness of the environment was not significant in lowering *Immersion* during game play in game A. Figure 54 describes these results.

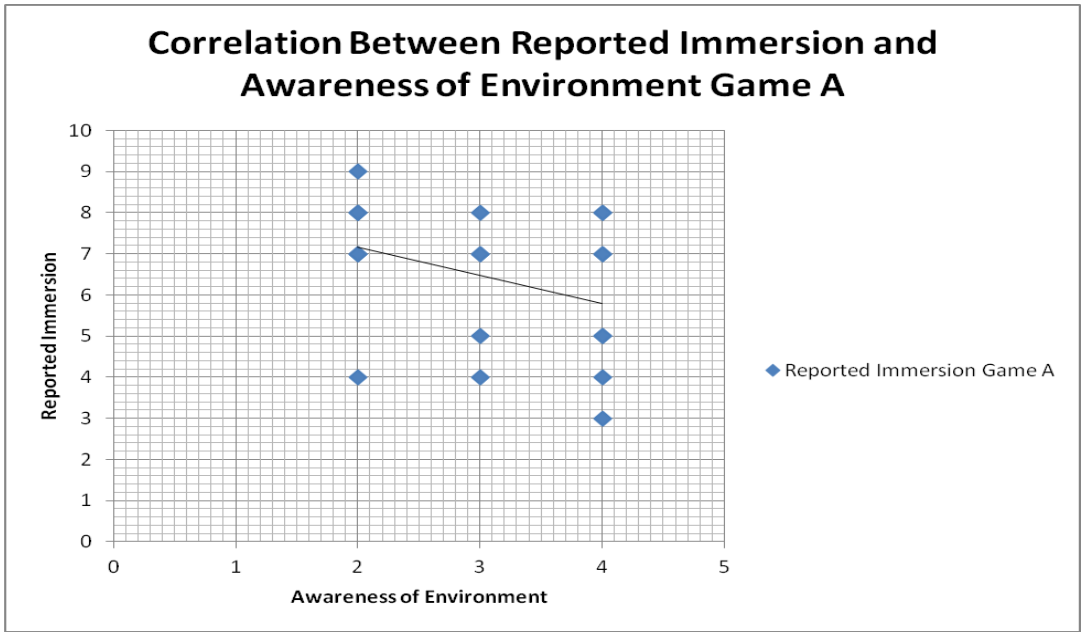


Figure 54: Correlation between reported immersion and awareness of environment game A

Following this, participants (N = 21) were surveyed about the level of *Immersion* they experienced during game play in Game B (M = 6.10, SD = 2.91) and their awareness of the surrounding environment during game play in Game B (M = 3.10, SD = 1.09). A Pearsons R analysis of this data revealed a moderate negative correlation between awareness of the environment and reported *Immersion* (r = -.459) in addition this correlation was significant (p = .036). In turn this suggested that the more aware of the environment participants were the lower overall *Immersion* was experienced during play in Game B. However it also suggested that awareness of the environment was this significant in lowering *Immersion* during game play in game B. Figure 55 describes the results of this correlation test in Game B.

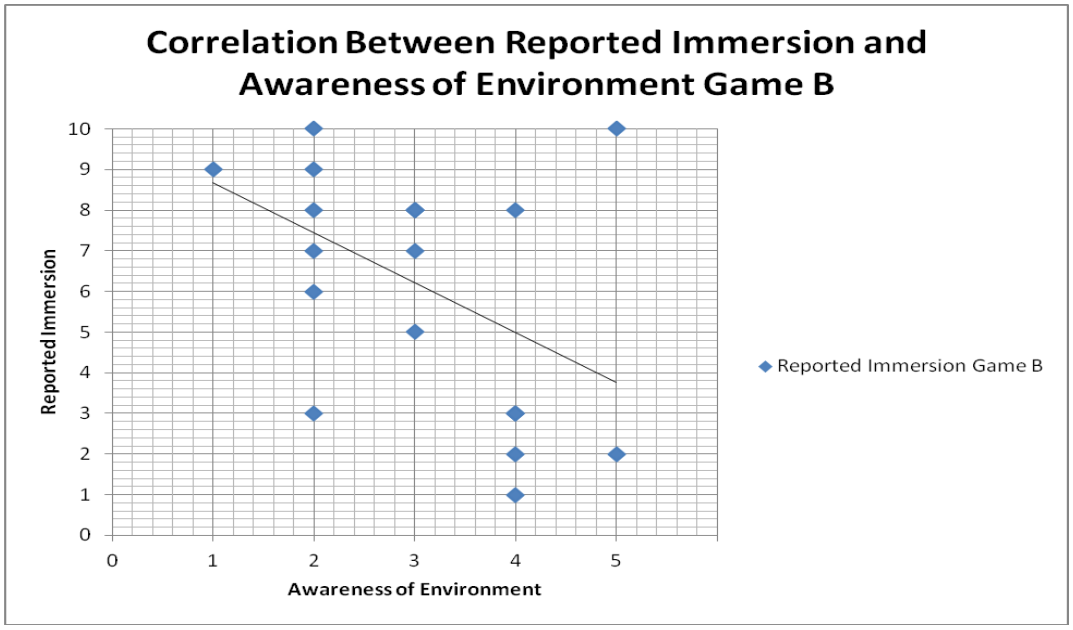


Figure 55: Correlation between reported immersion and awareness of environment Game B

Observations made during participant play suggested that participants who enjoyed playing a game desired to play it for longer and became more immersed. This was represented by observed positive displays leading to increased concentration and focus into the game space. Due to this it was hypothesized that enjoyment was causing players to become more engaged with the game, leading them to become more immersed and causing desire to continue to play to be higher. Distribution of the results of recorded participant enjoyment of playing the game and desire to continue playing were sufficiently normal to perform this correlation. To see if a correlation between enjoyment and the desire to continue to play was present a Pearsons Correlation test was performed. Figure 56 describes the results of this correlation test in Game A. Participants (N = 21) were surveyed about the level of *Enjoyment* they experienced during game play in Game A (M = 3.76, SD = 0.995) and their desire to play the game for longer (M = 2.52, SD = 1.03). A Pearsons R analysis of this data revealed a moderate positive correlation between *Enjoyment* and the desire to continue playing (r = .615) in addition this correlation was significant (p = .003). In turn this suggested that the more a participant enjoyed themselves the more they desired to play for longer. Participants (N = 21) were then surveyed about the level of *Enjoyment* they experienced during game play in Game A (M = 3.76, SD = 0.995) and how far they were immersed whilst playing Game A (M = 6.47, SD = 1.72).

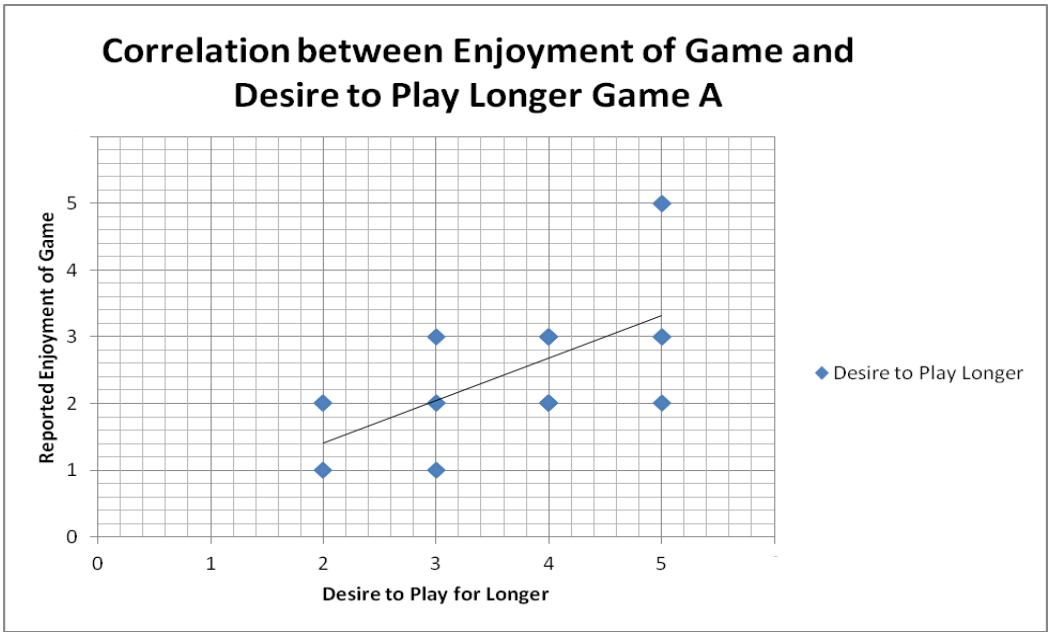


Figure 56: Correlation between reported enjoyment and desire to play longer game A

To see if a correlation between *Enjoyment* and level of *Immersion* was present in Game A, a Pearson's Correlation test was performed. Distribution of the results was sufficiently normal to perform this correlation. A Pearson's R analysis of this data revealed a moderate positive correlation between enjoyment and levels of *Immersion* (r = .595) in addition this correlation was significant (p = .004). In turn this suggested that the more a participant enjoyed themselves the more they were immersed into the game. Figure 57 describes these results.

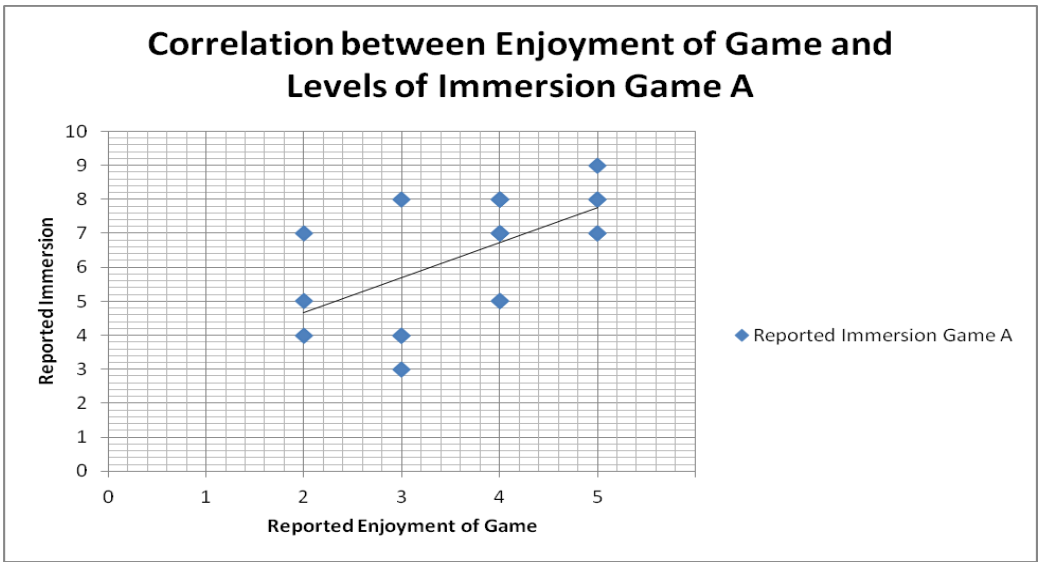


Figure 57: Correlation between reported enjoyment and levels of immersion game A

Finally, Participants (N = 21) were then surveyed about their desire to continue playing Game A for longer (M = 2.52, SD = 1.03) and how far they were immersed whilst playing Game A (M = 6.47, SD = 1.72). To see if a correlation between the desire to continue to play and levels of user *Immersion* was present a Pearson's Correlation test was performed. Distribution of the results was sufficiently normal to perform this correlation. A Pearson's R analysis of this data revealed a moderate positive correlation between desire to play and levels of *Immersion* (r = .642) in addition this correlation was significant (p = .002). In turn this suggested that the more a participant wanted to play the more they were immersed into the game. Results of this test are represented in Figure 58.

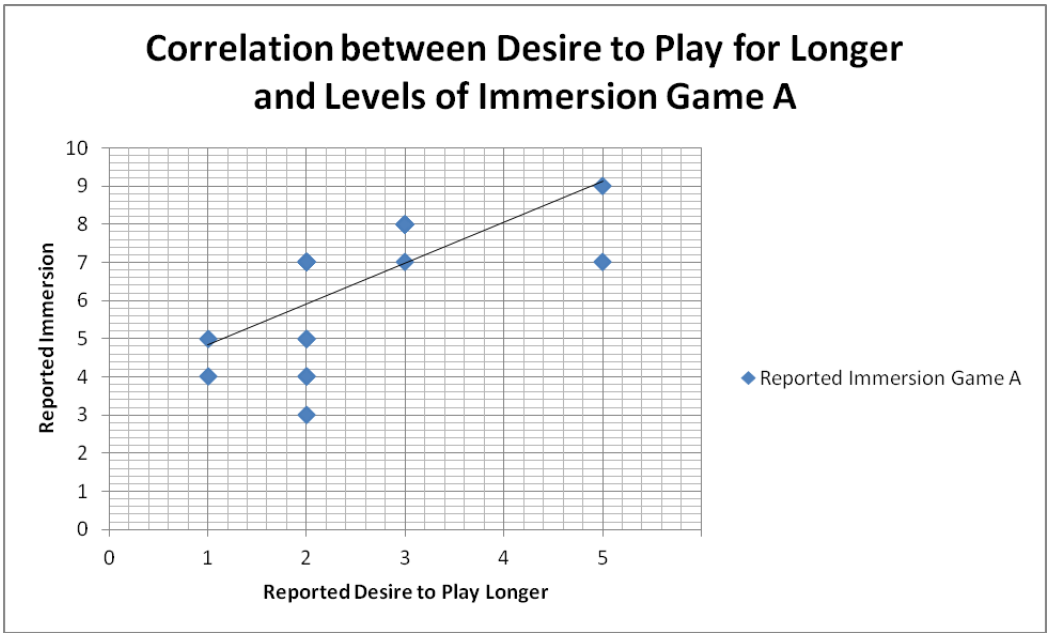


Figure 58: Correlation between desire to play longer and levels of immersion game A

For Game B. Participants (N = 21) were first surveyed about the level of *Enjoyment* they experienced during game play in Game B (M = 3.29, SD = 1.31) and their desire to play the game for longer (M = 2.67, SD = 1.32). A Pearsons R analysis of this data revealed a strong positive correlation between *Enjoyment* and the desire to continue playing (r = .812) in addition this correlation was significant (p =<.001). In turn this suggested that the more a participant enjoyed themselves the more they desired to play for longer. Figure 59 describes the results of this test.

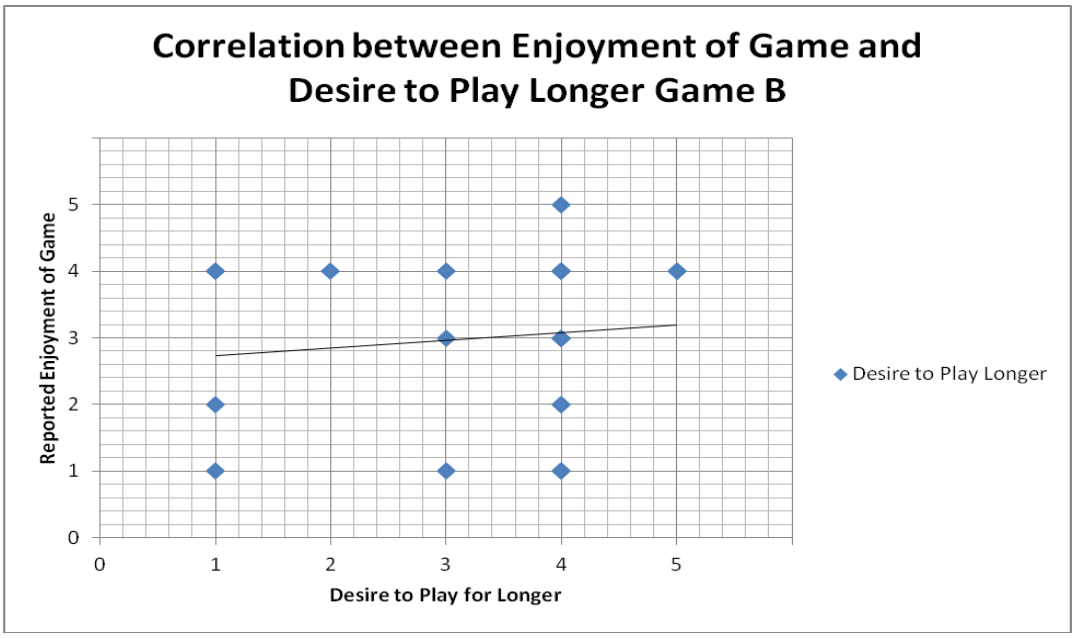


Figure 59: Correlation between reported enjoyment and desire to play longer game B

Following this, participants (N = 21) were then surveyed about the level of *Enjoyment* they experienced during game play in Game B (M = 3.29, SD = 1.31) and how far they were immersed whilst playing Game B (M = 6.10, SD = 2.91). To see if a correlation between *Enjoyment* and level of *Immersion* was presents, a Pearson's Correlation test was performed. Distribution of the results was sufficiently normal to perform this correlation. A Pearson's R analysis of this data revealed a moderate positive correlation between *Enjoyment* and levels of *Immersion* (r = .438) in addition this correlation was significant (p = .004). In turn this suggested that the more a participant enjoyed themselves the more they were immersed into the game. Results of this test are represented in Figure 60.

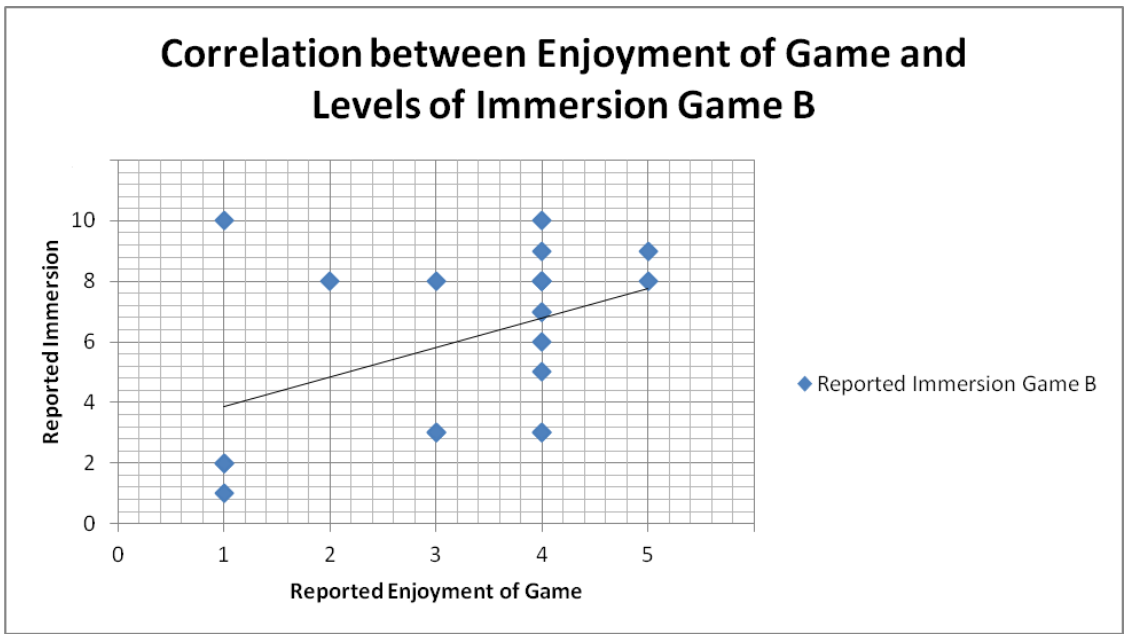


Figure 60: Correlation between reported enjoyment and levels of immersion game B

Finally participants (N = 21) were then surveyed about their desire to continue playing Game B for longer (M = 2.67, SD = 1.32) and how far they were immersed whilst playing Game B (M = 6.10, SD = 2.91). To see if a correlation between the desire to continue to play and levels of user *Immersion* was present a Pearson's Correlation test was performed. Distribution of the results was sufficiently normal to perform this correlation. A Pearson's R analysis of this data revealed a moderate positive correlation between desire to play and levels of *Immersion* (r = .478) in addition this correlation was significant (p = .028). In turn this suggested that the more a participant wanted to play the more they were immersed into the game. Results of this test are represented Figure 61.

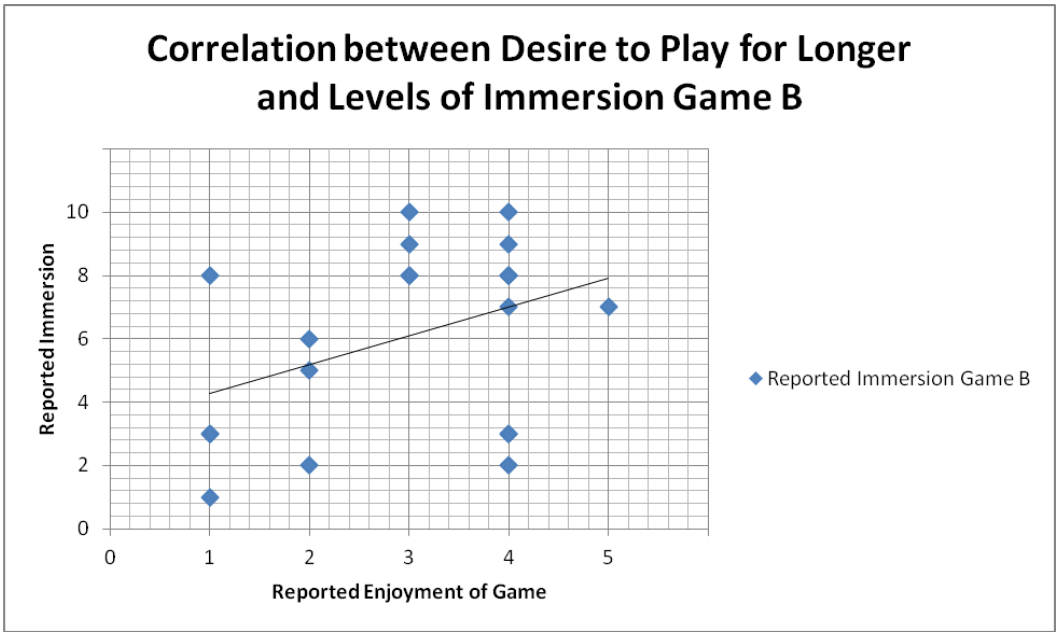


Figure 61: Correlation between desire to play and levels of immersion Game B

8.5 Application of the study in the immersion model

This study was an attempt to help identify and capture how *Immersion* is developed and diminished during a *User Experience* (UX). From the observations and results collected from the study, I was able to consider that the experience of *Flow* did occur in some of the participants and was a result of high levels of *Immersion* (which I would term *Absorption*), *Enjoyment* and *Embodiment* from engaging in the activity of video game playing. I was also able to consider that the experience of *Boredom* was the result of *Anxiety*, *Disengagement* and *Frustration*. I therefore considered that *Flow* and *Boredom* were opposing experiences to one another and that the various features which promoted or diminished these experiences could somehow be mapped down. In doing so this study helped direct the initial framework and structure of the *Immersion Model of User Experience*. I modelled this initial framework as such:

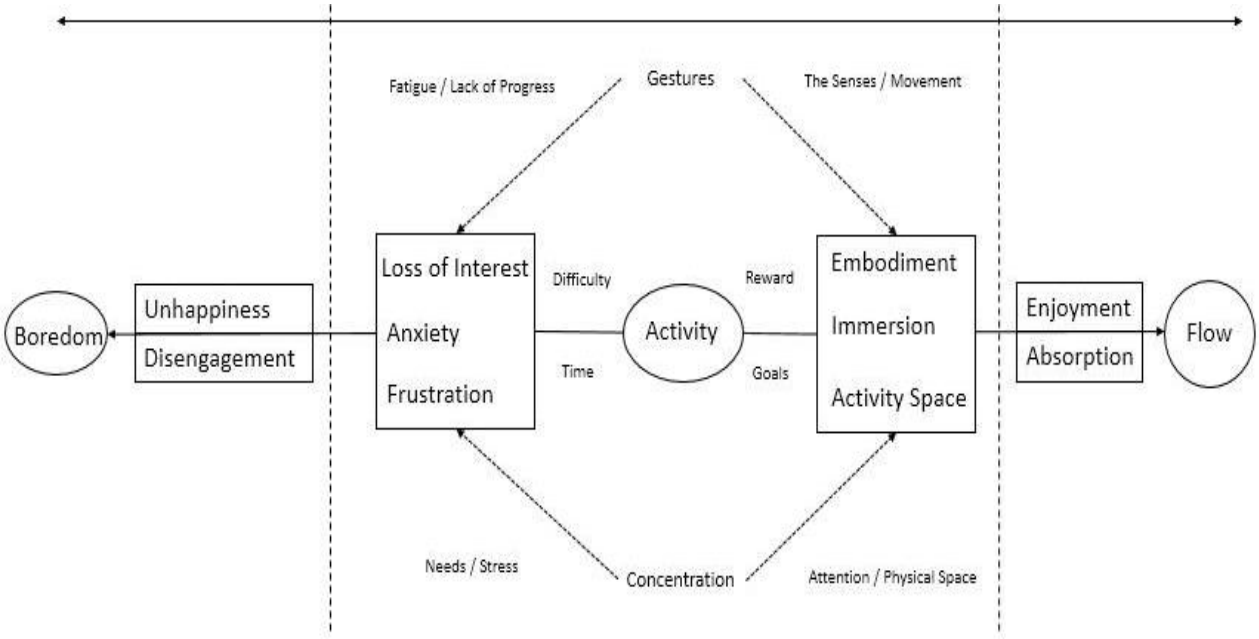


Figure 62: Initial Framework of the Immersion Model.

However during the review of the participant feedback and observations made during the study, it was clear that participants did not simply exist in a binary state of *Boredom* or *Flow*. This lead to considerations that a *Neutral State* must somehow exist between these two extremes, raising the hypothesis that when not engaged in activities, individuals are able to continue to cognitively and physically function without concern. This then prompted further investigation and a review of the findings of the previous studies as discussed in Chapters 6 and 7, as well as prompting further investigation into why *Flow* was desirable and *Boredom* undesirable. From this research I was able to conclude that *Boredom* was cognitively and physically harmful to the individual during a UX and hence was an experience individuals aim to avoid. To avoid this experience, I then considered that individuals must therefore choose to leave the *Neutral State* and engage in activities by engaging in the *Activity Space* by committing their cognitive and physical resources. In doing so this prompted consideration that a more complex mapping was needed resulting in the *Immersion Model* as discussed in Chapters 1, 3 and 4. During the restructure of the model, additional research into UX then prompted considerations that a range of different experiences could exist depending on the different features an individual encountered during an activity. From this I began to try and characterise the common experiences an individual may have during the activity and was able to develop this concept in the form of the common experiences discussed in Chapter 4.

8.6 Conclusion and future direction

Participant feedback, interviews and questionnaires about UX in playing video games suggests that examining which features foster and break *Immersion* appears to be worthwhile and worth pursuing further.

For this study the idea that *Immersion* could exist naturally in activities such as video game playing but differed to *Flow* was of considerable interest and that further investigation into understanding the differences between *Immersion* and *Flow* was warranted. In particular it was considered that if *Flow* is the result of intense *Immersion* into activity this warranted an examination into what features fostered or hindered such *Immersion*. In addition as I considered that *Flow* was the desirable experience of becoming immersed, there must also be an undesirable experience that exists; which I consider to be *Boredom*.

In order to address this gap in knowledge the study aimed at examining the following research questions:

1. Which features create or break *Immersion* in activities?

2. What is the undesirable experience and what features lead to this experience?

From observations and feedback collected during the study. I consider that attaining *Flow* in an activity is a sought-after experience which is created by first becoming immersed and then subsequently absorbed into an activity. In the study, I observed that *Immersion* was fostered by progression as well as interest and *Enjoyment* that resulted from playing video games. I also observed that the more enjoyment a participant had, the more immersed they described themselves. In particular I consider that during events where participants were experiencing enjoyment and high levels of concentration into playing the game, this was when participants were experiencing a level of *Immersion* known as *Absorption*. This was supported by

observations when participants were successful in the game, they would display positive behaviours such as verbal celebrations or physical behaviours such as smiling or dancing.

Participants who displayed these behaviours would then focus and concentrate more into the game in a continued effort to progress more and experience more *Enjoyment*. When reaching this point, we consider that participants were then experiencing *Flow* as they were enjoying the activity of playing video games simply because they found playing the video games to experience more *Enjoyment* enjoyable. Due to this, further investigation is necessary to try and capture the exact point that *Immersion* becomes *Absorption* and *Absorption* becomes *Flow* in the individual.

In the study it was noted that interest and engagement was generated by the design of the games. Here graphics, music, and game play features all helped encourage participants to engage and be interested to play the games; and in turn rewarded them for their progression during play. This raises questions about how design of activities affects encouraging engagement and interest in individuals and subsequently *Immersion* and *Flow* in different activities. Further investigation is warranted in other activities to see if common elements exist in breaking and fostering *Immersion* across similar activities and this study can be used to help further investigation into similar areas of research such as *User Experience* design and *Human Computer Interaction*.

During the study it was discovered that *Immersion* was broken by several different features. Elements which broke attention were awkward controls, environmental distractions, disinterest from repetitive goals and activities as well as becoming frustrated at unbeatable challenges. By breaking concentration into the game activity all of these elements contributed in reducing participant *Immersion* across one or both the games. The study showed that elements such as *Anxiety* and *Frustration* can lead an individual to be disengaged from an activity and create a desire to cease participation in an activity. Further investigation is required to find which other elements may impact participant *Immersion* levels in activities. In particular a weakness of the study was that it assumed by forcing participants to break concentration for a short period between games to complete the interviews and questionnaires. It was hypothesised that this would 'reset' the participant’s level of

Immersion. In doing so it wasn't clear if the reported levels of *Immersion* in Game B compared to Game A were impacted by this. This therefore suggests that research to see if *Immersion* levels can be 'carried over' between different activities.

Finally from the study I consider that a state of *Immersion* is enjoyable and *Flow* is the desirable outcome of becoming immersed. I also consider that a negative experience *Boredom* is the least desirable experience of an activity. Between these two extremes, I argue there is a *Neutral State* of the individual as if experience was just binary between *Flow* and *Boredom* individuals would require being engaged in activities so as to be perpetually immersed. I consider that this is not a possibility as during the study participants either found elements that either impacted upon their *Immersion* (such as awkward controls or repetitive game play) or created conditions which led them to disengage in an activity (stress and anxiety at challenges too difficult to overcome) but did not place them in a state of *Boredom*. I therefore consider that a range of elements are encountered during engagement in an activity, and that in doing so a range of experiences depending on these features must exist. This warrants a further investigation into what range of experiences are possible and what elements cause them to develop.

Chapter 9. General Discussion

9.0 Summary of findings

The aim of this Thesis has been to explore and encourage discussion into understanding *Immersion* in *User Experience* (UX) in *Human Computer Interaction* (HCI) through engagement with activities. I have discussed the results of my research into defining and measuring *Immersion*, the features that contribute to deepening or diminishing *Immersion*, as well as the motivations to why we become and desire to be immersed.

Immersion involves focusing concentration into an activity, which is deepened by our embodiment and the effect of the activity spaces we engage within. When the deepest levels of *Immersion* occur, known as *Absorption*, this leads to the optimal experience in an activity known as *Flow*. I argue that *Immersion* in an activity is part of a dynamic process of a desire to avoid a negative experience known as *Boredom* and map this in a model of UX known as the *Immersion Model of User Experience*.

The *Immersion Model* has been developed from a review of a wide range of literary sources and disciplines and this thesis represents a wide exploration of the different uses and definitions of *Immersion* across a large variety of different topics. In addition, three studies were used to develop and justify the findings presented. The first study, an investigation to examine the use of gestures as an interaction method between devices, explores the role of *Embodiment* in developing *Immersion* in UX. Here I highlighted how gestures can be a powerful tool in developing *Embodiment* in user activities by making interactions feel natural and easy to implement. The second body of work, an ethnographic study in user interaction with a digitally enhanced museum exhibition, suggested that the design and interactions we have with the *Activity Space* is an important component in fostering different kinds of experiences from our *Engagement* in activities. Here I consider that activities are defined by their physical and cognitive boundaries, which I term *Activity Space*, and this space

determines and influences our attention and behaviours when engaged in the activity and contributes to developing or diminishing different features of an experience. Finally a study of video game playing suggests that *Flow* is the most desirable experience of an activity and helped emphasize how a pessimal experience, known as *Boredom* exists. In addition this study highlighted that when not engaged in activity there is a *Neutral State* that individual's experience.

An aim of this Thesis was to see the role of *Immersion* in computing activities, specifically in the context of UX and HCI. Here I argued that the *Immersion Model* is an original contribution to the research of UX, as it highlights various avenues of study to explore and provide solutions to existing paradigms and topics of research. Specifically, the *Immersion Model* can contribute to the examination of user behaviour and experiences across a wide scope of computing research such as design, user testing and usability design. All of which seek to understand user motivation and *Engagement* within technologies. Examples of this include exploring how technology can improve overall happiness, as well as areas such as ubiquitous computing which explore how and why individuals experience and incorporate the use of personal technology with their everyday lives and world around them. Alternatively, due to the broad range of research and review undertaken, this body of work may also be useful to research areas such as *Virtual Environments, Presence* in virtual reality systems, digital art, as well as media studies.

Another aim of this Thesis was to see what value and role *Immersion* had in *User Experience.* Here I explored how *Flow*, the optimal experience in activity, is a desirable aspect to develop in activities. *Flow* is the experience of happiness and *Enjoyment* from engaging in a task, where the individual feels rewarded from their *Engagement*. The desire for *Flow* is motivated by a desire to avoid a pessimal experience known as *Boredom,* as well as escape from a *Neutral State* of cognitive and physical idleness. Avoiding *Boredom* in activities is important as it is an experience characterised by *Anxiety*, *Disengagement* and *Frustration* that can have profound cognitive and physical health effects. The *Immersion Model* highlights that reaching this *Flow* experience is far more complex that just focusing on an activity; and overall the type of experience is determined by a range of different factors. In turn these factors can combine and create a range of different types of experience.

I argue that the *Immersion Model* can be used also as a means for designers and researchers to try and identify and characterise the types of UX particular technologies and systems provide and explore how to attain the optimal experience in users. In support of this, in this Thesis I have explored how a variety of factors such as environment, difficulty and human needs can diminish or foster *Immersion* and can be critical in enabling or denying an individual from reaching the optimal experience.

Through the literature reviewed and studies performed I have demonstrated that *Immersion* is a rich and interesting topic worthy of investigation and consideration in not only understanding HCI, but human experience as a whole. I consider that a unique aspect of the *Immersion Model* is that it represents a wide and flexible approach to understanding user experiences with technology. The *Immersion Model* is not a new form of HCI, but rather a reflection of existing research and understanding. In this Thesis I have explored how philosophy and psychology have already explored many of the different aspects of user experience and in doing so have been able to show that the study of *Immersion*, our experience of the world and why we engage as we do; have been well explored concepts well before computing became prolific. Therefore I propose that a valuable aspect of the *Immersion Model* is that it serves to examine HCI paradigms in knowledge of a wide variety of topics that may go unconsidered in the development of HCI and *User Experience* as a whole.

9.1 Limitations and future direction

A key point to stress is that the *Immersion Model* is not absolute, nor does it represent the definitive model of UX in HCI. What the model does contribute however is a starting point that has been lacking in HCI for understanding *Immersion* in *User Experiences*; as well as the motivation for why certain experiences occur as well as the features that create different types of experience. Overall the *Immersion Model* represents a reflection of current understanding and knowledge of *Immersion* and UX across a variety of topics. It was created from a retrospective of the three studies performed as well as the literature review to validate the findings presented.

One limitation is that validation of the *Immersion Model* is complicated by how UX is a highly subjective matter, with experiences often differing from user to user significantly. As demonstrated in the Thesis, only four generalised 'common experiences' where characterised from the research. This is due to how UX can differ vastly between activities, as well as the elements and features they encounter within those activities. Limitations of the model are therefore the range of features, as well as types of experiences possible, in an activity may not be represented accurately. This is further compounded by another limitation of a lack of validation of the model across a variety of different UX in different computing activities.

In addition the conclusions drawn in this study are based on the various observations made across all three studies. Though this has been beneficial by allowing elements to be reconsidered and reviewed with each development and discovery, each of the studies themselves carried a variety of drawbacks that limits their value as definitive proof of the accuracy of the *Immersion Model*. For example, overall the number of participants across the Gestures and Video Gaming studies was limited and therefore not a significant representation of the overall population of users. In the case of the Seven Stories study, although participants numbered well into the hundreds, limited feedback was gathered due to the vulnerable nature of the audiences observed. In doing so, what was observed and recorded across these studies only maps accurately into the specific context and activities of each study, rather than being suitable for wider generalization. Caution must therefore be taken when generalizing the *Immersion Model* across all forms of engagement in different *Activity Spaces*. A direction of future work will therefore require a further investigation into applying the model to different activities with the intent to validate the findings in particular contexts, with a possible direction for this future work being comparison of the *Immersion Model* to existing models of user experience such as Hassenzahl's model.

During this research I explored the role of space and movement within spaces using them to demonstrate the influence environment has on behaviour and UX. However, of all the studies performed only the Seven Stories study was performed in the 'natural' *Activity Space*. In regards to the gesture study the design of the study required performing actions with devices turned off and the participant removed from the 'everyday' environment and interactions that occur by being located in a limited access media room. This contrasts greatly with the inter-

connectivity of everyday use and experiences with technologies that participants engage within. Comparatively the study of video games required participants to come to a business office during working hours to take part in the study and use predefined equipment; whereas typical playing often occurs either in the home or social settings outside of work or personal commitments. Playing of video games is also often performed using equipment personalized to the users own preferences, rather than those used in the generalized settings of the study. Further research into the impact that such considerations have on the *Immersion Model* is warranted.

Additional limitation of the work is that socio-economic data was not used in consideration of the various factors of the *Immersion Model*. Modern devices are continually pushing the boundaries of capability and user interaction methods, however the differences between capabilities of devices, as well as the associated financial cost, are often significant. For many, cutting-edge or advanced technologies are simply too expensive to buy, meaning that UX of a particular field of technology (for example Smartphones) can be significantly impacted between different devices and their availability for the user. Furthermore the research did not consider elements such as education, social class or background in the development of the *Immersion Model*. Individuals come from a variety of backgrounds and circumstances, each with their own interests, likes, dislikes and views regarding what is engaging for them and what is not. Due to this the *Immersion Model* may only reflect the views of those that took part in the studies and its development. Therefore a future direction of the research is into the impact of socio-economic background and UX and how this then factors into *Immersion* is warranted.

Finally this thesis explored the optimal experience and pessimal experience of users in activities. I consider that between these extremes a *Neutral State* of experience for the individual. However due to differences between individuals, how accurate this *Neutral State* is open to debate. Individuals all experience the world differently and although this thesis has tried to accommodate a wide generalization of experience, a wide spectrum of attitudes and personalities of users exists therefore this *Neutral State* may not be completely accurate. Some individuals for example take great enjoyment from just experiencing the world around them, whilst others may require complex or niche elements before they experience any

emotional or physical reward. This was highlighted by the third study of participants playing video games; where a wide variety of different attitudes, personalities and emotional states by and from participants was observed prior to and during game play. In doing so how these user elements effect engagement and experience remains unclear. As although from the research I was able to infer that enjoyment and happiness are desirable aspects of engagement in activities; how the emotional state and attitudes of the user prior to engaging in an activity and its impact on experience was not explored.

9.2 FINAL WORDS

My parting statement is that *Immersion* is a unique and interesting aspect of User Experience and the range of future research into the topic is of far greater scope and scale than this Thesis has been able to cover. The term itself has a variety of different connotations and contexts of use; and though in this thesis I have been able to consider that *Immersion* is needed to foster *Flow*, I believe that this is only the first step into an even wider body of research.

Despite this, I believe that the contribution to the topic this thesis presents is one of both originality and value to the topic of HCI. I believe that *Immersion* is both a powerful tool and simple term that helps us grasp the complexity behind what we feel, what we do and what we experience in our *Engagement* in the day to day world. Although the work presented here is only a small dip into the depths of immersion, no doubt future research will get into the flow of it all.

APPENDICES

APPENDIX A. GESTURE STUDY INFORMATION SHEET AND INITIAL QUESTIONNAIRE

Overview of the study

Please read this form carefully, and feel free to ask any questions that you have now or that come to mind as you read this form. The purpose of this form is to tell you about the experiment and to inform you about your rights as a research volunteer. If at any time you feel unable to continue participating in the experiment (for whatever reason), please inform the investigator and you will be released immediately. There is no deception involved in this study. So, again, please ask any questions that you may have about the study, what you will be asked to do, and so on.

Thank you for agreeing to participate in this study. We are collecting data from about 25 participants to help us in identifying how to improve the interaction with mobile phones when used in combination with other devices and our studies could not be completed without your help. The purpose of our research is to investigate means of interaction beyond pressing buttons and using a touch screen.

You will be participating in a study that involves three different steps. You will first be asked to fill out a brief questionnaire at the beginning of the test. This questionnaire will ask general questions about your background, your mobile phone, and your computer skills. In the second part, you will be asked to perform a list of tasks using a mobile phone. Your activities will be observed by at least one investigator, and will be recorded on video. You may ask investigators questions about the test during this time only if you encounter a problem that prevents you from completing your task. The investigator will explain the procedure in more detail at the beginning of this phase. At the end of the study, you will be asked to fill out

another short questionnaire about the test. You will also receive a compensation for your time of 10 GBP.
From start to finish, the test should take approximately 30 to 45 minutes.

Please now fill in the initial questionnaire.

Initial Questionnaire Participant number: _____

Information about yourself

In order to analyse the results from this study, it would be very helpful if you could provide us with some information about yourself. This information will only be used in the context of this study, and will not be passed on to a third party. If we publish the results of our research, we will thoroughly anonymise all personal information so that it will not be possible to identify the individual that produced it.

1. Please tell us your age.

❍ 20-25 ❍ 26-30 ❍ 31-35 ❍ 36-40 ❍ 41-45 ❍ 46-50 ❍ 51-60 ❍ 61 and older

2. Please tell us your gender.

❍ male ❍ female

3. Do you own a mobile phone?

❍ yes ❍ no (please continue with question 6)

4. If so, please tell us the manufacturer and type of your mobile phone.

Manufacturer: _____ Type: _____

5. How would you rate your expertise as a mobile phone user (select one)?

❍ very inexperienced ❍ inexperienced ❍ some experience ❍ experienced ❍ very experienced

6. Have you ever used a public display/interactive kiosk system (e.g. a touchscreen-based ticket vending machine, an interactive information display in a shopping centre)?

❍ yes ❍ no (please continue with question 8)

7. How would you rate your expertise as a user of public display systems (select one)?

❍ very inexperienced ❍ inexperienced ❍ some experience ❍ experienced ❍ very experienced

8. Have you ever used a tabletop computer (e.g. an interactive display-based system embedded into a horizontal surface)?

❍ yes ❍ no (please continue with question 10)

9. How would you rate your expertise as a user of tabletop computers (select one)?

❍ very inexperienced ❍ inexperienced ❍ some experience ❍ experienced ❍ very experienced

10. We would like to use photo and video material recorded during the study in academic publications. We will anonymise the material so that people shown will not be identifiable.

❍ Yes, I am happy with this use of the recorded material.

❍ No, do not want the recorded material to be used in this way.

Thank you very much for your help.

APPENDIX B. GESTURE STUDY FINAL QUESTIONNAIRE

Final Questionnaire Participant number: _____

Your opinion

Please read the following statements carefully and then tick one of the circles to indicate whether and how strongly you agree or disagree with each statement.

Statement about using gestures with mobile phones to trigger actions	
It would work well for phone-to-phone interaction	Strongly Disagree ❍ ❍ ❍ ❍ ❍ ❍ ❍ Strongly Agree
I do not think it would work well for phone-to-tabletop interaction	Strongly Disagree ❍ ❍ ❍ ❍ ❍ ❍ ❍ Strongly Agree
I would use it if it was available for my phone	Strongly Disagree ❍ ❍ ❍ ❍ ❍ ❍ ❍ Strongly Agree
It would work well for phone-to-public display interaction	Strongly Disagree ❍ ❍ ❍ ❍ ❍ ❍ ❍ Strongly Agree
I do not think it would work well for phone-to-phone interaction	Strongly Disagree ❍ ❍ ❍ ❍ ❍ ❍ ❍ Strongly Agree
I do not think I would use it if it was available for my phone	Strongly Disagree ❍ ❍ ❍ ❍ ❍ ❍ ❍ Strongly Agree
It would work well for phone-to-tabletop interaction	Strongly Disagree ❍ ❍ ❍ ❍ ❍ ❍ ❍ Strongly Agree
I do not think it would work well for phone-to-public display interaction	Strongly Disagree ❍ ❍ ❍ ❍ ❍ ❍ ❍ Strongly Agree

Please list the three most **negative** aspects about using gestures with a phone to interact:

Please list the three most **positive** aspects about using gestures with a phone to interact:

Please write any further comments below:

Please list the three activities that would lend themselves best to being triggered by phone gestures.

Please list the three activities that are the most inappropriate for being triggered by phone gestures.

Thank you very much for your help.

APPENDIX C. BASIC VIDEO ANNOTATION SCHEMA FOR GESTURE STUDY

Coding scheme experimenter sheet

Matching gesture-device-task:

poorly:	p
neutral:	n
well:	w
don't know:	d
inappropriate:	i

Distance between the two devices during the gesture:

constant:	0
changing:	1

Devices physical touching during gesture:

not touching:	0
touching:	1

Speed of gesture:

constant:	0
changing:	1

Location of device during the gesture:

constant: 0

changing: 1

Rotation of the device (changing orientation):

no rotation: 0

rotation: 1

Delay between end of question being read and start of physical gesture:

in seconds

Time between the start of the physical gesture and its end

end of gesture = user saying done or

= user indicating degree of matching without being prompted

= Dan starting to ask for degree of match

duration of the gesture in seconds

Special - anything unusual happening

pointing:	p	(anything that could be pointing)
anything else:	x	(anything that is unusual/worth checking)
nothing:	leave empty	

APPENDIX D. GESTURE STUDY CONSENT FORM AND INITIAL QUESTIONNAIRE

Consent Form **Participant ID #:**

Important Information:

Please read and sign the following CONSENT FORM carefully before beginning the study. If you have any questions or queries about any this or any other forms please inform the study operators.

Consent Information:

I agree to participate in this study "Immersion in video games". The purpose of this study is to obtain information, which will be used in research related to defining and identifying immersive experiences by individuals in games. I understand that I will be playing two video games over the course of the study as well as a time-awareness task as I play. After playing I will be completing questionnaires that ask about my experiences playing these video games.

I agree that I am unaware of any health concerns that may be affected by the playing of video games.

I understand that my participation is for research purposes only; it will not benefit me personally, but may contribute to knowledge of the topic. I understand that I will answer truthfully and to the best of my ability and I am not answering on behalf of another individual or organization. I understand that I may omit answering any questions I do not want to answer without prejudice or penalty. I have been informed and understand that I may leave this study at any time on my own volition without penalty or reprimand.

I have been informed and understand that the results and findings of this study are confidential. To maintain individual confidentiality, I understand that I will be identified by a code number on this and any subsequent research in which I participate and that results are to be published in group statistical form, without names or other identifying information.

I agree that participation in this study will require me to be filmed on camera. I agree to being filmed on camera and I understand that my confidentiality will be maintained in accordance with the Data Protection Act 1998. I understand that my confidential data will not be used for outside the University of Newcastle upon Tyne or given out to third parties and that images used in the research will not reveal my identity.

If I have any questions or concerns about this study, I understand that I may contact Dr. Peter Andras of the University of Newcastle upon Tyne, Claremont Tower, NE1 7RU (peter.andras@ncl.ac.uk) or John Dawson of the University of Newcastle upon Tyne, Room 6.45 Claremont Tower, NE1 7RU (j.d.dawson@ncl.ac.uk) to voice my queries. I also understand that I may contact these individuals at any time during the study to withdraw.

If you have read and understand the above consent form and wish to take part in this study, please continue. If you do not wish to take part in this survey, you may decline to participate at this time.

Please print and sign your name below if you agree to these terms:

Signed_____

Print Name_____

Date_____

Pre-Game Questionnaire **Participant ID #:**

Gender (please circle one): Male Female

Age (please circle): 18-24, 24-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, 61-65, 65-70, 71+

Occupation (please specify):_____

Directions: Please circle the best answer for each of the following questions, or write your answer in the space marked "other".

1. Have you ever played video games before? Yes No

2. Do you currently play video games? Yes No

<<If you answered "No" to either question 1 or 2 please answer question 3, if not skip to question 4.>>

3. For what reason(s) do you not play video games? (Please circle appropriate)

A. Cost D. Lack of skill

B. Not interested E. Restrictions (Parents, Religious Requirements, other)

C. Not enough time F. Other

If "Other" please specify:

<<Please skip to Question 12>>

4. How long have you been playing video games?

A. 1-6 months
B. 6 months - 1 year
C. 2-5 years
D. 6-10 years
E. 11 or more years

5. How did you get started playing video games; who or what motivated you to play?

A. Self Interest
B. Other female/s
C. other male/s
D. advertisements (magazines, TV, newspaper)
E. the internet
F. Other

If "Other" please specify:

---

6. How often (approximately) do you currently play video games in a month?

A. daily
B. weekly
C. once or more a month
D. Once or more in 6 months
E. Once or more a year
F. Less than once a year or never

7. How good do you feel you are at playing video games?

A. very good
B. moderately good
C. not very skilled
D. no skill

8. What devices do you use to play video games? (please circle as appropriate)

A. PC/ Laptop	C: Phone	E: Arcades
B. Consoles	D: Tablet / Portable Device	F: Other

If "Other" please specify:

---

9. What genres, or video game categories, do you enjoy to play? (Please circle up to 3 choices from the list).

Video Game Genres (for #9)

Action	Pinball
Adventure	Platform
Arcade	Real-time strategy
City-building games	Role PlayingGames
Dance Games	Racing
Economic simulation games	Real-time tactical

Educational

Exercise games

Fighting

First-person shooter

Flight

God games

Massively Multiplayer Online Games

Maze

Music

Space

Sports

Stealth

Survival horror

Turn-Based Strategy

Turn-Based Tactical

Other (please specify)_____

10. Do you have any favourite game titles to play (list maximum of 5)?

#1._____#4_____

#2._____#5_____

#3._____

11. Based on the answers to questions 9 and 10, what attracts you to these games?

_____

_____

_____

_____

_____

_____

_____

<Please Skip if you did not answer Question 3>

12. If you do not play games what features would attract you, to play video games?

_____

_____

_____

_____

13. What would you like to see in a video game made just for YOU?

_____

_____

_____

_____

_____

APPENDIX E. POST-GAME-PLAY IMMERSION REVIEW QUESTIONNAIRE

Post-Game-play immersion review Questionnaire.

Statements used to identify and evaluate the relationship between gamer and game after playing a game of < > for < > minutes.

Please rate how far you would agree with the statements below after playing the game < >.

SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree.

Section 1: Your Personal Experience of the Game:

1. I felt that I had an emotional attachment with the game.

SD D N A SA

2. Emotional attachments are important to me when I play games.

SD D N A SA

3. I was interested in seeing how the game's events would progress.

SD D N A SA

4. I was in suspense about whether I would win or lose the game.

SD D N A SA

5. Being able to win or lose a game is important to me when I play games.

SD D N A SA

6. I felt involved with the game and wanted to interact further with the characters.

SD D N A SA

7. Character interaction and development are important to me when I play games.

SD D N A SA

Section 2: Your personal views of the design of the game:

1. I enjoyed the graphics and imagery of the game.

SD D N A SA

2. Graphics and imagery are important to immerse me in a game.

SD D N A SA

3. I was interested in playing the game based on its visual appearance

SD D N A SA

4. If a game did not look interesting I would not play it

SD D N A SA

5. I enjoyed playing the game.

SD D N A SA

6. If I felt I would not enjoy a game I would not play it

SD D N A SA

7. I would like to have continued playing the game for longer.

SD D N A SA

8. I prefer to play games for a long time (2 or more hours) rather than in short sittings (1 hour or less).

SD D N A SA

9. I would play the game again at a later date.

SD D N A SA

10. Playing the game was fun.

SD D N A SA

11. I felt good playing the game

SD D N A SA

12. The controls were easy to pick up

SD D N A SA

13. Game controls must be easy to pick up if I am to play a game

SD D N A SA

14. There were frustrating aspects of the controls to get the hang of.

SD D N A SA

15. I felt I had to be constantly aware that I was using controls.

SD D N A SA

Section 3: Reflection of game play within game.

1. I felt myself to be progressing through the game according to my own volition.

SD D N A SA

2. Games should allow me to progress as I wish, not because the game says so.

SD D N A SA

3. The world of the game felt “real” as if I was in a real world.

SD D N A SA

4. Interacting with the game world is an important aspect to me when I play games.

SD D N A SA

5. I was aware of my surroundings.

SD D N A SA

6. I felt detached from the outside world whilst playing the game.

SD D N A SA

7. I play games to detach myself from the real world.

SD D N A SA

8. At the time the game was my only concern.

SD D N A SA

9. I play games to ignore other concerns.

SD D N A SA

10. I did not feel the urge to stop playing and see what was going on around me.

SD D N A SA

11. I was interested to know what might be happening around me.

SD D N A SA

12. I felt more involved with the game world than the real world as I was playing.

SD D N A SA

13. I prefer to be more involved with the game world than the real world.

SD D N A SA

14. To me it felt like only a very short amount of time had passed.

SD D N A SA

15. When playing the game time appeared to go by very slowly.

SD D N A SA

16. When playing the game time appeared to go by very quickly.

SD D N A SA

17. Time keeping is important to me when playing games.

SD D N A SA

18. How far would you describe that you have been "immersed" whilst playing this game? (10 = very immersed; 1 = not at all immersed)

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