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Master Thesis

Discovering Aspects of Gaming QoE: an explorative study

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Matriculation Number: 396476

24.05.2019

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Acknowledgements

This thesis is the final milestone of my double master degree with the European Institute of Innovation and Technology (EIT). It has been an incredibly see-sawing experience and I would like to thank my entry university, the University of Twente in the Netherlands, for making my studies worthwhile and for the knowledge and expertise they provided me with in the field of Human-Computer Interaction & Design. I would also further like to extend my gratitude to my bachelor university, the University of Glasgow, for showing me what a supportive, student-centred university environment looks like and for making me trust and fall in love with education.

I am also thankful to my supervisors for their help and support supervising this thesis work and for allowing me to plan and carry out my own research on a topic that fits my interests and adopting qualitative research methods that reflect my career and academic goals. Finally, I am grateful to all participants who took part in my studies for their precious insights and time invested.

I, Pietro Romeo, hereby declare that this thesis is the result of my original research work. Wherever contributions of others have been involved, every effort has been made to indicate this clearly with due reference to scientific literature.

Eidesstattliche Erklfärung

Hiermit erkläre ich, dass ich die vorliegende Arbeit selbstständig und eigenhändig sowie ohne unerlaubte fremde Hilfe und ausschließlich unter Verwendung der aufgeführten Quellen und Hilfsmittel angefertigt habe.

Berlin, ____________

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(Signature [Pietro Romeo])

Abstract

With the increasing popularity of digital games as an interactive medium, the issue of evaluating the quality of experience (QoE) of gaming platforms has become a main point of interest in the fields of Human-Computer Interaction (HCI) and User Experience (UX) research. The complex nature of gaming experiences calls for specific evaluation metrics for the UX of digital games, and a large number of psychometric dimensions and concepts such as immersion, presence, flow, fun, engagement, and involvement have been proposed for subjective evaluation of gaming experiences.

Challenges in adopting these concepts arise from often too broad definitions and existing overlaps between some of them. Existing validated scales for evaluating the UX of games by means of psychometric dimensions are scarce and heavily rely on self-assessment questionnaires with too many items. The main scope of this project is to identify and evaluate the efficiency of such quality dimensions across different gaming platforms.

Mit zunehmender Beliebtheit digitaler Spiele als interaktives Medium ist das Problem der Bewertung der Quality of Experience (QoE) von Spielplattformen zu einem Hauptinteresse in den Forschungsgebieten der Mensch-Computer-Interaktion und der User Experience (UX) geworden. Die komplexe Beschaffenheit von Spielerfahrungen erfordert spezifische MessgröÃen zur Evaluation der UX digitaler Spiele. Dazu wurde eine Vielzahl psychometrischer Dimensionen und Konzepte wie Eintauchen, Präsenz, Flow, Spaß, und Engagement für die subjektive Bewertung von Spielerlebnissen vorgeschlagen.

Herausforderungen bei der Übernahme dieser Konzepte ergeben sich aus häufig zu weit gefassten Definitionen und bestehenden Überschneidungen zwischen einigen von ihnen. Bestehende validierte Skalen zur Bewertung der UX von Spielen mittels psychometrischer Dimensionen sind rar und stätzen sich stark auf Selbstbewertungsfrageögen mit zu vielen Items. Der Hauptgegenstand dieses Projekts ist die Ermittlung und Bewertung der Effizienz solcher Qualitätsdimensionen für verschiedene Spieleplattformen.

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1 Introduction

1.1 Context

User Experience (UX) has been used as an umbrella term for the set of techniques and methodologies that aim at understanding and studying the quality of experience of interactive products in the field of human-computer interaction (HCI) [BAH11]. The past three decades have seen an enormous shift of the videogame industry from a niche industry to blockbuster entertainment business [MHT13], with economists and market researchers highlighting the phenomenon of a "mass exodus" to the virtual world [Cat08], and with the online gaming community counting more than 100 million gamers in Europe alone. [McG11]

Quality of Experience (QoE) is defined as "the degree of delight or annoyance of the user of an application or service. It results from the fulfilment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user's personality and current state" [CMP12]. When it comes to the QoE of games, on top of common usability factors, one needs to take into account the playability of the game. Playability has been defined in terms of the degree to which the game is fun, usable, and capable of generating positive sensations in the player [SVSPZ12][Usa17].

Numerous frameworks have been proposed to classify and evaluate player experiences. The Game Experience Questionnaire (GEQ) [IDKP13] was developed as a self-report method to assess the UX of a game in terms of Competence, Immersion, Flow, Tension, Challenge, Negative and Positive Affect, amongst others. Ijsselsteijn et al. were criticised for not publishing any empirical studies regarding the validation of the psychometric qualities included in their questionnaire [**?**]; furthermore, factors analysis showed that the GEQ fails to meet satisfying criteria of invariance for some of its items. [Nor13] By contrast, the Player Experience of Need Satisfaction (PENS) [RR07] framework developed by Immersyve has been empirically proved to be reliable in predicting fun/enjoyment of a game, as well as game ratings, sales, player's loyalty to the developer and sustained engagement with their titles. PENS measures include dimensions based on player's intrinsic and extrinsic motivation, namely the need for Autonomy, Competence and Relatedness, plus the additional factors of Presence (defined as either Physical Presence, Emotional Presence or Narrative Presence) and Intuitive Controls. Phan et al. developed a validated the User Experience Satisfaction Scale (GUESS) [PKC16] based on a review of 13 existing questionnaires on the UX of games, 15 lists of game heuristics, and 3 user satisfaction questionnaires commonly used in HCI studies. The nine subscales identified in the GUESS were Usability/Playability, Narratives, Play Engrossment, Enjoyment, Creative Freedom, Audio Aesthetics, Personal Gratification, Social Connectivity, Visual Aesthetics.

1.2 Motivation

The vast amount of identified psychometric dimensions for evaluating the UX of games often suffer from too broad definitions and overlapping among some of the concepts [Ber10]. For instance, Presence has been commonly defined as subjective sensation of "being there" [BZSS95], but also as a "perceptual illusion of non-mediation" [LD97], and as "the (suspension of dis-)belief" of being located in a world other than the physical one [SU94]. Immersion has been identified as one of the defining aspects of the experience of gaming, but the term still lacks a clear, consistent definition and it is often used interchangeably with Presence [BC04]. Moreover, the concepts of Engagement, Engrossment, Absorption and Flow have been identified as being part of or related to Immersion [EM05].

Another related issue arises from the tendency of most game UX questionnaires to measure one or more of these overlapping constructs while often relying on a large number of items for in- or post-game self-assessment by players: the GUESS questionnaire contains a total of 55 items [PKC16], the GEQ totals 33 items (plus another 14 items for its in-game module) [IDKP13], the PENS subscales account for a minimum of 21 items [RRP06]. While measurement theory advocates the use of multiple constructs, it has been suggested that single-measurement scales may be effectively used to measure psychological constructs as long as these are sufficiently narrow and unambiguous to the respondent [WRH97] [TKI00]. ITU-T Standards for gaming QoE recommend to limit the amount of items addressed during a self-evaluation task, depending on the study objective and in order to avoid fatigue and training effect in the test participant [MAB+15] [MSZ18]. At present, this task is usually left to the experimenter.

The purpose of this study is to investigate player's mental models and attitudes towards gaming in order to explore and potentially identify novel constructs that may be used to more effectively assess the QoE and UX of computer games.

1.3 Scope

Different research questions have been identified within the scope of this project:

- R1. "What are the main aspects that define one's quality of experience when playing videogames?"

- R2. "How do players understand concepts related to gaming QoE?"
- R3. "How do players understand questionnaire items commonly used to evaluate gaming QoE?"

1.4 Outline

This dissertation comprises a total of 7 chapters:

- **Chapter 1 - Introduction** is the current chapter exposing the research problem, including its context and the motivation behind it;
- **Chapter 2 - Fundamentals and Related Work** introduces existing models that have been developed to map the experience of playing videogames, as well as frameworks that are commonly used to evaluate the UX of gaming;
- **Chapter 3 - First study - Methodology** introduces the methodology, user research techniques adopted, and limitations related to the first exploratory study aimed at addressing R1;
- **Chapter 4 - First study - Analysis & Discussion** provides an overview of the insights collected during the first study as well as an explanation of the frameworks and methodologies used to analyse the data, and a reflection on the findings;
- **Chapter 5 - Second Study: Methodology** introduces the methodology, user research techniques adopted, and limitations related to the second study aimed at addressing R2 and R3;
- **Chapter 6 - Second Study - Analysis & Discussion** provides an overview of the insights collected during the first study as well as an explanation of

the frameworks and methodologies used to analyse the data, and a reflection on the findings.

- **Chapter 7 - Conclusion** sums up the work conducted, providing recommendations and input for future studies.

2 Fundamentals and Related Work

This section provides an introduction to the relevant context, terms, methodologies and industry standards in the fields of HCI, UX, and videogame research.

2.1 Human-Computer Interaction, Quality and Usability

That of HCI is a multidisciplinary field that deals with the study and understanding of human behaviour in relation to technology, usually with the aim of improving the quality of a computer system or software application. A unified, commonly agreed on definition of HCI is somehow still lacking, as numerous different disciplines contribute to HCI research yet the focus of HCI spans across different topics, methodologies, fields and schools of thought [OO03]. Instead of providing an outright definition of what HCI is, the view hereby proposed is that of HCI research as generative problem-solving, as proposed by Oulasvirta Hornbæk [OH16].

The discipline of User-Centric Design (UCD) is generally associated with HCI and focuses on how to design technology that is pleasant and easy to use [Dix09]. The standard definition of usability defines it as the extent to which a product can be used for its specified purpose in its context of use [Iso98]. The term user experience (UX) is sometimes used in HCI literature as an interchangeable term for UCD, but recently it has evolved to include also non-instrumental needs and experiences of products beyond mere usability, taking into account what occurs before, during, and after the interaction [BAH11]. Another intrinsically related concept is that of Quality of Experience (QoE), which deals with how a product or service is perceived by their user in terms of quality of use.

	User Experience	**Quality of Experience**
Origins	Human-Computer Interaction	Telecommunications
Primary Driving Force	Human-driven, human-centred	Technology-driven, technology-centred
Main focus	Evaluate and understand the user experience and process of experiencing to improve the design and creation of a product or service that enables for more valuable, pleasurable experiences, and the fulfillment of be-goals	Evaluate (technical) quality perception to guide the optimisation of technical parameters at different layers
Main research "objects"	Products, services, artifacts that a person can interact with	Multimedia communication systems
Research methods	Both qualitative and quantitative, with strong emphasis on qualitative	Predominantly quantitative, increasingly mixed-methods
Research aims	Understanding, modeling	Quantifying, modeling
Research approach	Holistic	Isolation of specific factors

Table 2.1: Main differences between UX and QoE research. Adapted from Wechsung, I., De Moor, K. (2014) [WDM14]

While the two concepts of UX and QoE have many similarities, the two originated from different fields and with a different focus: the goal of UX is to improve the human experience of interacting with a product or service (before, during and after such interaction occurs), while QoE aims at evaluating and improving the technical quality perception of multimedia systems. Table 2.1 highlights some of the main differences between UX and QoE, as summarised by Wechsung & De Moor[WDM14].

2.1.1 Definitions

The scope of this project compassed both UX and QoE aspects of gaming, with a primary focus on HCI and UX research methodologies. To aid with the understanding of the different terminologies used, the following working definitions are provided:

- A **Human-Computer Interaction (HCI) research problem** is *"a stated lack of understanding about some phenomenon in human use of computing, or stated inability to construct interactive technology to address that phenomenon for desired ends"*. [OH16]

- **Constructive research** is *"aimed at producing understanding about the construction of an interactive artefact for some purpose in human use of computing"*. [OH16]

- **Usability** is *"the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use"*. (ISO 92411-11) [Iso98]

- **User Experience (UX)** is *"a person's perceptions and responses that result from the use or anticipated use of a product, system or service"*. (ISO 9241-210) [DIS09]

- **Quality of Experience (QoE)** is *"the degree of delight or annoyance of the user of an application or service. It results from the fulfilment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user's personality and current state"* [LCMP$^+$12].

- A **game** is a *"a rule-based system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort* *in order to influence the outcome, the player feels emotionally attached to the outcome, and the consequences of the activity are negotiable"* [Juu18].

- **Playability** is defined as "the degree to which a game is fun to play and is usable, with an emphasis on the interaction style and plot-quality of the game; the quality of gameplay". [Usa17]

2.2 Modelling the experience of gaming

2.2.1 MDA model

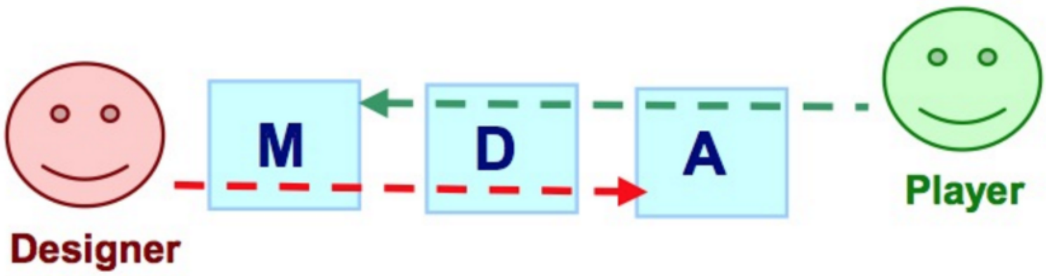

Figure 2.1: Mechanics, Dynamics and Aesthetics model from Hunicke et al. [HLZ04]

Previous research has attempted to map the complex experience of playing video games into different models. For instance, the Mechanics, Dynamics and Aesthetics (MDA) model by Hunicke et al. [HLZ04] understands the dynamics of a game (i.e., the way the game reacts to player's input) as a bridge between the components of the game (mechanics) and the emotional response evoked in the player (aesthetics). This model aims at understanding the interaction of a player with the game - the gameplay, e.g., the experience of a game.

2.2.2 SCI model

The Sensory, Challenge-Based and Imaginative (SCI) immersion model [EM05] distinguishes three dimensions of immersion after which it is named: sensory immersion, which deals with the I/O feedback of the game (usually a multimodal combination of visual, auditory, and/or haptic feedback); challenge-based immersion, which is reached when one manages to find a balance between competence and challenge; and imaginative immersion, defined by the ability of the player to relate to the story and characters in the game. Similarly to the MDA model, the

SCI model also defines the gameplay experience as a link between game structures and affective response in the player.

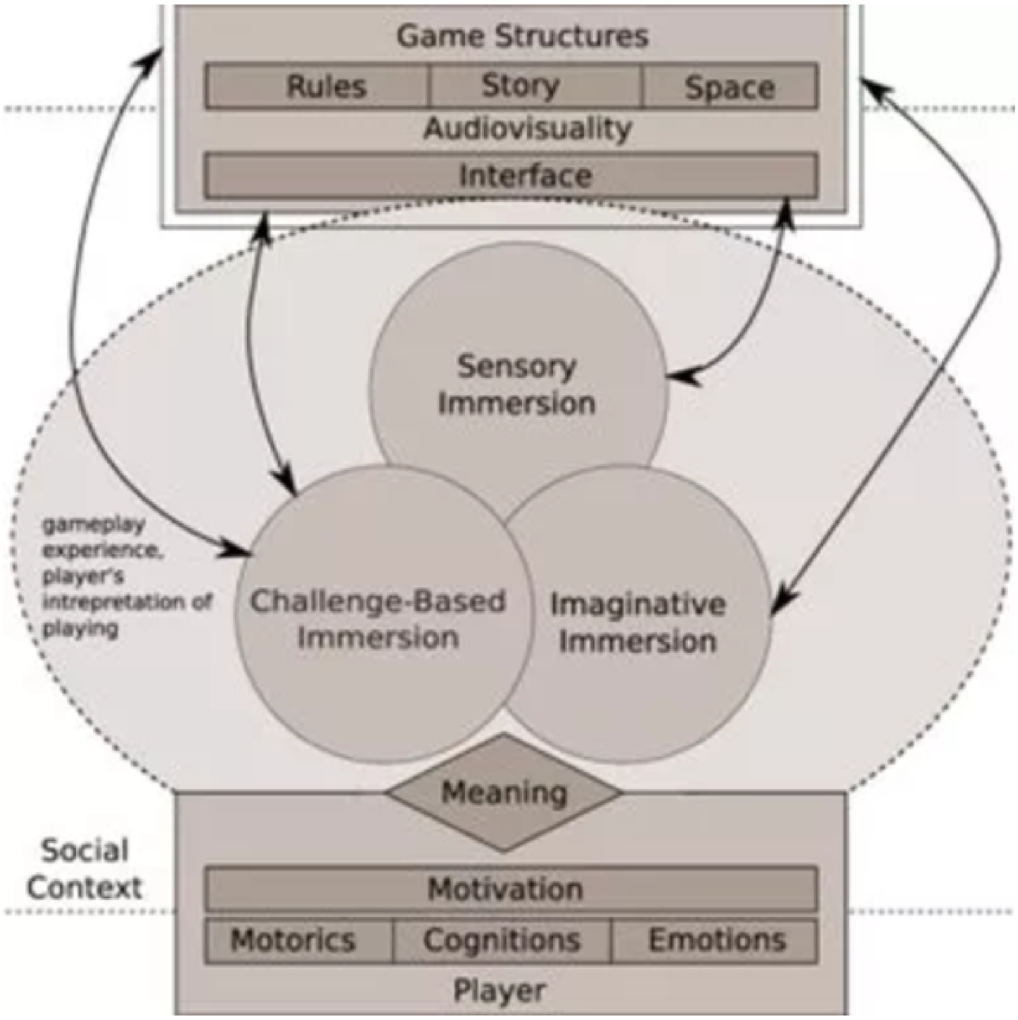

Figure 2.2: SCI model from Ermi & Mayra [EM05]

2.2.3 Gaming Taxonomy

Moeller et al. [MSB13] proposed a taxonomy that differentiates between Quality of Service (QoS) and QoE of games. QoS comprises influencing factors and interaction performance highlights two layers of quality features defining the player experience, one related to the game itself and another related to the psychological state of the player.

Influencing factors

Influencing factors can come from the user, from the system, or from the context: **user factors** can usually be assessed through questionnaires and regard the *experience* of the player (i.e., how experienced are they with videogames); their *playing style* (e.g., are they "achievers" who like to overcome obstacles and reach goals, "explorers" who like to wander around and discover new things, "socialisers" who like to interact with others, or "killersâ who like to destroy enemies); their *intrinsic motivation* for playing; *static and dynamic factors* such as their demographics and current emotional status.

System factors are, for instance, the *game genre* (which could be a combination of one or more of 42 identified genres); the *game structure* (i.e., how many players, cooperative or competitive mode, whether player is against computer or another player or teams of players, etc.); the *game mechanics and rules*; the *technical system setup* (e.g., server characteristics, transmission, interface, device); game and system *design characteristics*.

Finally, **context factors** comprise *physical environment factors* in terms of room characteristics (space, acoustics, lighting, etc.) and usage situation (e.g., at home, while on the move, etc.); the *social context* (security and privacy of the player, relationship with other players if involved, parallel activities of players); the *ex-*

trinsic motivation (e.g., a financial or social reward); and *service factors* (e.g., access restriction, availability of the system, resulting costs).

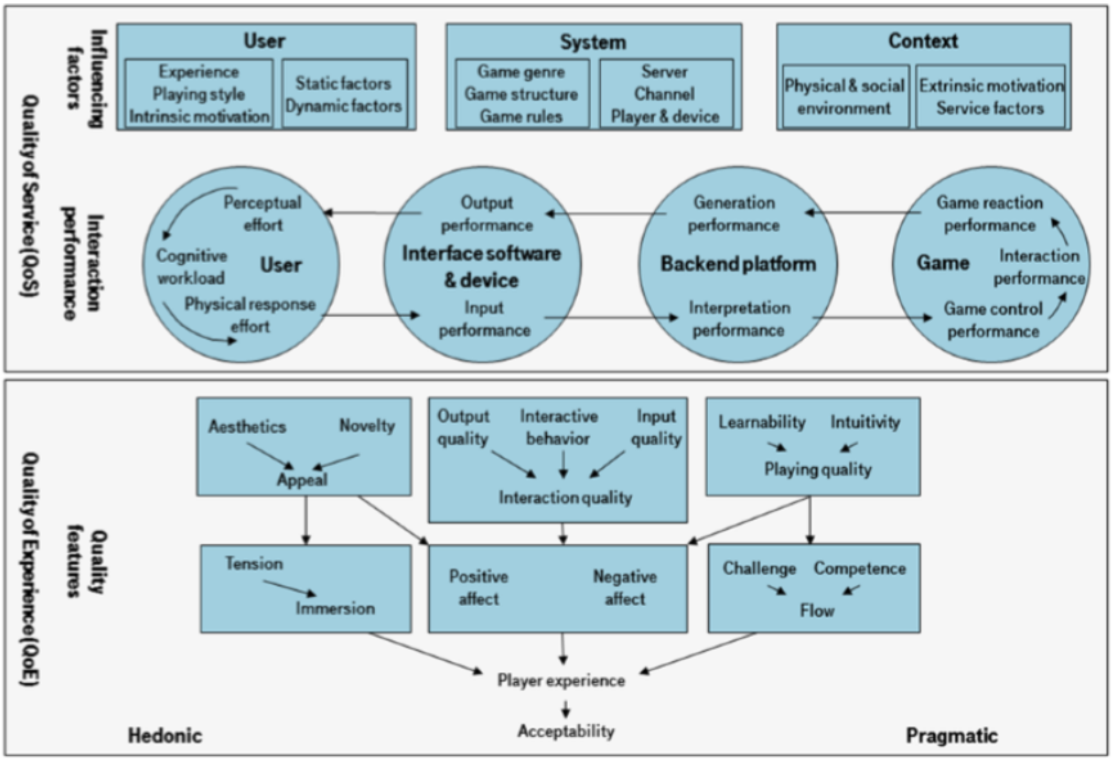

Figure 2.3: Taxonomy of gaming by Moeller et al. [MSB13]

Interaction performance

User performance is affected by the player's **perceptual effort**, that is, the effort required to decode system messages and to understand and interpret their meaning; their *cognitive workload*, i.e., the costs of task performance (such as obtaining an âoutcomeâ in the game); and the **physical response effort**, i.e., the physical effort required to interact with the game.

System performance aspects regard *user interface performance* in terms of input and output; *backend platform performance* (how well user input is interpreted to generate the corresponding output by the system); *game performance* (performance of user control over interaction of the game rules and game reaction, e.g. game success, time-on-game, game errors, etc.).

Quality features

Quality features defining the QoE are also layered in the taxonomy. The first layer comprises the appeal of the game, its interaction quality and its playing quality. **Appeal** is defined as the extent to which game is perceived as interesting, novel and surprising. The appeal of a game is determined by its aesthetics (i.e., the sensory experience elicited by the game) and by its novelty.

Interaction quality refers to the playability of the game in terms of how its functional and structural elements (e.g., input/output, interactive behaviour of hardware and software needed to play the game) elicit a positive experience in the player. **Playing quality**, finally, refers to the âusabilityâ of the game, in terms of ability to learn, control, and understand game mechanics.

The second layer comprises psychometric dimensions such as tension, immersion, positive and negative effect, challenge, competence, and flow / absorption. The output is the overall **player experience**, i.e., the degree of delight or annoyance of the player after the gaming experience which contributes - together with other factors such as accessibility, service conditions and price - to the **acceptability** of the game (how readily a player will actually use the game as a result of player experience).

2.2.4 Evaluating gaming experiences

Several different theoretical frameworks of UX have been proposed regarding evaluation of user needs and experiences with an interactive product, focusing on users' sensations, emotions and behaviour in the context in which the interaction occurs, going beyond mere task performance [ACLM07] [BAH11]. This is particularly relevant to videogame UX because of the complex nature of the media: compared to general UX which mainly focuses on the usability of an interactive system, video games feature an important quality measurement, namely playability [SVSPZ12]. Playability is defined as "the degree to which a game is fun to play and is usable, with an emphasis on the interaction style and plot-quality of the game; the quality of gameplay" [Usa17] (section). Moreover, challenging elements are desirable in videogames as they provide the players with a sense of reward and achievement upon overcoming them, in contrast to other task- and productivity- oriented digital applications for which the goal of UX designers is to minimise challenges [MSB13].

When it comes to evaluating the UX of games, numerous empirically-derived concepts have been proposed, often with somewhat broad definitions [THKN10]. For instance, the concept of "flowâ, first introduced by Csikszentmihalyi in 1975, is defined as "an optimal experience", a desirable state of mind that an individual can achieve while engaged in a task, which videogames can often trigger [CC75]. The terms Immersion and Presence are often used somewhat interchangeably because of their broad definitions, yet they are understood as two distinct concepts that are not necessarily experienced at the same time [SW05].

Flow

Csikszentmihalyi first introduced the concept of flow as the state of "total involvement" in an autotelic activity (e.g., dancing, rock climbing, playing chess), uncovering a link between intrinsic motivation and play prior to the raise of videogames

[CC75]. Flow is *"an equilibrium between boredom and fear, between requirements and abilities, and it is a dynamic experience of complete dissolution of an acting person in his/her activity"* which occurs *"when people do intrinsically rewarding activities in which they feel optimal challenged relative to their level of skill"* [HC96]. In relation to videogames, Grodal talks of a "remarkable new type of media" that allows one to experience "the full experiential flow", thanks to their interactive aspect and engaging nature [Gro99]. To reach and maintain flow requires one to focus their attention on a given set of stimuli over time, with the person-environment interaction allowing for the application of one's skills to the addressing of certain challenges often resulting in an optimal experience[NC14].

A related trait to flow is that of **cognitive absorption**, which Webster and Ho conceptualise as identical as flow, but without the interaction (or control) factor. They state that passive cognitive engagement may be possible, for instance when one is watching TV, while passive flow is not [WH97]. Hassenzahl also relates the concept of flow to the positive UX resulting from the fulfilment of one's be-goal, such as a need for competence [Has08].

Presence

Lombard and Ditton [LD97] provide a generalised description of presence as "the perceptual illusion of nonmediation", which occurs when the player fails to perceive or acknowledge that there is a medium between them and their virtual environment, acting as if such medium weren't there. They also identifying six distinct, more specific conceptualisations of presence: namely *presence as social richness* (the sense of "intimacy"), *presence as realism* (the sense of experiencing something "real"), *presence as transportation* (the sense of "being there"), *presence as immersion* (the sense of being submerged by the virtual environment), *presence as social actor within the medium* (the sense of perceiving social interactions within the medium - e.g., interacting with virtual characters), and *presence as medium as social actor* (the sense of perceiving the medium itself as a social actor).

Tamborini and Bowman [TBE+10] consider three main dimensions of presence in videogames: *spatial presence* (or physical presence), i.e., the extent to which one feels as if they were inside the game world; *social presence*, i.e., the extent to which one perceives other users in the virtual world as actual social actors; and *self presence*, i.e., the extent to which one experiences their virtual self as their actual self.

Spatial presence	**Social presence**	**Self Presence**
Sense of being physically located in a virtual environment	Sense of how virtual social actors are experienced as though they are actual social actors	Sense of how the virtual self is experienced as if it were the actual self
Sense of interacting with virtual objects as though they have actual, physical properties	Comprises copresence, psychological involvement, behavioural management	

Table 2.2: Three dimensions of presence according to Tamborini and Bowman [TBE+10]

Slater et al. [BZSS95] defines the concept of presence as "the sense of being there", that is, the state of mind resulting from the processing of a combination of stimuli which results in one feeling as if they were present in time or space in a given environment - either a real environment in a remote location mediated by a teleoperator (*"telepresence"*) or a virtual environment generated by a computer through a combination of multisensory stimuli (*"virtual presence"*). In a more recent paper Slater[Sla03] highlights the distinction between presence and emotional engagement, suggesting a further divide between the concepts of presence and immersion. It has been claimed that presence is an inherently biological phenomenon and feature of core consciousness, rather than a "suspension of disbelief" which is a feature of extended consciousness and results in *imagined presence* rather than in the perceptual illusion of nonmediation [WW03].

Immersion

Immersion has often been deemed as one of the core aspects of gaming and even considered as a requirement for player enjoyment. Yet, there is still a need for a complete understanding of what immersion is and the term is often used to describe concepts related to presence, or vice versa[JCC+08].

Janet Murray's definition highlights how the term is related to the physical experience of someone being submerged in water: *"the sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus"* [Hig98]. Brown and Cairns [BC04] used grounded investigation to elaborate on this definition, especially with a focus on videogame immersion, defining three successive phases of player immersion: *"To enter the level of **engagement**, the gamer has to overcome the barrier of gamer preference, invest time as well as effort and have the attention to learn how to play the game. To enter the stage of **engrossment**, the player needs to combine game features and master the control of the game in order to become emotionally attached. While players in this state are less aware of their surroundings and themselves, they might reach a state of **total immersion** by overcoming the barriers of empathy and atmosphere. In total immersion gamers described a sense of presence and of being cut off from reality to such an extent that the game was all that mattered"*. They also stress how being grounded theories, these dimensions are descriptive rather than predictive. Characteristics of immersion are then one's lack of temporal awareness, one's loss of awareness of the real world, and the involvement and sense of being in a task environment.

Witmer and Singer [WS98] also mention involvement - the psychological state one may experience by attaching significance to a coherent set of stimuli, activities or events that they are focusing on - in relation to immersion, stating that both are necessary conditions for one to experience Presence. The aforementioned SCI model implies that in order to be "fully" immersed, a player needs to experience three sub-dimensions of immersion deriving from sensory, challenge-based, and imaginative stimuli.

For the purpose of this dissertation the following definitions are used:

- **Flow** is "considered to be an equilibrium between boredom and fear, between requirements and abilities; it is a dynamic experience of complete dissolution of an acting person in his/her activity. The activity itself constantly poses new challenges, so there is no time for boredom or sorrows. Intrinsic motivation is important for flow, as well as control over the game." [CC75]
- **Absorption** refers to "being in a state of deep attention with the event experienced. Absorption is "identical to flow, just without the dimension of control. Individual control is not necessary for cognitive engagement, because "passive engagement" (e.g., watching TV) might exist while "passive flow" is impossible". [WH97]
- **Involvement** is "is a psychological state experienced as a consequence of focusing one's mental energy and attention on a coherent set of stimuli or meaningfully related activities or events. Involvement is increased by performing tasks and participating in activities that stimulate, challenge, and engage the user either cognitively, physically, or emotionally." [WS98]
- **Presence** is "a psychological state of "being there" mediated by an environment that engages one's senses, captures attention, and fosters active involvement. The degree of presence experienced in this environment depends on the fidelity of its sensory components, the nature of the required interactions and tasks, the focus of the user's attention/concentration, and the ease with which the user adapts to the demands of the environment. It

also depends on the user's previous experiences and current state" [SU94]

- **Immersion** is "A psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences. Specially with a focus on games, immersion is used to describe the degree of involvement with a computer game and has been classified into three phases as: "engagement", "engrossment", and "total immersion" [WS98]

3 First Study - Methodology

Two research studies adopting different methodologies have been devised to address different aspects of the problem. The first study had an exploratory scope and addressed research questions R1 and R2.

3.1 Background

Grounded theory is a qualitative research method aimed at inductively developing theories through the systematic gathering and analysis of data sourced via interviews, field observations, or documents and other media materials [SC94]. Qualitative research methods are often devised together with quantitative studies, but compared to the latter, they require a smaller number of participants. This is because the focus of qualitative research is to unveil *heterogeneities in meaning* through in-depth understanding of a phenomenon (that is, focusing on the why and how rather than the what) [Dwo12], which is crucial for HCI research for its aim is to investigate the human experience in the context in which an interaction occurs [BAH11]. UX research, as well, relies heavily on qualitative research methodologies, with the "think aloud" method being the most commonly practiced and arguably the most important type of usability study [Nie17], in which a user is observed while interacting with a system and verbalising their experience as it occurs ("thinking out loud") [VSBS94].

The motivation for adopting qualitative research lies in its relevance to the field of HCI and in the explorative nature of this project. The reasoning behind the choice to combine grounded theory and think-aloud was two-fold: while the former is more suited for generative research, the latter is ideal for evaluative research. The study was designed to comprise both of these aspects in order to i) uncover mental models towards QoE of gaming (through generative research) and to assess the effect of network degradations on the playing experience (through evaluation research). A similar approach towards the exploration of gaming experiences using grounded theory had been adopted by Calvillo-Gamez et al. [CGCC15], but with the majority of their data collected from written video game reviews in magazines rather than from direct feedback and observation of players.

3.1.1 Study design

Semi-structured interview

The first part of the study was devised to explore people's experiences and attitudes towards gaming, in order to identify the most defining aspects of QoE in relation to game experiences. A questionnaire script was drawn up around the following topics:

(i) Player characteristics - i.e., attitudes and motivations for gaming;

(ii) Gaming Experience - i.e., subjective understanding of "Quality of Experience" in relation to videogames;

(iii) Cloud Gaming - i.e., specific expectations regarding the QoE of cloud games;

(iv) Network Degradations - i.e., perceived effect of different types of observed network degradations on QoE.

To introduce topic (ii), the following definition of general QoE was presented to the participant, both orally and written form:

"Quality of Experience is the degree of delight or annoyance of the user of an application or service. It results from the fulfilment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user's personality and current state";

Similarly, a definition of cloud gaming was provided to introduce topic (iii):

"Cloud gaming refers to a game that resides on a company server rather than on the gamer's computer or device. The gamer enters the game by installing a client program that can access the server where the games are running. The main advantage of cloud gaming is that the company can upgrade the games without having to worry as much about the capabilities of usersâ computers.

The client program that the gamer installs is usually very light in that it doesn't require a lot of processing power to work. The gamer can then select from the available games within that client and play them on the server. The processing power for running the game is provided by the server, but the speed of the connection can become an issue for the gamer. Cloud gaming companies usually charge a fee or subscription, operating much like online video rental services."

Think aloud

The second part of the study was evaluative. To address topic (iv) each participant was first asked to play a simple game with play mechanics similar to "T-Rex Runner" (the game that launches on Google Chrome browser in response to a lack of internet connection). Participants played the game under normal network conditions and then with four different types of simulated network degradations: 250ms delay, 25% control packet loss, 15 frame-per-seconds (fps), and a combination of all of these, and asked to think aloud while they played. In addition to this, the participant was also introduced to three different videogames and shown videos depicting three types of network degradation (Blockiness, Jerkiness, Low Packet Loss) for each of them. The three chosen games were NieR:Automata, a single-player action role-playing game; League of Legends, a multiplayer action real-time strategy game; and Hearthstone, an online collectible card game that can be played as either single- or multiplayer.

Post-study Questionnaire

A short post-study questionnaire was also devised, in which participants were asked to rate on a likert scale from 1 to 7 how important is it for them, in order to achieve a positive gaming experience, that a game is i) fun, ii) challenging, iii) aesthetically appealing, iv) easy to control, v) of high video quality, vi) of high audio quality, vii) responding to input without delay.

3.1.2 Participants

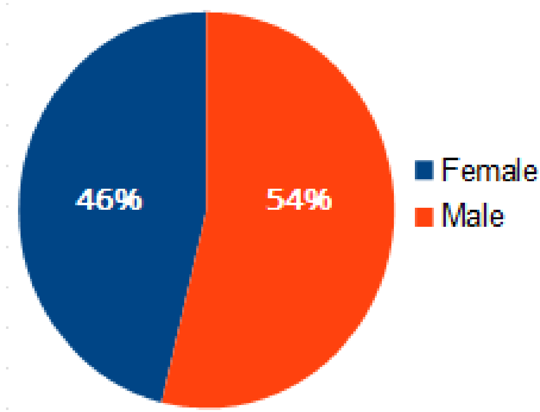

Figure 3.1: First study - Gender distribution

There is no agreed ideal sample size qualitative studies, but the number of participants commonly used for in-depth for in-depth interviews is generally much smaller than that used in quantitative research studies [Dwo12]. The broadness

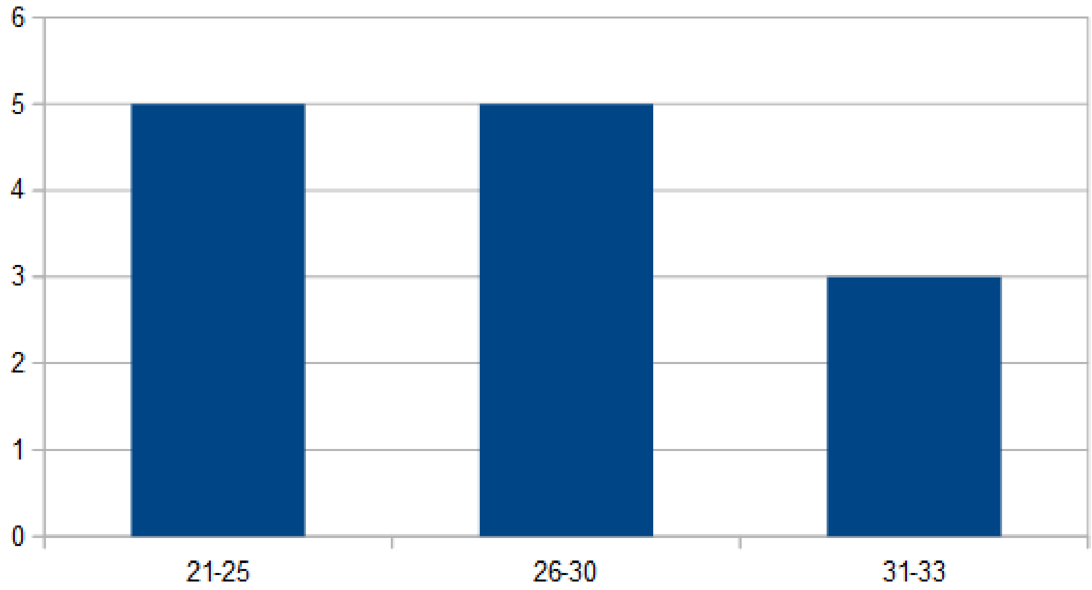

Figure 3.2: First study - Age distribution

of the study, sample specificity, methodology(-es) used and quality of dialogue all affect the "information power" held by each research session, with the number of sessions required to generate valuable insights varying accordingly [MSG16].
To uncover every facet of gaming experiences, taking into account different types of video game genres, gaming consoles, and player types, would be unrealistic without an extremely large amount of sessions; but for this type of exploratory research it was not expected to investigate all aspects of the phenomenon, but rather to collect a sufficient information power to complement or challenge current knowledge in order to motivate further research [MSG16].

For this purpose, a total of 13 participants (7 female, 6 male; aged 21-33, average: 27.53) with different gaming backgrounds were recruited. Each interview session lasted 60 minutes and was audio recorded, everyone who took part in the study was compensated 15 euros for their time.

Participants were asked to rate their level of expertise as “gamers” on a scale from 1 (novice) to 5 (expert), with 3 participants self-defining as novices or near-novices, 5 as neither novices nor experts, and 5 as near-experts. The number of self-reported average hours per week spent gaming varied from 1 to 25, and devices used for gaming including smartphones (10 participants), home gaming consoles and laptops (7 participants), desktops (5 participants) and handheld gaming consoles (1 participant).

3.2 Limitations

One potential limitation regarding the think aloud session comes from the fact the game used in the session has very basic game mechanics and visuals (in order to minimise confounding variables when testing different network conditions). Whilst the feedback obtained is surely valuable, most commercial games tend have more complex mechanics and appealing aesthetics which may contribute to a different QoE. To partially address this, participants were later exposed to videos showing different types of commercial games, but another limitation here was that no audio from the games was available and that participantsâ evaluation was not based on actual interaction with the games.

Ultimately, the most noteworthy limitation of this study was the vastity of its scope and the (foreseen) idiosyncratic characteristics of the participant. Whilst the qualitative research methods adopted do not generally require a great number of participants, the complex facets of gaming QoE with its great variety of player types, game genres, etc., called for a larger amount of recruited participants in order to unveil heterogeneities in meaning. While this allows for a more complete picture of people-s motivations and attitudes towards gaming, it also calls for extra caution when drawing conclusions.

4 First Study - Analysis & Discussion

4.1 Grounded Theory

The grounded theory approach requires one to analyse the data collected iteratively, e.g., to start developing a theory based on the analysis of an initial sample of data (**Theoretical Sampling**) and then return to the analysis with a new sample, in order to uncover new insights, repeating this process until saturation is reached. This process is called **Constant Comparative Method**, and involves three stages: first, the data is *openly coded*, e.g., quotes, words and observations are labeled (or "coded"). These labels are used to relate data artifacts to each other, grouped based on common themes or *axial codes*. Finally, each of these labels and themes are reviewed and organised - *selectively coded* - in order to formulate a theory[SC94][CGCC15].

A coding scheme was developed with the aid of the Reframer software tool for qualitative research by Optimal Workshop [1]. The tool allowed to transcribe observations from each session and to tag each of them according to emerging themes, which were in turn categorised according to the topics covered by the interview, with a total of 85 observations and 45 "tags" recorded. Möller et al.'s Gaming Taxonomy from section 2.2.3 was then used to interpret the coding scheme generated as a base for discussion.

[1] https://www.optimalworkshop.com/reframer

The variety of emerged themes draws, expectedly, a complex picture of gaming experiences which is highly affected by the participant's idiosyncratic characteristics as a player, at least when it comes to motivations, attitudes and expectations of gaming; whereas a higher agreement in the participants' responses was observed in the second part of the study which dealt with network degradations.

4.1.1 Motivation to play games

As expected, different types of player types emerged amongst the 13 participants who took part in the study. It was important, in order to get a complete picture of their answer, to first of all clarify what motivates each of them to play games. The most common word used to describe why people choose to play videogames was "fun", with the participant then asked to further elaborate what makes video games "fun" for them. Various - and sometimes opposite - reasons were identified. For instance, P02, P03, and P011 explicitly mentioned the possibility space (e.g. the extent of decision-making possible in the game world) to be a main motivating factor:

> P03: *"You can do stuff that you cannot do in the real world (...) you can do whatever you want" P11: "during my bachelor studies I fell in love with open world games, you have a horizon of decision-making in this case..."*

Unlike P03 who likes this possibility space to extend beyond the realms of the "real" world, P04 favours games which are based on the real world:

> P04: *"I only play simulation games. I like this idea of realistic type of things that you can do, as a pilot, or someone driving a train... because these videogames kind of show you the real world, also the landscapes of certain countries..."*

Social aspects (either cooperation or competition) were mentioned by a few participants:

> P07: *"I play for social aspect, but also to relieve me from stress"*

> P11: *"My dad didn't talk much but when playing with him I had a chance to connect and he opened up... so it was a very positive experience"*

> P01: *"Since I am not very good at sports, being good at videogames - especially in online games, there is a competition factor... that is why I play mostly online"*

Finally, stress relief and the ability to switch off one's brain were often cited as motivation to play games.

> P08: *"I don't want to have any thoughts... I want to have fun"*

> P06: *"When I play games, it focuses my attention on something specific. If I am playing music, my brain is still functioning. But when I am playing videogames, it's like I'm turning my brain completely off and very, very focused on just one thing"*

> P03: *"Sometimes it's just nice to sit down and do nothing, and turn off my mind. The main reason I play videogames is that I can just switch off my brain."*

4.1.2 High gaming QoE linked to a desire to keep playing

Despite all being provided with a same written definition of gaming QoE, participants had different interpretations of what QoE is. The concept was most commonly understood as something similar to that of "flow" (or the related engagement/involvement).

> P01: *"(QoE is) the degree of delightment, which fluctuates day by day. It can be higher when you have a new game which you are really enjoying it, but after a while it drops when the game becomes 'stale' or if the online community starts to decrease. Then you switch to another game to keep the QoE at a higher level"*.

P04 defines a prerequisite for reaching high QoE:

> P04: *"I think it's about the fulfillment of (the player's) expectations. If certain videogames require a realistic type of scenery, that should be considered when designing those games. So to have the sceneries as detailed as possible, even the small details..."*

Interestingly, when asked how can one tell whether they are having a positive gaming experience, a large number of participants excitedly linked a high QoE to a desire to keep playing.

> P01: *"I know I am having a positive experience if I don't want to quit. In single-player campaigns it's easier to tell because you want to get to the end of the story... so it's easier to tell if you want to keep playing. For online (games), you still want to keep playing, you know... but most of the time it's just a match after another match... and then even let's say you get frustrated because your squad keeps losing and you want to stop playing, but then after 10 minutes you are not enraged anymore so you get it back, go with another squad and go at it again"*

> P03: *"(...) when you just want to play, when you feel like you can do everything and you can still the challenges as well, so i think it's best when you can see the challenge but you still enjoy it, so you feel some kind of 'flow'..."*

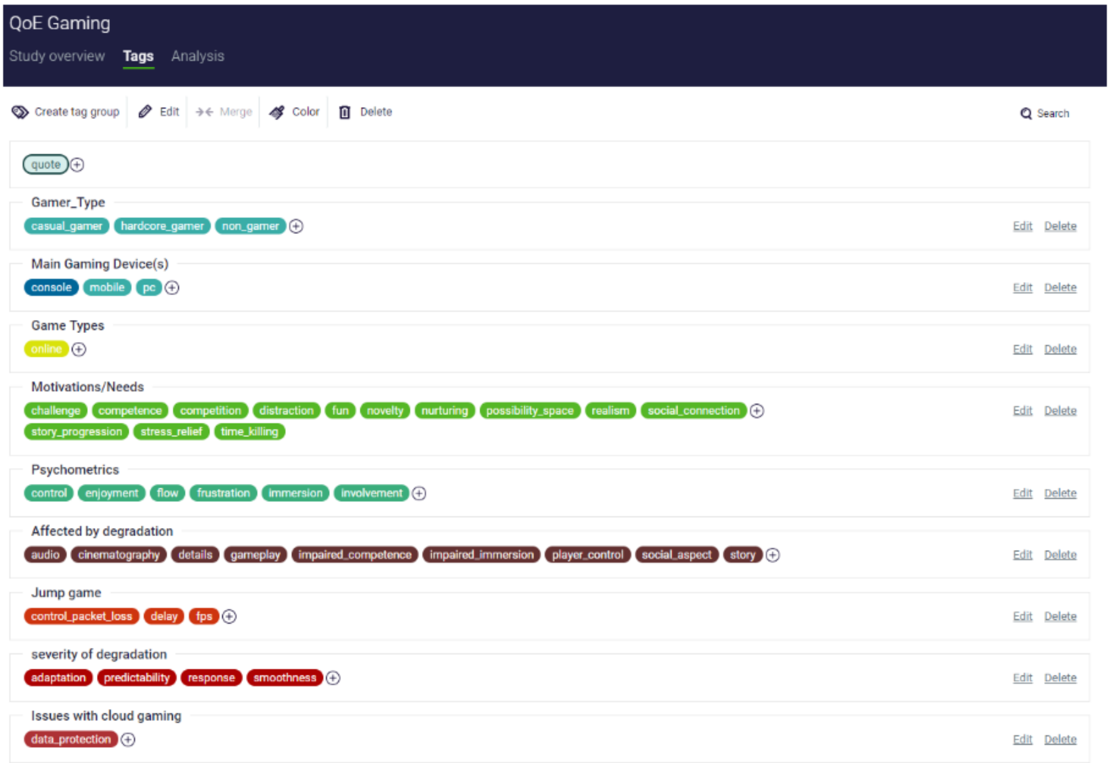

Figure 4.1: Interface of Optimal Workshop's Reframer software for qualitative analysis.

4.1.3 Network Degradations

Compared to the previous, more exploratory part of this study, participants' responses during the evaluation stage were considerably more homogeneous. In general, lowering the interaction quality of the game (in terms of input/output) had a negative effect on player experience, which was also mediated by playing quality, in accordance to Möller et al.'s taxonomy (section 2.2.3). For instance, learnability and adaptability to a given playing condition seemed to contribute greatly to the extent to which players were able to enjoy the game. P6 enjoyed playing the game in the condition 1 because of the added challenge. Table 4.1 highlights codes from the think aloud session in which participants were exposed to different types of network degradations affecting quality features.

Delay	Packet Loss	Low FPS
P06: "I realised that I have to press (the space bar) before it gets too close to the box..."	P06: (after failing to adapt gaming style to work around degradation) "Okay, now this feels like a bug. Sometimes it works, sometimes it doesn't... I don't like this. It feels random, I actually want to have a chance to win, you know."	P6: "This feels slower to me... but I am enjoying it, because I am winning (...) but if I keep playing, it hurts my eyes, so eventually it gets annoying"
P05: "The least bad degradation... at first I thought I couldn't play but in the end I could overcome all the obstacles"	P08: "this one is unpredictable, is like 'oh yeah i'm doing really good, oh shit there goes my high score...' this is even worse than the one before."	P02: "this one is difficult to watch... they are not bigger, I know that, but the way they move makes them different to predict. (...) This would give me a headache.... but at least the gameplay is not affected, so that's a good thing. I mean, the gameplay... the input is not affected. The gameplay is affected, very muchâ
P08: "It was somehow predictable, it made the whole experience bad but at least if I know I need to jump in advance before the square I know I need to do this."		P11: "in a game like this, I'd rather have the ball jump when i tell the ball to jump and less smooth animations."

Table 4.1: Highlights from think aloud session about each gaming condition

Participants almost unanimously agreed on "how bad" each of the three conditions was when compared to one another: Delay was considered as having the least impact on one's playing experience as the player could adapt their own gaming style to the condition; Low FPS was deemed as having the least effect on gameplay in terms of control input; while Control Packet Loss was regarded as having the most negative effect on QoE due to its unpredictability and impact on one's ability to proceed with the game, no matter their skills or effort to adapt to the condition.

It is noteworthy to mention that one of the participants, P06, actually found that the increase of challenge due to some of these conditions had a positive effect on her QoE, highlighting how user factors and idiosyncratic characteristics of the player still have an influence on one's experience.

> P06: *"If I found that there is a rhythm in the movement... I can adjust my playing to that rhythm, and it becomes less annoying. If everything has a delay, I can adapt my speed to that delay. But if everything is*

going smoothly, and then suddenly there is a delay, then it's annoying because I cannot adapt to it. (...) If there is a balance, and I can still win, I see that as challenging and I like that. But if I feel that it is down to luck, then it's just annoying."

While not many other participants claimed to enjoy the added challenge, the theme of experiencing lower quality due to an effect on player's competence and ability to win came up more than once.

> P11: "When you want to continue a mission and you can't because you see before of certain technological problems, because of bugs, glitches, if you have a high buffering rate you see only a picture in one minute, that's not very satisfying in the end... To have a good experience I can use this game and have a success, or continue certain experiences or certain missions, make some efforts in my gaming skills. In Skyrim, I want to complete certain missions, acquire some skills, or maybe just collect flowers... there has so be some progress.â

The negative effect on QoE due to impacted competence may be further enhanced if the game is multiplayer due to its more competitive aspect.

> P02: *"I you have that kind of lag (in multiplayer) you cannot react on time with what the other players are doing... the fact that there are other players and you're playing with half a second of delay... everybody is ahead of you... they have an advantage. (...) If I get killed in NiER:Automata (because of lagging), I would just try again. But in multiplayer there is a competition, you know... that would make me angry."*

The same may hold true even for to social, not necessarily competitive, aspects:

> P03: *"You are part of a group, you are playing with other people... this is what I personally think it's the only valuable part of the game, and it's*

> *gone... this destroys the social aspect, it does not give the feeling that you are part of something but rather that you are missing something. (...) I think it's pretty frustrating."*

Lower QoE is not only the result of impaired player competence, but also the impossibility to experience the possibility space or exploration of a game:

> P02: *"You already know the graphics in LoL and Heartstone. The maps are those, the character are those, you already know everything... it's not that difficult. But with NiER: Automata maybe I want to, you know, explore the details, or see the graphic design of the game..."*

5 Second Study - Methodology

The second study had an evaluative scope and addressed research question R3.

5.1 Background

Sorting techniques are commonly used in social psychological research to validate or confute hypotheses regarding social psychological structures and eliciting agreement of item categorisation by means of Multidimensional Scaling (MDS).[WL09]. Card sorting is a particularly popular UX research technique for assessing the information architecture of a digital product based on mental models of its users, who are provided (physically or digitally) with a set of cards containing items to sort into different categories. This categories can be provided by the researcher (closed card sorting), created directly by the participant (open card sorting), or a mix of the two (hybrid card sorting).[SW04] The relations between items sorted can then be visualised by means of a similarity matrix and measured through cluster analysis.[PB18]

5.2 Study design

5.2.1 Setup

A remote, unmoderated hybrid card sorting test was devised to assess how 50 items from different game experience questionnaire would be categorised according to different psychometric dimensions. The study was designed and launched

Cards

1. I was really drawn into my gaming task.
2. This gaming experience was fun.
3. I felt involved in this gaming task.
4. I felt that I really empathised/felt for this game.
5. I was interested in seeing how the game's events would progress.
6. I was in suspense about whether I would win or lose the game.
7. I sometimes found myself to become so involved with the game that I wanted to speak to the game directly.
8. I enjoyed the graphics and imagery of the game.
9. I became unaware that I was even using any controls.
10. I enjoyed playing the game.
11. I felt myself to be directly travelling through the game according to my own volition.
12. It was as if I could interact with the world of the game as if I was in the real world.
13. I was unaware of what was happening around me.
14. I felt detached from the outside world.
15. At the time the game was my only concern.
16. I did not feel the urge at any point to stop playing and see what was going on around me.
17. In the computer generated world I had a sense of "being there".
18. Somehow I felt that the virtual world surrounded me.
19. I had a sense of acting in the virtual space, rather than operating something from the outside.
20. I felt present in the virtual space.
21. I was completely captivated by the virtual world.
22. The virtual world seemed more realistic than the virtual world.
23. Things seemed to happen automatically
24. My thoughts went fast
25. I played longer than I meant to
26. I lost track of time
27. I didn't answer when someone talked
28. I couldn't tell I was getting tired
29. If someone talked to me I didn't hear
30. I felt like I could not stop playing
31. The game felt real
32. Playing seemed automatic
33. I played without thinking how to play
34. Playing made me feel calm
35. My thoughts/activities ran fluidly and smoothly
36. I had no difficulty concentrating
37. My mind was completely clear
38. The right thoughts/movements occurred of their own accord
39. I knew what I had to do each step of the way
40. I felt that I had everything under control
41. Something important to me was at stake there
42. I had to not make any mistakes there
43. I was worried about failing
44. I lost track of where I was
45. I felt different
46. Time seemed to stand still or stop
47. I felt just the right amount of challenge
48. I did not notice time passing
49. I was totally absorbed in what I was doing
50. I was completely lost in thought

Figure 5.1: Complete list of cards used in the task.

using a free student trial version of the OptimalSort software tool from the User Research Platform Optimal Workshop [1].

Items included in the study were those referring to Felt Involvement (FI) from the User Engagement Scale (UAE); those referring to Spatial Presence (SP), In-

[1] https://www.optimalworkshop.com/optimalsort

volvement (INV) and Experienced Realism (REAL) from the iGroup Presence Questionnaire (IPQ)[SRF18]; those from the Immersion Questionnaire (IQ) proposed by by Jennet et al (2008)[JCC+08]; the items referring to Absorption, Flow and Presence from the Game Engagement Questionnaire (GEngQ)[BFC+09]; and all the items from the Flow Short Scale, including the three items related to Anxiety ("I won't make any mistakes here", "Something important to me is at stake here", "I am worried about failingâ).[RVE03] Item were selected wherein they consisted on an agreement statement (e.g., "I felt that I really empathised/felt for the game"), while discarding those formulated as a question (e.g. "How immersed did you feel?"). To further reduce workload for the task and to avoid redundancy, negative statements (e.g., "I did not feel any emotional attachment to the game.") were also discarded. Finally, all times were turned into past tense for consistency (e.g., "The game feels real" was changed to "The game felt real").

Prior to the card sorting task, participants were asked to fill a pre-questionnaire survey which included definitions of Involvement, Presence, Immersion, Flow and Absorption (based on the Standardised Recommendation ITU-T P.809 for Subjective Evaluation Methods for Gaming Quality[MAB+15]. During the card sorting task, participants were asked to categorise all the questionnaire items based on what they thought was the best fitting quality dimension. Pre-titled categories were Involvement, Immersion, Presence, Flow and Absorption (with provided definition available for review), but participants were invited and encouraged to create as many additional categories as they felt was necessary. After completing the task, they were asked to fill out another short survey, the same as that in the previous study.

The research questions that were addressed during these study are as follows:

- (i) How closely does the participants' grouping of questionnaire items match the expected quality dimensions?

- (ii) What are, if any, questionnaire items that are consistently grouped together in unexpected ways?
- (iii) What are, if any, "ambiguous" questionnaire items that may not be related to a specific dimension?

5.2.2 Participants

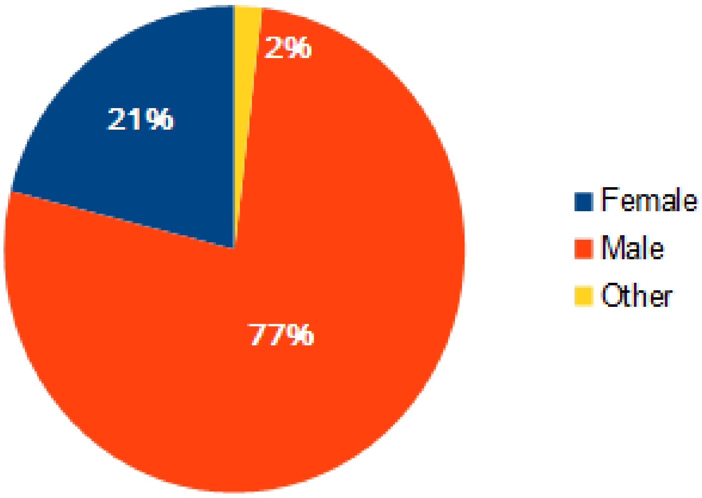

Figure 5.3: Second study - Gender distribution

The recommended number of participants for a card sorting study varies between 15 and 50, with fewer participants needed for usability testing and more if card sorting is used as a generative research method to uncover people's mental models.[Nie04][TW04] For this study, 52 full responses were collected out of 119 participants.

Participants were recruited through different social media such as reddit and Facebook and specifically targeting individuals interested in gaming or game design, and no incentive was given for taking part in the study. The 52 final respondents were aged 14-54 (average: 25.5), with 40 male and 11 female participants (1 identified themselves as "other"). The majority of the respondents were from the US (23), followed by Canada (5), the UK (4), Germany (3), Sweden (3), the Netherlands (2), Italy, Ireland, Spain, Portugal, Croatia, Austria, New Zealand, South Africa, Japan, Singapore, India and Turkey.

5.2.3 Limitations

A potential limitation of this study may be the quality of the participants. While participants were not screened based on their relationship with gaming, a selective recruitment approach was used, targeting specifically communities and individuals interested in gaming. Yet, with non-incentivised online recruiting there always comes a risk that some of the responses may not be accurate. Furthermore, card sorting tasks are generally best carried out in the native language of the participants in order to ensure full understanding of the terms used. Based on their declared nationality, it is estimated that about only half of the participants of this study were native English-speakers, with the remaining half speaking English as a second language.

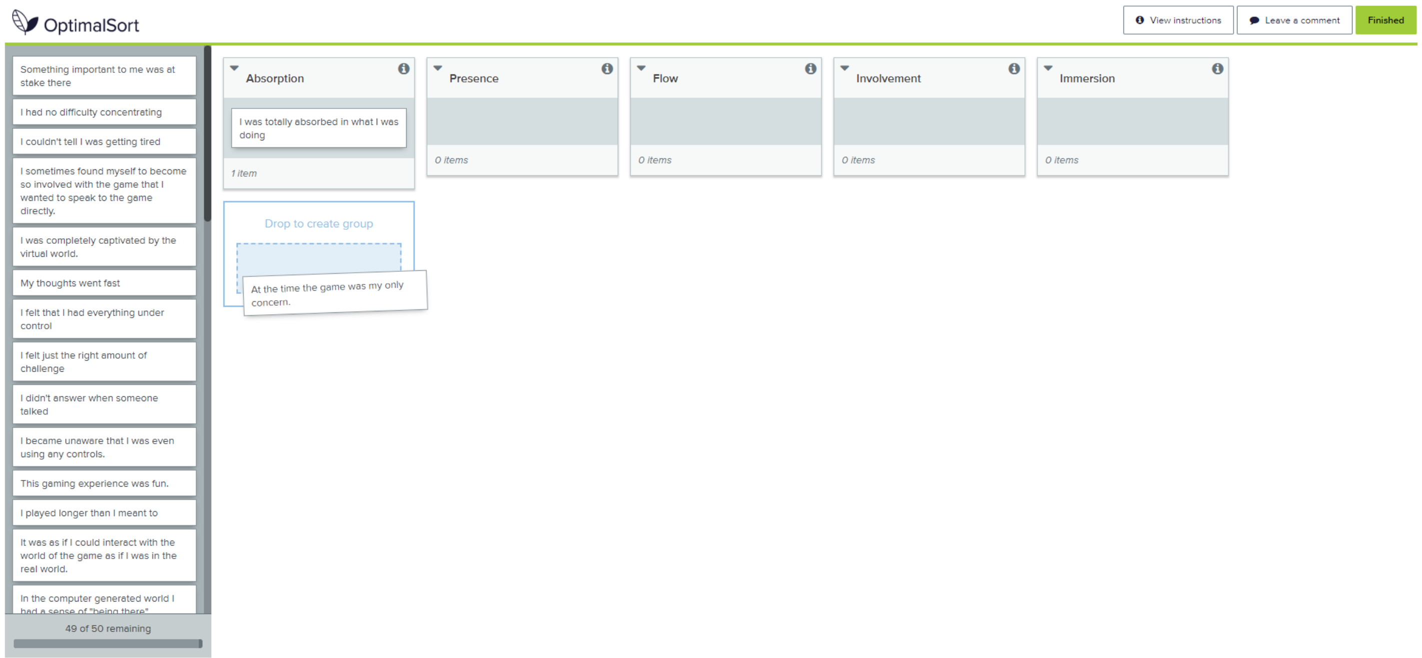

Figure 5.2: Study setup as seen by participant in OptimalSort. Participants had to drag-and-drop all the items from the left-hand side column into either one of the five pre-set categories or on a empty space thus creating a new category, as shown in the picture.

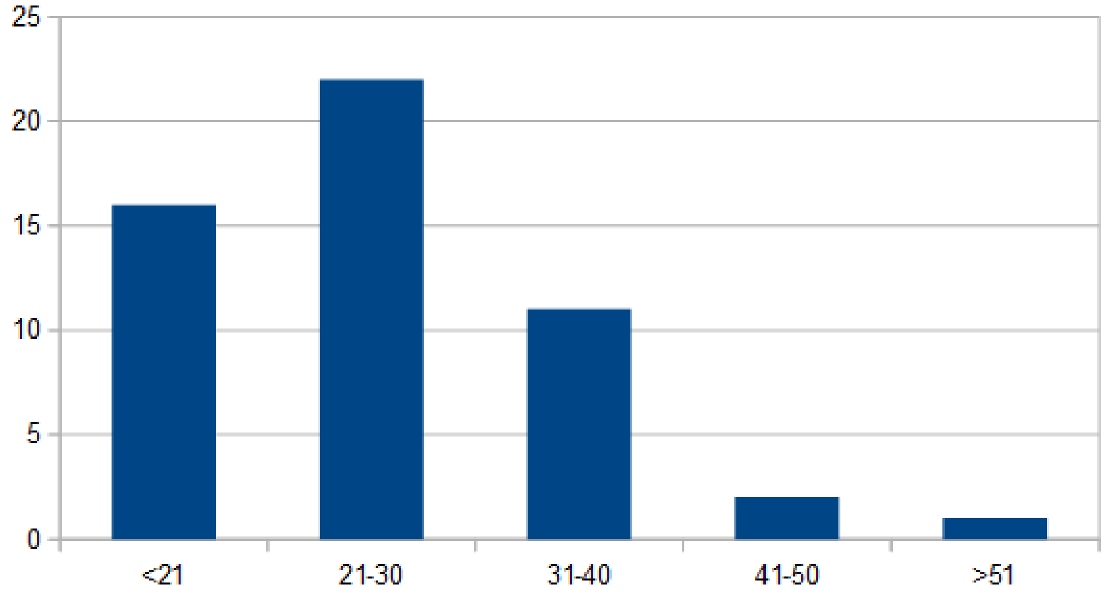

Figure 5.4: Second study - Age distribution

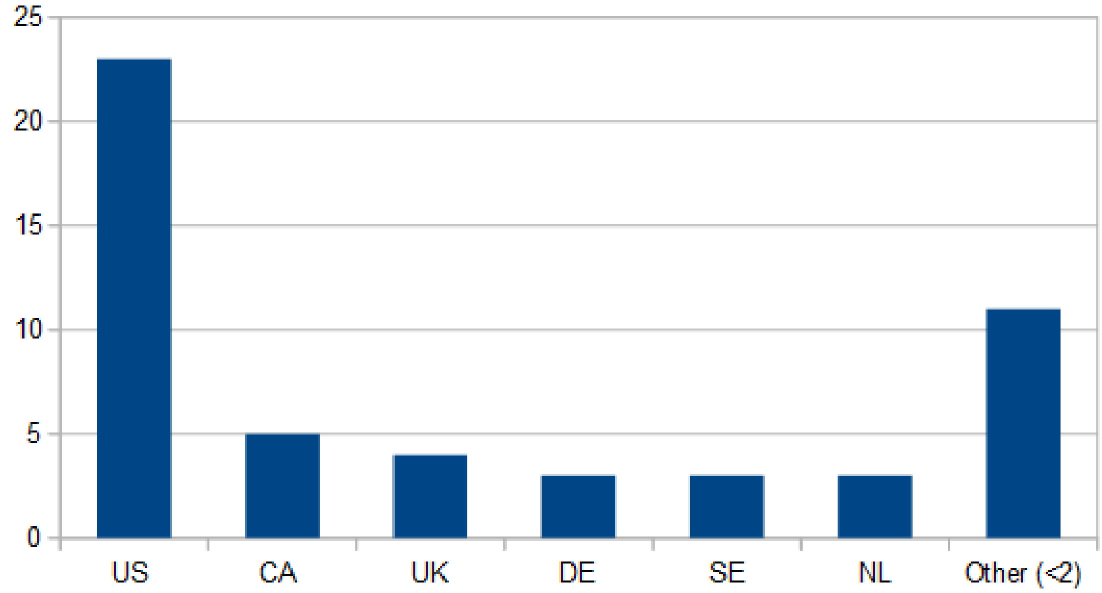

Figure 5.5: Second study - Country distribution

6 Second Study - Analysis & Discussion

6.1 Cluster analysis

Dendrograms are commonly used to visualise the results of card sorting based on cluster analysis performed on the similarity matrix. An Actual Agreement Method (AAM) algorithm is best used when 30 or more participants have completed the test, and only shows absolutely factual relationship between sorted items, showing the percentage of participants that grouped cards in a given cluster together.

A dendrogram for this study is shown in Figure 6.1. Items "This gaming experience was fun" and "I enjoyed playing the game" were paired together the most often (56% agreement), and appeared the most under "Involvement" (21 and 20 times respectively). Clustering with additional items from the participants-generated Involvement category (e.g. the Felt Involvement and Anxiety items) brings the agreement level down to 10%.

The second-strongest cluster (28% agreement) included items "I enjoyed the graphics and imagery of the game", "Somehow I felt that the virtual world surrounded me", and "I felt present in the virtual space". While the latter item has a higher correlation with the Presence category, the former two were split almost 50-50 between Presence and Immersion.

Two clusters had a similar agreement score of 26%. The first one comprised 5 items: “At the time the game was my only concern”, “I played longer than I meant to”, “I didn’t answer when someone talked”, “If someone talked to me I didn’t hear”, “I felt like I could not stop playing”; all of which were mostly grouped under Absorption. One of the participants created a category “Entrapment” containing solely these items.

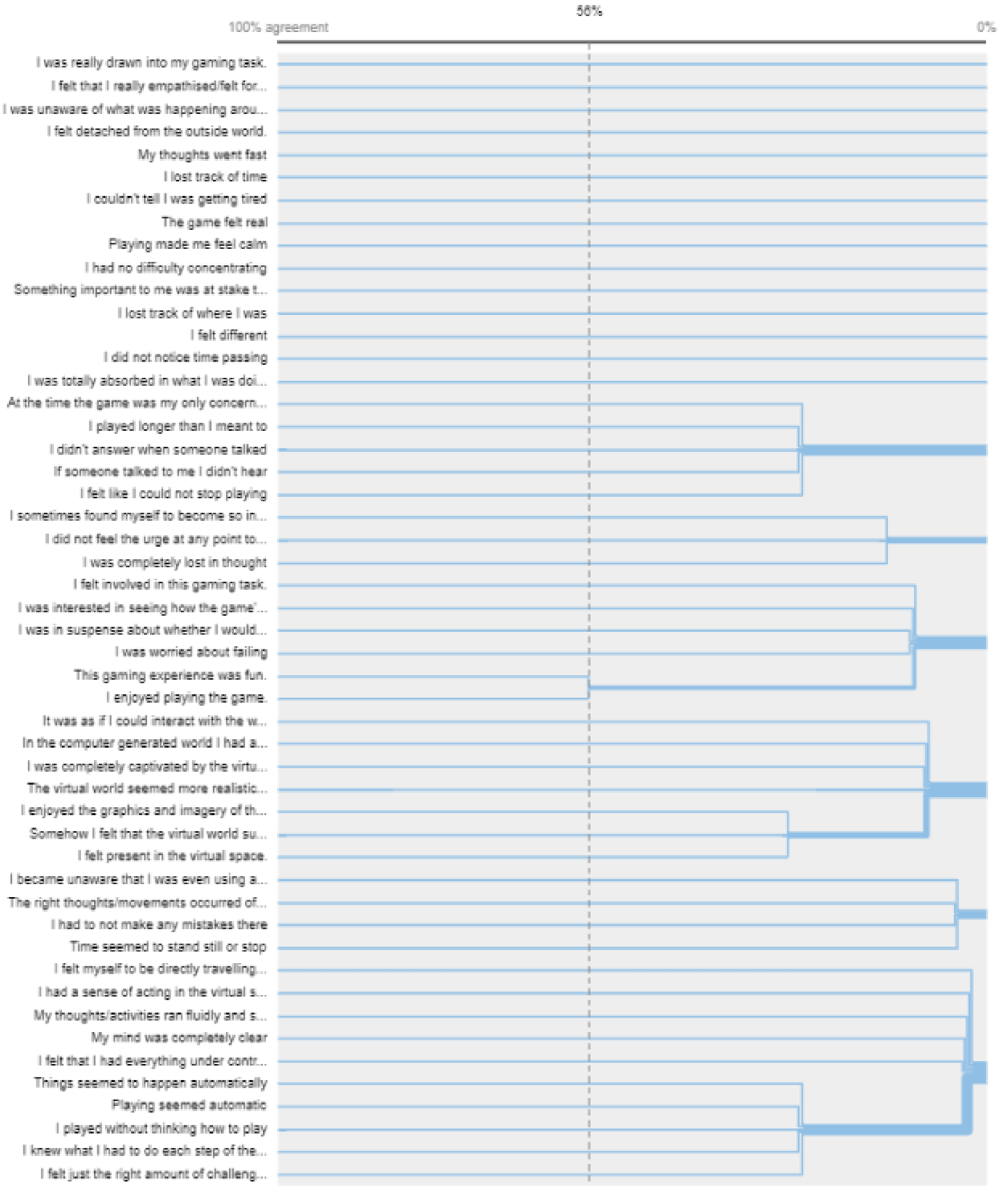

Figure 6.1: Dendrogram from card sorting study.

The second cluster with a 26% agreement consisted of items “Things seem to happen automatically”, “Playing seemed automatic”, “I played without thinking how to play” (GEngQ), “I knew what I had to do each step of the game”, “I felt just the right amount of challenge” (FSC). This agreement is mostly made under the category “Flow”.

6.2 Participant-centric Analysis

Participant-centric analysis (PCA) treats each participant's submission as a "vote" for a certain way of categorising items, than compares it to all other submission in order to find the most "voted" information architecture. Interestingly, the most agreed-upon way of categorising items in this study only had three categories instead of five - "absorption", "flow", "immersion" (see figure 6.2 for reference).

Figure 6.2: PCA results.

6.3 Similarity Matrix

A similarity matrix shows how many participants agree with each pairing of two items, highlighting clusters of related items. Figure 6.3 illustrates this (the darker the colour, the higher the percentage of participants who grouped the items together).

Four main clusters can be identified as the darker blue patches in the matrix, from top to bottom:

(i) "Loss of (spatial/temporal/self) awareness"

(ii) "Real versus Virtual"

(iii) "Enjoyment, Anxiety, Felt Involvement"

(iv) "Flow"

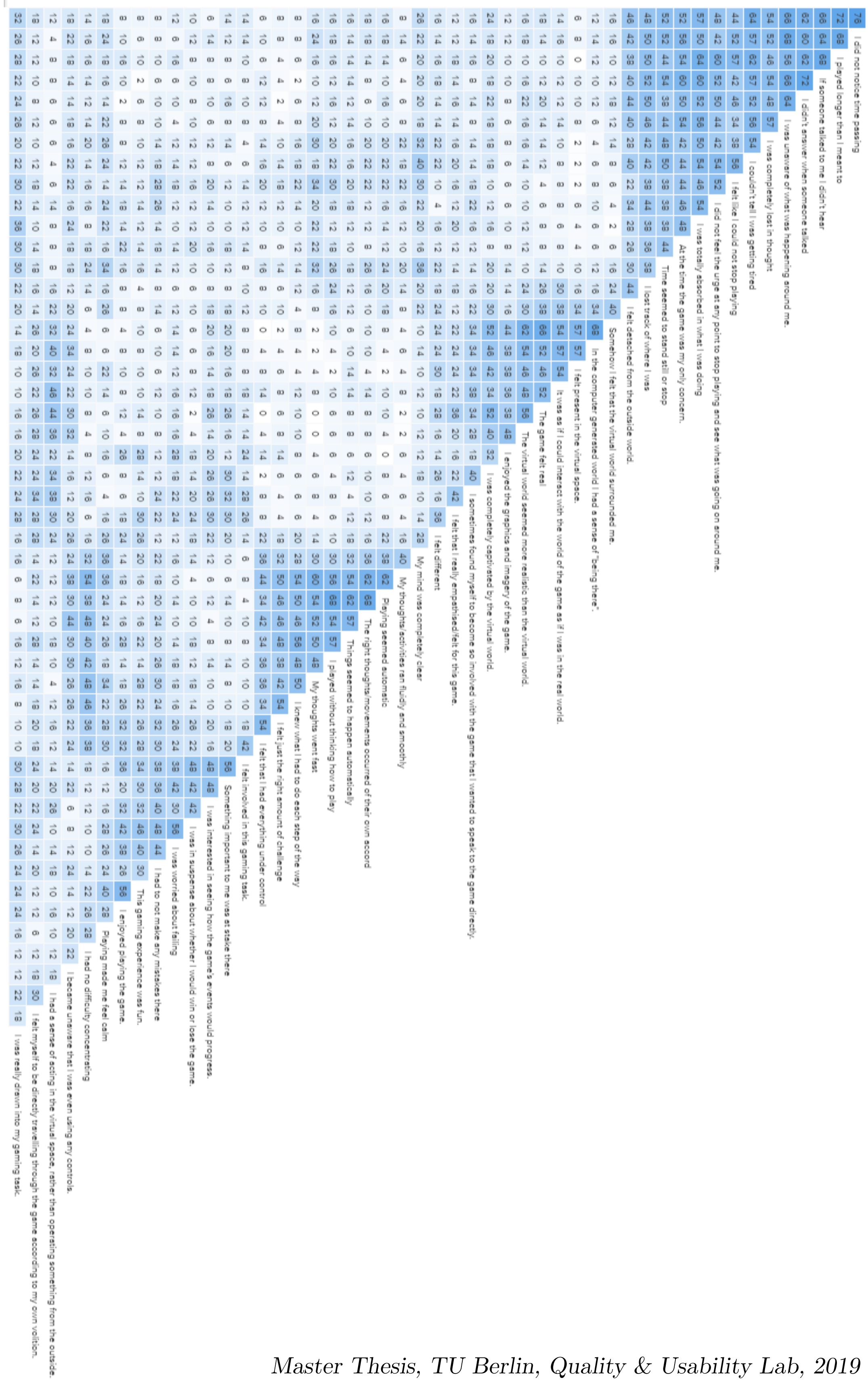

Figure 6.3: Similarity Matrix generated from card sorting study results.

6.4 Standardisation Grid

A standardization grid shows the number of participants that placed a card into a given category, allowing to identify items with high-level agreement (or lack thereof).

6.4.1 Absorption

Name	Absorption
I was totally absorbed in what	39
If someone talked to me I didn	33
I played longer than I meant t	32
I didn't answer when someon	31
I was unaware of what was ha	30
I lost track of time	29
I couldn't tell I was getting tire	29
I was completely lost in thoug	28
I did not notice time passing	27
I did not feel the urge at any p	27
At the time the game was my	25
I felt like I could not stop playi	24

Figure 6.4: Standardisation grid for Absorption.

Unsurprisingly very high correlation with item "I was totally absorbed in what I was doing". More surprisingly, items from the Game Engagement Questionnaire that were expected to correlate to Flow and Presence had instead a high correlation with Absorption ("If someone talked to me I didn't hear", "I played longer than I meant to", "I didn't answer when someone talked".

6.4.2 Flow

Name	Flow
My thoughts/activities ran fluic	35
Playing seemed automatic	33
I knew what I had to do each :	32
I felt just the right amount of c	32
The right thoughts/movement	31
I played without thinking how	31
Things seemed to happen aul	30
My thoughts went fast	29
I had no difficulty concentratir	25
My mind was completely clea	22
I felt that I had everything und	20
Playing made me feel calm	17

Figure 6.5: Standardisation grid for Flow.

High correlation of almost all items of the Flow-Short Scale (except Anxiety items which are categorised under involvement and “I do not notice time passing” item which is categorised under Absorption). Items “Playing seemed automatic” and “Things seemed to happen automatically” from GEngQ also mostly categorised under Flow.

6.4.3 Involvement

Name	Involvem...
I felt involved in this gaming t	35
I was in suspense about whet	27
Something important to me w	26
I was interested in seeing hov	24
This gaming experience was t	21
I was worried about failing	20
I had to not make any mistake	20
I enjoyed playing the game.	20
I felt that I had everything unc	18
I was really drawn into my gar	17
I sometimes found myself to b	15
I felt that I really empathised/f	13
At the time the game was my	11

Figure 6.6: Standardisation grid for Involvement.

High correlation with Felt Involvement (FI) items as well as with Anxiety items from Flow Short Scale questionnaire, and additionally with a few items from the Immersion Questionnaire by Jennet et al, namely "I was interested in seeing how the game's events would progress" (24) and "I was in suspense about whether I would win or lose the game" (27).

The one item related to involvement (INV) from the iGroup Presence questionnaire was only grouped under "Involvement" 5 times, appearing the most under "Immersion" instead (20 times).

6.4.4 Presence and Immersion

Name	Presence
I felt present in the virtual spa	33
In the computer generated wo	25
Somehow I felt that the virtual	21
It was as if I could interact witl	19
The virtual world seemed mor	18
I enjoyed the graphics and im	16
I felt different	15
The game felt real	13
I was completely captivated b	12
I had a sense of acting in the	12
I sometimes found myself to b	10

Name	Immersion
The game felt real	29
I had a sense of acting in the	26
Somehow I felt that the virtual	24
It was as if I could interact witl	22
The virtual world seemed mor	21
In the computer generated wo	21
I was completely captivated b	20
I felt detached from the outsic	20
I felt that I really empathised/f	18
I felt myself to be directly trav	18
I enjoyed the graphics and im	18

Figure 6.7: Standardisation grids for Presence (left) and Immersion (right).

There wasn't any strong categorisation of any item with either Presence or Immersion according to the participants' mental models, but many items were more-or-less evenly split across the two categories.

Expectedly, "I felt present in the virtual space" was categorised more often under Presence (33 times against 13 for immersion), while items "The game felt real" and "I had a sense of acting in the virtual space, rather than operating something from outsideâ were more prominent under Immersion (respectively 29 and 26 times against 13 and 12 for Presence).

Other items "In the computer generated world I had a sense of being there", "Somehow I felt that the virtual world surrounded me", "The virtual world seemed more realistic than the real world", "It was as if I could interact with the world of the game as if I was in the real world" were split almost evenly.

Interestingly, the expression “sense of being there” was used to describe Presence in the definition provided to the participants during the study, but was still categorised under Immersion by nearly half of the participants.

Item “I felt detached from the outside world”, on the other hand, was often categorised under either Immersion (20 times) or Absorption (16 times), but less often under Presence (9 times).

7 Conclusion

The objective of this thesis work was to uncover aspects defining the QoE and UX of gaming, motivated by the need for a more comprehensive understanding of those factors that affect and are used to evaluate player experiences. Different methodologies adopted from the field of UX research were applied: a grounded theory approach was devised to investigate people's mental models and attitudes towards gaming, with insights collected by means of semi-structured interviews and think aloud gaming sessions, and backed by existing literature in the fields of gaming and HCI; a hybrid card-sorting technique was then used in a different study to assess the understanding of popular game UX questionnaire items by participants.

The outcome of the first study draws a complex picture of gaming characterised by individual and contextual differences in the way people experience games. While this makes drawing general conclusions difficult, it is in line with existing models and literature on gaming QoE. Responses from this study clearly show that idiosyncratic characteristics of the players, including their intrinsic motivations, goals, preferences and attitudes cannot be ignored when evaluating gaming experiences.

Results from the second study support the idea that better defined and less overlapping definitions and questionnaire items may be needed to better assess gaming QoE by means of self-reporting, and that the industry may benefit from shorter questionnaire. Of all the items assessed, only those belonging to the Flow-Short-Scale were consistently sorted by the participants into the respective category. Future work should also address how to distinctly assess Presence and Immersion, making sure that the participant understanding of the concept is in line with what the researcher is trying to investigate.

One possible question raising from this is if quantitative measures based on self-assessment can be a reliable and/or sufficient source of data to evaluate gaming experiences. As it is impossible to model the experience of gaming without taking into consideration the player, it is advised that future researchers in both the realms of service quality and user experience may benefit from using human-centred research methodologies and from complementing quantitative data with more in-depth qualitative insights about their participants.

List of Acronyms

HCI	Human-Computer Interaction
UX	User Experience
QoE	Quality of Experience
UCD	User-Centred Design
GEQ	Game Experience Questionnaire
GEngQ	Game Engagement Questionnaire
PENS	Player Experience of Need Satisfaction

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Annex

Study Briefing - Quality of Experience of Gaming

The aim of this study is to collect insights and opinions on your perceived Quality of Experience (QoE) in relation to videogames. Quality of Experience (QoE) is defined as *"the degree of delight or annoyance of the user of an application or service. It results from the fulfilment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user's personality and current state"*. Please acknowledge that there are no right nor wrong answers and you are not being evaluated in any way, we are merely interested in knowing your point of view. This session will last approximately 60 minutes and will be audio recorded. All the data will be anonymised and only kept for the duration and purpose of this research study. You may withdraw your participation at any time during or after the study, without providing any reason, and with no repercussions. Should you have any questions after the study, you can reach me at p.romeo@campus.tu-berlin.de.

Consent of the participant

I have read the information about the study "Quality of Experience of Gaming" and I am ready to participate in the study. I have been informed that the following data are collected: recording of your voice and the answers to a questionnaire. I agree that all data gets stored and used anonymously for scientific analysis. All information I provide in this study will be kept confidential. All information is used for scientific purposes only. Personal data will not be passed on to third parties. I am aware that the participation is voluntary and I can revoke it at any time without giving reasons, without any disadvantage to me.

In addition, I also know that everything I've seen and heard during today's experiment is confidential, and I declare that I will not share that information.

Name: ______________________________

Date: ______________________________

Signature: ______________________________

INTERVIEW SCHEDULE

Checklist

Before the interview

- ❏ Inform the participant that the interview is meant to explore their experiences and thoughts during the experimental session. Let them know that there are no right nor wrong answers and you are merely interested in their point of view.
- ❏ Tell the participant the session will last approximately 60 minutes.
- ❏ Ask the participant whether they agree to have their interview session recorded. Make sure to record the whole interview.

During the interview

- ❏ Do **not** change the wording or order of the interview questions. If the participant does not understand a question, be cautious when providing clarifications as to not influence the participant's answer.
- ❏ Do not interrupt the participant. You may keep the conversation up by backchanneling, i.e. by nodding and mumbling "mhm", "uh-huh", etc., occasionally. Otherwise, stay as passive as possible.
- ❏ If the participant already answered a question at a deeper level of the question tree while answering a question at a higher level of the tree (i.e. if a participant's previous answer anticipated a subsequent question) you may skip the deeper level question after confirming that the participant does not want to add any additional information to their answer.

After the interview

- ❏ Briefly summarise each of the answers provided by the participant. This is both to ensure that you understood the participant correctly and to provide them with a chance to correct you and clarify vague answers.
- ❏ Make participant fill out the post-study questionnaire.
- ❏ Thank your participant for their contribution and ask them if they have any final questions before dismissing the session.

Interview Script - Quality of Experience of Gaming

Questions in light gray are potential follow up questions.

Part I. General Introduction

- Please describe your own experience with computer games.
- What types of games do you play?
- Would you consider yourself a “gamer”?

- Why do you play videogames?

Part II. Gaming Experience

- Based on the definition of Quality of Experience that was provided to you, how would you describe QoE in relation to videogames?

- When you are playing a game, how can you know that you are having a positive experience?
- What characteristics do you look for in a video game?
- What do you think makes the gaming experience better in a game compared to other games?

- What types of gaming devices do you use?
- For each of these devices, how does your gaming experience differ?

- What are characteristics of each device do you think may affect the gaming experience?
- Consider characteristics of the input device - e.g. the controller
- Consider characteristics of the output device - e.g. the screen
- How important are video quality and audio quality for each device?

Part III. Cloud Gaming

Please consider the following definition of cloud gaming:

  - *Provide participant with written definition*

- What are your thoughts on cloud gaming?
- What types of cloud games would you play?

- What do you think may be issues with cloud gaming?

- What do you think may affect the gaming experience when playing a cloud game?

Part IV. Network Degradation

The next part of the study aims at investigating the effect of network degradations on cloud gaming. In order to give you a sense of how these may affect the gaming experience, you will now be asked to play a simple game under five different simulated network conditions. For each of them, please describe your gaming experience. Try to be as vocal as possible and express your thoughts as you play. In particular, please focus on describing your own feelings while playing the game rather than the game itself.

In this game, you control a round-shaped character. Your objective is to avoid all square obstacles in order to increase your score. You can make your character jump by pressing either the space bar or upward directional arrow.

- *Make participant play without degradation*
- *Make participant play with degradation 1 (250ms delay)*
- *Make participant play with degradation 2 (25% control packet loss)*
- *Make participant play with degradation 3 (15 fps)*
- *Make participant play with degradation 4 (all of the above)*

- In general, how did these different network conditions affect your gaming experience?
- How was the *playability* of the game affected for you?
- How was the *enjoyability* of the game affected for you?

Assume that you were playing your favourite game of choice under these conditions. How would your experience be affected?

- Consider different gaming devices that you own. For each of them, to what extent do you think the gaming experience may be affected by different network conditions?

In the following part of the study you will be shown three examples of games you may be familiar with: **NieR:Automata**, a single-player action role-playing game; **League of Legends**, a multiplayer action real-time strategy game; and **Hearthstone**, an online collectible card game that can be played as either single- or multiplayer.

- *Show reference videos without degradation (**explain basics of gameplay**)*

Hearthstone is a turn-based game in which you duel an opponent using a deck of collectible cards, the opponent can be either the computer or another player.

League of Legends is an online multiplayer game in which you create a character and have it compete against other teams of players.
NieR: Automata is an offline single-player game in which you follow the story of 2B, an android created by survivors in a post-apocalyptic world to battle the machine lifeforms that have invaded the planet.

For each of the three games, you will now be shown three examples of network degradation that could occur during cloud gaming. For each of them, please describe how you think that the gaming experience may be affected. In particular, please focus on how do you think these degradations may affect your own feelings while playing the game rather than on the video quality itself.

- *Show videos for Degradation 1 (Blockiness)*
- *Show videos for Degradation 2 (Jerkiness)*
- *Show videos for Degradation 4 (Low Packet Loss)*

- In general, to what extent do you think the aforementioned types of network degradation affect the quality of experience in cloud gaming?
- Would you still be able to enjoy playing games under these conditions?
- How did you think the each of the three games was affected compared to the others?

- Consider different gaming devices that you own. For each of them, to what extent do you think the gaming experience may be affected by different network conditions?

- *Recap participant responses*

- *Give post-gaming questionnaire: https://pietro50.typeform.com/to/lYmruq*

- *Fill out payment form*

- *Debrief and give incentive*