Understanding and Evaluating Cooperative Video Games

by

Bardia Aghabeigi

Bsc. Iran University of Science and Technology, 2006

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

School of Interactive Arts and Technology

SIMON FRASER UNIVERSITY
Spring 2011

APPROVAL

Name: **Bardia Aghabeigi**

Degree: **Master of Science**

Title of Thesis: **Understanding and Evaluating Cooperative Video Games**

Examining Committee:

Chair: ______________________________

Dr. Marek Hatala
Associate Professor,
School of Interactive Arts & Technology

____

Dr. Magy Seif El-Nasr
Senior Supervisor
Assistant Professor,
School of Interactive Arts & Technology

____

Dr. Thecla Schiphorst
Supervisor
Associate Professor,
School of Interactive Arts & Technology

____

Dr. Kate Hennessy
External Examiner
Assistant Professor,
School of Interactive Arts & Technology

Date Defended/Approved: February 21, 2011

SIMON FRASER UNIVERSITY
LIBRARY

Declaration of Partial Copyright Licence

SFU SIMON FRASER UNIVERSITY
THINKING OF THE WORLD

STATEMENT OF ETHICS APPROVAL

The author, whose name appears on the title page of this work, has obtained, for the research described in this work, either:

(a) Human research ethics approval from the Simon Fraser University Office of Research Ethics,

or

(b) Advance approval of the animal care protocol from the University Animal Care Committee of Simon Fraser University;

or has conducted the research

(c) as a co-investigator, collaborator or research assistant in a research project approved in advance,

or

(d) as a member of a course approved in advance for minimal risk human research, by the Office of Research Ethics.

A copy of the approval letter has been filed at the Theses Office of the University Library at the time of submission of this thesis or project.

The original application for approval and letter of approval are filed with the relevant offices. Inquiries may be directed to those authorities.

Simon Fraser University Library
Simon Fraser University
Burnaby, BC, Canada

Abstract

Cooperative design has been an integral part of many digital and table top games since their inception. With the recent success of games like Resident Evil 5 and *Left4dead*, many video game designers and producers are currently exploring the addition of cooperative patterns within their games. In this thesis, I present two contributions. First, I present a set of cooperative design patterns. This framework can be used by game designers to add co-op content in their games. Second, I present a set of validated performance metrics that can be used to gauge the users' experience in a cooperative game. In this study, we developed the performance metrics. I then applied them to evaluate four commercial cooperative games. I further validated these metrics through a qualitative content analysis method where I investigated the relationship between the metrics derived by our study and the metrics derived by game reviewers.

Keywords: Game Metrics; Game Design Patterns; Expert Game Reviews; Cooperative Games; Game Playability Testing

Table of Contents

List of Figures

List of Tables

Work Credit:

In this section, before I start the thesis topic, and go over different chapters, I would like to appreciate everybody who helped me in this project and work. Also, I should mention that this work was done based on a bigger research study supported by Bardel Entertainment Inc, MITACS Corporation, and EMIIE lab at Simon Fraser University, and several researchers have been involved in this research. In this page, I will credit those people who have been involved in this thesis.

Dr.Magy Seif El-Nasr from Simon Fraser University: She supervised whole the procedure, and spent a lot of time for development of ideas, and designing of experiments.

Dr. Thecla Schiphorst from Simon Fraser University: She supervised part of validation study design, and spent a considerable amount of time for brainstorming on triangulation methods and qualitative analysis.

David Milam from EMIIE lab: He helped in experiment design, analyzing games as a game user expert, running the experiment, and validation of results.

Mona Erfani from EMIIE lab: She helped in experiment design, analyzing games as a game user expert, running the experiment, and validation of results.

Beth Aileen Lameman from EMIIE lab: She helped in experiment design, appointment setting, interviewing in experiments.

Hamid Maygoli (independent researcher): He helped by giving psychology feedback on players' behaviors, and interviewing in experiments.

Sang Mah from *Bardel Entertainment*: She supported the research by providing space and contacts.

Andrew Pope from *SunShower* Games Inc: He helped in analyzing games from a design perspective.

Andrew Osborne from *SunShower* Games Inc: He helped in analyzing games from a design perspective.

Drew Batcheller from Simon Fraser University: He helped with literature review, playing and analyzing co-op games, and validation of methods.

Definitions:

Game Metrics:
Behavioral evaluation is commonly based on the collection of quantitative ***telemetry data*** about player-game interaction, which are subsequently extracted from logs or databases, and refined or analyzed into game-play parameters named metric**s** [2]. Any action the player takes while playing can potentially be recorded and stored, from low-level data such as button presses to in-game interaction data on movement, behavior etc.

Game Design Patterns:
We use the word pattern here to mean a specific set of design choices concerning rules or mechanics which can be applied to solve similar design challenges or problems. This should not be confused with the term patterns used in software development to denote a software design pattern. As this is a quite different concept.

Expert Game Reviews:
The professional reviews of commercial games that investigate and rate games from different perspectives such as character, game world, social aspect, combat, performance, graphic, sound and so forth.

Cooperative Games:
Cooperative games emphasize participation, challenge, and fun rather than defeating someone. Cooperative games emphasize play rather than competition. Cooperative games are not new. Some of the classic games we participated in as children are classic cooperative games because of the play emphasis. There may be competition involved, but the outcome of the competition is not losing and sitting out the rest of the game. Instead, it may involve switching teams so that everyone ends up on the winning team [3].

Game Playability Testing:
Play testing is defined as in-house, formal observation of temporary consumer testers. The author suggests finding testers familiar with the genre of the game being developed and performing the evaluation at a time when bugs have been fixed, but the game is not too far into development to be changed significantly. During play testing, the ratio of monitors to testers should not be less than one-to-one, and monitors should be noting places where the players get stuck, questions they have, subjective comments, and emotional reactions they have while playing the game, such as boredom or frustration.[4]

Chapter 1. Introduction and Research Questions

It was not until around the 1960s that the first digital games started to appear on the market. The first titles were *Spacewar* (Steve Russel 1962), *Computer Space* (Nolan Bushnel 1970), *Tennis for two* (Ralph Baer 1966), and *Pong* (Attari 1972). Entertainment was the main purpose of these games. While digital games did not emerge until the 1960s, board and physical games and play long existed before digital games. The very first documented game was *Senet* developed by the Ancient Egyptians (3100 BC). According to [5], this game was found in pre-dynastic and first dynasty burials of Egypt. The game was composed of a board with a grid of thirty squares and two sets of pawns. Each player should move the pawns based on their shape or color inside the grid. The player who gets all the pawns off the board is the winner. As one can see, the very first game developed or known to mankind, is a game developed to be played with two players. This enforces the importance of the social component of games and play.

While games have existed for thousands of years, games were mainly seen as a source of entertainment. It is not until recently that games have started to emerge as a form of serious play for training, health, and educational applications. This movement to use games for training or education has stimulated a growing number of publications in different fields, such as urban simulations (city structures and etc), and army simulations, flight training programs, education, to mention a few [6]. This situates games as important objects of study and development academically and intellectually.

The game industry is becoming a multi-billion dollar industry [7]. Numerous websites currently exist publishing articles discussing video games' business as well as development. These sites include *GameSpot* (*www.**gamespot**.com*), *Gamasutra* (*www.**gamasutra**.com*), and *GDC-Vault* (*www.**gdc**conf.com*). Additionally, in the recent years we see more young generation game players who play regularly and frequently. "According to reports in Time Magazine, and The LA Times, 90% of U.S. households with children have rented or owned a video or computer game, and young people in United States spend an average of 20 minutes per day playing video games. And this makes digital games the second most popular form of entertainment after television [7]." All these facts combined show that video games are creating a new culture and an emergent medium that has a large impact on millions of households within North America and beyond. Therefore, it is important for researchers to study and develop tools and techniques to enhance these products.

Since its inception, the game industry has very quickly grew as a new media and creative form resulting in many video games with various different topics, subjects, and styles [8]. Game genres have emerged [8], including: Action, Strategy, Role Playing Games (RPGs), Sports, Vehicle Simulation, Real-Time Strategy (RTS), Adventure, Puzzle, Platformer, and Online [8]. Games also vary in terms of the number of players, including multiplayer, single player, or Massively Multi-player online (MMO).

In this thesis, I focus on cooperative games, called Co-Op for short. Cooperative games are usually played in a small group of 2-4 players. These games can be played online or within the same space. Co-op games encourage and promote collaborative game-play, where players play together within the same group. The goal is not to win as a player but as a team of players. This kind of games is starting to gain more attention in the industry, this can be observed through the many new game releases which include a Co-op play mode as a feature, including *Resident Evil 5* (Capcom, 2008) and *Left4dead* (Valve, 2008). In addition, there have been numerous industry talks and articles on this topic, including [9-14][15],[16].

Cooperative games use both synchronous and asynchronous methods to encourage cooperation. Further, synchronous cooperative games are two kinds: some require players to share the same physical space, e.g., *Little Big Planet* (Sony Computer Entertainment Europe - 2008); others provide online Co-op, such as the *Halo Series* (Microsoft Game Studio – Bungie 2001 to 2010). In this thesis, I specifically concentrate on synchronous cooperative games that can be experienced in the same space. I believe there are many advantages to this kind of games both at the social and educational levels that make them worthy for academic study. This is specifically important since these kinds of games have been understudied.

Sharing a common physical space while playing a game can lead or encourage a variety of different game-play and social interactions; this, in my view, will inevitably add to the social value of these games [17]. This is important to note considering the common belief that video games are thought of as a medium which isolates players from the realistic world. Additionally, co-operative games can have a potentially high educational value. By cooperating within a game environment, players can learn group problem solving techniques. For example, collaboratively solving spatial puzzles in a platformer game may allow players to better understand how to solve similar puzzles in other domains. In addition to the social and educational value, co-op games are also popular and have a high entertainment value. Results from a background questionnaire with 60 kids, 6-16 years old, revealed that kids like and appreciate seeing games with more cooperative content [3]. When asked to choose between cooperative and competitive games, 55% of them preferred cooperative games. 77% of them stated that they would like to play games that embed both cooperative and competitive patterns.

While cooperative games have such entertainment, social and educational value, they are hard to make and are not very well studied. As one designer put it, "it is hard to make a good cooperative game. It doesn't always work [personal communication]." While there has been a lot of research on game design in the past, including several conferences and journals devoted to this subject, e.g. [18-23], cooperative game design received very little attention. I know of only very few researchers who have studied co-op games. Among these few research efforts, Zagal et al. discussed co-op design patterns [17]. Also, Bjork [24] devoted a chapter in his book to the discussion of design techniques for social interaction, and a small part of this chapter discussed cooperative game design. These previous works create the foundation for the work done within co-op games. However, previous work has several limitations: (a) they did not address cooperative mechanics or most recent mechanics that exist in current commercial video games, and (b) they did not develop a technique to assess or evaluate the co-op game designs. In terms of the first limitation, both Rocha et al. and Bjork et al.'s works concentrated on the introduction of mutual goal as a principle which can encourage cooperative game-play. They, however, they did not introduce advanced techniques, which have been used to implement this principle. In this thesis, I will introduce several game design techniques that have recently been used to promote co-op strategies. This will contribute a set of mechanics that can be used by other games to promote co-op play. In addition, in this thesis, I will propose a metric based approach to evaluating co-op games that can be used by others to evaluate the co-op aspects of the game play.

Therefore, in this thesis I attempt to address the limitation of the previous works on co-op games by investigating co-operative game design patterns and devise a method to evaluate them. In particular, my research questions are:

1. What are the different existing cooperative techniques used in current video game played with multiple players in the same space?
2. Can we develop and validate a method for evaluating cooperative games, specifically multiplayer games that are played in the same space?

This research was done in several stages. In the first stage, I concentrated on developing the cooperative design patterns. Previous work, in particular [25], have identified several cooperative design patterns, but are limited as they did not investigate new techniques and patterns that have manifested in new multi-player co-operative games. In an effort to extend this work, I conducted a qualitative study to extract cooperative patterns from games that can be played in a multiplayer co-op mode within the same space. This study was conducted in several play sessions, where I used MDA framework [26] to analyze game mechanics. I ran these sessions with three different game experts including two indie game designers, and a professional game player with experience in game testing. In these play sessions, I either played with or observed the experts, and we vocalized the mechanics that we see working, and I took notes of those utterances. Based on these play sessions, I developed a set of cooperative design patterns. This is the first contribution of this thesis.

In the second stage, I focused on developing a set of performance metrics to evaluate the effectiveness of the cooperative patterns. I collaborated with a group of experts from the EMIIE lab at Simon Fraser University. We[1], as a group, conducted some play testing sessions with four cooperative video games, which exploited a considerable combination of explored cooperative design patterns. From these sessions, we developed an initial list of metrics which were revised and validated through user experience expert interviews and a research team review process. Generally, this process was iterative in nature.

The third stage focused on using the performance metrics to gauge the user experience within cooperative games. In this phase, we conducted a comprehensive user study on four cooperative video games, selected from previous phase including *Rockband 2*, *Lego Star Wars*, *Kameo*, and *Little Big Planet*. These studies were all videotaped. We also recorded observation notes, survey and interview answers. For my thesis, I took the metrics developed in the second phase and revised them through applying them as a video coding model on all play sessions. The outcome of this phase is twofold: (a) I developed connections between cooperative performance metrics and the cooperative design patterns identified in the first stage, and (b) I developed a revised set of performance metrics that was applied as a video coding method; this method was also tested for reliability through inter-rater agreement. These two outcomes comprise the second and third contribution of the thesis.

The fourth, and last, stage focused on validating the performance metrics defined in the third stage of this research. To validate these metrics, I triangulated several data

[1] I will use the word ‘We’ for the work that was done collaboratively and the word ‘I’ for the work that was done alone.

sources, including post-questionnaires used after each study session, game reviews done by experts or passionate gamers. I selected the latter one as a reliable source. I used content analysis, where I collected all expressions which describe the cooperative experience, or aspects of fun or frustration. I then numerically quantified this data into a set of parameters defined as percentages of cooperative metrics perceived by the community of game experts and players. I correlated metrics discussed in the reviews to the ones I defined in order to find how meaningful and important the metric system is. I used this process to validate the metrics defined within this thesis.

Structure for the Thesis

The thesis is composed of several chapters which delve deeper into the research, methodology and findings.

Chapter 1: Introduction.

Chapter 2: Related Works. This chapter will discuss the related works. It goes over game research fields in two main categories including game design lessons and game evaluation methods. In the former, I will discuss traditional game design techniques and methods developed by professional game designers and researchers. I will also discuss game design patterns that evolved from qualitative and quantitative user studies. In the latter section, I will discuss evaluation approaches, such as traditional play testing methods, psychology measurements, heuristic evaluation, telemetry and metric based system, along with some hybrid methods that have been employed by the industry and academic communities.

Chapter 3: Research Questions and Process. This chapter will explain the research process that I developed to answer the research questions posed above. I will not discuss the research methods in detail as they will be discussed in subsequent chapters. However, I will discuss them briefly to give the reader an understanding of the overall process.

Chapter 4: Developing Cooperative Game Design Patterns. This chapter describes the first stage of the research. In particular, in this chapter, I will discuss the co-operative game design patterns as well as the methods I developed and performed to identify these patterns.

Chapter 5: Evaluating Cooperative User Experiences. In this chapter, I will elaborate on the performance metrics developed, and how they were applied to video code and analyze interactions within four commercial co-op games to produce a measure of effectiveness of the cooperative game design.

Chapter 6: Validation of Cooperative Evaluation Method. This chapter explains the validation process that I developed and performed to validate both the game design patterns discussed in chapter 4 and the performance metrics discussed in chapter 5.

Chapter 7: Discussion and Application. In this chapter, I will discuss the contributions of the thesis and elaborate on several foreseen applications of the work. I will also discuss several directions for future work.

Chapter 2. Related Work

In this chapter, I will review previous works within the game research field. Game research is a growing field of research with contributions in many different areas and directions. A complete review of the game research literature is beyond the scope of this thesis, instead I chose to concentrate on areas related to my work, which specifically clusters around: game design lessons or patterns and game evaluation methods.

2.1. Game Design Lessons or Patterns

During the last couple of decades, game designers, similar to designers in other fields, have spent a considerable amount of time analyzing and investigating different video games and traditional board games, to extract different design ideas, which can be used for new products, or can be changed and evolved for creation of new concepts and genres. Some of these lessons are based on experience or anecdotal evidence from gameplay sessions with designers. For example the lessons and models introduced by Doug Church, and Mark LeBlanc are great examples of this category [27]. Others concentrated on deriving these design lessons from actual empirical studies, which included using hybrid techniques such as qualitative observation, quantitative methods and grounded theory to extract the design options which promote the gameplay [29-31].

2.1.1. Experienced Designers discussing their design patterns

Doug Church introduced a design language which can help designers to better understand each others' works, and communicate clearly and constructively [27]. He called the language a "Formal Abstract Design Tool[27]". It constitutes a clear discussion of video game design techniques, which are abstracted from several games and can be applied as design patterns in different games. This concept is very close to design patterns, which I use in this thesis, but his approach is an abstract model and thus may not be used directly to solve a design problem.

Church investigated the *Mario 64* (Nintendo 1996) game extracting two formal abstract tools: intention and perceivable consequence. The former refers to designing game levels and missions by giving players the ability to plan ahead while considering different game style options. The latter examines the design of feedback systems that can allow players to predict the impact of their actions while planning to solve a problem, accomplish a task, or encounter a combat. This work was very inspiring to my work. I was inspired by this work, and how a qualitative critique of video games can help to extract design principles. Even though his approach is abstract and does not present practical design solutions for existing problems, it presents an interesting way to analyze games qualitatively. In contrast, my work, which will be described in next chapters, is more focused on Cooperative games and introducing design solutions which meet the design problems, emerged among game community for creating better products.

Another significant work is Marc LeBlanc's MDA (Mechanics, Dynamics Aesthetics) framework, which can be used to analyze or design games [26]. He uses this framework to better understand games based on a cause and effect model. He considers rules and game code as mechanics which can create dynamic behavior based on user input, and interpreted that as game dynamic. He explains that game dynamics can create different kinds of fun and enjoyment, which he defined as Aesthetics. He discusses eight kinds of fun or aesthetics, including: sensation, fantasy, narrative, challenge, fellowship, discovery, expression, and submission. He argues that designers should define their goals based on the aesthetics of the experience they want to develop, and try to adjust the mechanics to achieve the desired aesthetics [26]. In my view, this systematic approach can be used either to improve a design or analyze a game design component. Using this model for analysis, one can extract the game mechanics which is correlated to a dynamic that then causes the aesthetics (fun experience) in the game. I used this systematic approach as a tool in my research to extract cooperative game mechanics and dynamics, which will be discussed in a later chapter. One of the aesthetics he defined –fellowship– is one of the important elements of fun based on the MDA model. In this thesis, I categorize mechanics which magnify fellowship and social aspect of cooperative games, and generalize those categories as a set of patterns.

2.1.2. User Study extracted these Design Patterns

The last section explored approaches to game design lessons based on critique or reflection. In this section, I discuss related works that extracted design lessons based on user studies.

One such work is Carlo Fabricatore's work [28]. Fabricatore developed a comprehensive qualitative study using 39 action video games. His goal was to investigate, which elements of game-play are important from a player point of view, and how designers can make better decisions when taking users' preferences into account. He ran several play sessions over the 39 selected action/adventure games with 54 male participants. During these studies, he took observational notes and used post play questionnaires to gauge participants' experience. He then applied a grounded theory method of analysis to extract explicit and implicit game concepts from participants' game-play observation notes and questionnaires. He categorized the concepts and developed a hierarchal qualitative design lessons for action games elements and categories. For example, he categorized the action game elements to three high level groups including: 1. entity, 2. scenario, and 3. hierarchy of goals, in which, for instance, entity refers to set of non-player controlled, or variable-attitude objects, which might have a friendly or hostile behavior against player protagonist. Then he extracted some other sub-groups and specified the group relations based on users' explicit or implicit statements in post interviews, e.g., Identity, Energy and Equipment categories as children of the Entity group. Finally, he devised design lessons based on user explicit or implicit suggestions and preferences for each category. For instance, he devised a very applicable design guideline for the identity group which is a child of the entity group. He made this guideline based on user comments about this fact that they need to be able to recognize their friends in games. He, thus, created a design technique that recommends designers to prepare the entities in such a way that players can easily understand whether they are friendly, hostile, or neutral to player's protagonist [29]. This approach inspired me to categorize the design mechanics of cooperative games with similar properties as a set of design patterns. Additionally, in this approach, design lessons have been built based on gamers post session interviews, and limited to player experiences and sentences they explained, while in my approach, I benefited from the comments and focus group analysis with indie game designers who can criticize games and extract design techniques more efficiently than users. I used professional gamer experience in my studies as well. Furthermore, the design recommendations, which he developed, are based on players' preferences and were not tested or validated in current commercial titles. It is, therefore, hard to predict the level of success for recommended patterns, especially due to limitations of his participant pool in terms of number, sex, and age groups.

In addition, David Milam et al. [30] investigated the question of level design. In particular, he investigated several 3D action/adventure video games, including *BioShock* (Irrational Games 2007), *Fear* (Monolith Productions 2006), *Lost* (Ubisoft 2008), *Medal of Honor* (Electronic Arts 2004-2008). Using participant behavior data extracted through video coding as well as interviews from game designers, he extracted five 3D level design patterns: 1. Path Movement and Resistance, "which is the general narrative goal for the player to continue through a linear mission/quest [30]," 2. Pursue AI, that is "Incentive to move around the level in response to friendly or hostile characters [30]," 3. Path Target, which is "orienting and directing player movements or attention toward visible targets in the level [30]," 4. Collection, that "incentivizes and rewards items placed around the level [30]," and 5. Player is vulnerable, which means that they can die that represents a danger to the players' safety [30]. He validated these patterns with game designers. Unfortunately, as I was working concurrently on my studies and since his work was just recently published, I could not benefit from the methods used or lessons deduced; also, it was almost impossible to have access to game designers who made the co-op games.

2.2. Methods for Game User Studies & Evaluation

In addition to design lessons and patterns, my thesis looks at testing and evaluation methodologies for co-op games. Thus, I review here work that has been done to date on game usability or evaluation techniques.

Testing and usability evaluation is an integral part of any software development process. A video game can be considered an interactive software system, where engagement and fun are important factors in comparison with other software systems. Applying usability evaluation and software testing methods with some adaptations is necessary for video games.

There are many methods that exist for usability and user testing within the Human Computer Interaction community [31]. Many of these methods have to be adapted to evaluate and test games, thus accommodating measurements for engagement and fun [32]. Game evaluation and testing methods have been researched in the past. Isbister [33] and Bernhaupt [34] have compiled two edited books to discuss methods that are currently used by practitioners and researchers for evaluating games. These methods borrow from the wide variety of methods developed within psychology, sociology, and human computer interaction, including qualitative methods: surveys, interviews, observations, and ethnography, and quantitative methods, In addition to these methods, game researchers have also developed several new methods including game logging or telemetry, which include the low level data of game-play such as events and triggers, as well as triangulation techniques that triangulate data from different measurement sources [35]. In this section, I discuss these methods in detail.

2.2.1. Heuristics

Usability inspection methods have the ability to improve design process, in contrary with play testing methods, they don't need player involvement and rely on master evaluators who investigate the game interface and dynamics, and figure out the usability pitfalls. So they are inexpensive and can be done in shorter amount of time. Also, inspections can be applied iteratively during the design process [36]. But most of recent developed usability techniques are not suitable for games, as they have quite different design procedure and considerations. For example, usability techniques, such as cognitive walkthrough [37], pluralistic walkthrough [38], and task analysis [39], are mostly based on this fact that people will accomplish determined tasks in an application, while the concept of task sequence is not applicable in video games, as people can play games in different ways, and some games consider randomness and unpredictability of actions as a main element in their design [36].

For example, Nielson developed his heuristics primarily for desktop applications [40]. They refer to common user-interface cases, such as dialogs, redo, undo, and error prevention. However many of these ideas have limited meaning in the game context, and does not cover important concepts such as camera angles, control mapping, and etc. [36].

On the contrary, heuristic evaluation has the potential of being a powerful tool for game evaluation as it gives a good flexibility to game evaluators in inspection process. Heuristic experts will look openly at interface and other aspects of game mechanics or dynamics while searching for cases which do not conform to a set of usability principles named game heuristics [36]. However, developing a comprehensive heuristic set and validating it is a big challenge in application of this method.

In addition to Nielson's work, Federoff et al [4] did an interesting literature and survey review of different game usability heuristics including Nielson's, Crawford's, Shelly's, and Clanton's works [41-43][44]. She then developed and validated a combined framework built based on the aforementioned works using a case study approach which was not very comprehensive. She conducted a study by inspecting and observing five people in a game development company; she spent one day with each person, observed their works, and designs closely, while asking them to think loudly. Then she asked each person a series of questions about usability issues. She verified some of the identified heuristics from previous works, and identified some new heuristics for game interface, story, and play [4]. Even though this work showed the importance of using heuristic methods in prototype development, it is a starting point for introducing different heuristics for different game genres and elements. Another point about this work is its inability to captivate the players' performance. This is an instinct problem of heuristic evaluation which neglects users and only concentrates on experts. I used the concept of expert knowledge from this work in this thesis, but I concentrated on an approach in evaluation that can acquire player experience and quantify that to compare and evaluate different games.

2.2.2. Play Testing

Play testing is a traditional approach for usability testing of video games, in which a game designer is involved throughout the entire design process to understand how players experience the game, and its final goal is to acquire useful feedback from players to improve the game. This can be very effective in so many cases where the companies cannot afford to employ experts to evaluate their games using more advanced quantitative systems such as metrics, video encoding techniques, and so forth [45][7][46].

There are three different play testing methods commonly accepted in the game community, including: 1. Think-Aloud, 2. Focus Group testing, and 3. Naturalistic Observation technique [45]. I will describe each technique in more detail in this section and elaborate on the advantages and disadvantages of each. Also, it should be mentioned that, Bill Fulton categorized these methods into Usability, Surveys, and Focus group testing [46]. While the methods themselves are not very different, his categorization is.

Using a Think-Aloud protocol, a game player is asked to sit down and play a video game, while a user experience researcher, or designer, is present in nearby to listen and observe player actions. The player is given a set of instructions about how to play the game, such as exploring some specific sections of game, or using some specific features, and etc. She will then be asked to say out loud what she is thinking as she takes actions or makes decisions within the game. This mechanism allows the user experience researcher to collect both player actions, and their thoughts while making these decisions. This process will be repeated several times to get different players perspectives on game. [45-46].

The advantage of this approach can be summarized into three important factors. First, the team members can understand what the players are thinking about different areas of a given game, and especially those segments that cause problems within the game session. Second, this process is well designed with an iterative development process, and “research has shown that, this method has worked out in more than 75 percent of the cases for solving design problems, while using at least a group of five people for play sessions [45].” Finally, this approach allows other game development team members to see firsthand the problems and bugs in the game, which is really important to fix [45].

This method also has several disadvantages. For example, not everybody can talk aloud while playing games, and this can cause the frustration for uncooperative players. In addition, as this technique is not a natural way that people play games, and thus, can cause some problems. For example, people can mention some secondary reasons for their actions, while the main cause of action remains neglected [45].

In a focus group technique, designers and other team members get together as a small group of potential players, and discuss their opinions on the design of interface elements, game-play mechanics and dynamics, and narrative. Usually, a moderator compiles a list of questions which should be answered based on initial brainstorming sessions. She asks different members to openly discuss each game feature and question, and explain their perspectives and reasons. This process is done mostly for development of prototypes in pre-production cycle [45].

There are some pros and cons for this technique as well. For example, having multiple ideas and minds speaking about one topic is better than one. Thus, using this technique a lot of ideas can be generated. Also, the sessions can be video recorded for producers [45], so that they can get a good feedback of their team members feeling about game features, rather than reading long and time consuming reports of each session. In contrast, there are some negative points. Focus groups rely on having a good moderator who can listen to everybody, and lead discussions appropriately. Also, in some cases multiple minds can be easily led with one person who has a strong view, and explains his comments loudly [45].

Finally, in a Naturalistic observation method, which is a special observation method borrowed from social science field, the design members, observe players while they are playing either some similar games or their initial versions in a natural environment, such as game clubs, game centers and tournaments, and etc. In these sessions design members try to derive solutions to their design problems through observing how players react or interact with other games and take notes on how other games solve similar design problems. The good point about this method is in its setting. A lab setting can impose some distractions and stress on players. In a naturalistic setting these distractions can be avoided, and a lot good information can be potentially collected. However, it will be very hard for designers to capture what players are thinking while taking different decisions. This method is widely used in pre-production stage [45].

I should mention that, mostly game user experience groups, mix these approaches with some survey questionnaires which try to collect some background information of players, such as age, sex, game favors, game genres, and so forth. In some cases, they apply some post interviews to capture the general perceptions and perspectives of players either about their games or similar rival titles.

There are different variations on these research methods which have been developed and customized with game companies for specific game problems. Some of these methods have been presented in books and online articles [33][47], while others are private research known only to specific game companies. Exploring all these methods is outside of scope of this thesis.

2.2.3. Telemetry and Metrics, Visualization

In this sub-section, I will describe some quantitative methods and related works, which concentrated on game metrics and telemetry data, and will enumerate how these different techniques can be applied to measure the effectiveness of game-play behaviors.

Nowadays, evaluation of players' actions and behaviors inside gameplay, is commonly done on ***telemetry** data*—a set of quantitative data representing player and game interactions acquired from game log files and databases [48]. A set of gameplay metrics [49],[50] is developed based on this data. Any event caused by the player can be saved, from low-level data, such as interface interactions, to in-game interaction information on locomotion. From this telemetry data, game user experience experts can formulate ***Game metrics***. For example log-in can be tracked as a metric which represent the number of times player logs in and out [48]. Mellon [51] categorized game metrics into three types: "1) **Player metrics** (in-game behavior, player interaction with different components of the game systems, community behavior, and customer service evaluation); 2) **Performance metrics** (e.g. server stability, monitoring changing features) and: 3) **Process metrics** (e.g. turnaround times of new content, blocks to the development pipeline) [48]." ***Gameplay metrics*** are a subset of player metrics, which are quantitative parameters showing how well players have dealt with game elements and objects [48].

Another work on metrics is the work by Swain [52]. He presented metric based methods to assist game-play improvement and promotion, such as using heat maps to record and visually analyze player experience. Some of these techniques are also discussed in industry reports [53],[54], and can be collected from personal communication with game developers [48].

Other researchers have also explored the development of computer science data analysis methods, such as data mining, to help develop patterns from tracked player behaviors. For example, Kennerly [54] applied standard data mining algorithms, and adapted them to the specific context of games, to fine tune in-game economies and catch cheating players [48]. Within the MMOG domain, Duchenaut & Moore [9] used recording of player social actions which happen on servers in *Star Wars Galaxies* (Sony Entertainments 2003) to locate patterns of interaction and how they have been impacted by the game system. The results were a series of design guidelines to promote social activities in MMOGs [48].

In addition, Lazzaro and Mellon described the use of game-play metrics as indicators of player fun (experience) in digital games, e.g. recording the regular interaction events or what players spent their game money on in *The Sims Online* (Maxis 2002). They found that increasing the complexity of features in digital games can improve player motivations for paying more money on virtual items [48].

2.2.4. Physiological measurements

In another interesting work, Regan Mandryk describes two experiments designed to test the application of physiological measures as an evaluation method of user experience within video games [55]. She could find evidence that there is a different physiological emotional response in players sensor signals when playing against a computer versus playing against another human player while he selected NHL game (Electronic Arts 1991-2011) as her test case [55]. In addition, she provides guidelines for collecting physiological data for user experience analysis, which were informed by her empirical investigations [55].

2.2.5. Hybrid

Further, some researchers developed tools that track and visualize this data. Microsoft developed an online tracking system, named *TRUE* (Tracking real-time user experience) [56], to collect and visualize gameplay metrics and synchronize them with other data, including attitudinal behavior and observational data [56]. This enabled them to "detect issues and understand root causes in the same way usability testing does [56]." They validated their system within two games: *Halo 2* (Bungie Studio 2004) and *Shadowrun* (FASA Interactive 2005). Borner and Penumarthy presented one of the very first attempts to visualize several virtual world (*Active Worlds*) metrics, including user trails and chat analysis, allowing better visualization of group behaviors within virtual worlds [58]. Thawonmas and Iizuka developed a visualization method to cluster players based on the similarity of their actions using CMDS (Classical multi-dimensional scaling) and Key-graphs [59]. More specifically, some researchers attempted to visualize players' strategies within a popular first person game, called *Return to Castle Wolfenstein: Enemy Territory* (Splash Damage 2003) [48]. They built a system that uses overlays on top of the game screens to allow spectators to visually track abstract information, such as areas of activity and distribution of players over time. Also, Chittaro et al. developed a visualization technique called *VU-Flow*, which aimed to provide a method to visually highlight interesting navigation behaviors for single or groups of players within a virtual world [48].

Few studies concentrated on defining methods for evaluating engagement and enjoyment of games. Sweetser and Wyeth developed a model called GameFlow [60] based on Flow [61] to address this issue. The model consisted of a set of qualitative criteria for measuring eight specific elements of a game: concentration, challenge, skills, control, clear goals, feedback, immersion, and social. They validated the model by evaluating two commercial games and comparing their results to that of expert reviews. Yannakakis and Hallam [62] explored the development of a quantitative experimental model specifically targeting simple arcade and augmented reality games. They concentrated on challenge as a main aspect of engagement.

In this thesis, I specifically propose a set of validated Cooperative Performance Metrics CPMs for analyzing and evaluating cooperative play occurring within the same space. Furthermore, I will specifically explore the development of methods for measuring cooperative performance while considering both social and game-play interactions happening in the shared physical space, and we specially concentrated on metric based system platforms which can track players' performances in a quantitative way, so we will be able to compare the games based on those measures values.

2.3. Cooperative Game Design Patterns

There are few research works that explored cooperative games. For example, Zagal et al. looked at cooperative patterns within board games [17]. Also, Bjork and Holopainen [24] present a large number of game design patterns and discuss an example set of patterns that included social interaction ones. They developed a framework, for design, analysis, and comparison of games based on game design pattern. They used different techniques for developing design patterns and their validation, including structural analysis, play testing sessions, interviews for collecting and harvesting patterns, and expert interviews and holding workshops, and online media that makes the patterns accessible to industry people and academia, and their feedback can be applied to refine and validate the compiled list of patterns. Also, they categorized these patterns to different groups, including: actions, events, narrative, social interaction, immersion, goals and etc. then they divided each group to some sub-categories, and between these new sub-groups, the collaboration branch has a close relationship with our work. According to their work, the easiest way to achieve cooperation is using team-play mechanics, such as playing in a campaign mode in a shooting game, or the same team group, in a sport genre [24]. Also, they believe that the equivalent level of cooperation can be approached by introducing "Mutual Goals" with "Shared Rewards" to players [24].

In this thesis, I extended the work of Rocha et al. [1] and I will discuss the main reasons in chapter 4. They identified six cooperative game patterns:

- *Complementarity*: is one of the most commonly used patterns in co-operative games. It basically implies that players play different character roles to complement each other's activities within the game. Most game developers define character roles and abilities to enable this pattern [1].
- *Synergies between abilities*: is another pattern that allows one character type to assist or change the abilities of another character type. For example, in *World of Warcraft* (Blizzard 2001), a shadow priest (who deals mostly shadow damage) can cause an enemy to become more vulnerable to shadow damage, which also causes an increase of damage that the warlocks (another character type played by another player) cause [1].
- *Abilities that can only be used on another player*: is another pattern that can be seen in *Team Fortress 2* (Valve 2007), where medics have weapons that allow them to heal other players, which directly helps other players. [1]

- *Shared Goals*: is a simple pattern used to force players to work together. One example is the quest structure in *World of Warcraft* (Blizzard Entertainment 2001), where a group of players are given a single quest with one goal [1].
- *Synergies between goals*: is a pattern that forces players to co-operate together through synchronized goals. A recent example of this pattern is the achievement system developed for the *Pyro* and *Medic* character classes within *Team Fortress 2*. One of the *Pyro*'s goals is to kill three enemies while ubercharged (being made invulnerable by a *Medic*). The *Medic*, on the other hand, has a different goal, which is to ubercharge a *Pyro* while the *Pyro* burns five enemies. Such chain of goals allow for synergies between goals.

Rocha et al. then added another pattern category named *special rules* to denote rules that are used to enforce cooperation within teams. For example, designers can encode rules to denote specific effects to actions within the game when performed on a friendly player. The idea behind these differences is to promote and facilitate cooperation. A good example is the rule in FPS (First Person Shooter) games that prevents damage when players accidently shoot other players on the same team, known as *Friendly Fire* modes [1].

While Rocha et al.'s work presents a very good start in documenting some cooperative patterns, not all interesting cooperative patterns were documented. In this thesis, I extend this model by adding several patterns we observed based on analysis of twelve cooperative games, and thus I present a more comprehensive set of cooperative design patterns.

Chapter 3. Research Objectives and Process

My main research objectives that guide this master's thesis are:

1. Identifying and developing *cooperative design techniques* that exist within video games played by 2 or more people in the same physical space
2. Developing and validating a method for evaluating cooperative games, specifically multiplayer games that are played in the same physical space

This research was developed through two stages. I used a combination of methods to address these objectives. I will discuss these methods within this chapter. The overall view of research objectives, data sources, and methods applied for achieving those targets are depicted in table 3.1.

Table 3.1. Relationship between Objectives and Methods

Objective	Source Data	Method	Outcome
1) Design Patterns	▪ Existing Frameworks ▪ Cooperative games	▪ Close Reading (initial Set) ▪ Close Play & Reflection (Final set)	▪ Set of Design Patterns for creating Co-op Content
2) Evaluation Method	▪ User Study Sessions video files, observation notes	▪ Video Encoding, Metric definition	▪ Evaluation method including Metric definitions and video encoding technique.

For targeting the first research objective, I, in collaboration with other colleagues in Simon Fraser University, devised a qualitative study over existing design literatures and frameworks, and successful commercial games. Then I used close reading and close play approaches to select and develop a set of design guidelines, which can benefit designers working on co-op games. The details of this process will be described in the next section.

In the second study, we conducted a user study with over 60 participants, and observed their social and game-play behaviors while interacting with each other. I then developed a set of qualitative and quantitative metrics which can be measured through a validated video encoding technique to gauge the player performance and experience. Finally, I used the metric system as a measurement tool for comparing commercial games with each other. I will elaborate on this process on section 3.2.

3.1. Goal 1: Identifying Cooperative Game Design Patterns

This particular research idea started within a project in collaboration with an interactive virtual world Company called *Bardel Entertainment*. Bardel Entertainment was interested in developing cooperative games for kids, specifically engaging kids in a cooperative play within the same space. I was one of the researchers who were asked to engage in an investigation to identify and develop a set of cooperative game patterns.

This stage of the research was divided into four phases. Phase 1 involved an extensive literature review of the subject of cooperative games. Phase 2 involved two sub-phases: (a) close reading session done by two researchers on 12 co-op games. The 12 games were selected based on a review of a total of 215 titles that included co-op in one way or another. We only selected games that exhibit cooperation and collaboration rather than competitive play. Subsequently, (b) I also conducted my own play session that used a method similar to close reading to analyze game mechanics used in several current co-op games. I then integrated the co-op patterns that resulted from these two sub-phases. Phase 3 involved a validation process where I asked game designers, who are not involved in the project, to confirm the integrated patterns from phases 2a and 2b. Phase 4 was done after the second stage of this research project, as shown in figure 3.1. In this phase, I verified the patterns through a content analysis method where I qualitatively reviewed what expert and non-expert game reviews say in their online reviews about the game mechanics at play, then matched these to the game design patterns developed.

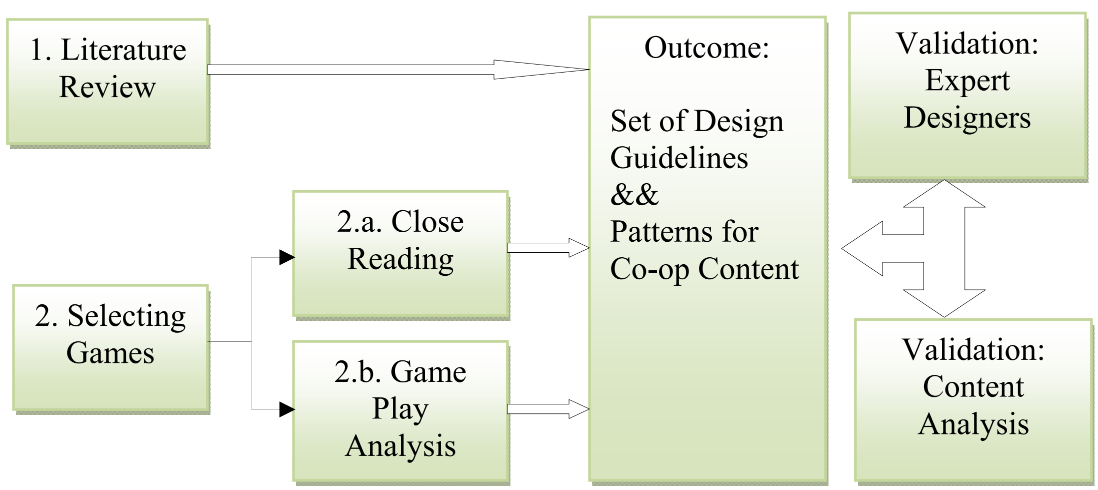

Figure 3.1. the general overview of design framework development process.

The methods used within these phases are different. Phase 2a involved two researchers closely reading 12 games and extracting some patterns based on previous research on video games design pattern [26][27], which point out the multiplayer design choices. In phase 2b, I repeated the same process while two game designers played those games and talked about the game mechanics at play loudly; I asked them to concentrate on cooperative design techniques. This phase resulted in some cooperative game design patterns. These were then used as catalysts to my own study to extend and verify the patterns in phase 3.

The objective of phase 4 is to validate the cooperative patterns extracted and primarily verified with expert game designers in phase 3 using a qualitative research method. This was done through a qualitative content analysis method, where I coded 36 expert and non-expert online reviews and then matched the coded text from the reviews to the patterns extracted in the previous phases. I then generated a list of verified patterns. This process and methods will be discussed in more detail in subsequent chapters.

Next I elaborate on the second goal of the thesis, and the steps I took to reach it.

3.2. Goal 2: Developing an Evaluation Method for Testing Effectiveness of Cooperative Patterns

Evaluating games can be achieved using different techniques which were reviewed in Chapter 2. One particular approach which I used within this thesis is a mixed method approach for defining effective quantitative metrics that can measure players' performances in a systematic and objective way. Using these measures I can then develop a model mapping the metrics to design patterns used in video games. Thus, my research within this goal constitutes two phases. Phase 1 is the development of metrics for measuring players' performances. Phase 2 constitutes developing a validity measure for the metrics by triangulating the metric values with online design reviews. For these two phases, I used different research methods.

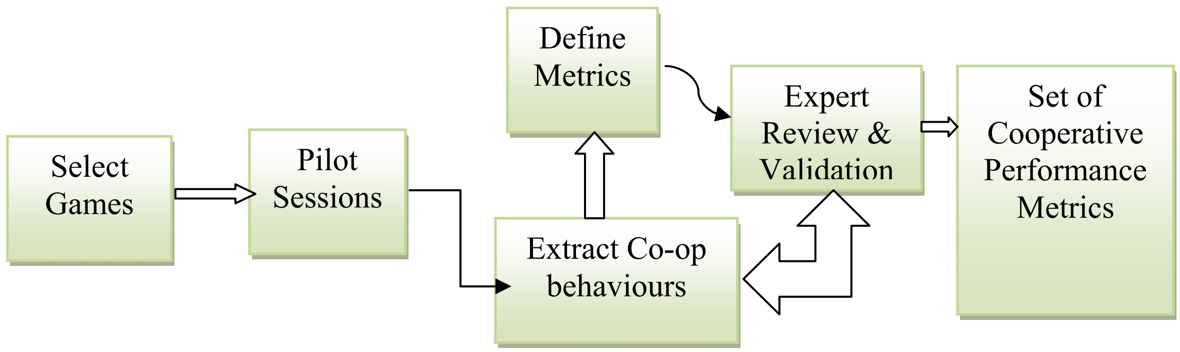

Figure 3.2. the general overview of metric development process.

The main challenge of this objective is developing a comprehensive and objective set of metrics that can summarize and cover players' performance and signify their enjoyment or frustration experiences while playing in a cooperative mode. I, in collaboration with a team of researchers from EMIIE lab (as discussed earlier), used several methods to develop and validate these metrics. The process is shown in figure 3.2. After selecting the games, we conducted some pilot studies over four Co-op games, and observed different game-play and social interactions emerged while kids playing those games. Based on our observations, we then developed a list of metrics, and defined each metric using a qualitative description of events that fit in that metric category. In next step we asked a team of experts to verify the compiled metrics and add their observation as well. To measure players' performance while playing cooperative games, we defined game metrics that consider both social aspect of these games and game play ones, and defined these metrics in such a way that can be measured from participant observation. Also, we considered the cause of each event or metric to see which design pattern or other source led to that behavior. We ran two pilot studies with 3 kids each. Using these two studies, in a team of 6 researchers, we developed several metrics through an iterative process that can be viewed in the above diagram. In each iteration, we extracted a list of social and game-play behaviors observed from players during sessions or through video files, then we categorized those behaviors based on their similarity to different groups and categories. Then we started to define the main features and characteristics of each category in a qualitative way. Next we sent those behavior categories and their definitions for some game HCI experts to validate and add their own notes. Finally we used the acquired metric list for categorizing the next iteration session, so that we can differentiate between behaviors which are emerging and those were recognized in previous iteration.

I then defined a method for objectively video coding these metrics within the play sessions. I went through several iterations to develop a training set for metrics coding; in the process refining the metrics and further defining them. I then did an inter-rater reliability test in order to validate the video encoding process and ensure reliability. We then conducted a user study with four co-op games (named earlier). We ran over 60 kids ages 8-12 in groups of 2-3 per session, resulting in 23 sessions. I applied the developed set of metrics on the 23 sessions to measure cooperative behavior of players identifying events with the specific metrics qualities identified. I also identified the cause of each event. As a result of this phase, I compared selected games based on values measured by metrics, to compare their cooperative contents. I used the causes' results between metrics and design patterns to depict and infer the relationship of design choices and their impact on cooperative performance. Finally, I finished my experiments by triangulation the user study results and matching them with users' and experts' perspectives presented through their own reviews. For this phase, I selected only two of four studied games and matched their results with qualitative expressions of online users or experts. More details will be discussed in Chapter Six. Additionally, I will describe the development of these metrics and validation methods in detail in Chapter 5.

Blank page
Notice inserted by SFU Library

Chapter 4. Developing Cooperative Game Design Patterns

Chapter 3 overviewed the methods I used to derive the cooperative design patterns. In this chapter, I will discuss in detail the findings and cooperative game patterns I defined. The overall process can be viewed in figure 4.1.

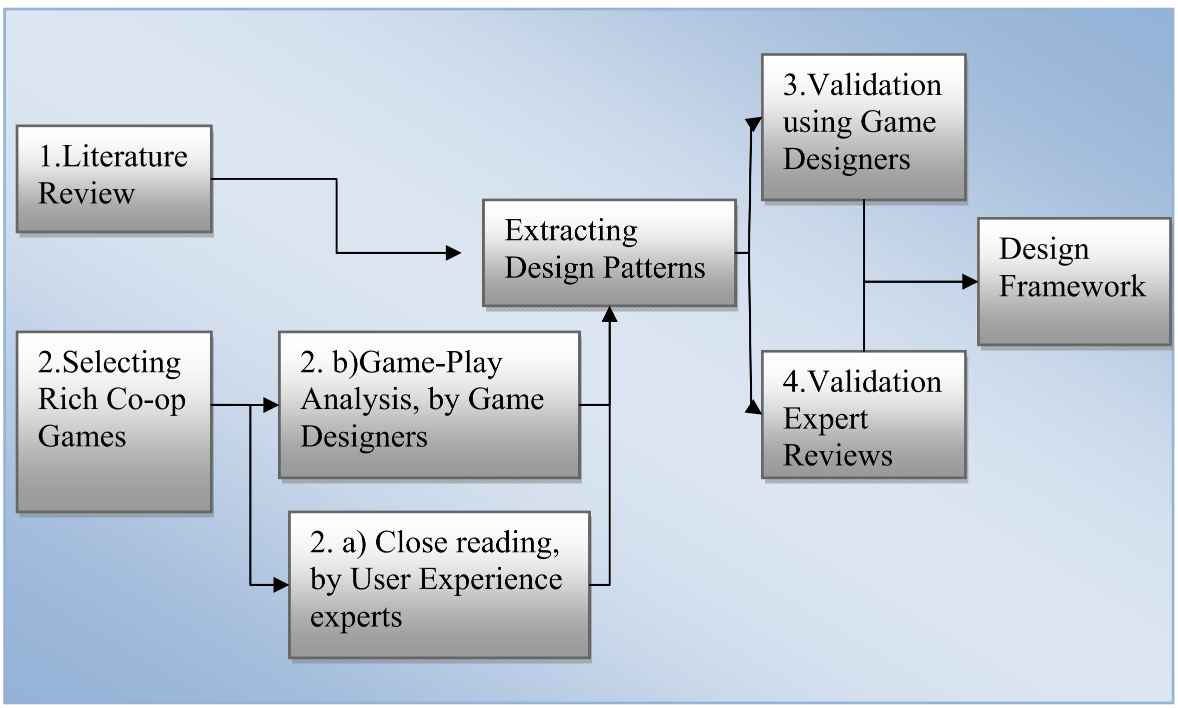

Figure 4.1. The overall process of conduction of design framework.

Towards the goal of developing a list of good game design patterns, I reviewed previous work. This work is all reviewed in Chapter 2. In literature review, I explored two main methods for extracting design patterns. These methods are both discussed in

Bjork et al.'s book [24]. These methods are (1) *Structural Analysis* and (2) *Play Testing*. Structural analysis is a method, where I analyze game structures based on game community reviews and common knowledge. This method can be used without playing games as it uses other designers' reviews or game ideas which have been spread inside the community. Play Testing method is a process by which game mechanics are extracted through a play session, where one or more researchers play a game. The session is normally recorded and notes are taken on the specific aspects reviewed about the game.

There are advantages and disadvantages to both methods. The play testing method is more time consuming as it requires an entire play session which might need playing whole the game. It is also problematic for some games, as some parts of the game may not be played at all due to the non-linear nature of some games. In the contrary, the structural analysis gives the power of using other game community experts in our method, but this also can limit the domain of our investigation to available studies, and reviews.

We finally selected the play testing approach and conducted two variations of it, including: 1. close reading by HCI researchers, 2. game-play analysis by game designers. Instead of using casual players in our test sessions, I invited game researchers, and game designers to play games and criticize them loudly while I observed their game-play. I will elaborate on these methods in next coming sections.

Next I will describe the steps depicted in figure 4.1 in more detail.

4.1. Selecting the games for the *playtesting* sessions

My initial research resulted in a total of 215 PC and video games that had a multiplayer component. I filtered these games to a manageable set by looking at those games that ranked highly in experts' votes. I checked games reviews and rankings, in gaming websites such as *GameSpot.com* and *GameRanking.com.* I kept games that rated greater than 8 out of 10.

After this initial review, I selected fourteen games for deeper analysis that included cooperative modes; these were: *Left4Dead* (Valve 2008), *Resident Evil 5* (Capcom 2009), *Beautiful Katamari* (Namco Bandai 2007), *Kameo: The Elements of Power*, *Lego Star Wars*, *Wall-E* (THQ 2008), *Cloning Clyde* (Microsoft 2006), *Rock Band II* (Electronic Arts 2008), *Harry Potter and the Goblet of Fire* (Electronic Arts 2005), *Kung Fu Panda* (Activision 2008), *Little Big Planet, Boom Blox* (Electronic Arts 2008), *Mario Galaxy* (Nintendo 2007), *and Army of Two* (Electronic Arts 2008). I then extracted design patterns using these 14 games.

4.2. The Play-testing procedure (Game-Play Analysis)

In this section, I will discuss two separate studies which I conducted with the help of two indie game designers named Andrew Pope, and Andrew Osborne, with collaboration of an expert game tester named Drew Batcheller on all the aforementioned games.

I asked two indie Game Designers to play the 14 selected games. I conducted 14 sessions. I asked each game designer to use a think aloud technique and elaborate on design paradigms that he sees significant while playing. They played the game together. I observed their utterance and behaviors. I asked them to stop each game after 20 minutes. I then interviewed them about different concepts ranging from, mission's goals, reward systems, camera movement, collaborative puzzle design, the multi-player experience, graphics, sound effects, and etc. In fact, we used MDA framework [26], discussed in related work, as a strong base for extracting game dynamics which led to fellowship, and cooperative aspect of game. Then, I asked the designers, to investigate those game dynamics, and find the corresponding game mechanics which caused them to emerge. This process was done in a focus group testing to analyze design options. Then, we summarized and generalized the extracted mechanics as design patterns for each game.

In this paragraph, I will describe the process of finding a design pattern sample in *Lego Star Wars* game, using this method. While these two designers were playing a level in the mentioned game, one of them used a special character named *Jar-Jar* inside the gameplay by switching its own character and replacing with the new one. Then they solved different puzzle problems by applying *Jar-Jar* special abilities and supporting of other player in combat moments, as *Jar-Jar* lacked combat mechanics. This process created a very interesting cooperative experience inside that level, which caused the designers to talk about that loudly several times. In the post interview, they mentioned this dynamic as a significant system in cooperative experience. We then did a focus group test to extract design mechanics behind this dynamic. As a result, we figured out, that providing a third character, which has some specific capabilities, can be considered a good design mechanic, and this character type need to complement other player abilities. Also players need to be able to switch to this character arbitrarily and replace an AI with their own main character. We finally generalized this technique as the *Shared Character* design pattern with following features:

- Providing a third character with special abilities for solving the problems
- Mechanic of switching to this character for either of players in both directions.
- Replacing the switched character control with an AI which follows the players.

They then played each game for one hour. We had three discussions for each game. After each game I compiled a list of my observations and their interview answers for the three interviews or discussions conducted for each game. I then asked them to take a look at game mechanics in each section which cause the cooperative dynamics and experiences, and generalize them as design patterns using a focus group discussion method. In this process, I joined the designers' group, and brainstormed about different possible design techniques which can lead to those experiences, and then we formulated them, as discussed in the example.

I did the same process for every game. Based on this data I then developed a list of extracted patterns for all games which were unique in comparison with other previous works discussed in Chapter 2.

Also, in parallel, but not at the same time, I asked a passionate gamer named Drew Batcheller to play all those games with me, and use the same technique of thinking aloud about his experience inside the game. I then compiled a list of patterns which I observed from his game-play, and asked him to verify as well. The purpose of the second study was to ensure the fact that I will explore the most significant part of each game, while playing with a hard core gamer, who can explain his experience very well. Thus, we can overcome the aforementioned problems with play test method, such as not exploring enough experiences, or reporting secondary reasons for each experience.

Table 4.1 depicts this study protocol, along the people being involved, and total time being spent.

Table 4.1. Game-Play analysis protocol for extracting design patterns

Time/Session	People involved	Instruments used
28 hours/ 28 sessions	Andrew Pope, and Andrew Osborne from *SunShower games* Inc. Drew Batcheller, a professional tester, with test experience in *Electronic Arts*.	MDA framework, as an analysis tool for extracting game mechanics and patterns for cooperative experience [26]

The analysis process took two months to complete.

4.3. Close-reading by User Experience Experts

During this time, two colleagues in Simon Fraser University, namely Mona Erfani, and David Milam, who are game user experience researchers, analyzed each game in detail using game design theory and previous work on cooperative game design. They identified distinct design techniques, including resource sharing, controls (user interface), shared goals and puzzles, and reward structures. They also noted visual design characteristics, such as camera settings. They explored different cooperative design techniques by looking at main game mechanics, and objects, and object relations. They developed a set of design patterns based on this analysis. Then, I compiled a combined list of their findings for each game. Then I refined that list based on the patterns explored in base framework (Rocha et al, see chapter 2) and studies discussed in the previous section. For example in several games, we found a design technique which introduces a mutual goal to players, and encouraged them to achieve that goal while collaborating with each other. Both Rocha et al and Bjorn's work had referred to this technique as *Shared Goal*, so I did not add these findings to my framework as it already exists from base framework (Rocha et al).

I then combined all lists and removed duplications, and made an extended framework that needed to be validated with another external source. The validation process will be discussed in the end of this Chapter. I will explain the design framework in next section discussing some tangible examples

4.4. Findings: The final Set of Patterns

I further extended this framework to include the following patterns that I thought were important but were not discussed by previous work:

- *Camera Setting:* there are three design choices for developing a successful camera in a shared screen co-op games—split screen horizontally or vertically, one character in focus, all characters are in focus (the screen doesn't move unless all characters are near each other).

- *Examples:* we explored these camera techniques while playing with selected games, the *Lego Star Wars* was a good example exploiting camera pattern where all players are in focus, and this fact indeed limits their movements, and encourages them to solve the navigational puzzles in a collaborative way. *Resident Evil 5* and *Left4Dead* are examples of split screen pattern, where the former benefited from a horizontal separation, which uses some special distinctions for each view, and the latter benefited from a vertical split. As these games are action games and need quick combat and reactions, using a split screen paradigm can be considered as a best solution. Limiting players' movement to another players' location, using camera technique, can cause a lot of problems. For example players' reaction time in combat moments can be delayed, and it causes frustration for players to show a quick response. Usually in combat moments, the players need to have a good level of freedom in their movement, so they can change their locations appropriately while fighting with enemy entities. Finally, the *Little Big Planet* is another example which gives the camera focus to one player and makes her the leader of co-op play. This technique was a decent choice for this game, as players need to build and explore together, and having the player role control the camera movement can make the construction phase easier while causing problems solving navigational puzzles, which may lead to death of one player who is following the leader.

- *Interacting with the same object:* providing interactive objects that can be manipulated by characters' abilities. In *Beautiful Katamari,* players share a ball. Similarly, in *Little Big Planet,* both players can push or grab one object together. I identified this pattern while observing *Beautiful Katamari and Little Big Planet* games. The game designers specified a good cooperative experience while pushing and moving the same objects for solving mission goals or puzzles. Then we extracted the main game mechanic for this dynamic which was preparing an interactive object that can be manipulated with the players at the same time, and it can solve mission goals or puzzles in a specific situation or movements of shared object.
- Similar to shared goals is *Shared Puzzles*: this pattern is a general category for all cooperative design puzzles; also discussed in this pattern were observed in games such as *Lego Star Wars* and *Little Big Planet*, where both players encounter a shared challenge or obstacle. We extracted a mechanic which encourages collaborative actions for solving the same puzzles and follows these rules:
    - Providing an obstacle which needs cooperative actions to be taken to overcome
    - needs a sequential or parallel execution of some players' actions
    - needs to encourage the players' attendance in the same game space so that they can benefit the same experience
- *Shared Characters*: providing a shared NPC (Non-Player Character) equipped with special abilities that players can assume. This pattern can be seen in *Lego Star Wars*, where both players have the ability to assume a special character, but only one can.

This enables discussions among players concerning how to share the character. The *Jar-Jar* character is an eminent example of this technique in aforementioned game.

- *Special characters targeting lone wolf*: this pattern focuses on the design of NPC characters that target players who are working alone. In *Left4Dead*, the *Hunter* and *Smoker* are good examples of this pattern. We ran into this pattern while playing *Left4Dead*, and we noticed that, the player who prefers to play alone, and involves herself less in cooperative process, is a potential target of Enemy AI, we verified this finding with one of GDC 2009 conference talk about this game [16].

- *Vocalization*: are patterns that embed automatic vocal expressions on player characters that alert players of different challenging events. It, thus, encourages players to play close together and support each other. We also found this technique in *Left4Dead* as a modern and novel example of cooperative games, which encourage players to fight close each other while they can be alarmed automatically, in the case of any danger by vocal expressions of other players[16].

- *Limited resources*: is concerned with providing a limited number of resources, and thus encourages players to share or exchange resources to reach the same goal. *Resident Evil 5* uses this technique; many examples of this pattern can be seen in board games [6].

Table 4.2 shows example patterns from 8 games.

Table 4.2. Example patterns for eight studied games.

Game	Significant Design Pattern

Mario Galaxy	• Limited resources: the number of stars collected is a shared resource. • Shared Goal: the goal for both players is to gather a certain amount of stars. • Complementarity: the shadow player supports the player controlling Mario.
Resident Evil 5	• Camera Setting: split screen in horizontal mode. • Limited resources: sharing ammo. • Abilities that can only be used on another player: healing the other player. • Shared Puzzles: opening locked doors by solving common puzzles, co-op attacks for defeating strong NPCs, co-op jumping for solving platform puzzles.
Left4Dead	• Vocalization: AI system which control players, play voices which keep other players safe from attacks which they cannot see them directly. • Special characters targeting lone wolf: Smoker and Hunter are good examples of this technique, which mostly attack and hunt players who moves in a far distance in relation to others.

	• Limited Resources: offering a limited number of ammos and guns in the beginning of each level, encourage players to plan their combats ahead, and share their guns with each other • Abilities that can only be used on another player: healing the other player. • Camera Setting: split screen in vertical mode. • Shared Goal: the goal for all players is to survive a mission while solving navigational puzzles.
Lego Star Wars	• Shared Puzzles : there are a series of navigational and obstacle puzzles which need players cooperation to solve, mostly platform puzzles that encourage players to move in an specific order to open some bridges which lead them to next steps. • Camera Settings: Focus on all players, which motivates players to play and move close to each other. • Shared Character: the Jar Jar character which encourages players to take different roles, and support each other play. • Shared Goal: conquering the shared missions, and

	collecting and dividing common gold and reward.
Rock Band II	• Shared Goal: Finishing the Same performance • Complementarity: the players will take roles which complement each others' performances, for example guitar player complements the role of drummer in a performance • Abilities that can only be used on another player: saving a player who has failed. • Synergies between goals: each player needs to finish a separate goal, for example the drummer needs to play his own notes, while the guitarist should do the same, but the performance of former one has impact on performance of the latter, so they should save each other in the case that one of them failed
Little Big Planet	• Camera Setting: Shared screen with focus on one player, which is helpful for construction phase, but makes some confusions for navigation and play phase, as one player might die a lot while the other player is heading in a far distance, and has the main camera focus, and never stops for the other player to reach. • Shared Puzzles: a series of shared obstacles which

	need to be solved in a collaborative process. Shared Goal: passing common missions, and building common structures
Kameo Elements of Power	• Camera: Split screen, vertical mode which is a decent choice as game needs some quick reactions in combats, while confusing for solving navigational problems. • Shared Puzzle: opening obstacles inside tunnels, opening doors which need both player collaboration, moving in ramp platforms which demand player consultation for finding the correct path. • Shared Goal: Conquering common missions.
The Army of Two	• Shared Goal : proceeding in shared missions. • Abilities on each other: healing each other in combat mode • Shared puzzles: in some fights, one player need to play the role of shield holder, while the other one move behind the former one, and attacks enemies. Also, in some other cases one player distracts the enemy, with non-accurate and random shoots and attracts their attention, while the other one can move around and

	conquer enemy from a better situation and angle. • Camera : Split screen and vertical mode.
Halo3	• Shared Goal: passing the same level, and achieving the next one, such as common tunnels which need to be conquered with both of players, and if one dies, passing them is almost impossible. • Interacting with a Shared Object: they use very well designed cars which encourage both players to cooperate, for example one is taking the turret responsibility in back side of the car, while the other drives, and solve the navigational puzzles. • Shared Puzzles: introducing heavy combat moments which only can be solved in a cooperative mode, and encouraging players to strategize first, and then attack the new kind of enemies which are only available in Co-op mode. Also, there are some navigational puzzles which need cooperation of both players, for example, there are some blue force fields, enemy units, erected in front of some heavily protected tunnels mouth, which need to be disabled. So one of the players needs to leave the car, and deactivate those force fields, while the other one is driving toward

	tunnel. • Camera: they use a horizontal split screen camera, as it gives wider angle to players to see different parts of map, as most of combat happens in outdoor maps., also they use a simple circular map, in their HUD system, graphic interface in 2D screen, which represents the players and enemies in color coded dots, which help players to avoid shooting each other, and have a better feeling about each other locational presence. • Special AI for Co-op: they use new kind of AI which is more challenging to conquer, as they have quicker movements, and can fly in some cases, and for heavy combat moment, players need to plan ahead, and support each other otherwise it will be impossible to pass these new AI system which only is available in Co-op mode.

4.5. Validation Procedure

For verification, the patterns were reviewed by an independent researcher, who has over 10 years of game industry experience. He confirmed the patterns and found them tangible and interesting. I developed a validation process through comparing the patterns to what experts or non-experts say about the games in their online reviews. I used several online gaming websites, including *GameSpot*, *GameRanking*, and *Co-optimus (www.co-optimus.com)*, as they are the most used and widely known resource of reviews for the game community. I started to use a pattern matching method. In this method, I looked over online reviews for each game, and tried to find either an explicit or an implicit expression which describes that design mechanic [63] so that I can validate the existence of those patterns based on other experts findings, I used 3 reviews for each game, which was selected from *GameRanking* website, and searched for corresponding expressions for each pattern. This pattern matching process will be discussed more in detail in Chapter 6, as I triangulate all my findings with online expert reviews. The result of the validation process will be described in next section.

4.6. Results of the validation of the identified Cooperative Patterns:

I could find all the patterns within the reviews. Even though some of them were not elaborated clearly and there were only some implicit expressions, there were just enough clues to allow me to find these relations. For example, shared character technique in *Lego Star Wars*, was not discussed in any review. This is due to the fact that this tactic was used in a few levels, and not whole the game, but there were some clues about sharing resources that I could infer the same for shared character, as a shared resource that can be played with any of players.

Chapter 5. Evaluating Cooperative User Experiences

Defining and evaluating cooperative performance is an elusive topic. This is due to the fact that cooperative performance is composed to a set of social and game play behaviors and interactions that happen while people play cooperatively with other people in a both physical and virtual shared environment. Thus, understanding the physical environment and actual play behavior within the virtual environment are both important. Following the methods discussed in Chapter 3, I will discuss the steps and procedures I conducted in order to develop the metrics and video coding system for assessing performance within cooperative games, considering both the players' social and game-play interactions. Also, I will discuss the metrics defined. Furthermore, I will also elaborate on results of applying the metrics within a study of four commercial Cooperative games. As discussed earlier, several researchers at the EMIIE lab helped me in conducting the study and collecting the data. In collaboration with this group I also initially developed the set of performance metrics. I, however, further performed the video coding and further development and refinement of the performance metrics, which I claim as another contribution for this thesis.

5.1. Overview of the process of developing the Cooperative Performance Metrics

The process of developing the Cooperative Performance Metrics (CPM) is illustrated in figure 5.1. In order to develop and test the metrics, we first conducted a pilot. Using this pilot study an initial set of metrics was developed. These metrics then were shown to an expert for feedback and review. Once we got the feedback, we then revised the metrics and applied them to 25 sessions under the main study for this thesis. The main study will be further discussed below.

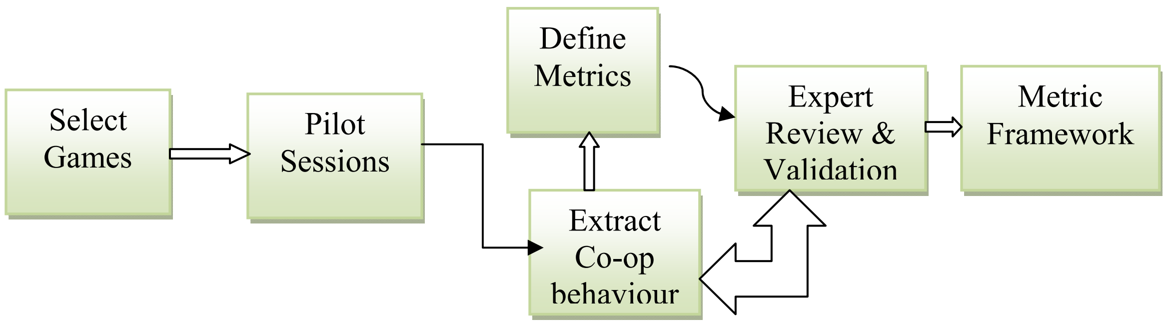

Figure 5.1. The overall process for developing CPM .

Figure 5.2 illustrates the steps I took to apply and in the process validate the CPMs. While the data collection and the initial development of the metrics were done in collaboration with the EMIIE lab colleagues, the process of applying and revising and validating the CPM was solely done by me fulfilling my master's contribution. Figure 5.2 shows the process of applying these metrics. This chapter will discuss in detail the different parts of the process. Here I will just summarize the parts. First, we conducted a study involving 60 kids ages 8-12 who were asked to play 4 different cooperative games. Their play sessions were recorded. We also ran several surveys and interviews with the kids that I used for my analysis. I then took the video recorded sessions and video coded all the events identifying the CPMs. In the process, I had to refine the CPMs to allow for untrained coders to video code any coop play sessions using the CPMs. I then validated the process through an inter-rater reliability measure, where I asked another rater to rate two sessions. I derived the Kappa measure. This allowed me to again refine and measure the reliability of the CPM as a video coding method.

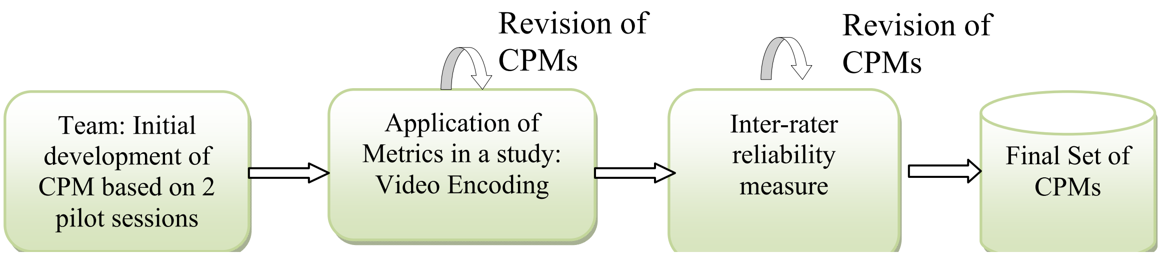

Figure 3.2. The comprehensive study process for evaluation of game.

5.2. The main study – application of the Metrics

5.2.1. The Study

In Spring 2010, we ran a study to investigate how players experience cooperative games that embed these patterns. This project was funded by *MITACS* and *Bardel Entertainment*. *Bardel Entertainments* was looking for some effective design techniques which can be used for online virtual world games targeting the kids between 8-12 years old audience.

We ran a study with a total of 60 participants: 18 females (average age=9.81), 42 male (average age=10.4) in a total of 25 sessions. Participants were recruited through bulletin boards, special contact lists, schools, and organizations, such as the Boys and Girls Club. We invited participants to come in groups of 2-4 participants: friends or family for a 3 hour play session. As they came in, they signed a consent form and were interviewed. The first interview included questions about their background, playing habits, and previous gaming experience. After this initial interview, we asked them to play four games in 10 minute-sessions. The games were chosen based on our previous analysis and their popularity given our target age group (8-12). The selected games were

Rock Band 2, *Lego Star Wars*, *Kameo*, and *Little Big Planet*. These games were discussed in Chapter 4; I will use the following abbreviations to denote the games: *RB*, *LSW*, *K*, and *LBP*, respectively. We selected these mentioned games as they had richer co-op contents and better experts' rankings in online Game ranking websites.

5.2.2. Data Collection

After each play session, participants were interviewed individually to gauge their perceptions on their play experience. For further analysis we videotaped all the play sessions front and back as shown in Figure 5.3. The interview was done by researchers in the EMIIE lab, which have been credited for this work in the beginning of thesis. They asked some background questions before starting each session, then after playing each game, they interviewed kids with specific questions about their experience during game-play (see Appendix A and B). Beth Aileen Lameman, One of the colleagues in EMIIE lab, in collaboration with *Bardel Entertainments* and Simon Fraser, scheduled all these sessions, which was quite an overwhelming task.

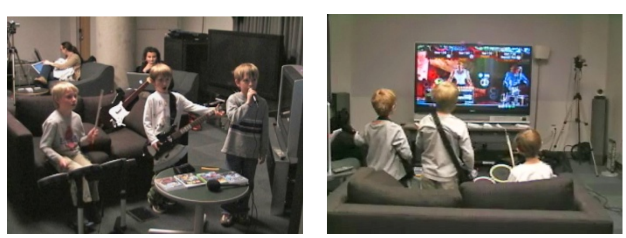

Figure 5.3. Screenshots of participants in a session.

5.2.3. Data Analysis – development and application of the metrics

5.2.3.1. Initial development of the metrics (team collaboration)

In order to analyze the cooperative nature of these games, we defined several metrics: *Cooperative Performance Metrics* (CPMs). These metrics are associated with observable events within a play session, and thus can be used as a basis for video annotation or structured observation of a cooperative play session.

We created these CPMs through an iterative process involving expert and team reviews. The first initial set of metrics was defined based on several play sessions, where researchers played cooperative games and others observed, we also used two sessions of our study, as a pilot to finalize the configurations and development of the metric system by observing the participants' major behaviors and interactions which were occurring in both social and game-play context. These metrics were then reviewed and revised by the team of five researchers involved in this study. The metrics were then used to observe and annotate three pilot cooperative play sessions. The metrics were also sent in parallel to three industry game designers working at *Electronic Arts* and *Square Enix*. Based on their feedback and the results observed from the two pilot sessions, we revised the metrics. In a meeting conducted with the research team, three with previous game industry experience, we discussed the metrics and approved the initial set CPMv1, which was used to video annotate the 25 play sessions.

The initial set of CPMv1 were as follows:

- *Laughter and Excitement Together*: which include moments in the game session, in which both players were excited about the same event.

- *Helping*: in which one player helped the other one either inside the game-play or by guiding through controllers.
- *Got in Each Others' Way*: which covers cases that, players have made different decisions which can lead to a conflict.

5.2.3.2. Video coding and refinement of the metrics

In this section, I will describe the process that was taken for developing and extending the CPM metrics, and the video coding technique which was defined to measure the CPM values for each play session.

At first, we conducted two pilot sessions which led to initial set of CPMs discussed in previous section, then by running more study sessions, we encountered with other either social or game-play behaviours which were emerged from new sessions. For example, we noticed that, players solve some problems together, while they are attending in the same virtual space. We noticed this experience causes them to enjoy, as they tried to play close to each other for creation of similar moments. These behaviours were observed during couple of sessions. Then we extracted this behaviour and categorized that as "Working out Strategies" which describes cases in which both players did a sequence of actions together in the same virtual space for overcoming a mutual problem. Also, we encountered some new variations of previous acquired CPMs during observing new sessions, for example we noticed "Helping Together" can have another variation, while players are helping each other in virtual worlds and not physical space. Furthermore, we noticed that players wait sometimes for each other while one player is ahead in game-play and other one is trying to reach to the same point. This mostly happened when one player had better game-play skills than the other one. So I categorized a new CPM, named “Waiting for each other”. Furthermore in some sessions, I recognized, that players take different roles, which support each others’ activities, and then, they repeated this pattern during other sections of gameplay as well. For example, in some cases, one player is the main combatant, while the other one supports her, with a close distance; this happens several times during game play. Also, in some other cases, one player takes the navigation role, and solves the most of navigation problems, while the other one is either supporting or following in a distance. Also, this happened in the social space as well, when one player took the leader role, and managed other player actions, mostly because of his previous role in that group, or his better game skills. Then I concluded this new group of behaviours as “Global Strategies” which describes the roles that players take to each other either in social space or game-play one.

To measure these acquired CPMs model, I developed a simple video encoding technique which goes over recorded video files, both players’ face perspective and game screen, and extract metric events based on qualitative definition of each CPM category, and increase values of each metric by one, if event belongs to that group. I did couple of tuning as this task can be quite subjective, by putting some proper constraints on metric qualitative definitions. Next section will elaborate on that.

5.2.3.3. Inter-rater reliability measure for the CPM – refinement

Table 5.1. Inter-rater Agreement (M stands for CPM).

Inter-rater	**Kappa for Metrics**					
	M 1	**M 2**	**M 3**	**M 4**	**M 5**	**M6**
Session 1	0.8	0.6	0.8	0.8	0.7	1

	8	7	3	6	8	
Session 2	1	0.7 5	0.8 6	1	0.6 0	0.83
Average	0.9 4	0.7 1	0.8 4	0.9 3	0.6 9	0.91

Before discussing the results, I will discuss the validation process I performed to evaluate the reliability of the results. First, to establish face validity, patterns and CPMs were developed through an intensive review process as discussed above. To establish scientific validity, I performed a formal validation process. I asked two independent researchers to rate two sessions given the CPMs and the cooperative patterns identified. All researchers were given an introduction to the CPMs and cooperative patterns and were shown an example of how to apply them using a video-taped gameplay session. Afterwards, they were given two videos of play sessions of *Kameo* and *Lego Star Wars* to analyze. I then performed inter-rater agreement and calculated kappa values [14, 15]. Table 5.1 shows the results of this process. Based on these results, we found that there were almost perfect agreements for *Laughter and Excitement Together*, *Helping*, *Global Strategies*, and *Got in Each Others' Way* CPMs; we found substantial agreements for *Worked Out Strategies*, and *Waited for Each Other* CPMs. The kappa values presented are sufficient to establish validity of the approach and the results [14, 15].

5.3. Final set of Cooperative Performance Metrics:

The final set of CPMs developed is as follows:

Laughter or excitement together, which we identified as events, where participants:

- laughed at the same time due to a specific game event;

- expressed verbally that they are enjoying the game, looking for utterances, such as "sweet", "it is a lot of fun", etc.;
- shook their heads and showed facial nonverbal behaviors that clearly expressed happiness or excitement.

This behavior was coded by labeling each event in the video that led to laughter or excitement based on the criteria above. As different people have different personalities, it is hard to count just one person and neglect the other, and thus we only labeled events where all participants laughed together, ignoring instances were one laughed without the other(s). I also imposed the constraint that researchers should label events happening in the same space only once per cause. As there were a lot of cases, that participants were showing several excitements for only one event inside game-play.

Another metric that is central to my work is an event that caused participants to *Worked out strategies.* This was identified when participants:

- talked aloud about solving a shared challenge;
- divided a game zone to different parts in order to divide and conquer;
- navigated the world while consulting with each other;
- Showing a pre-planned game-play behavior that emerges in the similar cases;

This is important as it refers to cases during gameplay where an obstacle encourages participants to consult with each other and make a local plan to resolve it. For example, in *Lego Star Wars*, there were different platform puzzles that required players to jump over some specific platforms to open the path. This challenge allowed players to consult with one another and make decisions together. Also, sometimes, we noticed that the players are following the same game-play pattern and plan in the case of similar challenges, without any talk, so we counted this cases as Worked Out strategy as well.

Another related metric is *Helping* each other. This metric corresponds with helping events. These events come in different varieties. For example, we often found that some players help others by leading them through the game, or by pointing to specific buttons. In *Little Big Planet*, we found many tangible instances of this metric, where participants helped one another by pointing to the controller or by handling the controller for the other player. Thus, I define events that signify this metric as events where players:

- talked about controllers, and how one can use the game mechanics;
- told each other the correct way of passing a shared obstacle;
- saved and rescued the other player while he or she was failing;

In our inter-rater agreement experiments, I found that researchers can confuse this tactic with the *Worked out strategies* tactic, especially if participants are helping each other. Thus, I imposed the constraint that researchers should label events under the *Helping* CPM when one player is helping the other and not when both are helping each other.

Global Strategies is a metric we created to refer to events where players take different roles during gameplay that complement each others' responsibilities and abilities. A tangible example of this parameter was observed in *Lego Star Wars*, where one player played the role of Jar-Jar (a character with high jumping capabilities) and the other one tried to support Jar-Jar while facing enemies. Another example is the *Rock*

Band game which participants need to take different roles that complement each other performances.

One important problem with cooperative games is the gap between skills which causes players to wait for one another. Most of the time this builds frustration, and thus we developed a metric called *Waited for each other* to label events, where one player waits for the other to catch up.

Another related metric is *Got in each others' way*, which is defined as events where one player leads and the other lags behind, or when one player wants to do an action, x, and the other wants to take a different action, y, and whereby taking these actions they will inevitably interfere or hinder each other's goals, and create some conflicting moments.

Generally speaking, we defined the first four metrics reflecting the positive cooperative events, that can generate a good social atmosphere in games, and the last two ones, as cases, that conflicts show up, even they can generate either positive or negative atmosphere. For example the waiting event can lead to frustration moments for one player in some cases, and can be interpreted as a good social stimulus that can encourage players to play together in a better social mood.

5.4 Experiment results and findings of applying the CPMs

I used the CPMs to annotate all game play sessions. A total of 3000 minutes of video data were reviewed and annotated (25 sessions front and back videos, totalling 50 60-minute gameplay videos). I went through all videos and labelled each CPM occurrence. For example, when a laughter event as described above is observed, I marked the video and annotated it by labelling the instance as *Laughter and Excitement Together* CPM. In this section, we discuss the totals, averages, standard deviation, 95% confidence intervals for all CPMs per game. We also discuss paired t-tests evaluating statistical significance of the results.

Furthermore, for each CPM label within the video analysis, the researcher identified a cause based on the cooperative design patterns, specifically: complementarity, synergies between abilities, shared goals, synergies between goals, special rules, camera styles, Interacting with the Same Object (ISO), Shared Puzzle (SP), Shared Character (SC), and Miscellaneous (PM). PM is a miscellaneous category that includes animations, cut scenes, or special elements that are specific to one game. For example, the dance animation in *Little Big Planet* caused much laughter. The mapping between CPMs and cooperative patterns were performed through a qualitative interpretive exercise.

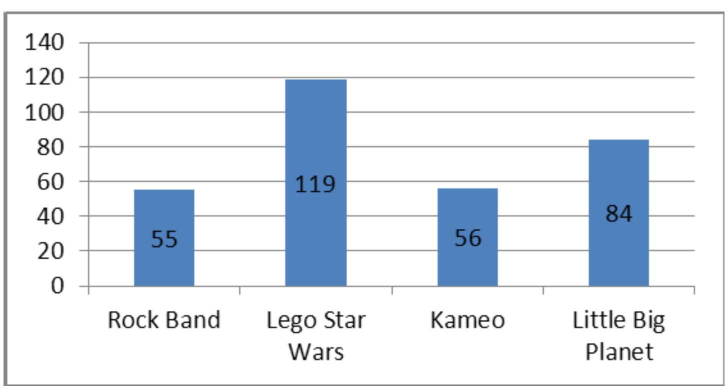

Figure 5.4. Comparing total number of Laughter and Excitement Together.

Laughter and Excitement Together Events

Figure 5.4 shows totals of events for all sessions labelled as *Laughter and Excitement Together*. Table 5.2 shows averages per session, standard deviation, and confidence intervals. As it can be seen, *Lego Star Wars* is in the lead with a lot more laughter and excitement events than the rest of the games. *Little Big Planet* follows, then *Kameo* and Rock Band 2 (same on average). We ran T-tests statistic method to check for significance of the differences between the games. T-test results were: RB-LSW (extremely significant, sig = .0001), RB-K (not significant, sig=.9), RB-LBP (significant, sig=.0014), LSW-K (extremely significant, sig=.0003), LSW-LBP (significant, sig=.018), and K-LBP (significant, sig=.009).

Table 2.2. Averages, Standard Deviation, 95% confidence Upper and Lower, per game for Laughter and Excitement Together.

Game Statistics	**Average**	**Standard Dev**	**Lower**	**Upper**
Rock Band 2	2.2	1.08	1.77	2.62
LSW	4.7	2.68	3.59	5.74
Kameo	2.24	1.74	1.55	2.92
LBP	3.36	1.87	2.63	3.36

Further analysis of the causes of these events reveals that, interestingly, PM is the main cause (shown in figure 5.5). PM includes a variety of different visual and audio patterns such as character design, character animations, interactive objects, and cut scenes. For example, the falling down animation in *Lego Star Wars* had a great impact on players' excitement. *Little Big Planet*'s character designs also had many exciting features such as dancing, shaking hands, etc.. In addition, as the figure shows, shared goals, complementarity, shared puzzles, and shared characters are important factors, that accounted for 14.1%, 10.2% and 11.4%, respectively.

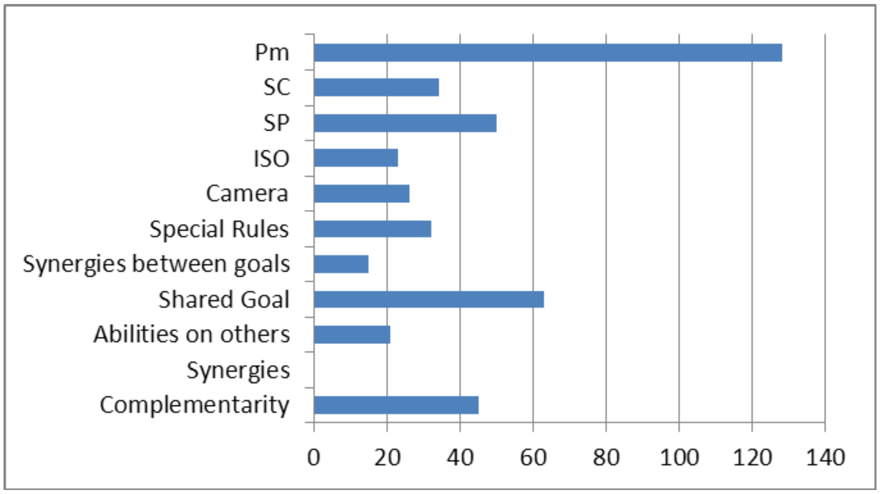

Figure 5.5. Patterns that caused Laughter events.

Worked Out Strategies

Figure 5.6 shows totals for *Worked Out Strategies* events for all sessions and table 5.3 shows averages, standard deviation, and confidence intervals. As it can be seen, *Lego Star Wars* is significantly in the lead and *Rock Band 2* is far behind all others with significance. We ran t-test between each pair. T-test results were: RB-LSW (extremely significant, sig = .0001), RB-K (extremely significant, sig=.0001), RB-LBP (extremely signficant, sig=.0001), LSW-K (extremly significant, sig=.0001), LSW-LBP (extremely significant, sig=.0001), and K-LBP (not significant, sig=.77).

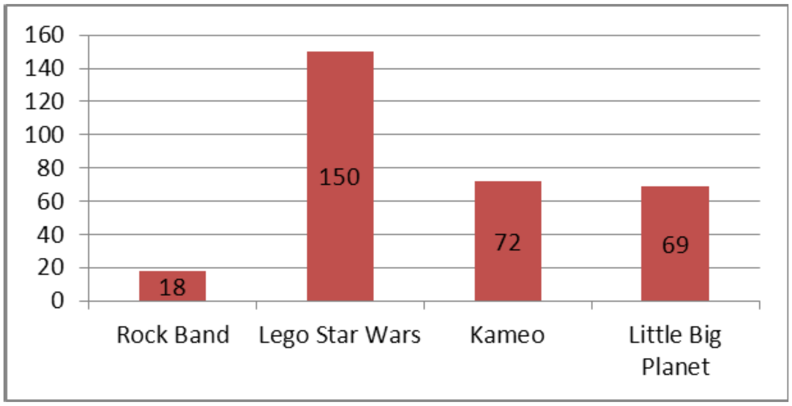

Figure 5.6. Comparing total number of Worked Out Strategies.

Table 5.3. Averages, Standard Deviation, 95% confidence Upper and Lower, per game for Worked Out Strategies.

Game Statistics	Average	Standard Dev	Lower	Upper
Rock Band	.72	0.68	.45	.98
LSW	6.08	2.812	4.95	7.2
Kameo	2.88	1.3	2.37	3.39
LBP	2.76	1.615	2.127	2.76

Figure 5.7 shows analysis of patterns that caused these *Worked Out Strategies* events. There is a direct impact of shared puzzles and shared goal (60.7%), complementarity (10.8%), shared character (8.1%), and camera pattern (9.1%). As players tried to solve puzzles cooperatively, they talked aloud and made plans. Shared character was also a cause for these events and was primarily observed in *Lego Star Wars*. Additionally, the complementarity of roles in *Kameo* made this game very challenging, as players switch to different characters to solve puzzles and divide tasks. In one observation, two players worked out their strategies so that one player explored the map while the other fought.

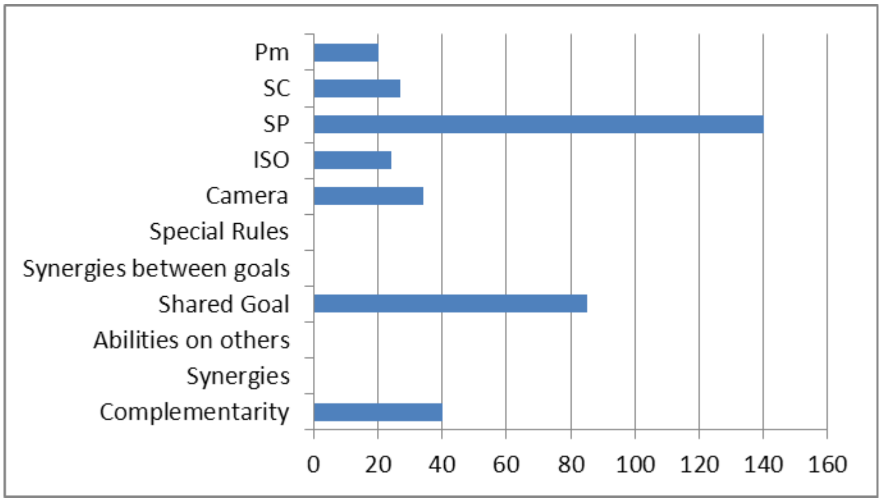

Figure 5.7. Patterns that caused Worked Out Strategies.

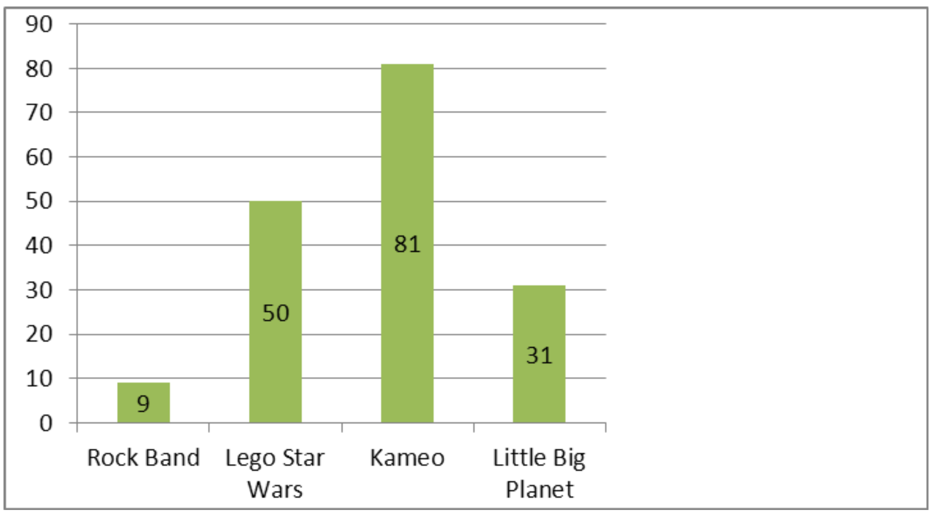

Figure 5.8. Comparing total number of Helping events.

Helping

Figure 5.8 shows totals of observed *Helping* events for all session. Table 5.4 shows averages, stdev, and 95% confidence interval per game. The results show that Kameo is significantly in the lead here. *Rock Band 2* is last with no overlap with other games. T-test results were: RB-LSW (extremely significant, sig = .0001), RB-K (extremely significant, sig=.0001), RB-LBP (extremely signficant, sig=.0007), LSW-K (very significant, sig=.008), LSW-LBP (signficant, sig=.034), and K-LBP (extremely significant, sig=.0001).

I deduce from observation and analysis of gameplay videos that *Kameo* was the most difficult game for players given all the other games. This may be due to the split-screen 3D game. But it was also obvious that many participants had a lot of problems with the controller and the obstacles within the game. This caused them to seek each others' help, and thus may explain the lead of *Kameo*. *Rock Band 2*, on the other hand, is a concentration game that didn't really give players time to help each other.

Table 5.4. Averages, Standard Deviation, 95% confidence Upper and Lower, per game for Helping.

Game Statistics	Average	Standard Dev	Lower	Upper
Rock Band	.36	.7	0.086	.634
LSW	2	1.33	1.43	2.49
Kameo	3.24	1.51	2.65	3.83
LBP	1.24	1.01	.84	1.24

Figure 5.9 shows a strong relation between *Helping* events and the shared puzzles and goals patterns. These two patterns cover 70% of the *Helping* metric. Also, it is interesting to note synergies between goals as a design pattern accounting for 10% of *Helping* events. *Rock Band 2* was the only game that used this pattern–since players' goals include finishing notes, and the other players' performance has a great impact on group performance.

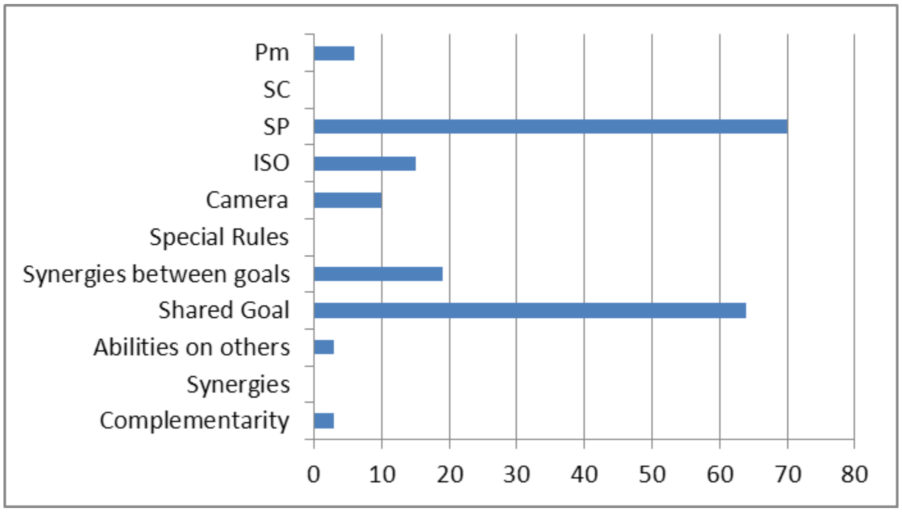

Figure 5.9. Patterns that caused Helping events.

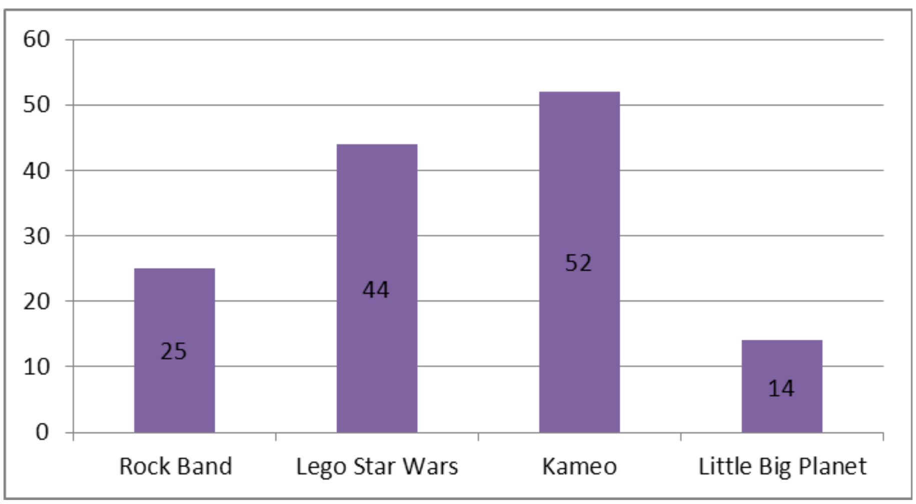

Figure 5.10. Comparing total number for Global Strategies events.

Global Strategies

Figure 5.10 shows totals of observed *Global Strategies* events for all sessions; table 5.5 shows averages, stdev, and 95% confidence interval per game. T-test results were: RB-LSW (very significant, sig = .017), RB-K (very significant, sig=.002), RB-LBP (not quite signficant, sig=.118), LSW-K (not significant, sig=.246), LSW-LBP (extremely signficant, sig=0.0001), and K-LBP (extremely significant, sig=.0001). As it can be seen, there is no significance between *Kameo* and *Lego Star Wars*, both in the lead. *Rock Band 2* and *Little Big Planet* following. The significant gap between *Kameo* and *Lego Star Wars* on the one hand, and the *Rock Band 2* and *Little Big Planet* on the other, shows that action adventure games support this CPM.

Table 5.5. Averages, Standard Deviation, 95% confidence Upper and Lower, per game for Global Strategies.

Game Statistics	Average	Standard Dev	Lower	Upper
Rock Band	1	1.08	.577	1.42
LSW	1.83	.868	1.486	2.181
Kameo	2.08	1.15	1.63	2.53
LBP	.56	.65	.304	.56

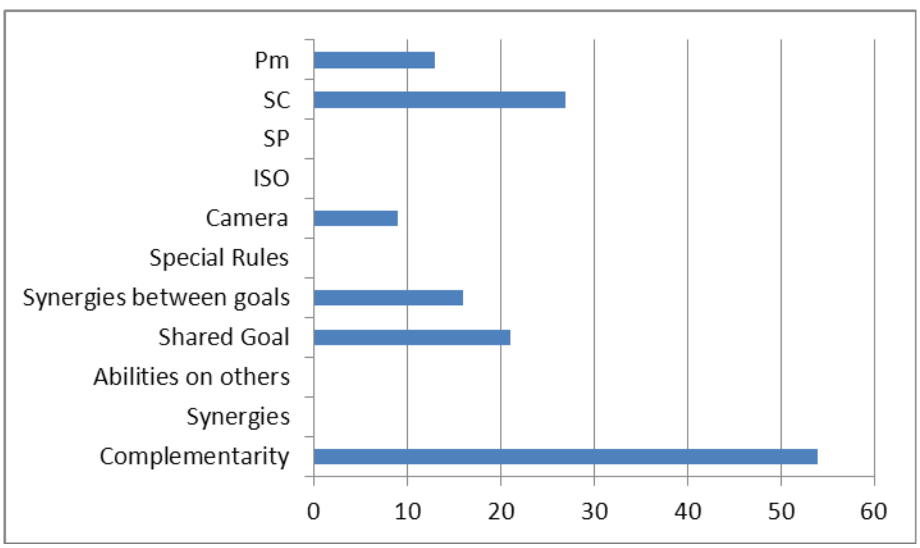

Figure 5.11. Patterns that caused Global Strategies.

Figure 5.11 shows relations between *Global Strategies* and causes. Complementarity and shared character design patterns account for the majority of these events. Together, they account for 58% of this metric. *Kameo* supports four different characters with different abilities that players switch between dynamically during gameplay. This feature makes it possible for players to assume different roles and develop tactics based on their desired character abilities. Likewise, *Lego Star Wars* uses the shared character pattern named *Jar-Jar*–the player who takes the role of Jar-Jar is responsible for big jumps that solve the platform puzzles in this game, but this character is vulnerable to enemies, and thus the other player has to support him.

Waited for Each Other

Figure 5.12 shows total events observed for all sessions for the *Waited for Each Other* metric, while table 5.6 shows averages, standard deviation, and confidence intervals per session. Like with *Global Strategies*, *Lego Star Wars* and *Kameo* are in the lead, overlapping in their confidence interval. Also, *Rock Band 2* and *Little Big Planet* follow with little overlap in their confidence intervals. T-test results were: RB-LSW (extremely significant, sig = .0001), RB-K (extremely significant, sig=.0001), RB-LBP (signficant, sig=.031), LSW-K (not significant, sig=.683), LSW-LBP (very significant, sig=.002), and K-LBP (very significant, sig=.013).

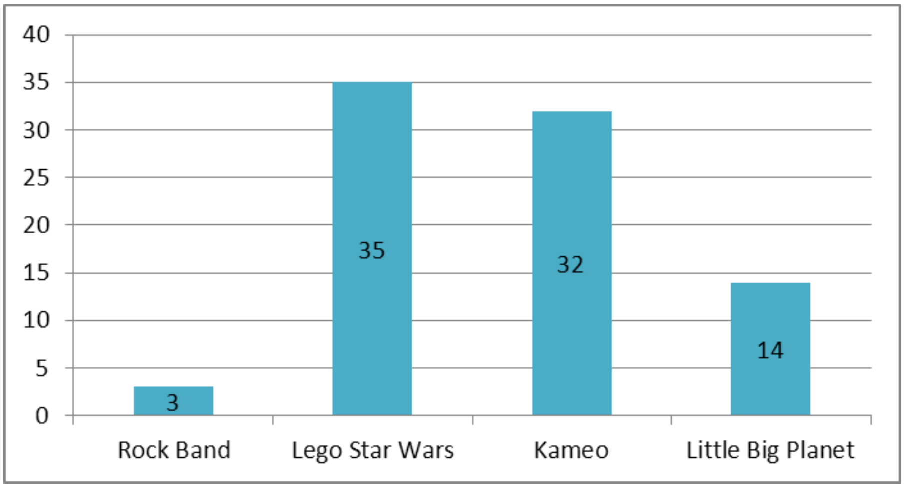

Figure 5.12. Comparing total numbers for Wait for Each Other.

Table 5.6. Averages, Standard Deviation, 95% confidence Upper and Lower, per game for Wait for Each Other CPM.

Game Statistics	Average	Standard Dev	Lower	Upper
Rock Band	.12	.33	0	.25
LSW	1.4	.977	1.067	1.85
Kameo	1.28	.936	.913	1.647
LBP	.56	.82	.238	.56

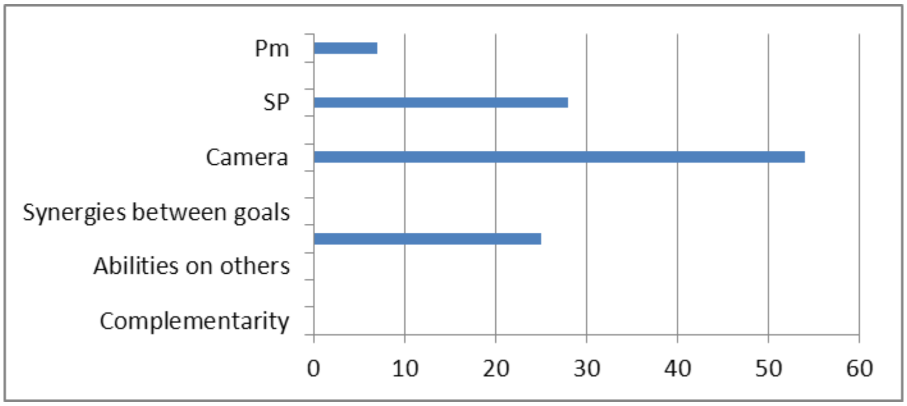

Figure 5.13. Patterns that caused Wait for Each Other events.

Looking at the causes for these events (see Figure 5.13), it is surprising to see that the camera pattern accounts for 47% of these events. When we take a closer look at the studied games, we see that in *Lego Star Wars*, the camera requires players to wait for each other to proceed. Conversely, *Kameo* has a split screen style, which gives players the freedom to solve puzzles independently. However, the shared puzzle structures in *Kameo* are designed in such a way that players need to reach the same checkpoints while progressing through the game levels. This caused players to wait for each. It should be noted that *Rock Band 2* has a pausing mechanism that players could use but didn't choose to in any of our sessions.

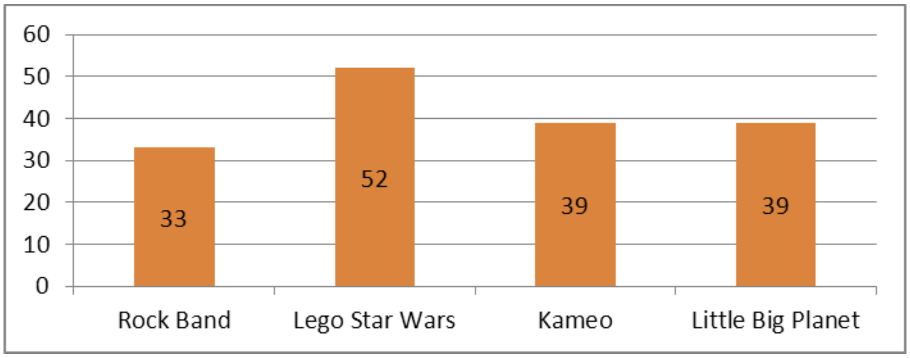

Figure 5.14. Comparing total number of Got in Each Others' Way events.

Table 5.7. Averages, Standard Deviation, 95% confidence Upper and Lower, per game for Got in Each Others' Way.

Game Statistics	Average	Standard Dev	Lower	Upper
Rock Band	1.32	1.52	.724	1.92
LSW	2.12	1.8	1.4	2.85
Kameo	1.56	1.227	1.07	2.04
LBP	1.56	.96	1.18	1.56

Got in Each Others' Way

Figure 5.14 shows total of observed events of *Got in Each Others' Way* for all sessions, and table 5.7 shows averages, stdev, and confidence intervals. As it can be seen, there is overlap between confidence intervals among all games. T-test results were: RB-LSW (significant, sig = .034), RB-K (not significant, sig=.5), RB-LBP (not signficant, sig=.5), LSW-K (not significant, sig=.2), LSW-LBP (not significant, sig=.14), and K-LBP (not significant, sig=1). This insignificance may be due to the fact that the CPM was observered for many causes.

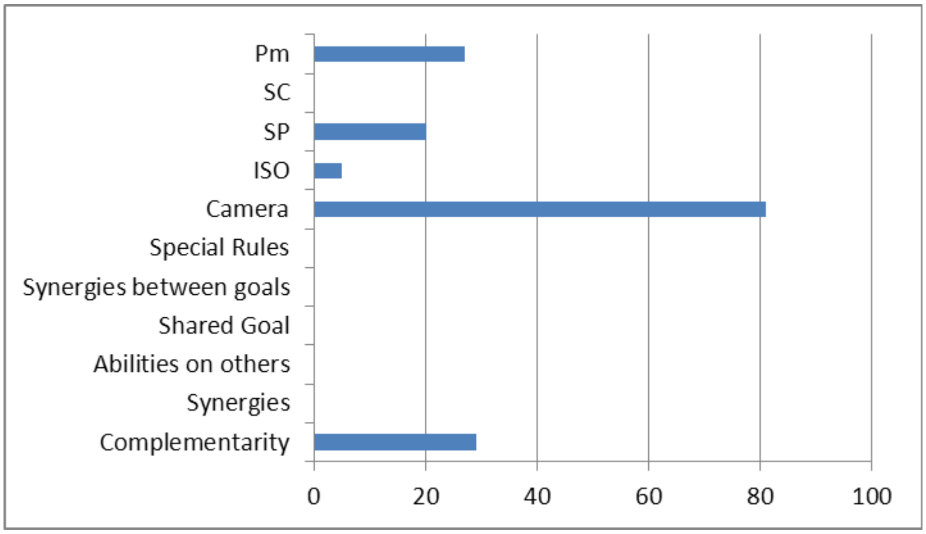

Figure 5.15. Patterns that caused Got in Each Others' Way events.

Camera pattern (50%), complementarity (17%) and shared puzzles (12%) have a great impact on this metric (see Figure 5.15). The *Lego Stars Wars'* camera depends on players' movements in relation to each other. Thus, if they want to move in opposite directions, they will get in each other's way.

Conclusion of these results

In conclusion, I present table 5.8, showing some of the significant cooperative patterns identified based on our results. Specifically, complementarity, shared goals, shared puzzles, and shared objects had a major impact on the identified CPMs. This is evident by the significant results we discussed, specifically in the *Global Strategies* CPM where *Lego Star Wars* and *Kameo* were clearly in the lead due to their use of shared goals, shared puzzles, and complementarity cooperative patterns. In addition, the results suggest that, for the age group we had (6-14), split screen and camera led by the first player caused *Waited for Each Other* and *Got in Each Others' Way* CPMs, which may have a negative impact on the play experience. Thus, designers need to be careful when designing camera settings. Furthermore, analysis of laughter and excitement shows that visual style and animation as well as cut scenes caused much of the *Laughter and Excitement Together* (Figure 5.5).

Another interesting point to note for cooperative designs is that *Helping* occurred when the game was difficult for players—the number of events observed was significantly higher for *Kameo*, which was rated the most difficult game by our participants. Thus, this CPM is directly tied to difficulty and can be used to tune difficulty of the game.

Table 5.8. Cooperative patterns leading to positive CPMs.

Game	**Pronounced Patterns**
Rock Band 2	• Complementarity • Synergies between abilities • Abilities on others • Shared Goals
Lego Star Wars	• Complementarity • Shared Goal • Synergies between goals • Camera: all characters are in focus • Interacting with same object • Shared puzzle and Shared character
Kameo	• Complementarity • Shared Goals and shared Puzzles • Interacting with the same object • Camera: split screen
Little Big Planet	• Shared Puzzles • Interacting with the same object • Abilities on others • Camera: led by first player

To summarize, designing effective cooperative patterns is an important area for the game industry, and has a direct impact on the development of educational as well as informal learning games. Developing methods for evaluating or analyzing players' cooperative play is still an untapped research area. In this thesis I presented several contributions. First, I proposed several cooperative game design patterns extending previous work. Second, I proposed a set of Cooperative Performance Metrics (CPMs) used for analysis of the cooperative games. Third, I presented results of a study analyzing the experience of 60 players playing cooperatively in groups of 2-3 four cooperative games: *Rock Band 2*, *Lego Star Wars*, *Kameo*, and *Little Big Planet*. The analysis resulted in valuable design lessons, which form another contribution of this thesis. These results were further validated through inter-rater reliability measures. In future research, I will extend this work by running additional experiments with different age groups and game types.

Chapter 6. Validation of Cooperative Evaluation Method

In this chapter, I will describe the methods and procedures that I took to triangulate various sources of data to outline the validity of research findings. The previous chapters outlined the impact of the cooperative design patterns on specific social or gameplay interactions, such as laughing together. However, the work up to this point did not discuss the impact of these results on player engagement. While I discussed the usefulness of the metrics in distilling co-op quality, I did not discuss how these metrics can be used to interpret player's engagement. While some of the metric values, like laughter or getting in each others' way, might have a direct impact on engagement, as observing an exciting moment can be interpreted as engaging or enjoyable, the findings from other metrics are not directly correlated with affect, and thus is more difficult to judge or assess. In this chapter, I will discuss the work I did to elaborate on how the CPMs metrics has been perceived among game experts, and passionate game players through the online game reviews.

To measure the impact of the metrics defined on player engagement or frustration, I considered using two different sources of data: (a) the post questionnaire used after study sessions, which included questions on the cooperative experience and rankings of the games played (also available in Appendixes), and (b) the online expert and non-expert reviews on the studied games from popular game review sites. The online reviews gives us an independent view of the different aspects of the game that may be of interest to players as well as some insights on the social or gameplay interactions within a cooperative experience. Expert reviews can be especially valuable due to their expertise with game development and their knowledge about what attracts, engages, or disengages audiences. Additionally, players' reviews can be considered a reliable source about how either enjoyment or frustration happens in game-play experience as they mention both positive and negative moments of their experience.

In this chapter, I will discuss the results of these two different triangulations. First, I will discuss the use of (a), which I found particularly problematic in terms of reliability. Second, I will describe a study that I conducted to gather the experts' reviews, and compare them with my results. I will present results that illustrate and validate the CPM measures and design patterns discussed in Chapters 5 and 4, respectively.

6.1. Using post questionnaire

The post questionnaire included 18 questions, which investigated different aspects of players' experience varying from their main object to impact of their actions on other players during the game-play session. Among these questions I discussed 10 specific cases which inspected the cooperative experience such as, other players ' responses to their actions, helping the group, their communication, sharing their goals, hindering each other and so forth. The complete set is available in Appendix B. We designed this questionnaire in a team of game user experience experts at Simon Fraser University, EMIIE lab, through an iterative process while holding some pilot sessions, and validated that with some other user experience experts, outside our team.

While we were progressing in the study sessions, and applying the post-questionnaires in each session, I figured out that the players responses to cooperative experience questions, does not match with their experience during game sessions. I found this fact while observing their behaviors in each session and looking their impressions in recorded video files. For example, I found several cases where one player gave up to play in game levels mostly because of big gap of skill levels, While they replied that they had a good cooperative experience, and enjoyed the other player responses.

In conclusion, I did not think the results of this post-questionnaire are reliable for the following reasons. First, the participants are too young, most were less than 13 years old; and thus they were agreeable and stated that had great collaboration in all games, while there were many observations that didn't support these statements. Second, their ranking was biased by the popularity within their age group or the novelty of the game.

I think the second approach, that of using online reviews, resulted in a more reliable method to compare and gauge engagement, as it is based on game experts or passionate gamers, who criticized games more carefully and dared to share their experience with the game community, considering the fact that their reviews can be evaluated through other game community people.

6.2. Data Collection: Collecting and Coding Reviews

Due to the number of games involved and reviews online, I decided to narrow down this study to only two games, including *LittleBigPlanet* and *Lego Star Wars*. I selected these two games as they are more appropriate to the target audience in this study, in comparison to *RockBand* and *Kameo* which are for older ages. Also, I believe showing the community's perception of CPMs for these two case studies will suffice the validity of other game study results.

I collected 40 reviews for each game using online game ranking websites: GameSpot.com, gamerankings.com, and Co-optimus.com. The reason I chose to collect reviews from these sites is due to their acceptance as a review resource by the game community. From the 40 reviews, 20 were expert reviews and the other 20 were gamer reviews. This was done in purpose to sample evenly between expert and gamer reviews. The reviews were randomly collected from the sites based on three basic requirements: the number of pages has to be more than 2-pages, the review should discuss different aspects of game-play, and the review should elaborate on the multi-player mode.

Once the reviews were selected, I then read all the reviews. I then went through them and qualitatively highlighted segments of the texts where:

1. Text expresses cooperative experiences, such as multiplayer mode, co-op mode, collaboration, and etc, and extracting the sentences that are related with those words.
2. Text expresses the fun aspect of game, and shows the positive points and significant success of those games, and extracting the sentences that are related with those words.
3. Text describes the disadvantages or weak points of games, which lead to frustration points, such as boring, weakness, not fun, and etc, and extracting the sentences that are related with those words.

4. Text describes features and dynamics of the game that are either directly or indirectly related to co-op features of the game.

These elements were important because I am looking to find the correlation between cooperative experiences coded in metrics with enjoyment and frustration perception of game-play experience. Figure 6.1 shows some examples of these texts highlighted

> The main story mode follows a sequential progression, so you open up new levels by completing them in order. However, even when you've finished a level, you'll want to return to collect the hidden items, keys, and point bubbles that you likely missed the first time around. Collecting items allows you more creative freedom in the form of stickers and costumes, whereas music and materials can be used in the creation mode afterward. You can also collect loot drops by putting stickers down in certain places, and there are puzzles that you can only solve by playing in the two- to four-player mode. These include gates that can only be opened remotely, objects that require multiple characters to pull, and in one brilliant scene, a car driven by one character while another dangles on a trapeze underneath.
>
> Little Big Planet poses a bit of a dilemma; it's miles more fun in multiplayer, but also more flawed. Figuring out the puzzles and experiencing the set pieces for the first time with others is one of the most memorable experiences we've had this year, and chances are that you'll find yourself recounting the best moments with your friends afterwards. Unfortunately, there's a downside to playing in multiplayer, and it's something that often afflicts platforming games: the camera. It frequently struggles to frame the action, and considering many precision jumps are required, certain sections become nigh-on impossible. The generous spacing of respawn points lets you retry most of the tricky sections, but if you fail after using up your lives, you have to restart the entire level. There were many occasions in multiplayer in which we intentionally killed ourselves, just so that one player could try a section without the camera jerking around all of the time.

Figure 6.1. Expert expressions on cooperative experience in Little Big Planet.

This method is qualitative. I used simple techniques of content analysis where I interpreted each text expression and investigated whether the expression is related to any of aforementioned elements that I decided to look for. I found some texts that didn't fit into any of these elements, but were related and thus I highlighted them. Figure 6.2 shows an example of a text that didn't fit into the elements originally discussed. In this case, the expert is describing a frustrating experience, mostly because of lack of difficulty settings and not having serious challenges for hardcore gamers who can finish game in less than six hours. The word "Sadly" specifies clearly this negative context.

Sadly, with no scalable difficulty level and relatively few truly testing challenges, stalwarts of the genre will be able to reach the last boss in less than six hours. This isn't counting the time it takes to go back and collect everything, but the fact remains, you can see all the main levels in one prolonged sitting. Clearly, if the community jumps on the creation tools then this longevity will be extended, but it will take time and great skill from home designers to match the creativity and professionalism of Media Molecule's work.

Figure 6.2. Expression about frustration moments not categorized in metrics.

6.3.Data Analysis: Interpretation and Categorization of messages

Using the CPM metrics, I developed 12 categories, where I added a positive and negative element to each of the 5 metrics and made two extra categories for elements that do not match with metric definitions, and explained either enjoyable or frustrating experiences. Table 6.1 depicts these categories with their descriptions. This twice number of categories, in comparison to the metrics, is due to the fact that there is a negative and positive interpretation for each metric that may be correlated with fun or frustration review elements.

Table 6.1. Expression categories based on metric qualitative definitions.

Expressions Categories	Related CPM	Description
1.Positive worked out strategy	Worked out Strategy	The excitement and fun experiences caused by worked out strategy or one of main significant design patterns which lead to this metric happening.
2.Negative worked out strategy	Worked out Strategy	The frustration or discouraging experience caused by Worked out strategy metric.
3.Positive helping each other	Helping	The fun experience have been emerged because of a game mechanic that promotes this idea, which one player help the other one.
4.Negative helping each other	Helping	The frustration caused by a game element that promotes the helping mechanism between players.
5.Positive global Strategy	Global Strategies	The fun experience has been emerged from a game mechanic which allows different players take leading and supporting roles.
6.Negative global strategy	Global Strategies	The frustration caused by game elements that make it possible for players to take different roles.
7.Positive Waiting	Waiting for each other	The excitement and fun experience emerged because of this game feature that limits players' movement to each other, and one player need to wait if she is too far ahead

		from other ones.
8.Negative Waiting	Waiting for each other	The frustration caused by game elements that impose one player to wait so others can join and reach to the same point.
9.Positive Get in Each other way	Got in each others' way	The excitement and fun experience caused by game mechanics create conflicts between players action, and decisions.
10.Negative Get in each other way	Got in each others' way	The frustration emerged from high conflicts in game-play that is a product of game multi-player mechanics.
11.Positive What else	Not applicable	The fun experience caused from game elements except than above
12.Negative What else	Not applicable	The frustration emerged from other game elements.

Using these categories, the design patterns discussed in Chapter 4, and the highlighted texts from the reviews, I then used a pattern matching technique to match each review to the metrics or the design patterns which significantly can cause that metric. I did that in several steps.

In the first step, I matched the categories with the highlighted texts. If there is either a direct or indirect reference to those definitions, I will put the expression in related group, considering the fact that the context of expression is positive or negative. For example, the first expression highlighted in figure 6.1 has been categorized in "Positive worked out strategy" as the expert is describing cooperative puzzles as an important game element in *LittleBigPlanet* which can creates moments that players make a collaborative plan ahead for solving them. I categorized neutral or not so negative or positive elements into the positive pile because they captivated the player or experts' attentions. This technique is limited as it is subjective and will require inter-rater agreement to establish reliability, but this task is left for future research.

In the second step, I took the remaining highlighted texts and tried to match them with the design patterns discussed in Chapter 4.

Example 1: *LittleBigPlanet*

"there are puzzles that you can only solve by playing in the two- to four-player mode. These include gates that can only be opened remotely, objects that require multiple characters to pull, and in one brilliant scene, a car driven by one character while another dangles on a trapeze underneath [64]. "

I extracted this expression by finding the word brilliant scene which convey a positive experience, in domain of cooperative game play, "playing in two or four player mode", can be considered as an example of both fun and cooperative experience. Then I matched this expression with "Positive worked out Strategy" as it implicitly mentions that more than one player needs to be involved for solving cooperative puzzles, and make a strategy for pulling and pushing objects.

Example 2: *LittleBigPlanet*

"The pod also allows you to manage your online activity in the world of *LittleBigPlanet* allowing you to easily arrange games with friends, which is fairly important as certain areas of the levels can only be accessed with the help of another player, although two players can play together on the same console [65]. "

I extracted this expression, as it explicitly is talking about cooperative element of game-play, "arranging games with friends", and then I categorized that, as a "Positive helping together", as it explicitly is talking about helping in game-play while playing in shared physical space. Also, I interpreted this expression as a positive one, as it has been in a positive context based on "fairly important" word.

Example 3: *LittleBigPlanet*

"There were many occasions in multiplayer in which we intentionally killed ourselves, just so that one player could try a section without the camera jerking around all of the time [64]."

I extracted this expression while it is clearly talking about a cooperative experience, and I categorized that as a "Negative Get in Each other ways", as it explicitly describes that one player should kill himself so that the other one can pass an obstacle, just because of camera design problem.

In the last step, I took the remaining highlighted expressions and put them in "Positive What Else" group, if they have a positive context, or categorize them in "Negative What else", otherwise.

I applied these steps for the 40 reviews for of the two games: *Little Big Planet* and *Lego Star Wars*. Using these codes, I then calculated a percentage for each CPM and design pattern, i.e. if a CPM, for example, received at least one expression for each review, then it will score 100%. This shows that the metric has been discussed or mentioned by all reviewers.

6.4. Results

In this section, I will describe the results from this validation study, and how this validation technique helped me to infer and find mappings between CPM metrics and engagement aspect of game.

As I discussed in previous section, I defined a quantitative parameter for each twelve extracted categories, which measure the percentage of how that category has been perceived by both experts and game players. This parameter was calculated based on the following formula:

$$\mathrm{P(G)} = \sum \min(numberOfExpression, 1) / Total\,\mathrm{Re}views$$

Where *P(G)* represent category perception parameter calculated by accumulating the number of reviews which have referenced that category at least one time divided by total number of reviews. I then multiplied this value by 100 to find the percentage and normalize the values for all categories. The results for both games can be found in Figure 6.3.

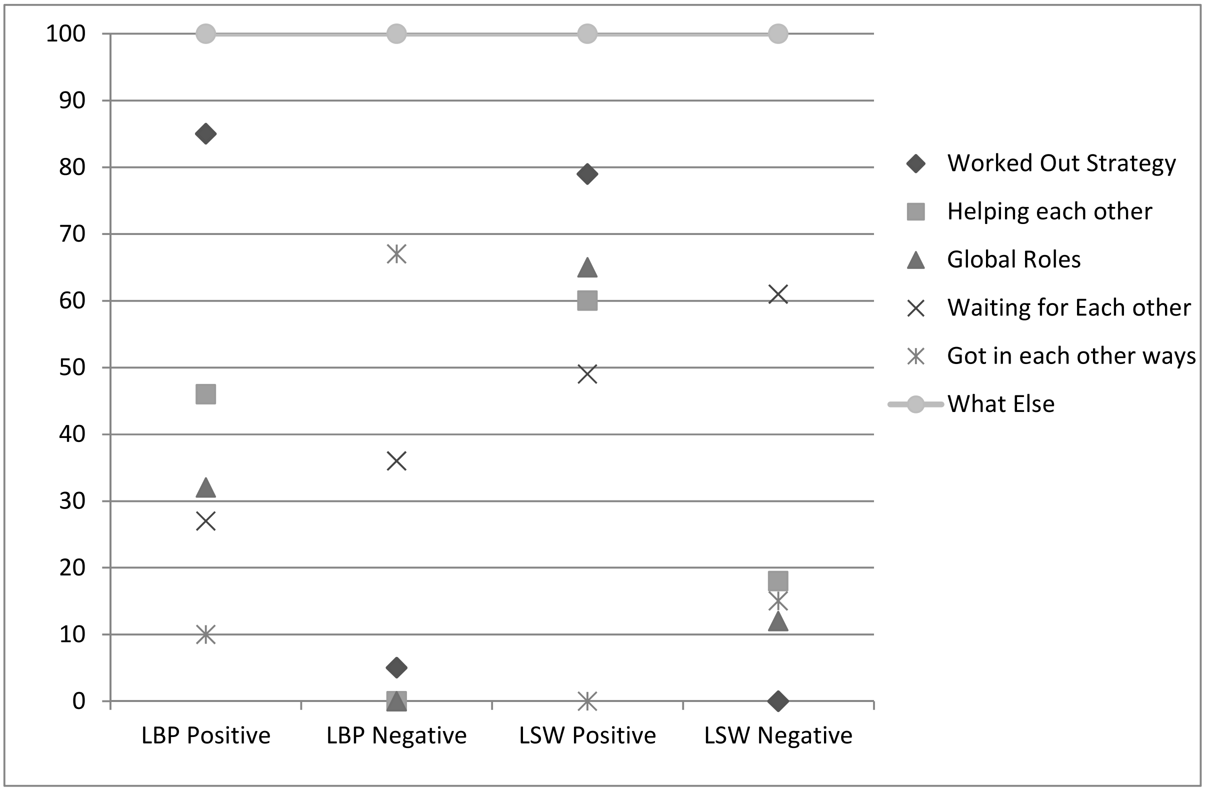

Figure 6.3. Metric categories perception parameter for both games (percentage).

As depicted in figure 6.3, some of metric categories have been perceived with a high percentage among the game community either game experts or passionate players, such as *Worked out strategy* and *Got in each other ways.* This means that these two groups have been expressed a lot either with explicit words or indirect clues.

Having values close to 50% for most of the categories shows a good perception of those metrics inside game community. This can be confirmed as both of studied games have relatively high values for all mentioned metrics some for positive categories and others for negative ones.

According to the above Figure, both players and experts found that the “worked out strategy” metric as a positive factor (the positive percentage is considerably greater than negative one for both games) that can lead to fun moments. From a qualitative perspective, while experts were talking about features in the game such as mutual resources and goals, they signified the existence of this metric in a positive way, which can encourage players to more collaboration, and experiencing fun moments together.

Global Roles is another metric which has been found mostly positive and fun. It can be inferred that game mechanics, such as “shared characters”, or “switching to different roles”, which allow players to take different roles, have been perceived and mentioned a lot in a positive context.

The *Helping each other* is the last considerably positive category, which can emphasize how both players and experts cares about either shared puzzles or saving options. As in the former case, players help each other implicitly by showing the path, or the solutions of game dilemma, and in the latter one, players save each others’ life using related game mechanic, so they can have a better play. The social aspect of these metric was out of reach of both players, and experts, as they mostly concentrated on game dynamics and not so much on social interactions can emerge in a shared physical environment.

The last two categories *Waiting for each other* and *Got into each others’ way* can be considered mostly negative dynamics, i.e. can lead to frustration moments, while the former one is half positive and half negative. The expressions which lead to these two categories were mostly related to camera designs. For example, the people who found the *Lego star wars* camera confusing mostly talked about this feature in a negative context.

Another metric which has an important impact on design is “Got into each other way”. This metric had primarily a negative qualitative connotation.

Chapter 7.Discussion and Application

In this chapter, I will discuss the work that I have done so far in the context of the community and present limitations of the study. I will also discuss the contributions of my thesis and how they can be used with both academia and industry people. I will then discuss several areas of future research.

7.1. Discussion of Results and Limitations

This thesis was done based on a comprehensive experiment on cooperative games to find better design guidelines and evaluation methods for this game genre. The *Bardel Entertainment*, in collaboration with *MITACS* and *EMIIE* lab in Simon Fraser University supported the experiments financially and in an academic manner. The general results, including: 1. design platform and 2. evaluation method, shows a satisfactory situation considering the project and thesis initial goals, and two validated solutions have been presented for thesis research goals, each for one, respectively. Also, the results of this thesis has been presented at the CHI 2010 conference, and two game companies including *Bardel Entertainments* Inc. and *Ubisoft Montreal* Inc., and their game designers and game user experts encouraged this research and are waiting for a final version of this work.

However, this research has some limitations, which definitely impacts the results; even though the validation process completely confirms the reliability of contributions. There were two main limitations for this work including 1. game genre, 2. physical game environment. The former one is due to us narrowing down the scope to specific game genre: such as action, adventure, puzzle, music, platformer, and etc., and not including others such as sport games, which are important either in cooperation or competition, and others which have no prominent cooperative example out in the market. This limits the application of presented solutions to just the specific mentioned genre. Also, as I studied cooperative games played in common physical space. Thus, the result can only be valuable and validated for games which encourage the cooperation while players attend in the same space, and cannot be applied directly to online version of co-op games.

These two limitations do not challenge the validity of results, but limit the domain of their applications. However, I believe the results can be considered as a base for further studies which improve this study limitations, such as online co-op games, and other game genres.

7.2. Contributions

This thesis comes with two main contributions, and a third secondary contribution that shows the relation of first two ones. The first outcome of this work is developing and presenting a list of cooperative game design patterns and guidelines, which can benefit game designers to better design cooperative games. The second outcome is developing and introducing a methodology and practical approach that can be used for evaluation of cooperative games, especially to measure their cooperative performance while playing co-op games. Finally, the last contribution, that emerged while developing the first two ones, is the impact of each design pattern on the performance of players. I presented a mapping that shows how different patterns can impact the dynamics of behaviors emerged from cooperative game-play, and how these behaviors can be considered as positive (fun) or negative (frustrating). In this section, I will discuss these contributions in more detail.

7.2.1 Patterns to be used by Designers

I summarized all design patterns presented in this thesis in the following paragraphs.

Design Pattern: ***Complementarity*** [1]

Description: is one of the most commonly used patterns in co-operative games. It implies that players play different character roles to complement each others' activities within the game.

Application: Designing characters with different set of abilities, while the combination of one player skills with others can solve a problem

Design Pattern: ***Synergies between abilities*** [1]**.**

Description: allows one character type to assist or change the abilities of another.

Application: Designing characters with different abilities, and define rewarding rules in a way that consider the performance of all players with different abilities, and punish or promote them based on group performance and not individual.

Design Pattern: ***Abilities that can only be used on another player*** [1]**.**

Application: Designing abilities which can encourage cooperative game-play, such as pushing and clapping animations in little big planet, and thumbs up action in *Army of two*.

Design Pattern: ***Shared goals*** [1]

Description: is a pattern used to force players to work together.

Application: Introducing mutual aims for players, and encouraging them to achieve the goal while cooperating with each other. Such as finishing performance in *Rock Band*, or group escape in *Left 4 dead*.

Design Pattern: *Synergies between goals* [1]

Description: is a pattern that forces players to co-operate together through synchronized goals.

Application: Defining different goals for different players, but depends the achievements of goals to each other.

Design Pattern: *Special rules* [1]**.**

Description: denote rules that are used to enforce cooperation within teams. For example, designers can encode rules to denote specific effects to actions within the game when performed on a friendly player. The idea behind these differences is to promote and facilitate cooperation.

Application: Designing actions that can be applied on other players, and benefit them from cooperative game play, for example embedding save option in shooting games which one player will be able to heal the other one, while getting close enough and using a specific order of game mechanics.

Design Pattern: *Camera Setting*

Description: There are three design choices for developing a successful camera in a shared screen co-op games—split screen horizontally or vertically, one character in focus, all characters are in focus (the screen doesn't move unless all characters are near each other).

Application: Designing Camera behavior, based on game goals, for example if the game aims to keep players as close as possible so that they can help them in fighting missions, or solving spatial shared puzzles, then using a camera model which depend players movements to each other is a great idea, while for those game ideas which player are supposed to explore different part of game environment and play in different roles while their works impacts each other game play, the Split screen is a better option, even in shooter games which need fast reactions, the split screen has been used more successfully.

Design Pattern: *Interacting with the same object*

Description: providing interactive objects that can be manipulated by characters' abilities. In *Beautiful Katamari*, players share a ball. Similarly, in *Little Big Planet*, both players can push or grab one object together.

Application: Designing a game object that can be interacted with both players, for solving game challenges, the ball in *Beautiful Katamari* is the best example for this idea

Design Pattern: *Shared Puzzles*

Description: This pattern is a general category for all cooperative design puzzles, also discussed in [1], [3]. This pattern was observed in games such as *Lego Star Wars* and Little Big Planet, where both players encounter a shared challenge or obstacle.

Application: Design and define mechanics which create puzzles in games that depend both players to work to each other for solving them, for example, designing doors which can be opened only with cooperation of both players, or designing AI characters who can be defeated only by a collaboration attack, the Tank character in *Left 4 Dead* is a tangible example.

Design Pattern: *Shared Characters*

Description: providing a shared NPC (Non-Player Character) equipped with special abilities that players can assume. This pattern can be seen in *Lego Star Wars*, where both players have the ability to assume a special character, but only one can. This enables discussions among players concerning how to share the character.

Application: Design a character which can be shared between two players, and while one player is playing in role of this shared character the other player support its actions. Jar-Jar is another great example in *Lego Star Wars*.

Design Pattern: *Limited resources*

Description: is concerned with providing a limited number of resources, and thus encourages players to share or exchange resources to research the same goal

Application: Design resources, which can be consumed and shared between players, so they get encouraged to work with each other, for example design a gun or ammo which can be traded or shared, and depend players success on their individual success, so they get the value of cooperation.

Design Pattern: *Special characters targeting lone wolf* [16]

Description: this pattern focuses on the design of NPC characters that target players who are working alone. In *Left4Dead*, the Hunter and Smoker are good examples of this pattern.

Application: Design an AI system which target players who are not playing in a collaborative mode, and try to play head of others, and not very supportive, Left 4 Dead, and Resident Evil 5, are really magnificent.

Design Pattern: *Vocalization*

Description: are patterns that embed automatic vocal expressions on player characters that alert players of different challenging events. It, thus, encourages players to play close together and support each other.

Application: Design AI characters in the same team as players, which can give them hints, while they are playing close to them, or embed this behavior in players characters, which encourage them to cover each other actions. The *Left 4 Dead* is a good example for this technique

Most of these presented techniques can be used in different contexts and game play styles, while some of them are more appropriate for specific game genres. For example, shared puzzles and shared character are mostly appropriate for puzzle adventure based games.

The next section re-introduces the second contribution of this thesis and explains the steps that should be taken to apply this outcome for evaluation and interpretation of games.

7.2.2 Method for Evaluation of Games

As Cooperative video games are emerging as a new trend in the video game market, evaluating them using a reliable approach is a very important endeavor. A good method for evaluating co-op games can help game developers, especially producers and designers, to have a better understanding about the richness of their cooperative contents, and how successful it can be to captivate player's attention.

In this thesis, I developed and tested a mixed method tool for evaluating cooperative video games. I will briefly describe it, while introducing the steps that need to be taken for evaluating a new cooperative game and how to interpret the results. The following table (7.1) will summarize the video coding technique developed for evaluation of games.

Table 7.1. CPM definitions, and video coding technique related to them.

Metric Name	Metric Description	Metric Application
Laughter or excitement together	• laughed at the same time due to a specific game event; • expressed verbally that they are enjoying the game, looking for utterances, such as "sweet", "it is a lot of fun", etc.; • Shook their heads and showed facial nonverbal behaviors that clearly expressed happiness or excitement.	This metric implies the explicit fun has been raised by participants while playing game in a cooperative mode, so having high values for this metric, represents the high degree of enjoyment.
Worked out strategies	• talked aloud about solving a shared challenge; • divided a game zone to different parts in order to divide and conquer; • navigated the world while consulting with	This parameter explains the degree which players have cooperated together for proceeding in game play, and low values represents to less

	each other. • Showing a pre-planned game-play behavior that emerges in the similar cases.	cooperation than cases which a high value for this parameter has been reported.
Helping each other	• talked about controllers, and how one can use the game mechanics; • told each other the correct way of passing a shared obstacle; • saved and rescued the other player while he or she was failing;	This parameter shows the positive social atmosphere which a cooperative game can create, and mostly dependent on what players do in physical space, for example helping each other using controllers, guiding each other, and etc.
Global Strategies	• players take different roles during gameplay that complement each others' responsibilities and abilities	This parameter measures both social and game play aspect of role taking in cooperative games, as people play indifferent roles, they can have a different experience, so this parameter will try to consider the number of times the people changes their roles, which high values shows players are interested in different dimensions of game-play, and low values represents the minimum effort for looking at game from other perspective, anyway, this parameter depends

		on this fact that game offer different roles or not.
Waited for each other	• where one player waits for the other to catch up.	This metric can show both engagement and frustration, and it really depends on the skill gap between players who are playing the games, if the players are in similar level, then this value represents a positive social and game-play atmosphere which encourage players to support each other, otherwise it depicts a high frustration for one player who need to sacrifice all his time for another one to catch up.
Got in each others' way	• when one player wants to do an action, x, and the other wants to take a different action, y, and whereby taking these actions they will inevitably interfere or hinder each other's goals, and create some conflicting moments.	This value mostly presents a negative situation which can lead to frustration moments, having a high degree of conflicts can lead to frustration while having an average value can be acceptable and in some cases challenging that encourage players to decide with each other.

The above table gives a good overview about each metric, how it can be measured, and what its values mean. I will describe the required steps for evaluating a new cooperative game as follow:

1. Study Session: conduct 8 to 10 study sessions while recruiting two or three players for each one (the player number depends on average number of co-op players)
2. Video Record: Record players from two different perspectives 1. The game play screen and 2. The players front view
3. Calculate CPM: measure each metric while coding the video files for each session based on definition of each metric (see above table), and consider cases where needs to be counted
4. Calculate the Average/Time: compute the average values for each metrics for all study sessions, and divide the value by play time. Finally, normalize values.
5. Compare with a Base Game: Compare the acquired values with another game with normalized CPM values. For example, one of four studied games in this research or maybe another version of the same game.
6. Interpret the Results: use the Metric application column in above table to infer qualitative results which can be useful for game designers or producers.

Following the aforementioned steps will lead the game analyst with a good understanding of quality of studied games, comparing with another competitive titles, or previous versions of the game.

7.2.3 Predict the CPM in Design

In previous chapters, especially chapter 5, I presented a mapping between each metric and design patterns used for all studied games, depicting the impact of design patterns on CPM values. I basically did this mapping by finding the cause of each metric event and categorize that cause in one of design pattern groups used in the game. Then we created another extra group named PM which is an abbreviation for pattern miscellaneous, and put the causes which could not be categorized in cooperative patterns. Finally, I established this mapping by choosing the pattern groups which had a significant normalized value in comparing with average value for all groups. This mapping can be found in a summarized table 7.2 in this section.

Table 7.2. Mapping between design patterns and CPM values.

Metric Name	Effective Pattern Groups (Sorted)	Application
Laughter or excitement together	1. Shared goals 2. complementarity, 3. shared puzzles 4. shared characters	These four patterns have a great impact on Laughter together metric, especially shared goal, Embedding a fun factor, such as a cool animation, in shared puzzles and final goals is the easiest way for using technique to increase this metric value. Also, designing a shared character with some astonishing abilities, and fun animation, can cause a lot of laughter together events.
Worked out	1. shared puzzles	Designing puzzles which only can be solved by

strategies	2. shared goal 3. complementarity 4. shared character 5. camera pattern	more than two players will create a good social and game-play atmosphere, and encourage people to cooperate with each other, for example, designing an interactive bridge which needs both player collaboration to pass by, is a good example for this patter. Also, using a Camera model the same as one in Lego Star Wars, can impose players to close to each other so, there will be more options and cases which they need to talk with each other for proceeding in game-play.
Helping each other	1. shared puzzles 2. shared goals 3. synergies between goals	Using a shared aim or challenge can motivate players to help each other, while on eplayers has found the way and the other one wandering to find the solution, Also, applying different goals for different characters with inter-dependency, will impose players to help and save others while persuading their aims, The rock band is a good example that each player in band need an acceptable average performance otherwise other players will fail too.
Global Strategies	1. Complementarity 2. shared character 3. shared goal 4. Synergies between goals	Designing characters with different abilities which can complement each other performances, is the best way for creating different role dimension to a co-op game, the "Kameo Element of Power" is the best example that has exploited this technique with providing different roles

		which can make players interested to switch and have a new experience each time.
Waited for each other	1. camera pattern 2. shared puzzles 3. shared goal	Applying a camera technique which make players' movement dependent is the best technique for creating waiting times, Also, constructing puzzles which need both player attendance in the same virtual space can lead this event remarkably, "Lego Star Wars" has used this technique very well, by conducting shared obstacle puzzles.
Got in each others' way	1. Camera pattern 2. Complementarity 3. Shared puzzle	The Best technique for creating this situation is using a camera pattern that limits players' moves. Anyway, the designer need to consider that, using this technique frequently can lead to frustration moments, so using that in some specific levels, with a large number of shared puzzles can be the best decision for creating conflicts that challenge players for cooperation.

Using the above table, game designers can have a better understanding of how their design decisions will create cooperative events in game. Designers can use different design and art techniques to create hybrid solutions which can enrich the cooperative contents. Having a clear understanding about impact of design decisions on player performances is really valuable. It can help both design and production team to predict the success of their game idea, and design, before finalizing their products, which is a really late time for this case.

Generally, using the contributions of this thesis potentially can help and save much money for game companies. This is considering the fact that, they can compare their games with other published titles, while considering CPM normalized values for both games, and interpret their success. By the way, this fact is constraint by quality of study sessions, and how well data being collected and not biased. In addition, applying video coding technique appropriately is very important before data analysis and interpretation. Also, they can predict their success, by using a suitable combination of design patterns techniques. Finally, if the game producers are looking for a specific cooperative behavior, they can select the design pattern which can generate those behaviors, and apply them in their game design. This level of success really depends on how well the general design guidelines can be implemented for specific game requirements, and come along with artistic and other creative solutions.

The next section will discuss, the future steps that can be taken for improving and extending this work, considering the lack of design features in exposed framework, and emerging demands of game industry.

7.3. Future Work

We can look at five different areas for extending this current works, and improve some of contributions. In this section, I will describe these five different areas first, then elaborate on each and point out my suggestion for its improvements.

These areas include:

1. Design Pattern Framework : By emerging new games and contents, new design patterns come to exist.
2. CPM framework: the presented framework even covers different kinds of cooperative game-play and social styles, new play styles will be emerged with new games, and this set is not a comprehensive one.
3. Engagement & Frustration: conducting some study designs which use physiology data to interpret engagement and frustration can be considered a very successful validation technique for this work.
4. Applying and Extending current framework for online Co-op games: Although this thesis contributions are based on synchronous cooperative games which happen in the same physical space, but most of design patterns can be potentially considered for online games as well. The online versions can varies from multi-player and MMO synchronous games to asynchronous social games in social networks such as Facebook.
5. Investigating other game genre : such as sport games which have a big audience who are interested in either competitive or cooperative aspect of game-play

In the first area, design framework, considering that we have different kind of game genres and not all of them have been merged with cooperative contents, so we are missing different combination of design decisions that can be made. While new games introduce these new hybrid techniques, the framework can be extended by generalizing those emerged techniques to new categories.

Also, Co-operative games constitute a sizable direction of research for social science researchers to investigate new and existing social cooperative behaviors which will be emerged from new Cooperative video games. The same technique discussed in this thesis can be used for definition and measurement of new social events.

Furthermore, having a study design which can triangulate the CPM outcomes with physiology data extracted from participants, can emerges a variety of patterns between players engagement and the events happened either in game-play or in social atmosphere.

Besides that, researchers can use this framework as a base for development of cooperative contents for online Co-op games. Most of design patterns identified in this study have the potential of being used in online versions as well. Anyway, the researchers need to consider some tuning, removing, and additions toward existing platforms so it can be helpful for online purpose.

Additionally, exploring more game genres, and devising design patterns and other evaluation methods is another extension of this work. For example, sport games usually have a very high pace, and video encoding techniques can have some potential problems, as it will be hard for a human subject to code and analyze data with a high frequency. And it is too time consuming.

In conclusion, I need to mention that for either using or extending these thesis contributions, the context and constraints of the work need to be considered. And it will be inappropriate to use these concepts directly in other genres which this study never addressed them. Also, the creativity and quality are two important factors which should be regarded while applying design lessons learned from this work on other titles.

Blank page
Notice inserted by SFU Library

Appendix A: Background Questions

Session ID	
Participant ID	
Age	
Gender	
INTRO QUESTIONS	**RESPONSE**
1. Do you have access to video games?	y/n?
1a. Computers and video game consoles?	device type
1b. How many?	count (#device)
1c. Are they in your room?	location of each device
2. What kind of games do you enjoy mostly? (genre) a. FPS b. RPG c. MMORPG d. Sports e. Strategy f. Board games g. Mobile games h. Puzzle i. Platformer j. Other, explain	A-J choice
3. Name 5 examples of favorite games	Examples
3a. Why do you like those games? You can Qualify with: • For story • For challenge • For Fantasy: i.e. being in a different world • For social experience • For being able to customize the world or the characters • Sensory: visual/audio • Just to pass the time	Comment
4. On average: Frequency of play/week	count (day)
5. On average: Length of play	count (hr)
6. Which setting do you typically play video games? a. Arcade b. Home c. Friends' house d. Computers in an internet café e. Consoles at a gaming store? f. Other, specify	A-F choice

7. Who do you typically play with? a. Alone b. Alone but on the internet or over Xbox live or Sony Home c. Friend or a group of friends (how many?) with brother, she didn't remember but she sometimes plays d. With a friend near by who may or may not be playing but is involved in the activity, explain.	A-D choice
8. How many different video games in any form have you played:	A-D choice
9. What is your preferred Gaming platform? a. PC b. PS2 or PS3 c. Xbox or Xbox360 d. Wii e. DS f. PSP g. Cell phone h. Other, specify	A-H choice
10. How much do you spend on online gaming or other gaming monthly, explain?	amount ($)
11. How old were you when you played your first video game? a. Never b. Before kindergarten c. Kindergarten – grade 1 d. Grade 2 – grade 4 e. Grade 5 – 6 f. Junior high school	A-F choice
11a. Tell me about it. Is this how you started playing games, tell me more	comment
12. Are playing for online subscriptions?	y/n?
12a. If you are playing for online subscriptions for what games?	comment
13. What is the longest time you have spent playing online in one session?	count (#hr)
14. How do you select games to play?	comment
15. Imagine you can make a game, what would it look like?	comment
16. What is the best game you ever played?	comment
17. What are features you hate in games?	comment
18. Is there any game that you hate in particular?	comment
19. Do you prefer to play alone or in a group?	alone/group/both?
19a. (what size)?	count
19b. Competitive or co-operative games?	comp/co-op/both?
20. Describe a normal weekday for you.	comment
21. Describe a normal weekend for you.	comment
22. Do play games for entertainment or education?	edu/ent/both?

22a. Do any of your parents have a say on the games you play	y/n?
22b. Do any of your parents have a say on the games you play (comments)?	comment
23. Are there benefits of playing games on your learning and skill abilities	y/n?
23s. What are the benefits of playing games on your learning and skill abilities?	comment
24. Is anyone against you playing games?	y/n?
24a. why?	comment
25. Do you play video games whenever you want?	y/n?
26. Do you have any online friends?	y/n?
26a. Comments	comment
27. Have you ever talked about video games for more than 10 minutes?	y/n?
27a. If so, where and with whom?	comment
28. Are you ever tired the next day because you stayed up too late playing video games?	y/n?
28a. Comments	comment
29. Would you rather play video games than watch a movie?	y/n/depends?
30. Is playing video games in your top three things that you like to do ?	y/n/same/not sure?
31. Do you like to play video games more than most of your friends?	y/n/sometimes?
32. How many friends do you have?	count (#friends)
32a. What do you typically do with friends?	comment
33. Have you played Rock Band 2 (y/n)?	y/n?
33a. Have you played LSW (y/n)?	y/n?
33b. Have you played Kameo (y/n)?	y/n?
33c. Have you played LBP (y/n)?	y/n?

Appendix B: Post Play Questionnaire

Game (i.e. Rock Band 2)	RESPONSE
1. Is this like any game you played before (y/n)?	y/n?
1a. Tell me about it.	comment
2. What were you trying to do and why?	comment
3. Did you like/dislike the game?	liked/disliked
3a. What did you like or didn't like. Give examples.	comment
4. Would you improve elements?	y/n?
4a. How would you improve the elements that you didn't like?	comment
5. Why would anyone play this game? • For story • For challenge • For Fantasy: i.e. being in a different world • For social experience • For being able to customize the world or the characters (not the cloths) • Sensory: visual and audio • Just to pass the time	comment
6. Was it difficult for you to play?	y/n?
6a. Comments	comment
7. Would you give this game as a gift?	y/n?
7a. Who would you give it to?	person
7b. Why?	comment
8. I felt that the other player(s) responded to my actions?	never/sometimes/ always
9. I communicated well with the other participants (never/sometimes/always)?	never/sometimes/ always
10. I helped the group reach the goal (never/sometimes/always)?	never/sometimes/ always
11. The group co-operated well (never/sometimes/always)?	never/sometimes/ always
12. The other players made helpful comments that allowed me to catch up?	never/sometimes/ always
13. The other players were hindering my progress or slowing me down (y/n)?	y/n?
14. I understand what to do exactly (never/sometimes/always)?	never/sometimes/ always
15. I was well matched with the other player(s) (disagree/agree/strongly agree)?	disagree/agree/str ongly agree
16. I felt pressure to lead the progress (never/sometimes/always)?	never/sometimes/ always

17. Did you do anything that helped or hurt the other player(s)?	y/n/sometimes?
17a. Explain and give examples.	comment
18. Did you share goals with the other players?	y/n?
18a. How did that impact your play?	comment
Please rank the games played today from your favorite to least favorite	

Game Referenced:

Harmonix (2008) Rockband 2, (Xbox 360, PS3, Wii) : MTV Games and Electronic Arts

Traveller's Tales (2007) Lego Star Wars (Windows, PlayStation 2, Xbox, Nintendo GameCube, Mac OS X): Eidos Interactive, LucasArts

Rare (2005).Kameo: Elements of Power (Xbox360): Microsoft Game Studio

Media Molecule (2008). Little Big Planet (PlayStation 3): Sony Computer Entertainment Europ

Steve Russell (1962). Spacewar (PDP-1)

Nolan Bushnel (1970). Computer Space (Arcade): Nutting Associates

Ralph Baer (1966).Tennis for two (Analog computer/Oscilloscope),

Atari Inc. (1972) Pong (Arcade): Atari Inc.

Capcom, (2008). Resident Evil 5 (Xbox 360, PlayStation 3, Microsoft Windows): Capcom

Valve (2008). Left4dead (Microsoft Windows,Xbox 360,Mac OS X) : Valve Corporation

Bungie (2001 to 2010). Halo Series (Xbox, Xbox 360, Windows/Mac-based PCs): Microsoft Game Studio.

Irrational Games (2007). BioShock (Microsoft Windows, Xbox 360, PlayStation 3, Mac OS X): 2K Games

Monolith Productions (2006) Fear (Windows, Xbox 360, PlayStation 3): Vivendi Universal

Ubisoft Montreal (2008). Lost (Microsoft Windows, Xbox 360, PlayStation 3, iPod, iPhone): Ubisoft

Electronic Arts (2004-2008) Medal of Honor (PlayStation, Game Boy Advance, PC (Linux, Windows), Mac OS X, PlayStation 2, Nintendo GameCube, Xbox, PlayStation Portable, Wii, Xbox 360, PlayStation 3) : Electronic Arts

Sony Entertainments (2003). Star Wars Galaxies (Microsoft Windows) : LucasArts

Maxis (2002) The Sims Online (Microsoft Windows): Electronic Arts

EA Canada (1991-2011) NHL series (PlayStation 3,Xbox 360) : EA Sports

FASA Interactive (2005). Shadowrun (Xbox 360, Microsoft Windows): Microsoft Game Studios

Splash Damage (2003). Return to Castle Wolfenstein: Enemy Territory (Linux, Mac (Universal), Windows): Activision

Namco Bandai (2007) Beautiful Katamari (Xbox 360): Namco Bandai

THQ (2008) Wall-E (Microsoft Windows, Nintendo DS, PlayStation 2, PlayStation 3, PlayStation Portable, Wii, Xbox 360, Mac OS X): Disney Interactive Studios

NinjaBee (2006). Cloning Clyde (Xbox 360): Microsoft

Electronic Arts (2005) . Harry Potter and the Goblet of Fire (Game Boy Advance, Microsoft Windows, PlayStation 2, PlayStation Portable, Xbox, Nintendo DS, GameCube): Electronic Arts

Luxoflux (2008) .Kung Fu Panda (Microsoft Windows 7, Wii, PlayStation 3, PlayStation 2, Xbox 360, Nintendo DS):Activision

Nintendo (2007). Mario Galaxy (Wii), Nintendo

Electronic Arts Montreal (2008). Army of Two (PlayStation 3, Xbox 360). Electronic Arts

References:

[1] J.B. Rocha, S. Mascarenhas, and R. Prada, "Game Mechanics for Cooperative Games," *ZON Digital Games 2008*, 2009, p. 72.

[2] T. Mahlmann, A. Drachen, J. Togelius, A. Canossa, and G.N. Yannakakis, "Predicting Player Behavior in Tomb Raider: Underworld."

[3] Magy Seif El-Nasr, Bardia Aghabeigi, David Milam, Mona Erfani, Beth Lameman, Hamid Maygoli, Sang Mah. (2010). Understanding and Evaluating Cooperative Games. CHI 2010.

[4] M.A. Federoff, "Heuristics and usability guidelines for the creation and evaluation of fun in video games," Citeseer, 2002.

[5] H.J. Murray, *A history of board-games other than chess*, Clarendon press, 1952.

[6] J. Raessens and J. Goldstein, *Handbook of Computer Game Studies*, The MIT Press, 2005.

[7] T. Fullerton, *Game Design Workshop, Second Edition: A Playcentric Approach to Creating Innovative Games*, Morgan Kaufmann, 2008.

[8] E. Adams and A. Rollings, *Fundamentals of Game Design*, Prentice Hall, 2006.

[9] B. Sheffield, "An Uphill Battle: Chris Ferriera On Army Of Two's Gameplay and Philosophy," *Gamasutra*, 2007.

[10] C. Remo, "Building Franchise Power: An Army Of Two Interview," *Gamasutra*, 2009, p. 6.

[11] P. Luban, "Multiplayer Level Design In-Depth, Part 3: Technical Constraints and Accessibility," *Gamasutra*, 2006, p. 5.

[12] I. Taylor, "The Death Of Local Co-op," 2010.

[13] P. Luban, "The Megatrends of Game Design," *Gamasutra*, 2008, p. 4.

[14] Greenwood-Ericksen and P. Goodman, "Why Left 4 Dead Works," *Gamasutra*, 2010, p. 5.

[15] D. Bowring, "Designing for Co-Operative Play in an Open World," 2010.

[16] M. Wallace, "From COUNTER-STRIKE to LEFT 4 DEAD: Creating Replayable Cooperative Experience," Game Developer Conference, San Francisco 2009.

[17] J.P. Zagal, J. Rick, and I. Hsi, "Collaborative games: Lessons learned from board games," *Simulation & Gaming*, vol. 37, 2006, p. 24.

[18] U. Hagen, "Designing for Player Experience." FDG 2010,

[19] J. Holopainen, T. Nummenmaa, and J. Kuittinen, "Modelling Experimental Game Design." FDG 2009.

[20] A. Kerr, "Representing users in the design of digital games," *Computer Games and Digital Cultures Conference Proceedings*, 2002.

[21] C. Lindley, "The gameplay gestalt, narrative, and interactive storytelling," *Computer Games and Digital Cultures Conference*, 2002, pp. 6–8.

[22] G. Lauteren, "The Pleasure of the Playable Text: Towards an Aesthetic Theory of Computer Games," *Computer Games and Digital Cultures. Tampere*, 2002, pp. 6–8.

[23] U. Hagen, "Where Do Game Design Ideas Come From? Invention and Recycling in Games Developed in Sweden," *World*, vol. 2004, 2007, p. 24.

[24] S. Björk and J. Holopainen, *Patterns in game design*, Cengage Learning, 2005.

[25] J.B. Rocha, S. Mascarenhas, and R. Prada, “Game Mechanics for Cooperative Games,” *ZON Digital Games 2008*, 2009, p. 72.
[26] R. Hunicke, M. LeBlanc, and R. Zubek, “MDA: A formal approach to game design and game research,” *Proceedings of the AAAI Workshop on Challenges in Game AI*, 2004, pp. 04–04.
[27] K. Salen and E. Zimmerman, *The Game Design Reader: A Rules of Play Anthology*, The MIT Press, 2005.
[28] C. Fabricatore, M. Nussbaum, and R. Rosas, “Playability in action videogames: A qualitative design model,” *Human-Computer Interaction*, vol. 17, 2002, pp. 311–368.
[29] C. Fabricatore, “Gameplay and game mechanics design: a key to quality in videogames,” *Proceedings of OECD-CERI Expert Meeting on Videogames and Education*.
[30] D. Milam and M.S. El Nasr, “Analysis of level design'push & pull'within 21 games,” *Proceedings of the Fifth International Conference on the Foundations of Digital Games*, 2010, pp. 139–146.
[31] A. Sears and J.A. Jacko, *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications, Second Edition*, CRC Press, 2007.
[32] B. Fulton, “Beyond Psychological Theory: Getting Data that Improve Games,” Gamusatra 2002.
[33] K. Isbister and N. Schaffer, *Game Usability: Advancing the Player Experience*, Morgan Kaufmann, 2008.
[34] R. Bernhaupt, *Evaluating User Experience in Games: Concepts and Methods*, Springer, 2010.
[35] J.P. Davis, K. Steury, and R. Pagulayan, “A survey method for assessing perceptions of a game: The consumer playtest in game design,” *Game Studies*, vol. 5, 2005.
[36] D. Pinelle, N. Wong, and T. Stach, “Heuristic evaluation for games: usability principles for video game design,” *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems*, 2008, pp. 1453–1462.
[37] C. Lewis, P.G. Polson, C. Wharton, and J. Rieman, “Testing a walkthrough methodology for theory-based design of walk-up-and-use interfaces,” *Proceedings of the SIGCHI conference on Human factors in computing systems: Empowering people*, 1990, pp. 235–242.
[38] R.G. Bias, “The pluralistic usability walkthrough: Coordinated empathies,” *Usability inspection methods*, 1994, p. 76.
[39] J. Annett and K.D. Duncan, “TASK ANALYSIS AND TRAINING DESIGN.,” 1967.
[40] J. Nielsen, “Usability inspection methods,” *Conference companion on Human factors in computing systems*, 1994, pp. 413–414.
[41] B. Shelley, “Guidelines for developing successful games,” *Game Developers Conference, San Jose.(ibid)*, 2001.
[42] J. Nielsen, “Heuristic evaluation,” *Usability inspection methods*, 1994, pp. 25–62.
[43] T.W. Malone, “Heuristics for designing enjoyable user interfaces: Lessons from computer games,” *Proceedings of the 1982 conference on Human factors in*

computing systems, 1982, pp. 63–68.

[44] C. Crawford, *The art of computer game design*, Osborne/McGraw-Hill, 1984.

[45] Greenwood-Ericksen, Preisz, and Stafford, “Usability Breakthroughs: Four Techniques To Improve Your Game,” *Gamasutra*, 2010, p. 6.

[46] B. Fulton and M. Medlock, “Beyond focus groups: Getting more useful feedback from consumers,” *Proc. Game Dev. Conf*, 2003.

[47] C. Bateman, *Beyond Game Design: Nine Steps Towards Creating Better Videogames*, Charles River Media, 2009.

[48] M. Seif El-Nasr, B. Aileen Lameman, B. Aghabeigi*,, A. Gagne, D. Moura, W. Foster, and A. Drachen, “Developing Methods for Evaluation of Virtual Worlds and Multiplayer
Games: An Early Report,” 2010.

[49] A. Drachen and A. Canossa, “Analyzing Spatial user Behavior in Computer Games using Geographic Information Systems,” *Proc. MindTrek.*

[50] N. Ducheneaut and R.J. Moore, “The social side of gaming: a study of interaction patterns in a massively multiplayer online game,” *Proceedings of the 2004 ACM conference on Computer supported cooperative work*, 2004, pp. 360–369.

[51] Y.H. Fua, M.O. Ward, and E.A. Rundensteiner, “Hierarchical parallel coordinates for exploration of large datasets,” *Visualization'99. Proceedings*, 2008, pp. 43–508.

[52] C. Swain, “Master Metrics: The Science Behind the Art of Game Design,” *Presentation at NLGD Conference, Utrecht, Holland (2008)*, 2008.

[53] P. DeRosa, “Tracking player feedback to improve game design,” *Gamasutra, Aug*, vol. 7, 2007.

[54] D. Kennerly, “Better game design through data mining,” *Gamasutra, August*, vol. 15, 2003.

[55] R. Mandryk, K. Inkpen, and T. Calvert, “Using psychophysiological techniques to measure user experience with entertainment technologies,” *Behaviour & Information Technology*, vol. 25, 2006, pp. 141-158.

[56] J.H. Kim, D.V. Gunn, E. Schuh, B. Phillips, R.J. Pagulayan, and D. Wixon, “Tracking real-time user experience (TRUE): a comprehensive instrumentation solution for complex systems,” *Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems*, 2008, pp. 443–452.

[58] K. Borner and S. Penumarthy, “Social diffusion patterns in three-dimensional virtual worlds,” *Information Visualization*, vol. 2, 2003, pp. 182–198.

[59] R. Thawonmas and K. Iizuka, “Visualization of online-game players based on their action behaviors,” *International Journal of Computer Games Technology*, vol. 2008, 2008, pp. 1–9.

[60] P. Sweetser and P. Wyeth, “GameFlow: a model for evaluating player enjoyment in games,” *Computers in Entertainment (CIE)*, vol. 3, 2005, p. 3.

[61] M. Csikszentmihalyi and M. Csikzentmihaly, *Flow: The psychology of optimal experience*, HarperPerennial New York, 1991.

[62] G. Yannakakis and J. Hallam, “Capturing Player Enjoyment in Computer Games,” *Advanced Intelligent Paradigms in Computer Games*, 2007, pp. 175–201.

[63] L. Bickman and D.J. Rog, *The SAGE handbook of applied social research methods*, SAGE, 2008.

[64] G. Cocker, “LittleBigPlanet Review,” *Little Big Planet is a novel, imaginative, and*

highly customisable platform game., 2009.
[65] D. Cartledge, “LittleBigPlanet Review: We head to the LittleBigPlanet to review this PS3 wonder.,” *LittleBigPlanet Review*, 2008.