Understanding co-located collaborative gaming: player strategies and breakthroughs

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NOTE BY THE UNIVERSITY

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ABSTRACT

Co-located multiplayer gaming is a popular activity that involves multiple people playing together in the same physical space. Previous literature has investigated instances of learning during play by considering the importance of player initiated strategies in overcoming problems. Such moments are seen as opportunities in which learning can take place. These moments, or breakthroughs, occur as a result of successful strategy use. However, there has been minimal focus within the context of collaborative play and how players develop strategies to overcome problems together. The present study investigated the types of strategies that resulted in breakthroughs when playing in a co-located collaborative setting. Eleven pairs of participants were tasked with playing a popular game, Portal 2, for 40 minutes. Observations and video analysis helped identify a set of player strategies that led to breakthroughs. Additionally, it was found that player expertise impacts the types of strategies used, which ultimately influenced the number of breakthroughs experienced and progress made in the game. This study builds on the methodology of breakthroughs and provides perspectives into instances of learning during play within a previously unexplored area. Furthermore, by considering the different approaches players undertake, games designers can ensure that their games support and maintain involvement for all players.
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CHAPTER 1. INTRODUCTION

According to Lazarro (2005) the ‘people factor’ is one of the main reasons for why we play games. It is therefore unsurprising that co-located multiplayer gaming has become such a popular activity. Co-located multiplayer games offer us meeting places in which rich interactions, social engagement and collaborative learning takes place (Voida & Greenberg, 2009). As such they have been of interest to educators for many years now. Others have suggested the importance of considering how informal learning takes place in entertainment games (Gee, 2007). There is a view that by utilising the essence of what makes gaming motivating and fun we can move beyond fact based content delivery in education games, to provide improved and more engaging ways for learning to occur.

Despite this, concerns have been raised in regards to how and what players learn while playing (Squire, 2002). A number of researchers have been addressing this by outlining a method of analysis using ‘breakdowns’ and ‘breakthroughs’ to help understand moments of gameplay in which learning occurs (Pelletier & Oliver, 2006; Iacovides et al., 2011). However, there has been limited attention on how such methods apply to multiplayer contexts. Although multiplayer gaming has been acknowledged by some, the sample size of collaborative play has been small (Iacovides, 2012). Furthermore, previous research has found that players employ a variety of strategies when attempting to overcome breakdowns during play, which results in the possibility for learning to occur in the form of breakthroughs. A set of strategies were established to account for the approaches players took in overcoming breakdowns (Knoll, 2012). However, similar to the work on breakdowns and
breakthroughs, the strategy list was solely based on single-player gaming experiences. The use of strategies in relation to breakthroughs during co-located collaborative play warrants further investigation.

The present study aims to address this gap in the literature by considering how players collaborate to overcome problems, and reach breakthroughs in a co-located setting. Focus will be placed on the strategies that players utilise that lead to breakthroughs. Additionally, the adoption of these strategies will be considered in relation to player expertise, providing deeper insights into how learning occurs in a previously unexplored area.

This study aims to provide a way of examining co-located collaborative gameplay at a more granular level. In addition, it will aid games designers by allowing them to consider the strategies used by different players to better support collaborative breakthroughs and learning during play.
CHAPTER 2. LITERATURE REVIEW

This chapter will address the literature on learning and videogames, social gaming and the methods used to help examine gameplay.

2.1. Learning and games

Videogames are naturally engaging and motivating for players because they have characteristics which make them fun, challenging and peak player curiosity (Malone, 1981). It is no surprise that educators want to harness the positive aspects of gaming to encourage learning in formal educational settings.

Educational games attempt to take elements of videogames design and combine it with educational content. However, edutainment games often take the worst part of education and combine it with uninteresting gameplay (Charsky, 2010). In recent years there has been a greater focus on so called ‘Serious Games’. These non-entertainment games are used for a variety of serious domains, including education. In contrast to edutainment, it is less focussed on drill and practice. Instead, as Charsky (2010) states, it places greater emphasis on designing gameplay to support players in “learning higher order thinking skills” (p.180). There has also been interest in investigating informal learning taking place within entertainment videogames. Gee (2007) argues that when playing games, the learning process is supported by the fact that they are an interactive medium which allows players to influence the virtual world through their actions. Players can experiment and probe the game world, with their acquired feedback they can go on to try additional ideas. Gee (2007) makes a case that playing games in this way is more beneficial than
being told about content and facts, and outlines a set of principles incorporated into what he calls ‘good’ games which supports the learning process.

According to Gee (2007) social factors are important area to consider because the act of thinking and reasoning is fundamentally a social process. Playing with others has been of interest for both serious and entertainment games. Such games can allow for the development of leadership, team building and collaboration skills (Bonk & Dennen, 2005; Ellis et al., 2008). For example, Hummel et al. (2011) used a scripted virtual collaborator in an educational setting to investigate the interactions and learning that takes place. Not only did the quality of learning improve, but students also found it to be a more insightful experience.

In many ways social, or multiplayer, games align well with social learning theories. Vygotsky (1978) discussed that it is possible to learn and solve problems above our developmental level when under “guidance or in collaboration with more capable peers” (p.86). He called this the Zone of Proximal Development (ZPD), which he claimed is a key feature of learning; the ‘zone’ being the difference between what we can do on our own, and what we can potentially do when amongst others. The ZPD is particularly pertinent to ‘play’, which Vygotsky considered as one of the most important contributing factors to early stages of development.

Gaming, especially multiplayer games, offers environments in which we can interact, work and play with others. In other words, these environments provide a safe and engaging way for players to potentially reach their ZPD. For instance, Gee’s (2007) ‘Distributed Principle’ states that knowledge and meaning within a
game is distributed across tools, technology, and other players. Such a distribution could entail players sharing their knowledge with one another to assist with particularly difficult sections of a game. The notoriously difficult game ‘Dark Souls’ illustrates this well. Players can leave information in the virtual world for others to find, warning them about upcoming traps or enemies. The power of these distributed systems stems from the ways they are interconnected to support learning. For example, many games have active online communities, or Affinity Groups, where knowledgeable individuals can connect to and make use of each other’s expertise (Gee, 2007). Another example of this involves watching others play a game in real time or via uploaded recordings. By becoming spectators of gameplay sessions, people may model and develop their own knowledge based on what they observe (Kim, Park, & Baek, 2009). Such distributed systems have even caught the attention of console manufacturers, with Sony offering the ability to stream and share gaming sessions on their upcoming PlayStation 4.

2.2. Social play

The previous section has briefly touched on some of the literature in the area of games and learning. However, it is also worth considering that many factors can influence social gameplay experiences. The following section will outline some of these and their impact on learning.

2.2.1. Environment and player types

Playing a multiplayer game in a co-located setting is a very different experience to playing online. De Kort and Ijsselsteijn (2008) suggest that social presence can be
greater in co-located settings. However, they also mention that this may be oversimplifying it since co-located gaming can take many forms. For example, sharing a TV interface is different to gaming at an internet café where players are situated in front of their own computers. Even when playing on the same interface, players are usually orientated in such a way that the focal point is the screen. Such arrangements can be counter intuitive to social practices like eye contact and other social cues (De Kort & Ijsselsteijn, 2008). Thus, playing a game in co-located space does not necessarily guarantee increased social presence or engagement, which may influence perceived learning outcomes (Richardson & Swan, 2003).

The environmental context is not the only contributing factor for engagement and experience. Voida and Greenberg (2009) found that co-located games serve as a meeting place for a wide variety of players with varying levels of expertise. They observed that players' expertise and skill levels differed from one game to the next. Also, the influence of real world experiences seemed to play a part. For example, a player who could play acoustic guitar, but with no gaming expertise, was on par with those who had substantial expertise with ‘Rock Band’ and ‘Guitar Hero’. Another key finding was that mentoring between the expert and novice gamers was commonplace, suggesting that learning in co-located gaming can largely be influenced by the expertise level of whom you play with.

Other literature also categorises players in terms of expertise (Reeves, Brown & Laurier, 2009). They used the game ‘Counter Strike’ to see how player behaviour constitutes skilled expertise. The players they observed, through practice, were capable of conducting a “symphony of combined complex activity in a terrain of
developing, emergent tactics” (p.26). In other words, the expert players not only knew the maps spatially but had learned about the importance of different features contained within, for varying contexts. Such findings point towards Gee’s (2007) ‘Intuitive Knowledge Principle’, which states that tacit knowledge is attained with continued experience in a particular game or genre. This sort of learning occurs over extended periods of play, and points towards expertise. The aforementioned studies highlight two potential ways in which player expertise can be classified.

Stevens, Satwicz, and McCarthy (2008) echo the view that it’s important to consider what goes on outside of the game, in terms of the environment and players, as this can help point towards the learning that occurs. They conducted an ethnographic study of children playing games in co-located settings and observed that learning was mediated by various group and social behaviours. They noted instances of interactions in the physical space directly influencing in-game actions. For example, there was an occasion when two friends were playing a two-player game, and one player shows the other how to perform a particular move by holding the controller in his line of sight.

They also witnessed players’ expertise levels defining the sort of interactions that took place. For example, a brother and sister exhibited teaching and learning roles. The brother, the expert, was a resource of knowledge for his sister. She would ask questions about the game mechanics only when needed. With another pair they witnessed an older, more experienced player, helping a young inexperienced sibling. An apprenticeship was established where the younger player would take advice and guidance, but would nevertheless go against it at times. Such interactions show that
players are in control of constructing their own learning environment as and when required (Stevens, Satwicz, & McCarthy, 2008). To surmise, Stevens et al. (2008) are of the view that the quality of the game design is not the only factor to consider, but rather it is the interactions between those in the environment that help give rise to engagement, knowledge transfer and learning to take place.

2.2.2. Game types

The physical space and who you play may influence players’ experiences of learning, but the type of game must also be considered.

Games typically support various forms of social play by employing different design mechanics. Using game theory, Zagal, Rick and Hsi (2006) identified three main gaming categories: collaborative, cooperative and competitive. With competitive games, players have opposing goals to one another. An example is a ‘beat ‘em up’ game like Street Fighter, in which players compete against each other to be victorious in combat. In contrast, with cooperative games players are presented with the opportunity to work together which could result in a mutual win condition for all involved. However, because players may have misaligned objectives, the outcome may benefit each of them in different ways. Collaborative games, unlike cooperative, are when all players share a single goal and work together to achieve it. Any outcomes, be they positive or negative, are shared by the entire team (Zagal et al., 2006).

Collaborative and competitive games are seen as being at opposing ends of the gaming landscape. However, the difference between collaborative and cooperative
gameplay is far more subtle. Cooperative games fit somewhere between competitive and collaborative types, containing elements of both. For example, a group of players in a massively multiplayer online role-playing game (MMORPG) may work together to overcome a particularly tough group of enemies, but one player may be more motivated in acquiring a rare item. Thus, the player may betray the group if an opportunity presents itself to acquire the item he seeks. In a collaborative game, players can also behave selfishly, but such a strategy may end up hindering the accomplishment of the shared goal for all. Despite this distinction between these two game types, the gaming industry and players often refer to them interchangeably, using the catch all term ‘co-op’. However, for the purposes of this dissertation Zagal’s et al. (2006) term ‘collaboration’ will be used.

Furthermore, collaborative games allow for interesting interactions and opportunities for rich learning to take place (Nardi & Harris, 2006). It is therefore an interesting game type to investigate the learning that takes place between different players.

2.3. Examining gameplay

The previous sections have explored games within the context of learning and social domains. The remainder of this chapter will describe potential ways of examining gameplay for instances of learning.
2.3.1. Strategies

Many researchers have investigated the use of player strategies, as these can help point towards how learning occurs during play. Akan and Cagiltay (2007) investigated how novices learn to play a game, and were particularly interested in the strategies they employed during the learning process. They used eye tracking to record eye fixations during the gameplay. Eye tracking is a widely used method within the usability evaluation field; the benefits of which are becoming more evident for videogame analysis. Akan and Cagiltay (2007) found that the highest level of fixations were during the puzzle sections of the game, suggesting that players were thinking more in these areas than any other. Their video data showed that trial and error was a key strategy players undertook to gain information about the game. Although their study highlights some player strategies, it says little about the relevance of eye tracking fixations on strategy formation or learning.

Pretorius, Gelderblom and Chimbo (2010) also used eye tracking to compare game learning patterns between children and adults. The data suggested that adults struggled more with the game because they were more reliant on the help as indicated by greater eye fixations. It was observed that children used a trial and error approach more so than adults, who were instead more systematic with their approach. For example, when stuck adults looked around the screen for clues, whereas children randomly clicked in an attempt to find an appropriate action.

Such studies help demonstrate some of the potential benefits of eye tracking in videogame analysis; the data can help point towards areas of interest in a game.
However, it must be noted that both Akan and Cagiltay (2007) and Pretorius et al. (2010) supplemented the eye tracking with video and interview data. This is because on its own, eye tracking doesn’t tell us the whole story. The data needs to be analysed carefully for it to convey meaning. There are also issues with it from a pragmatic perspective; first of all it is difficult to make comparisons between player fixations during moving parts of a game since each person plays it differently. For example, Pretorius et al. (2010) had to focus on consistent screen elements like when instructions were shown. Secondly, it is not always feasible option for examining co-located multiplayer games. A single eye tracking system is unable to simultaneously record eye saccades and fixations of multiple people, so cost can be an issue.

A widely utilised data gathering method in the gaming industry is that of gameplay metrics. This form of data remotely logs player actions that occur in the game. The greatest advantage of the method is that it offers vast quantities of data from large sample sizes. Huang, Zimmermann and Harrison (2013) explored how player’s patterns of play influenced their skill levels in ‘Halo: Reach’. They used data from three million different players from multiplayer gaming sessions spanning over a seven month period. The data was collected using an analytical player ranking system developed by Microsoft Research called TrueSkill. Their findings highlighted several player patterns that impacted skill development. For example, by not taking breaks between game sessions, players’ skill levels increased. The metrics were supplemented with open-ended interviews and questionnaires to gain deeper insights. An interesting finding emerged which brings to mind Vygotskys
most respondents stated they thought they played better when playing with those more skilful than themselves. A limitation with such an approach is that the data doesn’t say much about what players were thinking, or how they were interacting when playing together. For example, the talking and collaboration that occurs can impact skill and learning. The metrics don’t take this into consideration as it’s purely quantitative in nature.

Other researchers have explored the utility of using game design patterns in helping analyse gameplay. El-Nasr et al. (2010) created a set of metrics based on observable events during cooperative gameplay, which they called cooperative performance metrics (CPM). They identified a total of six CPM’s. For example the ‘Global Strategies’ metric involves gameplay events when players take on different roles to complement what each of their avatars can do. Alternatively the ‘Worked out strategies’ event encapsulates events in which players talk to each other to try and figure out a solution. Using the CPMs they analysed a number of gameplay sessions and occurrences of CPMs were mapped to a corresponding design pattern. The CPMs are, in effect, a way of evaluating the most prominent design patterns in a cooperative game. However, these don’t necessarily tell us about the process of learning taking place during the gameplay, but rather how we can evaluate games to ensure it contains good design practice.

The literature discussed in this section acknowledges the use of some of the common data gathering and analysis methods used in games research. The next section outlines a method which helps focus analysis specifically on instances of learning.
2.3.2. Breakdowns and Breakthroughs

There has been a body of work focussing on understanding the moment by moment gameplay that focusses on how and what people informally learn when playing games (Pelletier & Oliver, 2006; Iacovides et al., 2011). This section considers the literature on examining such instances of gameplay.

Pelletier and Oliver (2006) utilised Activity Theory as a basis for their methodology of analysing gameplay, to better examine players learning processes. They suggest, based on the work of Engeström (2001), that ‘contradictions’ are an important part of the active learning process. In other words, the learning process is one which is influenced by experiencing and overcoming problems in the activity. Pelletier and Oliver (2006) used the term ‘contradictions’, or breakdowns, to analyse gameplay. By analysing moments during play when breakdowns occurred, they could make note of strategies utilised by the player to try and overcome the problem. These scenarios were considered moments in which learning was taking place. The implication of this is that breakdowns during play can potentially contribute to player learning.

Pelletier and Oliver’s (2006) breakdown based method helps in identifying learning in gameplay, but it is not without issue. The problem is that the small sample of participants and specific games used, does not allow for wider generalisations to be made. Also, their findings didn’t adequately consider the players transfer of knowledge from other games. Although they were able to see it happen, they could not be certain where it was transferred from. This perhaps stems
from a more fundamental problem, the interpretation of player behaviour was based purely only on observation. As such, they could not be certain of the players’ intentions.

More recent work builds on the use of breakdowns. Iacovides et al., (2011) applied the concept of breakdowns in a multiple case study approach. Unlike previous work, Iacovides (2011) utilised multiple data gathering methods to get a better understanding of player intentions. Also, the approach was adapted to include the concept of breakthroughs to explain when breakdowns were overcome. Breakthroughs, as defined by Sharples (2009) are “critical incidents which appear to be initiating productive new forms of learning or important conceptual change” (p.10). What emerged was that breakdowns and breakthroughs occur in relation to player action, understanding and involvement. For instance, an ‘action’ breakthrough could be when a player learns a new game mechanic. An example of ‘understanding’ is when a player figures out how a puzzle works. Finally, ‘involvement’ may entail a player becoming more engaged in the game as a result of progression.

These categories offer a way of considering gameplay in greater levels of detail. Rather than labelling all problems as breakdowns (Pelletier and Oliver, 2006), a researcher is able to identify whether it’s a breakdown that occurs during normal course of play, or something more fundamental. The categories provide clues as to what the game design should mitigate or have more of. For example, ‘action’ breakdowns present opportunities for a breakthrough to emerge through the
successful use of strategies, whereas ‘involvement’ breakdowns are far less desirable because if a player experiences this they may stop playing the game.

Iacovides et al. (2011) suggest that overcoming a breakdown or progressing in the game doesn’t necessary mean learning took place. The concept of breakthroughs is important to consider, as these not only indicate overcoming a breakdown but suggest when learning occurred. However, the relationship between breakdowns and breakthroughs are more nuanced than this, and often the type of breakdown or breakthrough experienced impacts whether or not learning occurs. Therefore, the following section takes a more in-depth look at breakthroughs by exploring the findings from Iacovides (2012).

### 2.3.2.1. Breakthroughs and learning

For learning to occur, a player needs to understand how and why the breakthrough resulted in overcoming a breakdown (Iacovides, 2012). The dynamics of such situations are particularly interesting to consider in collaborative settings. For example, one player’s actions may cause the other to figure out the solution to the problem. Or communication between players may facilitate understanding breakthroughs.

However, understanding breakthroughs are not always required to progress in the game. There may be occasions when a player progresses with just an action breakthrough. The latter can occur by accident, resulting in progression but without the accompanying understanding breakthrough, which means learning hasn’t taken
place. Additionally, since players will not feel responsible for what happened this may make for an unsatisfying experience.

The above scenario may have a negative impact on player involvement, but the most detrimental outcome is if an action breakthrough doesn’t occur at all. This means that progress will be blocked to the player. An experience such as this may frustrate the player, and could result in a breakdown of involvement. There may also be times when involvement increases due to understanding breakthroughs, or it simply maintained as a result of action breakthroughs. Therefore, player involvement and learning can be seen as being in a constant state of flux during gameplay.

2.3.3 Breakdowns and Breakthroughs in identifying strategies

As previously mentioned, Pelletier and Oliver (2006) considered strategies as a way of pointing towards learning during play. However, they only outlined a small number of descriptive strategic approaches that players used during limited gameplay scenarios. Additionally, the small number of participants makes it difficult to apply these strategies to other games.

Knoll (2012) identified various strategies that players employ to overcome breakdowns. He found that the strategy used differed depending on whether the player was a ‘hardcore’ or ‘casual’ gamer. For example, casual gamers relied on trial and error more so than hardcore gamers. However, regardless of gamer type, trial and error was actually found to be the predominant strategy utilised by all. This was possibly due to the fact that participants had no prior knowledge of the games
used in the study. The focus of the analysis was on strategies developed after breakdowns, which according to Knoll (2012) takes into account all strategies and not just the ones that result in successful breakthroughs. Such an approach may be problematic for multiplayer games. However, by choosing to focus on how breakthroughs are achieved, player approaches, successful or otherwise, can still be considered. Additionally, this would take into account the fact that breakthroughs can occur without breakdowns. It is true that breakdowns make it easier to identify a breakthrough, but it does not mean they always occur in this way (Iacovides et al., 2011). These points are important to consider, especially with co-located collaborative games. The interactions between players could possibly have an impact on their experiences of breakthroughs, irrespective of overcoming an in-game problem.

The other limitation of Knoll’s (2012) study was that the strategies were created by analysing web based games only. Therefore, the extent to which these strategies are applicable to larger and more mainstream game warrants further consideration. Further, with multiplayer gaming, one can expect additional strategies to emerge. The broad group of strategies developed by Knoll (2012) provides a solid foundation to build upon.
2.4. Summary and research questions

This chapter has highlighted some of the literature surrounding learning and games, as well as the methods used within the field to examine gameplay. More recent work has focused on breakdowns and breakthroughs that occur during play. However, there has been limited attention on how such methods of analysis can help understand how learning and progression occurs during co-located collaborative gameplay.

The aim of the current study is to explore how players experience breakthroughs during co-located collaborative play. It will do this by considering how players of varying expertise develop and use strategies as a precursor to their breakthroughs. It will build on, and refine the current taxonomy of identified strategies (Knoll, 2012) thus ensuring its applicability to co-located collaborative gameplay.

This study will help explain the ways in which players collaboratively approach and overcome problems during gameplay. To do this, the analysis will address the following research questions:

1. What kinds of strategies lead to breakthroughs in a co-located collaborative setting?

2. How will player expertise influence the development of strategies leading to breakthroughs?
CHAPTER 3. METHOD

Previous research highlights the significance of considering breakdowns and breakthroughs as a way of identifying learning during play. However, the strategies employed by players that lead to breakthroughs within a co-located collaborative context have not been sufficiently investigated. This chapter outlines a study that aims to address the research questions mentioned in the previous chapter.

3.1. Participants

Twenty-two (11 pairs) participants were recruited for the study from the University College London ‘Subjects Pool’ and through social media. There was a mix of participants consisting of students and non-students, with a total of 19 males and three females. Their age ranged from 19-34, with an average age of 25.86. The participants were recruited in pairs, where the principle participant brought along someone they felt comfortable playing with, such as a friend or family member.

The advert targeted participants who play games, specifically those with experience in First-Person-Shooter (FPS) and Puzzle games (Appendix A). The reason for this was because the game being tested had elements of both these genres. It was important for participants to be proficient with controlling and navigating around an FPS environment so that they wouldn’t be confused with the view. Participants who identified themselves as suitable for the study got in contact, and were subsequently screened with a short questionnaire (Appendix B). The purpose of this was two-fold. Firstly, it was to ensure that their experience with games was actually in-line with their self-identification. For example, one respondent cited Pac
Man as the only game he played. Unfortunately, this did not fit the FPS and Puzzle criteria and thus he was not recruited. Secondly, the screener questionnaire was used to subtly gauge participants’ expertise level with the tested game (Portal 2: discussed in next section). It was important to attain this information so that pairs could be categorised into different expertise groups for the analysis phase.

3.2. Materials

**Portal 2:** All pairs of participants were tasked with playing a popular First-Person-Puzzle video game called Portal 2, created and published by Valve through their gaming platform ‘Steam’. The game employs a 3D first-person perspective, where the camera is viewed from the eyes of the game character. Portal 2 has a multiplayer mode in which two players each control a character to overcome a variety of puzzles in self-contained levels called ‘test chambers’. It has a unique gameplay mechanic where players create two different coloured portals that work together which allow for two-way movement through them. Figure 1 shows the portals placed on the walls within the game environment.

![Image of portals](image_url)

**Figure 1:** Player 1 has light/dark blue portals. Player 2 has red/yellow portals.
As mentioned in the previous chapter, the games industry labels such games as ‘co-op’, but for the purposes of the report it will be referred to as a ‘collaborative’ game. Portal 2 was considered as it is a good example of a game that fits along the spectrum of game types as identified by Zagal et al. (2006), where players need to collaborate to progress, otherwise neither of them can reach the end of the level. The game offers both online and co-located multiplayer options. The present study utilised the co-located split-screen mode. Three different sections of the game were presented to the participants, in the following order:

**Calibration Course:** This is the games multiplayer tutorial course. It introduces players to the basics of playing the game together, such as using four portals. It also introduces the in-game communication method the ‘Ping’ tool, which allows players to draw attention to places of interest as displayed in Figure 2.

![Figure 2: Player 1 pinging at wall. Small icon appears over pinged location.](image)

This was found to be a necessary inclusion to the current study because it gives participants a chance to become familiar with the controls as well as the dynamics of playing the game together.
**Team Building (Test Chamber 1 – 3):** This is the first set of test chambers available after the Calibration course in which players have to work through different test chambers that require team work and the use of portals. For the purposes of the present study the first three chambers were used because these introduce some important gameplay mechanics beneficial for the third map. For example, test chamber 2 introduced the timed buttons, and test chamber 3 introduced the thermal discouragement beams as seen in Figure 3, both pivotal for the final map in the study.

![Figure 3: Thermal Discouragement beams in Team Building Test Chamber 3.](image)

**Friendship is Magic 3:** Portal 2 has an active online community where people create their own test chambers using the games inbuilt tools and share it with others using the Steam platform. ‘Friendship is Magic 3’ is a highly rated map with five stars out of five, rated by 8334 players. It is a linear yet open ended chamber where one part of the puzzle opens up the next and so on.

Using a custom test chamber was important for the current study since participants with varying levels of Portal expertise were recruited. By using a custom test chamber, this ensured that even expert players were encountering
puzzles they were not familiar with. Thus, those acquainted with the game mechanics still had to collaborate to solve unfamiliar problems.

**Technical and Environmental Setup**

The sessions took place at a professional user-experience lab. Two different rooms were used for the sessions. Both were furnished like a living room, containing a comfortable sofa, coffee table and TV. The environment helped maintain ecological validity, it was important that the participants felt at ease whilst playing. Additionally, the comfort of the environment was to help reduce any uneasiness in regards to being video recorded and observed. The presence of other people has been found to have an impact player performance. Social facilitation theory explains that the social presence of a person observing another can influence behaviour and performance of a player (Bowman et al., 2013). To mitigate this, it was decided for the researcher to not be situated in the room during play. A camera was placed above the TV to capture video footage of the participants sitting on a sofa, which streamed to the researchers computer. A microphone was positioned on a table in front of the sofa to record any dialogue. A desktop-recording program called ‘Morae Recorder’ by Techsmith was used to capture the gameplay feed from the PC.

The game was running on an Intel i5 gaming PC with a dedicated graphics card. The PC was connected to a large screen LCD TV where the game was presented in a split-screen format. Participants interacted with the game via wireless Xbox 360
controllers, connected to the PC using the ‘Xbox wireless receiver’ adapter. Figure 4 shows the seating arrangements in the rooms.

![Image](image.png)

Figure 4: Player 1 and Player 2 seating arrangements.

**Other Materials**

A gaming questionnaire (Iacovides, 2012) was given to participants during the session before they started to play (Appendix C). This was to ascertain participants more general gaming habits and their relationship with games. It helped corroborate findings from the screener questionnaire.

Participants were provided with printed game information sheets, this consisted of the controller mappings and a high level explanation of some of the important game mechanics (Appendix D). These materials were provided because some participants had never played Portal 2 before. Additionally, the act of using the information sheet by the player was important to note since the study was focussing on player strategies in and out of the game.
3.3. **Design**

An exploratory case study approach, similar to Iacovides et al. (2011), was employed. Pairs of participants were categorised into groups according to their expertise level with the game. For the purposes of the present study, experts were classified as participants who had played Portal 2 or its predecessor before. In total there were three different categories of groups of pairs; experts, novices and mixed. In all cases, participants had previous experience with playing games.

Participants were tasked to play the three maps in the same order, as outlined in the materials section. The gathered data was predominantly video footage of participants playing the game, and video-capture of the gameplay feed. The videos and post play interviews were analysed for breakthroughs and player strategies. The coding of the footage focused on specific points of the gameplay when a breakthrough incident was witnessed. This was particularly important to consider because in a collaborative context a participant may have a breakthrough as a result of social interaction or dialogue, and not necessary just from overcoming a breakdown.

3.4. **Procedure**

**Pilot Study**

Pilot studies were conducted with three pairs of participants made up of friends of the researcher. The pilots resulted in a number of changes in the design and
procedure of the main study. The focus of the pilot studies was on the following areas:

1. To explore and find appropriate custom community maps to use in the study.
2. To see if the game was playable by players with varying experience levels.

An important finding that emerged was in regards to the difficulty of the game. It was observed that gamers who had never played a Portal game before had trouble with the core mechanic of the game. This led to the recognition that a printed information sheet would be beneficial for participants (as described in Materials section).

The other main change was the inclusion of first three sections of the ‘Team Building’ course. This was found to have a balanced set of puzzles that less experienced players could play to familiarise with certain collaborative mechanics that did not take very long to complete. The pilot also gave an indication as to the amount of time required to complete certain test chambers. For example, a community map that was originally being considered was found to take far too long to complete, thus was dismissed from the main study.

Main Study

Participants were welcomed and taken to the lab. They were handed the study information sheet and consent form (Appendix E). A verbal brief was given, and any questions participants had regarding the study were answered. Once the
consent form was signed, participants were given the gaming questionnaire in printed form.

The game was introduced to the participants, and some information was given. For example, they were told that they could stop or ask for help at any time. Participants were informed that they were free to use the printed information sheets during the gameplay or ask for help if needed. Before commencing, they were given verbal instructions on what to do during the gameplay section of the session. Participants were tasked to play the ‘Calibration’ course, followed by the first three test chambers of the ‘Team Building’. The last part of the play session involved the community designed custom map ‘Friendship is Magic 3’. After completing the Calibration course the game sends the players to a ‘central hub’ area, here the participants had to pick the Team Building course themselves. So before the play session began all participants were shown where they had to go. Once the first three test chambers of Team Building was completed, the researcher entered the room and manually changed the course to the custom map using a keyboard console command. The participants were stopped after playing the three sections of Portal 2, or until 40 minutes had passed.

To mitigate player distraction and the social facilitation effect, the researcher would only enter the room if participants picked the wrong level, or if they specifically asked for help. There was also an additional scenario when the researcher would interrupt, and that was within the first section of the Calibration course. If players were unable to make progress in understanding the core use of portals within 10 minutes, even after using the information sheet, then the researcher
would interrupt and re-iterate how they work. This was deemed necessary since the game gives players instructions upon entering the area, which could easily be missed.

During the play session the researcher observed the participants using the video stream from another room, and took note of important events that occurred. After the play session there was a brief semi-structured interview to review and discuss some of the key events that occurred during the gameplay. The interview was audio recorded to assist with the coding and analysis. The entire session lasted no longer than an hour in total. The participants were thanked, paid, and escorted out of the lab.
CHAPTER 4. ANALYSIS AND FINDINGS

The outcomes of the gameplay sessions with the participants is outlined and described in this chapter. The first section of the chapter focusses on the coding of the data and the player initialised strategies. It will start with a detailed look at how the new strategies were developed followed by a closer look at the strategies themselves. The final section of the chapter will focus on the role of player expertise and the way in which this influenced the strategies used and breakthroughs experienced.

4.1. Analysis

A large amount of rich data was gathered through questionnaires, observation and post-play interviews.

4.1.1. Questionnaire data

Two questionnaires were presented to the participants during the course of the study. The screener questionnaire (Appendix B) helped identify participants’ expertise level with the Portal games. For the purposes of the present study, expertise was defined as having experience and familiarity with the Portal games. The screener questionnaire asked about the types of games that respondents play, of which Portal was one of the options. It helped establish whether respondents played either of the Portal games, and if so, how often and how long ago they played it. Table 1 provides an overview of the expertise categorisation. However, there was an additional purpose of the screener questionnaire. The adverts asked for participants
who considered themselves as gamers experienced with FPS and puzzle games. The screener questionnaire elicited certain information to support respondents self-identification; this was to ensure those being recruited would be comfortable playing these types of games.

Table 1: Pairs categorised under expertise levels

<table>
<thead>
<tr>
<th>Non-expert</th>
<th>Mixed</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 4</td>
<td>Pair 1</td>
<td>Pair 2</td>
</tr>
<tr>
<td>Pair 6</td>
<td>Pair 10</td>
<td>Pair 3</td>
</tr>
<tr>
<td>Pair 8</td>
<td></td>
<td>Pair 5</td>
</tr>
<tr>
<td>Pair 9</td>
<td></td>
<td>Pair 7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pair 11</td>
</tr>
</tbody>
</table>

During the session participants were presented with the gaming questionnaire (Appendix C), which was helpful in identifying general gaming habits, such as participants’ relationship with games in general. It was used to further corroborate participants’ self-identification, as well as the findings from the screener questionnaire.

4.1.2. Observation and interview data

The primary source of data was the video recordings of participants synchronised with game footage of them playing the game, as Figure 5 shows. This allowed for the observation of participants’ interactions and dialogue in the physical space along with their actions within the game-space.
There were 11 gameplay sessions, which resulted in nearly 7 hours of video data used in the analysis. Throughout the report, participants are referred to in the following way: ‘Player X’, ‘Session X’. For example, P1S3 denotes Player 1 from Session 3. Appendix F shows the full breakdown of sessions and participant categorisation.

4.1.3. Coding the data

The first two gameplay sessions were analysed for critical incidents in the form of breakthroughs. A couple of technical issues were experienced with these sessions, but since the core gameplay was not affected the data was still useful to consider. The aim of this preliminary analysis was to develop an initial set of co-located collaborative strategies. The focus of the analysis was on the moment-by-moment player approaches and how these led to breakthroughs. So although the game provides players hints and highlights actions for them to do, these were not the main point of interest.
The process of developing a set of co-located collaborative strategies was systematic and highly iterative. To begin with, individual player breakthroughs were identified in the videos. To help narrow the scope of these events, incidents were classified as when “new forms of learning or important conceptual change” occurred (Sharples et al., 2010, p.10). To further focus the analysis, Iacovides et al. (2011) breakthrough and breakdown categories were utilised: action, understanding and involvement. For example, moments when a participant realised how to progress in the puzzle or when they learnt about a game mechanic was considered to be an Understanding Breakthrough. Instances when participants realised how to use the controller to perform an action were classified as Action Breakthroughs. Finally, moments when participants were visibly happy or showed enjoyment in the game were classified as Involvement Breakthroughs.

The researcher observed and iteratively analysed the moments before the breakthrough until all relevant details were noted. This included what participants did in the game, and the interactions they had. Breakdowns before the breakthrough, if any, were also recorded. Finally the interviews were used to get additional information to clarify any misconceptions surrounding events. The identified player approaches, where applicable, were placed into one of the five strategies defined by Knoll (2012). However, these strategies did not sufficiently cover the majority of the behaviours and approaches witnessed in co-located collaborative play so further categories were developed.

A long list of co-located collaborative player approaches during play was identified. Thematic coding was undertaken to combine and categorise similar
approaches in an iterative process. To help develop the categories of strategies a number of resources were adopted, for example the collaborative design patterns of El-Nasr et al. (2010) and the co-located learning arrangements identified by Stevens et al. (2008) were considered. The first two sessions were re-coded with the new set of strategies and player approaches were categorised under them as appropriate.

With the extended set of strategies the remainder of the gameplay sessions were analysed. The same process was undertaken and the new list of approaches were categorised under a strategy where appropriate. However, a number of novel approaches were encountered, and these were used to further refine the strategies. The finalised strategy set will be presented in the following section.

4.2. Findings: Player strategies

The focus of this section is to present the findings for the first research question; what kind of strategies lead to breakthroughs in a co-located collaborative setting? It will begin by briefly examining the relevance of the previously established strategies (Knoll, 2012) on co-located collaborative play. The focus will then be on the newly created strategies and how they relate to each other. Finally, the last part of the strategy findings section will look at instances of gameplay in greater detail in the form of vignettes.
<table>
<thead>
<tr>
<th>Player strategies</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial and Error/Probing</td>
<td>Players try out ideas in a systematic way, or they take an exploratory approach and attain feedback from the game</td>
</tr>
<tr>
<td>Transfer of Knowledge (Real World, Other Games, Within Game)</td>
<td>Player knowledge is transferred to the game to help reach breakthroughs. This can stem from their knowledge of the world, experiences from other games or from prior experiences within the same game.</td>
</tr>
<tr>
<td>Practice/Repetition</td>
<td>Players practice and repeat actions to gain better proficiency at it.</td>
</tr>
<tr>
<td>Reflection</td>
<td>A player thinks carefully about what to do, or what just transpired.</td>
</tr>
<tr>
<td>Accidental</td>
<td>A player accidently reaches an understanding breakthrough.</td>
</tr>
</tbody>
</table>

Table 2: Original set of strategies established by Knoll (2012)

Players in the present study exhibited many of the strategies from Table 2, suggesting that Knolls (2012) list can be applied to co-located collaborative settings. However, the existing definitions implied that players used these to solely overcome problems, or breakdowns. The important finding from the current study was that players in collaborative settings would actually employ these strategies irrespective of breakdowns or even their overall goal. For example, it was found that players would probe the environment to try out ideas for fun.

- P1S1 and P2S1: After starting the final map, P2S1 places a portal on the ceiling and floor and jumps through them, creating a continuous loop. P1S1 notices this, and is intrigued, he wants to know what would happen if he also jumps into the loop. He tries out his idea, for a short while they are both falling through the portals, but then they crash into each other. They both laugh and carry on with the task at hand.
The subsequent sections will examine the new set of strategies as shown in Table 3, and provide a brief example for each.

<table>
<thead>
<tr>
<th>Player strategies</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultation/Discussion</td>
<td>Emphasis</td>
</tr>
<tr>
<td>Surrendering control/</td>
<td>Observation</td>
</tr>
<tr>
<td>Taking over</td>
<td></td>
</tr>
<tr>
<td>Ask for help/Guidance</td>
<td>Dividing work</td>
</tr>
</tbody>
</table>

Table 3: Newly developed player strategy list

4.2.1. Consultation/Discussion

It was found that players would often consult and initiate discussions with one another. Players chat about the problem and environment, provide feedback about what they are doing, exchange ideas and distribute knowledge to assist in meaning making. Stevens et al. (2010) observed behaviour of ‘Exchanging Knowledge and Shifting Roles through Coordinated Talk and Embodied Display’, and Gee’s (2007) ‘Distributed Principle’ in which he states that knowledge is distributed across players, objects, and the environment were the main sources of inspiration for this strategy.

- P1S11 and P2S11: The players have encountered a puzzle which requires one of them to pass a cube to the other through a window in a wall. After much discussion they realise the solution.
4.2.2. Surrendering control/Taking over

This strategy is when a player willingly, or indeed unwillingly, surrenders control to their partner who performs the action on their behalf. It can also be used as a way to share the problem to encourage joint working out of a solution.

- P1S6 and P2S6: P1S6 is having trouble performing an action even after being told what to do. P2S6 decides to intervene directly. He leans over and starts pressing the buttons on her controller to partially complete the action, as seen in Figure 6. When she still finds it difficult to finish the action, P2S6 takes the controller off her altogether.

Figure 6: Player 2 leans over and starts controlling Player 1’s avatar.

4.2.3. Asking for help/Guidance

A player becomes an explicit resource for their partner. This is initiated by a player directly asking for help. For example, they may ask about a specific game mechanic or about what they need to do. Alternatively, a player gets help in the form of very specific step-by-step instructions or guidance.
- P1S4 and P2S4: In this example P1S4 is instructing P2S4 where the portals have to be placed. He is giving specific instructions and showing where the portals should be (Figure 7). Player 2 follows the instructions and they overcome the puzzle.

![Figure 7: Player 1 guiding Player 2 through the solution.](image)

4.2.4. Emphasis

Players place specific emphasis on points-of-interest during play. This was done either by using the ‘Ping Tool’ or through embodied gesturing outside of the game. An alternative form of the strategy is when players perform or demonstrate something in-game.

- P1S8 and P2S8: The players are discussing an event. To clarify what he is saying he points at the place of interest on the TV (Figure 8).

![Figure 8: P2S8 standing and pointing at TV.](image)
4.2.5. Observation

A player momentarily stops activity to watch their partner. A player may position their in-game view to focus on what their partner is doing. Alternatively, they may watch the other player outside of the game. Perhaps the most interesting element was the variation of the strategy which involved watching the other players’ side of the screen. The strategy occurs under different circumstances; for example, players split up from one another to perform different tasks.

- P1S3 and P2S3: As seen in Figure 9, P1S3 looks over and observes P2S3, to see the embodied demonstration of how to carry out an action with the controller.

![Figure 9: Looking over at partner.](image)

4.2.6. Dividing work

The players delegate roles and tasks to each other. During the play sessions it was noticed that players would split up to probe different areas of the map. This systematic division of the environment is similar to ‘divide and conquer’ strategy as observed by El-Nasr et al. (2010). However, when the game enforces this division, it can’t be considered a player initiated strategy.
- P1S5 and P2S5: The pair divides responsibility. As Figure 10 illustrates, P1S5 looks around the map using a vantage point, whilst P2S5 tries out the cube in different receptacles.

![Figure 10: Players performing different tasks.](image)

### 4.2.7. External resource

The final strategy observed involved players checking an external resource for information. Gee’s (2007) ‘Distributed Principle’ is a core part of this strategy. With the present study the only external resource available to players was a couple of information sheets (Appendix D).

- P1S9 and P2S9: They do not know how to fire their secondary portal. P2S9 checks the information sheet (Figure 11) and passes on the findings to P1S9.

![Figure 11: Player 2 consulting the information sheet.](image)
Additionally, this strategy is unlikely to be an approach solely used in collaborative play. The interviews corroborated the use of external resources under a variety of circumstances. Participants stated that they would almost always consult external help if they became frustrated or if they were stuck for more than a certain amount of time. The amount of time it took before getting help varied between respondents. Most said they would prolong it for as long as they could, and opt to take a break from the game first. One person stated that they would stop playing the game altogether. Others said they didn’t use external resources, suggesting that they preferred overcoming a problem on their own, as this was a more satisfying experience. For example, P1S5 said: “…I keep on trying and I eventually crack it, and I enjoy that! That sort of anguish, a bit of an extreme word, but you know…”

4.2.8. How the strategies relate to each other

The way in which the strategies occurred in relation to each other was quite nuanced. Firstly, the strategies are not mutually exclusive and can be used in conjunction with one another. For example, the ‘Emphasis’ strategy was used by players to support ‘Ask for help/Guidance’, because pointing at places of interest complemented verbal instructions. It was found that the ‘Surrendering control/Taking over’ strategy also occurred in conjunction with other strategies, when used with ‘Ask for help/Guidance’ or ‘Consultation/Discussion’ it effectively helps share a problem between both players. For example, at the start of the Calibration course, P1S5 voluntarily gave his controller to his partner. The pair would discuss and carry out ideas by exchanging the controller back and forth until
an understanding breakthrough was reached. Even though a player gave up control, he was encouraging a shared approach to tackling a problem. Additionally, it was found that ‘Observation’ was compatible with the ‘Emphasis’ strategy. When a player emphasised something, the other would pay close attention. However, observations can also occur irrespective to ‘Emphasis’. There were instances when a player would observe the others screen without there being any specific emphasis being conveyed, but when there was chat and discussion. Thus, the ‘Observation’ strategy often happened in addition to strategies like ‘Consultation/Discussion’ and ‘Ask for help/Guidance’.

Additionally, the strategies were utilised in different ways depending on the context of the situation. Due to the complexity of the game and the puzzles, pairs began with a particular strategy and often shifted to another. However, the shift was subtle. For example, players would begin with ‘Consultation/Discussion’ and would start giving specific instructions. Further, the execution of strategies was on a spectrum of extremity that varied between the players. For example, where one player would provide guidance in the form of gentle nudges, another would bark out orders. Both instances fit under the ‘Ask for help/Guidance’ strategy.

Finally, conflicts and problems when using strategies were observed throughout the gameplay sessions. For instance, the ‘Transfer of Knowledge’, ‘Reflection’ and ‘Consultation/Discussion’ strategies would occasionally cause players to overthink certain solutions. For example, the test chamber exit doors only open when both players are stood in front of it, in one such area in the ‘Team Building’ map P2S7 got confused. Instead of walking to the door where P1S7 was stood, he probed the
environment looking for a way of opening the door. P1S7 clarified the situation to his partner “I think we just both have to be here”. P1S9 experienced the same problem. In this situation he explored the area for even longer because P2S9 couldn’t definitively counter or explain how exit doors works, as such he too began to doubt. Eventually they found the breakthrough. However, in both instances the problem was self-inflicted due to excessive reflection and transfer of knowledge.

4.2.9 Vignettes

The following vignettes outline segments of play which illustrates multiple strategy use, and the way in which they interrelate and lead to the breakthroughs.

**Vignette 1: Watching other side of screen to consult and exchange ideas**

The players encounter a problem in the custom map which requires them to split up to perform different tasks. In this instance P2S11 created a chain of portals in an adjacent room to activate the laser in the main room. They were both initially in the same room, but they realise that one of them needs to investigate the impact of their action within the main room. P2S11 is unable to check, because leaving the room destroys his portals. Thus P1S11 ventures out.
As Figure 12 shows, whilst P1S11 is out in the main room P2S11 is no longer controlling his avatar, and is exclusively watching the other side of the screen. They pool their resources and work on the same task, as one player probes the area with portals, the other chimes in with suggestions. Player 2 occasionally becomes active with his avatar and emphasises certain things to assist in the discussion. He pings and gestures at the TV which helps spark the breakthrough for P1S11 who realises they have a cube which can refract the laser, and she immediately consults her partner about it. During this time she invites P2S11 to observe her screen again while she emphasises what has to be done.

During the interview the pair stated that watching the others screen was something they did quite often. P2S11 found it useful to look over at the screen as it helped with his orientation in relation to his partner, and also provided support during the more confusing moments. Likewise P1S11 said that watching the other players screen was “probably the best way to communicate”. This shows that the
‘Observation’ strategy is quite flexible and can often be used in a more subtle manner.

This vignette has shown a small segment of gameplay in which a variety of strategies occurred in relation to each other. Table 4 shows an example from the coding table which shows how the segment discussed was coded.

<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
<th>Approach</th>
<th>B.T</th>
<th>P1 Strategy</th>
<th>P2 Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>40:14</td>
<td>They understand why there is a receptacle on the wall in the main room.</td>
<td>P2: “Oh! There [Points TV] … can you … along there…”</td>
<td>Un</td>
<td>Reflection: realises why the receptacle was in the main room.</td>
<td>Consultation/Discussion: Questions P1’s idea of using the cube to angle the laser into receptacle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P1: “There we go, it goes through here, see? I need to… do that…” [creates portal over laser]</td>
<td></td>
<td>Trial and Error/Probing: tries out portals to get the laser into receptacle.</td>
<td>Observation: Watches P1’s screen.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P1 places portal behind laser in the main room, and realises that she needs to get it into the receptacle. But they now understand why the receptacle is for.</td>
<td></td>
<td>Consultation/Discussion: Informs P2 about receptacle and discusses her idea about using the cube. Chats about what to with the laser.</td>
<td>Emphasis: Pinging and pointing at the wall that is in the way</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P1: “That’ll be why that’s there” They discuss potential ways of removing the black wall in front of the receptacle.</td>
<td></td>
<td>Emphasis: Conveys the importance of the receptacle, invites P2 to check her screen</td>
<td>Transfer of knowledge (within game): Uses knowledge from earlier level about refracting laser.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P2 [no longer in-active]:“So can we like… is there a button we can press that can go there? Obviously that thing, that thing… [Pings at wall] will…”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P2 at this point has gone through the force field, so his portals have been destroyed and the laser is no longer shining.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P1: “Oh, oh, oh! We’ve got that one cube which has the reflective thing, so maybe we need to put like…if I hold the cube where I’m standing, if you look at my screen, then I can angle it so that it points in here.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P2 : “You think so?”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P1: : “Yeah, that’s why the…”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P2: “Yeah, yeah… get the cube”</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Un, B.T = Understanding breakthrough

Table 4: Extract of coded data for segment of gameplay
Vignette 2: Discussion between players leading to instruction

The pair has encountered a puzzle in ‘Team Building’ course. As Figure 13 demonstrates, one of the players has to cross the water and create a portal on Walls A and C. The starting side has a timed button which controls the door, so one of the players has to stay behind to keep the door open. During this short segment, the pair utilise the following strategies, ‘Reflection’, ‘Consultation/Discussion’, ‘Ask for help/Guidance’, ‘Trial and Error/Probing’ and ‘Emphasis’.

![Figure 13: Both players discussing ideas](image)

This segment is a good example of the dialogue and consultation that took place during the gameplay sessions. In this example P2S9 attains the understanding breakthrough slightly sooner than P1S9, which was a result of asking questions and sharing ideas with one another. What this segment also demonstrates is the subtle boundaries between different strategies; a discussion seamlessly turns into guidance. The approach undertaken by the pair works out quite well, P1S9 was eased into an understanding breakthrough predominantly because P2S9 maintained a dialogue with him and didn’t just issue orders. For instance, at one point P1S9 decides to
follow a new line of enquiry and probes the exit door, P2S9 permits this to happen. Once P1S9 sees that there is not much else to do he is more open to suggestions from his partner. At this point he is actually doing as asked, and provides feedback which P2S9 needed to help in his guidance. Finally, P1S9 experienced a minor action breakdown, but in the process of overcoming this he understood exactly what his partner was asking him to do. The ‘Consultation/Discussion’ strategy encapsulates the essence of collaborative play. Players are in a constant flow of talk and feedback, which is the backbone for the other strategies. Table 5 shows how this segment of play was coded, it highlights the interplay between the players.

<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
<th>Approach</th>
<th>B.T</th>
<th>B.D</th>
<th>P1 Strategy</th>
<th>P2 Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>26:40</td>
<td>They understand that the portals need to link both players together. P2 gets it first, and explains it to P1.</td>
<td>P1: “Now...portal there can you get through? ..No you can’t” he creates portals and asks if P2 can get through. … P1: “Huh?” P1 is slightly confused but then gets his orientation and aims at the far white wall, P2: “Yeah, create a portal there” P1: “But then you can’t press the button” … P2: “Urm, alright, do this. Go in, go back in through there” P1 suggests that P2 create a portal P1: “Yeah, you, you create a portal going here [Pings at wall]” P2: “What we need to do is create a portal on this side see that one there? [points at TV] And the opening for that to be on the other side… where I am” P1 ignored P2s comment, and is probing the exit door. P1: “Lemme go through... oh right...” He realises that he can’t do anything else in his area so reverts back to the task at hand. … P2: “So, come back through, and then create a, see right in front of you, create a right one there” P2 provides instructions to P1, P1: “Oh! Right, right, right. I get you”</td>
<td>Un B.T</td>
<td>Reflection: thinks about what he did with the first linked portals, and asks if P2 has access this way. Emphasis: pings at wall Consultation/Discussion: They chat throughout. Trial and Error/Probing Tries out certain ideas; goes to the exit door instead of listening to P2. Ask for help/Guidance: P1 is helped along by P2</td>
<td>Consultation/Discussion: They chat throughout, initially P2 is consulting and suggesting what P1 should do… but when it gets to a point where P1 is becoming confused he steps it up to the following - Emphasis: Points at TV where he wants a portal. Ask for help/Guidance: tells P1 what to do, to fire his ‘Right portal’ at the far wall, P1 finally gets it</td>
<td></td>
</tr>
</tbody>
</table>

* Un = Understanding, Ac = Action, B.D = Breakdown, B.T = Breakthrough

Table 5: Extract of coded data for segment of gameplay
4.3. Findings: The role of expertise

This section presents findings which addresses the second research question. Three different player expertise groups were considered. As previously mentioned, expertise was defined by familiarity with the Portal games. The expertise groups previously outlined will be compared in relation to strategies and breakthroughs experienced.

For comparisons to be made between the groups, the overall analysis period had to be capped. The time taken to progress through the sections differed between the pairs, some didn’t finish or even get to the final map. This meant that the strategy and breakthrough counts would have been skewed by differences in time, making for an unfair comparison between the types of strategies and how they relate to each pair.

Therefore, to be able to draw meaningful comparisons between the groups it was necessary to cap the analysis time to the fastest completion time which was 24 minutes for all three maps (average 29:02 minutes). Table 6 shows the progression of the pairs within this time.
The negative aspect of capping the time was that portions of the data couldn’t be used for the analysis. Nevertheless, interesting insights into the role of expertise was uncovered. Table 7 provides an overview of the strategy and breakthroughs counts for the different groups.
<table>
<thead>
<tr>
<th>Strategies</th>
<th>Non-expert (n=4)</th>
<th>Mixed (n=2)</th>
<th>Expert (n=5)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
</tr>
<tr>
<td>Consultation/Discussion</td>
<td>84</td>
<td>27</td>
<td>87</td>
</tr>
<tr>
<td>Ask for help/Guidance</td>
<td>42</td>
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<td>55</td>
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<tr>
<td>Observation</td>
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<td>9</td>
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<tr>
<td>Consult External Resource</td>
<td>8</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Surrendering control/Taking over</td>
<td>12</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Divide work</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Emphasis</td>
<td>25</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Reflection</td>
<td>12</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Transfer of Knowledge</td>
<td>6</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Trial &amp; Error/Probing</td>
<td>87</td>
<td>28</td>
<td>54</td>
</tr>
<tr>
<td>Practice/Repetition</td>
<td>11</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Accidental</td>
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<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>311</td>
<td></td>
<td>259</td>
</tr>
<tr>
<td>Average (total/n)</td>
<td>77.75</td>
<td></td>
<td>129.5</td>
</tr>
<tr>
<td>Breakthroughs</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Action</td>
<td>27</td>
<td>16</td>
<td>21</td>
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<tr>
<td>Understanding</td>
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<td>71</td>
<td>100</td>
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<tr>
<td>Involvement</td>
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<td>13</td>
<td>16</td>
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<tr>
<td>Total</td>
<td>168</td>
<td></td>
<td>137</td>
</tr>
<tr>
<td>Average (total/n)</td>
<td>42</td>
<td></td>
<td>68.5</td>
</tr>
</tbody>
</table>

Table 7: Total number and proportions of strategies & breakthroughs
The disparity in distribution of groups (Expert n=5, Non-expert n=4, Mixed n=2) makes it problematic to make direct comparisons between them based on counts alone. However, general overall differences can be seen by considering the average totals. To further investigate the influence of expertise on strategy and breakthroughs, the counts were calculated as percentages of each group’s total (strategy/total strategy * 100). These can also be found in Table 7 under the shaded ‘%’ column. These percentages indicate that the groups had different proportions of strategy use, but similar breakthroughs.

4.3.1. Non-expert pairs

Table 7 shows that, on average, non-experts (Pairs 4, 6, 8 and 9) employed fewer strategies than other groups throughout the session. Also, all but one pair failed to progress past the first map. This section will explore why this was the case. When these figures are considered alongside their lack of progress, it points towards two important findings. Non-expert pairs had to try a greater number of strategies to progress in the first place, and secondly they had issues developing successful strategies leading to breakthroughs.

It was found that breakthroughs in understanding made up the highest proportion of strategies, but given the nature of the game this isn’t very surprising. However, this also provides hints as to why they took longer to progress. The attain these understanding breakthroughs the non-expert pairs predominantly used the ‘Trial and Error/Probing’ strategy. This strategy is costly in terms of time required. For example, P2S8 adopted a probing strategy in the Calibration course when tasked to
retrieve his portal device. He investigated the different surfaces in great detail and tested ideas such as pinging at various markings he found. On the one hand, his exhaustive probing was helpful as it helped him attain an understanding breakthrough, but on the other it was time consuming. Unlike the other groups, the non-expert pairs couldn’t rely on prior experiences with the game, and so they spent longer probing until a solution was found.

An additional contributing factor to their lack of progress is possibly due to the limited utilisation of the ‘Ask for help/Guidance’ strategy. For example, it was observed that P2S6 rarely provided guidance to his partner, even after figuring out what to do. During the rare occasions when he did provide help, his partner either misunderstood or couldn’t perform the action. When this happened there was limited follow up explanations. Likewise, the ‘Consultation/Discussion’ strategy was used less frequently compared to the other groups. For example, P1S6 and P1S8 were mostly quiet throughout the session; since there was limited consultation within the pairs, the puzzles were effectively being overcome by one person, mitigating the benefits of playing collaboratively.

4.3.2. Expert pairs

In contrast to the previous group, the experts (Pairs 2, 3, 5, 7 and 11) used a greater number of strategies and experienced more breakthroughs. Additionally, as Table 6 indicates, with the exception of Pair 3, all expert pairs progressed quite far in the session.
Similar to the non-experts, the expert pairs also used ‘Trial and Error/Probing’ when encountering problems, but it made up a lower proportion of their strategy use. They made use of strategies such as ‘Transfer of Knowledge’ and ‘Consultation/Discussion’ to compliment the probing, thus allowing for quicker progress. This is reflected by their high number of average breakthroughs. Also, the number of strategies they used to attain these breakthroughs was not as high as the mixed group which indicates that they were more efficient and successful with their strategy use. A possible reason as to why this is the case is because the ‘Consultation/Discussion’ was their most commonly used strategy. For instance, they would discuss and give each other feedback, and often times they would challenge each other’s ideas and actions. For example, during a section in the Calibration course P1S11 stopped her partner from trying out an idea that she knew wouldn’t work. Such instances save time and effort, and it also explains the expert pair’s lower proportion of ‘Trial and Error/Probing’ use. This suggests that by discussing ideas, players become more effective in progressing and reaching breakthroughs.

**4.3.3. Mixed pairs**

This final section will discuss the mixed group (Pair 1 and 10), which consisted of pairs containing an expert and non-expert Portal players. As Table 7 shows, on average the mixed pairs used more strategies than either of the other groups, and their progression in the game was similar to that of the expert pairs. What this implies is that mixed pairs had to do more, i.e. develop more strategies, to reach the same level of progress as the expert pairs. The proportion of strategy use provides
reasons for why this may be the case. The main difference between the mixed group and the other groups is that ‘Trial and Error/Probing’ made up a slightly lower amount of their strategies, and conversely the use ‘Ask for help/Guidance’ was much higher. This indicates that the non-experts in the mixed pairs were somewhat reliant on their expert partners. This also explains why they probed less, instead opting to follow the guidance from their expert partner. For example, P1S1, the non-expert in the pair, would do as told by his partner throughout the whole session. He would still probe and try out ideas, but as soon as he got word from his partner, he would stop and carry it out. Thus, more strategies were used because players would still probe the game, but alongside this, they would also get explanations and instructions.

The mixed pairs experienced the same proportion of breakthrough types as the other groups, but they had the highest number of breakthroughs in total. Again, this is likely due to make-up of the mixed pairs. Perhaps more interestingly, the data also indicates that mixed pairs had a slightly lower proportion of involvement breakthroughs. This could be related to the extensive use of the ‘Ask for help/Guidance’ strategy. The more often players are told what to do the less they feel responsible for the breakthroughs. They instead become a means for progress, resulting in reduced involvement levels.
4.4. Summary

The analysis has resulted in two main outcomes. Firstly, the previously identified player strategies have been extended to account for co-located collaborative play. Secondly, these strategies have been considered in relation to player expertise.

The findings indicate that the proportion of breakthrough types were similar across the three expertise groups. Breakthroughs in understanding made up the majority proportion of overall breakthroughs, with action and involvement making up a smaller chunk. There were very small differences in the proportion of the breakthrough types between the expertise groups. For example, non-experts experienced a slightly higher proportion of action breakthroughs, mixed pairs had more understanding, and expert pairs had more involvement breakthroughs. However, the difference between the highest to lowest proportions was only 2%.

The data also revealed that player expertise impacts the types of strategies used. The ‘Trial and Error/Probing’ strategy made up the largest proportion of overall strategy used by the non-experts, whilst it was much lower for the mixed and expert pairs. Instead, their predominant strategy was ‘Consultation/Discussion’. The other key difference was that mixed pairs had a higher proportion of ‘Ask for help/guidance’. When this was considered with how far the pairs progressed, further insights were found. For example, the non-expert pairs didn’t progress very far because they predominantly used up a lot of time with the inefficient ‘Trial and Error/Probing’ strategy. Whereas the ‘Consultation/Discussion’ strategy meant that
expert and mixed pairs were more systematic in their approach. It can therefore be suggested that the use of strategies influences efficiency of game progression and the number of breakthroughs experienced.
CHAPTER 5. DISCUSSION

This study has investigated how pairs of players of varying expertise develop strategies and experience breakthroughs whilst working together during play. It focussed on breakthroughs in co-located collaborative gaming, an area that has not sufficiently been considered prior to this. Although multiplayer gaming has been acknowledged in some previous literature the sample size of collaborative play was quite small (Iacovides, 2012). The current study provides further insights into informal learning within this context. Furthermore, it builds on recent work which has considered the importance of player strategies in helping explain how learning occurs (Knoll, 2012). The previously established player strategies provided a starting point for the current study, but they were based upon single player gaming. As such, this study took the next step by considering strategy development within a multiplayer context. The study aimed to provide answers to the following questions:

What kinds of strategies lead to breakthroughs in a co-located collaborative setting?

By investigating how pairs of players of varying expertise reached breakthroughs, a number of different approaches were identified. It was found that the previously established strategies (Knoll, 2012) were applicable to co-located collaborative play. However, it is suggested that the definitions be refined to account for multiplayer behaviours. For example, ‘Trial and Error/Probing’ was often used for fun, irrespective of overcoming an in-game problem or achieving a goal.
This study has extended the original set of strategies, to account for co-located collaborative play. These included ‘Consultation/Discussion’, ‘Surrendering control/Taking over’, ‘Ask for help/Guidance’, ‘Emphasis’, ‘Observation’, and ‘Dividing Work’. Finally, the ‘External Resource’ strategy was also observed which applies to single and multiplayer contexts. Section 4.3 covers these strategies more extensively. It is proposed that these new strategies are combined on top of the previously established set to form a more complete taxonomy of player approaches, covering both single and co-located gaming experiences.

**How will player expertise influence the development of strategies leading to breakthroughs?**

The present study explored the above question by investigating the impact of player expertise on strategies used, and the influence this had on breakthroughs experienced.

The type of strategy used by experts, non-experts and mixed pairs of players was found to differ. For example, ‘Trial and Error/Probing’ made up the largest proportion of used strategies for non-experts, most likely due to the fact that they didn’t have prior experience with the game. Also, the proportion of strategy use was slightly different between expert and mixed pairs. The key difference was that mixed pairs used more of the ‘Ask for help/Guidance’ strategy. The reason for this is likely due to the fact that mixed pairs had a non-expert player. As a result, the expert player would help, instruct and explain instances of play more often to their non-expert partner.
In terms of breakthroughs it was found that the different groups experienced similar proportions of action, understanding and involvement breakthroughs within the same time frame. Despite this, the non-expert pairs had far fewer breakthroughs, on average, than the other groups. The difference in breakthrough numbers between the expert and mixed pairs was less stark. However, the mixed pairs had slightly more understanding and action breakthroughs compared to the expert pairs. This is possibly because the non-experts in the mixed pairs had more to learn during the course of play. As such, this type of group formation potentially fosters and maintains a stronger zone of proximal development.

5.1 Reflection of study

5.1.1 The approach undertaken

There were some issues regarding the recruitment of participant pairs. The principal participants were tasked with bringing someone they wanted to play with. Even though the recruitment adverts were explicit in asking for two players with gaming experience in FPS and puzzle games, some principle participants asked friends to join them who didn’t seem to fit the criteria. This was particularly evident with pairs 6 and 8. Both pairs contained players who responded to the screener questionnaire stating they play games several times a week. However it only became clear when looking at the findings from the gaming questionnaire that they cited games from older generation consoles. This, alongside their difficulty playing Portal 2, suggested that they weren’t experienced with FPS games and that their responses were based on prior relationship with gaming. The recruitment process highlighted
the difficulty in defining what constitutes gaming experience. Despite this, the approach undertaken was adequate in finding players specifically with and without Portal expertise.

The rooms in which the testing took place were furnished in such a way to encourage a natural gaming experience. This was important to consider because most co-located console gaming occurs in environments such as living rooms. Participants rarely took notice of the camera and would even chat about events in their lives outside of the game. Some were even slouched on the sofa whilst playing, suggesting that they were comfortable with the setting. Ecological validity, to a certain extent, was maintained. However, due to the facilities being used, the testing had to move to another room for five of the sessions. This resulted in a different split-screen view for participants because of technical limitations of the TV. Further, the amount of time participants had to play the game may have slightly reduced ecological validity. The participants reported in the gaming questionnaire that on average they play for 2.5 hours. For a game like Portal 2, 40 minutes may not have been a realistic amount of time.

Finally, there were difficulties with the critical incidents analysis undertaken. Internal thought processes were hard to code. For example, when interviewing pair 7, it emerged that they had played Portal 2 together at an earlier date. Therefore, they explained that they mostly remembered what to do in the first two maps. Although technically this falls under the ‘Transfer of Knowledge’ category, it was hard to code due to the nature of the breakthroughs they were experiencing. During the first two maps they would rarely talk about what they were doing, suggesting
that internal breakthroughs were occurring. It was tricky to distinguish between moments in which they remembered something and when they had to figure it out again. Pragmatically, only the obvious incidents could be coded. For example, the times when they would discuss and reflect on what they did when previously playing it. Although the interview revealed that these implicit breakthroughs occurred, it was not possible to put a number on it. The implication is that observational analysis, including the dialogue between participants, may not always tell the whole story.

5.1.2 The issue of generalisability

The current study took an in-depth look at player breakthroughs, and has presented a set of strategies covering the range of approaches used by pairs of players. It must be noted, that in terms of player type, only expertise was considered. Participants who had played the Portal games were classified as experts, but there is clearly a difference between someone who has played the game for a few hours and one who has played it to completion a number of times. Indeed, it was found that there was varying performances within each of the expertise groups, which suggests that additional factors that constitute expertise should also be explored. Furthermore, there is scope for investigating how other types of players develop strategies during collaborative play. For instance, players’ personalities could have an influence on social play and the approaches taken in the game (Bartle, 1996).

Secondly, only a single game was considered. Although Portal 2 is representative of a major videogame, it proved to be challenging for the non-experts.
Even with the Calibration course and information sheet, certain players had a lot of trouble with the game. There is a need to become proficient with the games core mechanics, and more importantly to look at the environment from a different perspective, as P1S9 (non-expert) stated in the interview “The portals were just a bit counter intuitive, you don’t think like that, so… like that last level 3[Team Building], that was a bit weird!” To account for the phenomenon of using portals they had to shift their conceptual model of how games can be played, so the approaches undertaken may have been quite specific to this type of game. Therefore, although the set of strategies were based on a popular collaborative game, further research is required to investigate the extent to which they apply to collaborative games with different mechanics.

Additionally, the applicability of the strategies to online play is especially pertinent. For example, the act of watching the other players screen is a quintessentially co-located approach to play. Interestingly, Portal 2 provides a ‘partner view’ for its online mode which shows a picture-in-picture of the other players screen. However, the vast majority of online games don’t have such features. In these cases, how will the removal of such approaches impact overall strategy use and breakthroughs? It certainly warrants further research. The differences between co-located and online approaches was further hinted at when the ‘Emphasis’ strategy was considered. The in-game ‘Ping’ tool was confusing to players in co-located play since they could point at the screen instead. As P1S11 stated “yeah, if we were online it would have been useful but it’s so much easier to point or to look at the other ones screen”. This was highlighted during the
Calibration course, in which the game caused some players to think the ping tool was more important than it was in a co-located context. For example Pair 6 took the ping messages in the literal sense, thinking the solution involved pinging. In reality the game was suggesting that a player can point where they want a partner to place portals (Figure 16). In this example, having an online centric mechanic within a co-located setting meant that it not only had reduced value, but was detrimental to players’ understanding and progress. Finally, the identified strategies were established for a collaborative multiplayer game. As section 2.2.2 outlined, other game types exist, it is unlikely that the strategies can be generalised to competitive multiplayer experiences.

![Figure 16: Game suggests the use of the Ping Tool.](image)

5.1.3 Future work

There is considerable scope for future work to explore additional aspects of multiplayer gaming and the influence these have on strategies and breakthroughs. These could include online gaming, competitive game types, as well as considering larger multiplayer games with more than two players. It is expected that the strategies employed across these different contexts will differ, but the co-located
collaborative strategies identified in this study can act as a basis for future development.

Additionally, there were certain strategies and breakthroughs which would benefit from eliciting other kinds of user data. Many of the strategies were multi-faceted, for example, watching each other’s screen made up an interesting part of the ‘Observation’ strategy. However, there was no way of knowing how often players subtly checked each other’s screens. For instance, P1S11 found it to be a great way of orientating himself in relation to where his partner was, but this could not be coded for using the gameplay videos alone. As eye tracking systems become cheaper and more flexible they may be of potential benefit. Future research could possibly examine sub-categories such as these in greater detail. Likewise, by considering biometric data alongside self-reported experience questionnaires, there could potentially be greater insights in regards to player involvement during play. Moreover, as section 4.2.9 indicated, players used different combinations of strategies. Further work can investigate this in terms of which combinations are more successful than others, or how these combinations differ between different game genres.

Finally, the interview data suggested that players employ additional approaches when playing at home, for example taking breaks from the game, talking to friends who aren’t present during play or checking video walkthroughs. Such behaviours are hard to account for in lab or observed conditions. An ethnographic approach would be helpful to consider for future work, as it can be useful for understanding these kinds of strategies in more natural environments over longer play sessions.
5.2 Practical Implications

The findings from this study indicate that games designers need to acknowledge that players with varying expertise will approach collaborative games in different ways. There are already some considerations for certain types of multiplayer games. For example, the ‘handicap’ option that most beat ‘em up games offer, allows for less skilled players to gain extra health or damage output. Alternatively, the dynamic-difficulty balancing mechanisms built into games like Mario Kart provides struggling players better items such as speed boost. Although this shows that games designers are considering players of different expertise and skill, it is based on competitive multiplayer games. This study has shown that there is also a need to consider such factors in relation to collaborative games.

Designers appear to rely on the fact that players in collaborative settings get the help they need from those they play with. But as this study has shown, the ‘Ask for help/Guidance’ strategy does not necessarily mean more efficient progress, and may even result in fewer involvement breakthroughs since a guided player may not always feel responsible for the progress. By considering the impact of varying levels of player expertise, games can be designed in ways to help support more engaging social play and joint breakthroughs. For example, one possible way is to provide mechanisms that enable more detailed explanations to take place. The game could offer a temporary switch in control of avatars, to allow the more experienced player to demonstrate the solution but without the action being permanent. Such a feature is analogous to the TV show ‘Quantum Leap’, in which the main character would jump into the body of someone else and live their lives for a short period of time.
This will offer the weaker player a chance to observe the action as well get an explanation, and most importantly carry out the action once control is given back to them. Thus, allowing them to consolidate a breakthrough and develop the skills they require.
CHAPTER 6. CONCLUSION

This dissertation has explored how learning can take place in co-located collaborative settings. It has carried this out by considering existing work focussing on identifying instances of learning during gameplay in the form of breakthroughs. The current study has filled the gap in the literature by applying the methodology to a multiplayer context to observe how pairs of players collaborate to develop strategies leading to breakthroughs. It has directly built on previous work by extending a set of player strategies to account for co-located collaborative play. Finally, the influence of player expertise in relation to strategy development was taken into consideration.

It was found that the non-expert pairs relied heavily on ‘Trial and Error/Probing’, resulting in less overall progress and the least number of breakthroughs on average. Mixed pairs had the highest proportion of the ‘Ask for help/Guidance’ strategy and their progression was in-line with that of the expert pairs, but involvement breakthroughs were slightly lower. Finally, expert pairs employed less strategies compared to the mixed pairs which suggests that they knew which strategies would be most effective in reaching breakthroughs. Additionally, they had slightly more involvement breakthroughs than either of the other groups. Therefore, not only were they more efficient in their approach but were more engaged with the process overall.

The implication of this is that players of varying expertise approach co-located collaborative games in inherently different ways. Educators and games designers
should support these broad strategies in their games to ensure that these types of players can all find ways to progress. Furthermore, games should support specific strategies more so than others for collaborative play. For example designs should encourage more detailed ‘Consultation/Discussion’ by having tools to better aid communication and ideas. This will help ensure all players have a chance of reaching breakthroughs and would maintain engagement during play.
REFERENCES


Retrieved from http://www.mud.co.uk/richard/hcds.htm


Appendix A: Study advert

Get paid £7 for playing a game and enter prize draw!

Do you play video games? You will be playing a multiplayer game, so you must bring a gaming buddy with you! The entire session will last no longer than an hour.

Please do contact me if you have any questions.

Need gamers who have experience with a variety of games including FPS and Puzzle games. The study aims to understand the strategies used by video game players in a multiplayer setting. You are asked to bring someone who you will be comfortable playing games with to participate alongside you in the study.

You will each be paid £7 at the end of the session + all participants will be entered into a prize draw raffle where you will have a chance to win a bunch of video games and gaming paraphernalia (courtesy of SEGA)!

**Details:** You will play different parts of the game together for up to 40 minutes. During this time you will be recorded with a video camera. Also, in-game actions will be recorded with appropriate software. After the game-play session there will be a brief interview where audio will be recorded.

Please be aware that we are not testing your gaming ability, instead we are interested in the game-play strategies that emerge when playing together.

On the day of the study you *must* turn up with your friend. If either one of you can’t make it you must let me know in advance, otherwise the session will be cancelled - you will not be permitted to participate in the study if you turn up alone.

Where: The testing will take place very close to UCL, at a comfortable, safe and professional user-experience lab.

Address: Bloomsbury Street, WC1B 3QT

Please do contact me if you have any questions.
Appendix B: Video games questionnaire extract

### Video games questionnaire

The questionnaire aims to understand about your experiences of playing video games.

Your name and email address is being asked for so that we can contact you in regards to participating in the advertised study. The data from the questionnaire will be used to match with the data collected from the study.

Only the data from respondents that will participate in the study will be kept and used. Responses will be kept confidential and names anonymised. The data will be collected and stored in accordance with the Data Protection Act 1998.

If you have any questions, please feel free to contact me at a.avanian.11@ucl.ac.uk

* Required

**On average, how often do you play multiplayer video games?**

- [ ] Less than once a month
- [ ] Once a month
- [ ] Several times a month
- [ ] Weekly
- [ ] Several times a week
- [ ] Daily

**On average, approximately how long does your multiplayer gaming session last?**

- [ ] 0 hour
- [ ] 1/2 hour
- [ ] 1 hour
- [ ] 2 hours
- [ ] 3 hours
- [ ] 4 hours
- [ ] 5 hours
- [ ] Over 5 hours

**Approximately how many people do you usually play multiplayer games with?**

- [ ] 1 other person
- [ ] 2 - 4 people
- [ ] 5 - 11
- [ ] 11 - 20
- [ ] 20 +
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<thead>
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<th>Game</th>
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<th>Never</th>
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<td>Portal 2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>World of Warcraft</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

In the space provided below could you briefly recall an interesting multiplayer gaming experience? *  
From any game
Which of the following games have you played in single-player mode? *

Single-player mode: the games story/campaign played on your own

<table>
<thead>
<tr>
<th>Game</th>
<th>Often (played it a lot, and finished the game)</th>
<th>Often (played it a lot, but haven't finished the game)</th>
<th>Sometimes (played it, but didn't get too far)</th>
<th>Barely (played it a little bit, e.g. at a friend's house)</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARMA 2</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>Army of Two</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>Borderlands 2</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Call of Duty: Black Ops II</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<td>☐</td>
</tr>
<tr>
<td>Dead Space 3</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Diablo 3</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>FIFA 13</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Gears of War 3</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Guitar Hero 6</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Halo 4</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Lara Croft and the Guardian of Light</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<td>☐</td>
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<tr>
<td>Left 4 Dead 2</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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<tr>
<td>Minecraft</td>
<td>☐</td>
<td>☐</td>
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<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Monaco: What's Yours is Mine</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Portal 1</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Portal 2</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Please mention any game(s), not listed above, that you are currently playing *  
multiplayer or single-player
If you have marked any of the previously shown games as 'Often' played (multiplayer or single-player), please provide brief information for each in regards to your play experience/accomplishments.

E.g. "WoW - I spend many hours playing in raids" or "Dead Space 3 - I have completed the co-op story X times"

If you have marked any of the previously shown games as 'Often/Some times' played (multiplayer or single-player), please provide an approximation of the last time you played them.

E.g. "Diablo 3 - summer last year, when it was released"

Which of the following platforms do you usually game on? *
Please select all that apply:

- [ ] PC/laptop
- [ ] Nintendo Wii
- [ ] Nintendo Wii U
- [ ] Nintendo 3DS
- [ ] Sony Playstation 3
- [ ] Sony PSP Vita
- [ ] Microsoft Xbox 360
- [ ] Mobile Phone
- [ ] Other: [ ]

Participating in the play session

If you and a friend would like to be contacted in regards to participating in the advertised study, please provide your name and email address below. By participating in the study you will get £7 each.
Appendix C: Gaming questionnaire

Gaming questionnaire

The questionnaire focuses on your experiences of playing computer and video games. All responses will be anonymised and kept confidential. We ask for your name, only so that we can match the questionnaire to other data collected.

1. Name

2. Age

3. Sex  Male  Female

Circle your response for each question below and please do not leave any blank.

4. What age did you start playing video games?

| Under 5 | 5-7 | 8-10 | 11-13 | 14-16 | 16-18 | 18 or above |

5. In an average month, how often do you play video games?

| Less than once a month | Once a month | Several times a month | Weekly | Several times a week | Daily |

6. On average, approximately how long does a typical gaming session last?

| 0 hour | ¼ hour | 1 hour | 2 hours | 3 hours | 4 hours | 5 hours | 5 hours+ |

8. Do you regularly use any of the following gaming platforms?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>a PC/laptop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b Nintendo Wii</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c Nintendo DS/3DS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d Sony Playstation 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e Sony Playstation 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f Sony PSP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g Microsoft Xbox 360</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h Mobile phone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j Other – please state</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. Which of the following types of video games do you play?

<table>
<thead>
<tr>
<th></th>
<th>Often</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Action &amp; Shooter e.g. Call of Duty, Grand Theft Auto</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>Adventure e.g. Lego Indiana Jones, Mystery Case Files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>Arcade &amp; Platform e.g. Mario Party, Little Big Planet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Board, Card and Casino e.g. Scrabble, Poker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>Children’s e.g. Peppa Pig, Pokémon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>Education &amp; Reference e.g. French Coach, Cooking Guide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g</td>
<td>Fighting e.g. Street Fighter, Super Smash Bros Brawl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>Music &amp; Dancing e.g. Just Dance, Guitar Hero</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>Puzzle e.g. Brain Training, Bejeweled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j</td>
<td>Quiz &amp; Trivia e.g. Buzz, Who Wants to be a Millionaire?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>Racing e.g. Gran Turismo, Mario Kart</td>
<td></td>
<td></td>
</tr>
<tr>
<td>l</td>
<td>Role Playing e.g. World of Warcraft, Mass Effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>m</td>
<td>Simulation e.g. Sims, Tom Clancy’s H.A.W.X.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>Sports e.g. Fifa 10, Wii Fit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o</td>
<td>Strategy e.g. Total War, Civilization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>Other – please state</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. In the space provided below could you please provide an example of each type of game you play? You can also list any games you are unsure about how to categorise here.
Appendix D: Game information sheets
Goal: Exit test chamber

Symbols and countdown timers

Ports

Primary-fire portal  Secondary-fire portal

Ports can be placed on any white surface, and work in pairs - this allows for two-way movement through each portal.

Objects, discouragement beams, and other environmental anomalies can also go through portals.

Cubes, Buttons and Receptacles

Place into...

- 84 -
Thermal Discouragement Beam

Beam activating relay on floor

Beam activating receptacle on wall

Discouragement Redirection Cube

Material Emancipation Grill

Cubes disintegrate and portals are removed

Excursion Funnel
Appendix E: Information Sheet and Consent form

Title of Project: Understanding co-located collaborative gaming: player strategies and breakthrough

This study has been approved by the UCL Research Ethics Committee: MSc/1112/002

Name, Address and Contact Details of Investigators:
Ara Avakian
UCL Interaction Centre
a.avakian.11@ucl.ac.uk

You have been invited to participate in this research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, please read the following information carefully and discuss it with others if you wish. Contact me if there is anything that is not clear or you would like more information.

Details
This study aims to understand the strategies employed by video game players and how breakthroughs emerge when playing together. During the session you will play different parts of the game with a friend for up to 40 minutes. There will be no interruption, apart from when the researcher will change the game map.

During the session you will be recorded with a video camera. Also, in-game actions will be recorded with appropriate software. After the gameplay session there will be a brief interview about the session where audio will be recorded. The whole session will not last longer than an hour.

Please be aware that we are not testing your gaming ability, we are interested in the gameplay strategies that emerge when playing together. At the end of the session you are free to ask any questions regarding the research and you will be given £7 for your time. It is up to you to decide whether or not to take part. However, if you do decide to take part, you will be given this information sheet to keep and asked to sign a consent form. Even after agreeing to take part, you can still withdraw at any time and without giving a reason.

All data will be collected and stored in accordance with the Data Protection Act 1998.

Title of project: Understanding gameplay strategies in co-located collaborative contexts
Ethics code: MSc/1112/002
Participant’s Statement

I  ……………………………………………………………………………………………………………………………
agree that I have

- read the information sheet and/or the project has been explained to me orally;
- had the opportunity to ask questions and discuss the study; and
- received satisfactory answers to all my questions or have been advised of an individual to contact for answers to pertinent questions about the research and my rights as a participant and whom to contact in the event of a research-related injury.

- I understand that I am being paid for my time and that some of my details will be used by UCL Finance for administration purposes.

- I understand that I will be video and audio recorded, and I am aware of, and consent to, any use you intend to make of the recordings during and after the project.

- I understand that the information I have submitted will be evaluated and used for a dissertation report. I understand that the report is a part of the HCI & Ergonomics MSc course, and may also be used by UCL Interaction Centre after the project is finished. Confidentiality and anonymity will be maintained, and it will not be possible to identify me.

I understand that I am free to withdraw from the study without penalty if I so wish, and I consent to the processing of my personal information for the purposes of this study only and that it will not be used for any other purpose. I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.

Signed:  Date:

Investigator’s Statement

I  ……………………………………………………………………………………………………………………………
confirm that I have carefully explained the purpose of the study to the participant and outlined any reasonably foreseeable risks or benefits (where applicable).

Signed:  Date:
## Appendix F: Gameplay sessions and player expertise

<table>
<thead>
<tr>
<th>Session</th>
<th>Player</th>
<th>Portal Expertise</th>
<th>Pair Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P1</td>
<td>Expert</td>
<td>Mixed</td>
</tr>
<tr>
<td></td>
<td>P2</td>
<td>Non-expert</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>P1</td>
<td>Expert</td>
<td>Expert</td>
</tr>
<tr>
<td></td>
<td>P2</td>
<td>Expert</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>P1</td>
<td>Expert</td>
<td>Expert</td>
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<tr>
<td></td>
<td>P2</td>
<td>Expert</td>
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<tr>
<td>4</td>
<td>P1</td>
<td>Non-expert</td>
<td>Non-expert</td>
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<tr>
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<td>P2</td>
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<tr>
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<td>P2</td>
<td>Expert</td>
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<tr>
<td>6</td>
<td>P1</td>
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<td>Non-expert</td>
</tr>
<tr>
<td></td>
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<td>Non-expert</td>
<td></td>
</tr>
<tr>
<td>7</td>
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<td>Expert</td>
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<tr>
<td>8</td>
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<td>Non-expert</td>
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<td>P1</td>
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<td>Non-expert</td>
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<td>Mixed</td>
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<tr>
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<td>P2</td>
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</tbody>
</table>