A model of cognitive loads in massively multiplayer online role playing games

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Abstract

Being one of the most commercially successful entertainment software applications, massively multiplayer online role playing games (MMORPGs) continue to expand in term of the revenue they generate as well as the involvement of users who congregate in their virtual space and form communities around them to support each other. Unlike conventional offline computer games, or networked games with limited numbers of players, MMORPGs are not merely software applications as they are usually seen as a space with complicated dynamics of social interactions. Hence, it is believed that playing these games might cause cognitive overload problems among the players as they have to constantly interact with the game world as well as with other users. We conducted an exploratory study using qualitative methods to explore cognitive overloads in Maple Story, a typical MMORPG. Our results reveal that several types of cognitive overloads emerge during the game playing. While some of these overloads pose serious problems even to expert players, players seem to develop strategies to overcome them. It is found that some forms of cognitive load are actually desirable in order to make the game challenging. We have also created a set of recommendations that can help game developers handle cognitive load problems in MMORPGs.

Keywords: Games; MMORPG; Cognitive load

1. Introduction

Massively multiuser role playing games (MMORPGs) are known as networked virtual environments where multiple geographically distributed users interact with each other in real time (Papargyris and Poulymenakou, 2005) offering an alternative channel for players to communicate, share experiences, socialize, and eventually form virtual communities.

Whilst playing MMORPGs, users are required to multi-task. Most significantly, players must learn to deal with the social dynamics around the game in addition to having to interact with the virtual space and game objects which are usually defined by the complicated game mechanics. This may cause cognitive overloads which can hinder the performance especially of beginner players. Cognitive load is often referred to as the amount of mental energy required to process a given amount of information (Feinberg and Murphy, 2000).

There is a vast amount of literature on cognitive processes as well as numerous previous studies that attempt to develop guidelines and recommendations to reduce cognitive loads in multimedia applications especially in e-learning. With the increasing popularity of MMORPGs, there is now some literature available on the study of these games, ranging from sociological and psychological effects (Turkle, 1995; Squire and Steinkuehler, 2003) to technical areas such as their network traffic characteristics (Kim et al., 2005; Chen et al., 2005).

As the interest of serious games (Stokes, 2005) continues to grow, it is not surprising that some researchers have begun to explore the potentiality of using MMORPGs for education. Although this idea appears promising as it encourages social interaction among learners, little has
been done to examine cognitive load problems when playing such games.

Therefore, this study is aimed at bridging the gap between the research in MMORPGs and that in cognitive psychology. We believe understanding this area better is crucial not only for educational games but also for the design of purely entertainment MMORPGs. It is important for game developers to be aware of the cognitive load issues players might be facing, especially novices, and how such issues can be dealt with appropriately.

Basically, we attempt to explore the following research questions in this study:

- What kinds of cognitive overloads exist when playing MMORPGs?
- What effect do cognitive overloads have on the players’ performance and engagement in the game?
- How are cognitive loads handled in MMORPGs?

In order to achieve this, we analysed people playing Maple Story, a typical MMORPG in which players are engaged in quests, fighting monsters, and cooperate with other players.

The article is structured as follows. Section 2 provides the literature on some previous studies on MMORPGs and issues of cognitive loads. Section 3 outlines the methodologies used in the study including the data collection and data analysis. Section 4 covers the findings of the study that address each research question. Section 5 concludes the paper by presenting some recommendations and possible future studies.

2. Literature review

2.1. MMORPG in general

With the advent of ubiquitous broadband internet connection and the increasing graphical processing power of personal computers, a new paradigm of gaming has emerged. MMORPGs have changed the game industry dramatically. MMORPGs provide a fictional setting where a large group of players voluntarily immerse themselves in a graphical virtual environment and interact with each other by forming a community of players.

Although the concept of multiplayer gaming is not new, the game worlds of most local network multiplayer games, as opposed to MMORPG, are simplistic and can accommodate only around 16 concurrent players in a limited space. On the other hand, a MMORPG enables thousands of players, represented through avatars, to simultaneously play in an evolving online virtual world (Yee, 2005). The game world is usually modelled with highly detailed 3D graphics, and allows individuals to interact not only with the gaming environment, but also with other players.

A MMORPG like a role playing game (RPG) involves killing monsters, collecting items, developing characters, etc. It however contains an extra aspect which is the internal sociability within the game. Unlike single player games which rely on other external modes of communication (such as mailing lists, discussion forums outside the game) to form the gaming culture, in MMORPGs the culture is formed within the environment itself (Ang et al., 2005).

These MMORPG virtual worlds represent the persistent social and material world, which is structured around narrative themes (usually fantasy), where players are engaged in various activities: slay monsters, attack castles, scavenge goods, trade merchandise, etc. On one hand, the game’s virtual world represent the escapist fantasy, on another, it supports social realism (Kolbert, 2001).

The MMORPG genre now boasts hundreds of thousands of users and accounts for millions of dollars in revenue each year. The number of people who play the games (and the time they invest in terms of activities within and around the game) is astounding. The MMORPG, lineage (NCsoft, 2005), for example, had more than 2.5 million active subscribers in 2002 (Vaknin, 2002) and, within a year, Ultima Online (Electronic Art, 2005) attracted more than one hundred and 60 million person-hours (Kolbert, 2001). According to more recent data, the subscription revenue from MMORPGs was USD 2 billion in 2005 (GameSpot, 2006).

These games are thus becoming the most interesting interactive computer-mediated communication and networked activity environment (Taylor, 2002).

Recently game designers have tried to utilise this strength of MMORPGs further by structuring in-game activities to maximise interaction. One of the examples of sociability by design in MMORPG is Star Wars Galaxies (Sony, 2005) which is organised so that players are steered towards certain locations in the game world where social playing is expected to take place (Ducheneaut et al., 2004).

Most MMORPGs are created to encourage long term relationships among the players through the features that support the formation of in-game communities. One of the most evident examples is the concept of guilds. Guilds are a fundamental component of MMORPG culture for people who are natural organisers to run a virtual association which has formalised membership and rank assignments to encourage participation. Sometimes, a player might join a guild and get involved in a guild war in order to fight for the castle. Each guild usually has a leader and several guilds could team up in a war. This involves a complicated leader-subordinate and leader–leader relationship.

In addition, to encourage social interaction, MMORPGs are specially designed in such a way that some game goals are almost impossible to be achieved without forming communities. For example, one player alone could spend a long period of time collecting all of the items needed to assemble a device. But a guild could ask its members to fan out in small groups and collect all of the necessary components in one day. Complex devices beyond the reach of any individual player could be quickly constructed by the guild. The guild could also accept donations from members and then distribute those contributions to others according to
their needs, benefiting everyone as a result of this collaboration (Kelly, 2004).

Apart from relatively long-term relationships such as guild communities, MMORPGs also provide many opportunities for short-term relationship experiences. For example, a player could team up with another player to kill monsters in order to develop the abilities of their avatars (level up) or some more expert players could help newer players to get through the game.

Having illustrated the social phenomenon around such playful virtual communities, it is believed that it is fruitful to study them further as we might be able to derive some useful implications on how successful computer supported collaborative work (CSCW) and computer supported collaborative learning (CSCL) environments can be designed.

2.2. Collaboration and community in games

Some CSCW researchers have begun studying networked computer games in general and MMORPGs in particular in order to understand the social interaction between players. For instance, a systematic analysis has been carried out by Muramatsu and Ackerman (1998) in order to examine the social arrangement and activities that give meaning and structure to the players in a MUD (multi-user domain), the antecedent of MMORPGs which is text-based. In addition, there is some research that attempts to find ways to utilise game industry solutions in CSCW by acquiring more understanding on player interactions to derive techniques to be applied to CSCW applications (Manninen, 2001; Dyck et al., 2003).

Besides, MMORPGs can be an online community mediated with CMC (computer mediated communication) tools. Online game communities play a very important role in facilitating social interactions in computer games. Online communities emerge through the use of CMC applications. The term online community is multidisciplinary in nature and slippery to define (Preece et al., 2002). For the purpose of a general understanding, Rheingold’s definition of online communities is presented:

“[online] communities are social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace” (Rheingold, 1993).

The Internet is the new frontier in social relationships, and people are using the internet to make friends, as well as enemies. In general, what bring people together in an online community are common interests such as hobbies, ethnicity, education and beliefs. Analysing such online communities around and within games is useful to reveal social interaction that happens outside the game which might provide some insights into game design that supports the formation of communities, thus enhancing sociability of the game. For this reason, in the next section we describe some studies which have been conducted to examine various aspects of MMORPGs, including their social dynamics, learning aspects, and design issues.

2.3. Some studies on MMORPG

The virtual space of MMORPGs has attracted an increasing body of research from various fields especially psychology and social science. Recently human computer interaction (HCI) research has attempted to tackle the practical issue of such games, namely sociability design: design that encourages social interaction among players and community building.

As mentioned earlier, quite contrary to the traditional view that computer game playing is mainly a solitary activity, it is becoming a social experience partly due to the emergence of ubiquitous networked computers.

A project has been undertaken by the PlayOn team in PARC research centre, in which two locations in the game Star War Galaxies were examined extensively for different patterns of interactivity and how they are affected by the game structure in these locations (Ducheneaut and Moore, 2004). Their main objective was to identify how game locations can be designed to encourage different styles of social interactions.

In their study, “virtual ethnography” (Hine, 2000) was conducted to observe the in-game activities. The researchers created two game avatars with different professions (combat-based and service-based) in order to obtain a wider view of the game. Ethnographic data were collected through a three month period in which the researchers explored the game, interacted with other online players, and eventually became part of the player community by joining a guild. During the observation, the computer screen was video captured for retrospective analysis.

Apart from these, the researchers, through their observation, identified two important locations where players congregate on a regular basis. In the second phase of the study, they created two additional avatars which were constantly connected to the game for a month in order to record the public activities in these two locations. The “/log” command was used to capture all the public chats which were saved in a text file. A parser program was then written to format the texts and extract useful data from it.

Through this combination of quantitative and qualitative data collection and analysis, it was found that the game Star War Galaxies does attempt to maximise social interaction through the careful design of the game structure and mechanics. One aspect that comes out from the analysis is the implementation of social spaces. Some locations are designed in such a way that players have to wait there and socialise. Besides, some locations are tied to the provision of a particular service such as the healing of battle fatigue in a specific location. Indeed, the concept of social spaces provides a shared understanding of how we are expected to behave (Harrison et al., 1993). For instance, most of us are aware that it is inappropriate to shout in a library.
Another aspect that is crucial in designing sociability is the interdependency between game avatars. The game is designed in a way that everyone has to rely on others to complete certain game missions. This encourages players to work together and join certain groups or communities as playing the game alone is less rewarding (less progress).

The analysis revealed a problem in the game, which is the awareness in social spaces. Awareness means “the knowledge of the presence of other people, including their interactions and other activities” (Nova, 2002). It was found that in some heavily populated spaces, players are not aware of the activities and presence of other players and this could result in breakdowns in social interaction.

Another problem in the game is the lack of social play. Their data showed that the player–player interaction in the game is instrumental rather than social. This means most players have short and infrequent interactions in order to satisfy their needs. As soon as their needs are met, they leave the place to pursue other game goals. Although there are some players who interact genuinely with other players for the sake of socialising, such interactions are usually not rewarded by the game; in other words, merely engaging in social play does not help progressing in the game.

Ducheneaut and Moore (2004) think that MMORPGs should be structured to reward both instrumental and social play. Players should be encouraged to actively control their avatars to socialise with other players rather than be engaged in brief interactions to only satisfy certain game goals.

Other studies on MMORPGs focus on the learning aspect within the game community. In a structurally and socially complex game such as MMORPGs, various skills are needed to play and succeed in the game and the development of these skills highly depends on the social interaction with other players in the virtual space.

In a study conducted by Papargyris and Poulymenakou (2005) player interactions in two MMORPGs were observed. It was found that in such multicultural and anonymous environments, many learning processes are evolving that affect both players' understanding of the game's state, and their social interaction and communication skills.

The main data collection of this study was centred on guilds in which a relatively permanent community is formed. The study reveals that skills in MMORPGs can be categorised into two categories: in-game skills (skills you need within the game to make progress and enjoy the game, such as the game stories, collaboration skills, game control, etc.) and emergent skills (implicit skills that emerge from the game playing, such as decision making and strategy planning and assessment skills).

Another study on the MMORPG Ultima Online showed that what Ducheneaut and Moore (2004) described as instrumental play and social play do exist in the virtual space. As a matter of fact, it is claimed that not only do they exist within the game, they often spill beyond the demarcated boundary of the rule-based system, and soak into the players’ physical life through various means, such as e-mail, online forum, and chatting tools.

Using methodologies quite similar to those used by Ducheneaut and Moore (2004), Kolo and Baur (2004) observed that most players seek more than merely strategic considerations (instrumental play) when interacting with other players. They search for communication and persistent social relations (social play).

2.4. A summary of the studies

These studies showed that unlike other genres of computer games, MMORPGs are a complex virtual world with complicated social interactions. This aspect should be addressed appropriately in order to ensure its success.

In line with these studies, we attempt to study this issue through the examination of players’ cognitive loads when playing the game. In the following sub-section, we describe the cognitive loads issues in general and how understanding cognitive load is useful in designing MMORPGs.

2.5. Cognitive load theory

Cognitive load theory is defined as the amount of mental energy required to process a given amount of information (Feinberg and Murphy, 2000). The major factor that contributes to cognitive load is the number of elements that need to be attended to (Sweller, 1994).

Our working memory makes it difficult for us to understand and process information that is presented to us simultaneously as this creates heavy cognitive loads upon the user (Wilson and Cole, 1996). A user’s attention could be focused by directing attention to the information that is most important or immediately relevant, through a technique called instructional cueing (Lee and Lehman, 1993). To prevent the diversion of a user’s attention, different element such as text, colour, and sound can be used to reinforce a message (Adobe Company, 2006).

Furthermore, it is suggested that working memory has a limited capacity of 7 ± 2 chunks items (Miller, 1956). This can be increased by chunking through the use of patterns, categories, and groupings. Working memory is the key resource in multitasking (Preece et al., 2002), hence overloading should be prevented as this affects the user’s concentration resulting in tasks taking longer to complete.

It is also believed that there are different levels of cognition: high cognitive level has low capacity, and can only handle one thing at a time while on a low cognitive level we can handle a number of tasks which are familiar to us. A task can be transferred from high to low level cognition by repetition. Through this transfer, a task might become an automatic process which requires very little effort and is performed rapidly (Goldstein, 2005).

The level of perceptual load that a player experiences is also dependent on a task as research shows that complex tasks hold attention better than mundane ones (Preece et al., 2002).
When cognitive load is increased a task becomes more difficult and perceptual load decreases therefore increasing the chance of a user being distracted (Lavie, 2005). Hence, it is thought that expert users are almost immune to distractors and can continue to concentrate on the task they are doing as they have enhanced visual information-processing capacity rather than greater distractibility (Lavie, 2005). When cognitive load on working memory is high there is no spare capacity for the user to keep up with other stimuli that they may be provided with and are unable to prioritise them. When this occurs the user is more vulnerable to interference by irrelevant low-priority distracters (Lavie, 2005).

There are techniques to reduce cognitive load in different contexts, some of which might successfully be applied to the playing of MMORPGs. These include eliminating redundant information, combing visual and auditory stimuli and only presenting one representation at a time to the user (Feinberg and Murphy, 2000). Furthermore, various sounds can be used to provide a player with feedback (Wilson and Case, 2000). The following list illuminates some principles that can help reduce cognitive load in learning (Cooper, 1998):

- **The goal free effect.** The goal free-effect suggests that problems should not be given with an end-goal, because it causes the learner to have to maintain several conditions in working memory while they engage in problem solving.
- **The split attention effect.** Split-attention occurs when learners are presented with multiple sources of information that have to be attended simultaneously. This principle states that instruction should not be designed that causes the learner to have to divide attention between two tasks.
- **The redundancy effect.** Using different modes of working memory for the same information source causes the redundancy effect. For example attending to both textual and graphical sources of instruction, results in a reduced portion of working memory being available for the process of learning.
- **The modality effect.** It asserts that effective working memory capacity can be increased by using multiple modes of working memory (e.g., auditory and visual) together rather than using one alone. However the information should be structured in such a way that it can not be understood with only one mode.

Little has been done on investigating cognitive loads in entertainment software. A study has been conducted to investigate split attention effects in interactive narratives (Ben-Shaul, 2003). Several interactive narratives were analysed and it was claimed that distraction in such narratives occurs as a result from split attention problems causing cognitive overloads among users.

When interacting with this kind of software, the reader’s attention splits between still images, animated images, moving images, textual comments, and the game-like arrows and hot spots to navigate. It was concluded that for interactive narratives to sustain deep wide ranged engagement, multi-tasking split attention problems have to be avoided or managed properly. Although split attention problems in multi-tasking can be eliminated easily by automation of one task (such as the navigation), this is undesirable since the whole point of interactive narrative revolves around the freedom of navigating through the story (Ben-Shaul, 2003).

In fact, this is also a typical dilemma of computer games: we want a game that is easy enough to learn, but not too easy to the extent that it becomes not challenging. For instance, to reduce cognitive load in a puzzle game we may reduce the difficulty level of the puzzle, but this might result in a boring game. We believe that there might be different types of cognitive loads in computer games than those found in interactive narratives as to disclose the game narratives, players need to solve puzzles or act fast to kill monsters, rather than just navigate.

Also, although a lot has been said concerning handling of cognitive loads in e-learning, we speculate that in the case of computer games, particularly MMORPGs, cognitive load issues might be manipulated differently from e-learning and other task-based applications, in which the game might be designed intentionally to overload the player’s cognitive capacities in order to increase the game challenge.

3. Methods

The game we used for this study was Maple Story (Wizet, 2006), which is a typical example of an MMORPG. It requires players to connect to the internet and log on to play. It allows them to develop their avatars’ level (level is a term used to refer to the strength of the avatar) and complete tasks while at the same time allowing them to communicate with other players. Through this communication, players can seek help or just socialise and make friends. It can take place in more than one way: a player can chat publicly using the screen at the bottom left corner (see Fig. 1) which allows all players to view and respond to what he or she has typed; or a player can make buddies and talk to them privately. A player has the opportunity of creating and working in a party depending on their level in the game. Party members can “whisper” to one another thus only allowing party members to be engaged in a conversation. Players can also trade items and buy goods from the “shop” as well as from other players. As illustrated in Fig. 1 they are required to keep track of several things while playing.

Upon the initial examination of Maple Story, we decided to focus our analysis on an in-depth study of game playing of a small number of players, rather than focus on short observations of large numbers of participants. This was due to the fact that unlike offline games, MMORPGs require a relatively long period of involvement in order
to elicit a more visible social interaction with other players. This is a very important factor we wanted to study as social interactions comprise a very significant part of the game playing, and thus might be taking away the cognitive capacity of the players.

We focused our analysis on three users (one expert player and two novice users). Two participants were female and one was male, all of them were between the ages of 13–18 (Table 1). We chose to use a combination of expert and novice players in order to compare the relationship between expertise and cognitive loads.

Although our focus of analysis is on these three participants, their game playing activities involved hundreds of other virtual players whose actions were also taken into account in our analysis. While the three participants were used as a major data source, other virtual players’ actions were used to support the observation of actions performed by the participants. For example, we observed how our participants communicated with other virtual players, or how the way other virtual players moved around in the game environment affected the performance of our participants. Over 20 hours of observation data were collected.

3.1. Data collection

Several steps were carried out to collect the data. First, participants were given a pre-questionnaire to solicit information about their prior knowledge on computer games in general and MMORPGs in particular.

A semi controlled participant observation in which the players were required to complete a list of pre-defined tasks was conducted. To better structure this part of the data collection, we played and familiarised ourselves with Maple Story and created a list of tasks that the participant needed to complete. The tasks were guided by the research questions, carefully designed and pilot tested. We also created a set of instructions, hints and tips so that the participants understood clearly what they had to do. By defining a set of tasks, rather than allowing the participant to explore the game freely, we were able to focus our data collection on specific areas and thus help answer our research questions. As the possibilities of play in MMORPGs are immense, in the absence of pre-defined tasks there is the danger that participant might just engage in activities that yield no useful data (e.g., turning the game into a chatting program rather than trying to achieve some game goals).

Whilst the participants were carrying out the study, the screen was video captured and observation notes were taken. After each game playing session (usually lasting from five to seven hours) interviews were carried out to reveal

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<td>Expert in MMORPG in general</td>
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Table 1
The basic profile of the participants
whether the players formed any particular strategies to overcome the cognitive load they encountered when playing the game. The interview also included questions that tried to find out how the players found the tasks, what techniques they used to help them play better and what difficulties they faced.

3.2. Transcription and analysis

We reviewed the research questions before transcribing the video clips so that we could focus on relevant activities and events, e.g., whether the participants had a problem logging in and how they fought monsters. We noted down some of the online conversations between the participants and other players that we thought were relevant. Attention was paid particularly on cases when the participant failed to do some tasks because they were engaged in something else.

More specifically, our data analysis was structured as follows:

- First, by focusing on the difficulties participants were facing when playing the game, the data were broken down and conceptualised.
- The data were broken down based on player’s goals. One block of data consists of a series of player’s actions to achieve a certain goal. Once the goal was achieved or changed we considered the subsequent data to belong to another block.
- The main concepts (difficulties faced by the participants) of each block were identified by the researchers.
- Then the concepts of difficulties were categorised to develop a model of cognitive loads and each category was described and supported with empirical data.
- The same process was carried out for different sets of data in order to enhance the model.
- The relationship between the observed cognitive loads and the participants’ opinions regarding the difficulties/challenges elicited from the interview was also identified.
- Finally, based on the categories, the video clips were re-examined to identify the strategies developed by the participants to cope with the different types of cognitive load. The same process of coding and categorisation was conducted to identify the categories of strategies.

4. Findings

Let us now attempt to answer our research questions posted at the beginning of the paper.

4.1. What kinds of cognitive overload exist in MMORPG playing?

Our results show that cognitive load exists in at least five different forms when playing MMORPGs.

Fig. 2 illustrates the general view of cognitive loads that are present when playing MMORPGs. The model indicates that players need to process the user interface to interact with the game objects. They also have to construct either their own identities and understand other players’ identities in order to interact with each other.

In some cases, user interface processing affects not only game interactions but also social interaction. The same goes for identity construction which might affect game interaction as well. For example, to chat with another player involves the interaction with the user interface (chatting window), while the avatar’s identity plays a role when interacting with some game objects such as weapons and armours as certain items can be used by avatars with particular characteristics.

Finally, when playing the game, players are constantly interacting with the game and other players. Thus it results in parallel game and social interaction loads.

We will now discuss in detail each of these cognitive loads.

4.1.1. Multiple game interaction overloads

Playing Maple Story involves interacting with a large number of game objects. These include various monsters to fight and items to pick up, game props such as ropes and portals, NPCs (non-player characters), the item inventory system and the character equipment system, etc. It is found that these interactions, when carried out separately, cause no significant cognitive problem to either expert or novice players. However, in most cases, these actions need to be performed simultaneously in order to play successfully and this results in what we call “multiple game interaction overloads”.

For examples, it was observed that the participants were often stung by monsters when trying to pick up items or money, showing that it is difficult to carry out two tasks at once even though both tasks are relatively simple when performed separately.

In the interview, Novice_2 expressed the opinion that he would have preferred to do fewer things at once and thought
that this would have increased his performance because he would have had the opportunity to focus more on a specific task. He suggested that the game could be made less complicated by having less things going on at once and by linking tasks in sequence so that they flow better.

However, our results also imply that “multiple game interaction overloads” do not persist throughout the game playing as they exist only at the early stages and thus do not result in serious hindrance to the progression in the game.

For instance, Novice_1 stated that she found it easier to cope with having to do tasks simultaneously as time went on and she developed strategies to overcome the problem. She also felt that having fewer tasks to complete at the beginning of the game would have made the game simpler and helped her gain knowledge that would allow her to cope better with multi-tasking later in the game.

4.1.2. Multiple social interaction overloads

Being a game played by a massive number of players at the same time and in the same virtual space, MMORPGs like Maple Story require the player to not only interact with game objects but also to interact with other game players. There are various reasons why a player has to communicate or interact with other players. These include cooperative interactions such as trading with other players, casual chatting, fighting monsters together to improve the chance of success, as well as competitive interactions such as competing with each other to kill monsters (to gain experience points), to collect items and money. It is found that if a player has to interact or communicate with more than one person at the same time, “multiple social interaction overloads” occur. Compared to “multiples game interaction overloads”, this is a more severe problem as our data shows that it affects both experts and novices.

For instance, Novice_1 failed to accept a trade request as she was looking for other players from whom she can purchase a magician’s hat. By the time she noticed the request she was looking for other players from whom she can pur-

expert_1 illustrated in the interview:

“Things can go wrong very quickly when you are trying to do lots of things at once because your attention is divided . . . that monsters can attack you while you are talking [and thus] make things more difficult.”

Another example includes failing to accept a trade request (social interaction) when busy buying items from a shop (game interaction) or being attacked by monsters (game interaction).

Here, we would like to illustrate this through an observation we made in our study:

Expert_1 saw the message “Selling orange mushroom caps 50 each” and replies “can I have them”. However there was a mushroom monster where she was and it was continually stinging her. She tried to fight it and realised the monster was way too strong. She then quickly got onto the rope and accepted the invitation, however she had taken too long as the trade window was already closed. The user then typed “me plz (please)” in the hope of getting another trade request and tried to justify why she did not accept the first invitation and typed “the mush (mushroom) was in my way”. However there was no response from the other player.

In a conventional game this would not be a problem and the player is likely to focus on fighting. In this particular case of MMORPGs, the participant was desperately trying to get to a safe place to accept the trade.

In another less common example, the participant was checking the character information of a player, while at the same time that same player sent her a party invitation (an invitation to join a group/party of players working together to achieve common goals). As the participant was too busy reading the information (game interaction) she did not notice the invitation (social interaction).

4.1.4. User interface overloads

Apart from interacting with the game and other players, the participant also needs to keep track of the information (particularly visual information) in the game user interface. This information comprises the displayed name of players, hints and help information, chatting window, the player’s health and magic status, description of the items, the mini map that indicates the location of all monsters and players in one area, etc. We call this type of overloads “user interface overloads”.

The most common example of user interface overload that happened to novice participants was the inability of monitoring the health status, resulting in continuous death of the game avatar, i.e., the participants failed to attend to important information as the game screen contained a lot of other irrelevant information.

In the interview, Novice_2 stated:

“It is hard moving around in the game because you need to keep track of HP (health point). You were often too engaged in other stuff and failed to monitor your HP and forgot to recover. So you died quite a lot.”

There is another concern among the participants of the chatting messages being mixed up with game hints. This
resulted in the participants not making full use of the available tips.

4.1.5. Identity construction overloads

As players are taking on another identity when playing the game, they need to keep track of their game avatar and the names of the avatar they are interacting with. “Identity construction overloads” occur when players fail to construct and identify their own identities or others’ identities in the game.

An example that supports this is when the participant failed to reply to another player’s question even though it was obvious that the player was talking to her as the player used the participant’s avatar name. She did not answer even though the other player asks her the same question several times in a relatively safe area.

This overload afflicts players more severely when they have to interact with more than one player. For instance, Expert 1 found it difficult to identify party members and her own avatar when many players were in one place due to the limited avatar appearances available.

Novice 1 pointed out that:

“When there were vast numbers of players in the game, other players did not reply to you as they did not know if you were talking to them... it is confusing as you did not know which players were talking to as names were not mentioned.”

Novice 2 also believed that when many players were congregating in one area, it was difficult for him to see players’ names, making it difficult for him to communicate. It was the case because he relied on the displayed name to construct the identity of other players as many players can use the same avatar appearance.

4.2. What effect does cognitive overload have on the user’s performance and enjoyment?

In our view, the cognitive overloads that exist in MMORPG games make the game harder for the participants and can sometimes hinder their performances and might result in frustrations. There are three main unwanted effects of cognitive overload:

The user keeps “dying”. The participant’s avatar dies not because of the lack of skills to deal with the monsters, but as a result of unnecessary cognitive overloads. For example, when checking the key settings Notice 1 was being attacked by monsters and eventually died because the key settings window obscured her from seeing her avatar.

The user fails to attend to some actions. The participants often failed to accept trade requests in time or respond to others’ invitation for grouping. This can result in the loss of opportunities that might put the player in a more advantageous situation.

The user misses important information. Participants failed to attend to important information that might help them play better. For instance, it is difficult to keep track of what other players are saying if they are not near the participants because the message only appears in the general chat screen which is overloaded with tones of messages.

Although some cognitive loads in Maple Story hinder the user’s performance, they make the game more challenging and interesting. Also some of the cognitive loads are not a problem as over time the users got used to it and began to use various strategies to cope with it.

A sign of cognitive overload is when people start to make frequent mistakes. However our study showed quite the opposite as although the participants continued to make mistakes throughout the game, their performance improved as they progressed in the game and the cognitive load present became less of an issue even though the game became more demanding. If cognitive loads did not exist at all in the game (e.g., the player eventually learnt to avoid totally being attacked by any monster), the game playing would have become less meaningful as it would not anymore possess any challenge.

When Expert 1 was asked what effect it would have had on her performance if she was to concentrate on one thing at a time, she replied:

“Like having more than two things to do at once because it makes the game a bit more interesting and a bit harder...”

In a similar way, Notice 1 commented:

“I did not mind having to do more than one thing at a time at once and it would have been boring otherwise, although it would have been easier and I would have performed better if I was to concentrate on one thing at a time.”

Therefore, the most important question here is “how do we balance off cognitive overload effects with the game challenge?” Although more studies need to be conducted to answer this question, based on our observation, we hypothesise that “multiple game interaction overloads” is the least severe type of overload and can be overcome rather quickly as time goes. “Multiple social interaction overloads” pose more problems as social interactions are more unpredictable during the game development phase. The most serious problem is the “parallel game and social interaction overload” and we suggest that the game should be designed in a way to minimise these parallel interactions.

4.3. How could cognitive load be handled in MMORPG games?

Although cognitive loads exist throughout the game especially as the player level increases, there are strategies that the participants can use, some of which are devised by the user whilst others are provided by the game itself.

Our study showed that the users we observed developed at least six categories of strategies to cope with cognitive loads.

4.3.1. Game interaction techniques

The players develop various techniques to deal with the game objects, especially monsters, so that they can focus their cognitive capacities on something more complicated and more cognitively demanding.
4.3.2. Identifying safe places
The participants learnt to ensure that they are in a safe place when checking things like key settings, various inventories, when talking to other players and accepting trade request and party invitations.

By doing this the participants eliminate the possibility of any danger from monsters and therefore could concentrate on the task. With this type of games the player needs to be alert of all situations and cannot focus solely on one task unless they have covered themselves from all dangers.

During the study, it was observed that Expert_1 always ensured that she was in a safe place before talking to another player. She also kept track of health status and restored it when necessary by standing still in a safe place, or by consuming food or potion.

4.3.3. Short-term social interaction
During the game play, the participants often asked for help from other players in order to complete the given tasks. For example, the participants used the trade function in the game to obtain items they required.

In some cases, the participants made announcements to let other players know what they were looking for. For instance they announced that they were selling an item, looking for an item or wanting to join a party. This way anybody who was interested or willing to help became aware of what the participants wanted and as a result they received a party invitation, a trade request or helps if they asked a question.

4.3.4. Long-term social interaction
The participants utilised the in-game party mechanism to form social groups with other more advance players and stay with the group for a relatively longer period of time in order to gain both experience points and money. There were several methods used by the participants when in a party which helped them.

- The participants attacked monsters with party members, which was effective when fighting powerful monsters.
- While party members were fighting the participants often stayed close behind and collected items, which was not feasible when on their own.
- Party members helped the users to be aware of and recover their HP (health point). This was because it was easier for other party members to see their HP. Party members protected the participants when recovering their HP.
- There were times in the observations where a party leader fought powerful monsters for the benefit of the participants while they stay in a safe place.
- The participants formed buddies, some of which they later communicated with even if they were in a different channel and got help or tips from them.

4.3.5. Interaction and information filtering
The participants learn to prioritise tasks and information. They learnt not to attend to irrelevant information and not to respond to people who are not going to help them. In this way the participants are reducing cognitive loads as they are not concerning themselves with conversations of other players and instead are concentrating on completing the tasks. The participant did not respond immediately to party members, especially those irrelevant to them.

Besides, the participants become more aware of important information that requires constant attendance such as the health status. They monitored health status and recovered it when necessary by sitting at a bench, standing still or consuming food or potions in a safe place. Furthermore, when in the shop, some of the users would keep an eye out for people dropping items especially players who looked rich as they tend to drop many useful things like money, food and often unique things that the user could later trade.

4.3.6. Communication shortcuts and techniques
The participants learnt to minimise the time spent on communicating by using shortcuts and employ techniques to make their chatting messages salient to other players.

The users used the left and right arrows key to repeat recent sentences that they have previously typed and this strategy saved them time so that they could focus on something else. Facial expressions were used instead of typing a message because it was quicker to show that the user was grateful, happy, or amused. This technique was especially useful when the user was busy fighting or in areas where there were many monsters.

5. Discussion and conclusion
We have presented a model of cognitive loads for MMORPGs that consists of five categories: multiple game interaction overloads, multiple social interaction overloads, parallel game interaction, and social interaction overloads, user interface overloads as well as identity construction overloads. Although our result implies that parallel game and social interaction overload causes unwanted problems even for expert players, it is found that not all cognitive overloads affect game playing negatively. In fact it is hypothesised that multiple game interaction is an important factor of making the game challenging and thus more enjoyable. Our observation reveals that users develop various strategies to cope with these overloads. Based on the results, we recommend several design principles that game designers might consider when developing MMORPGs to help users handle cognitive overload more effectively.
5.1. Recommendation for game designers

By handling cognitive load better the game will remain challenging and fun but will at the same time become more manageable for players, especially beginners. We claim that game designer can help players cope with cognitive loads and we list below some recommendations to achieve this for MMORPGs.

5.1.1. Handling multiple game interaction overloads

This type of overloads could be reduced if proper care is taken during the game development. For example, the game could provide appropriate feedback to the players when a certain action is performed or a certain action fails. For example Novice_1 failed to eat the apple that she was given by a helper but no feedback was given to acknowledge this failure. This could be easily prevented with relevant and contextual feedback.

In addition, game developers should be aware of the strategies that players use when playing the game and should facilitate them. For example, some form of alert could be issued when players are getting attacked, which will be particularly useful if a player is concentrating elsewhere in the game.

5.1.2. Handling multiple social interaction overloads

Game designers could help reduce multiple social interaction overloads by improving the usability of chatting and trading systems or any other systems that mediate social interactions among players.

One of the ways to achieve this is through better personalisation of the interface, e.g., by providing the player with message templates to choose from.

5.1.3. Handling parallel game and social interaction overloads

This type of overload could be reduced quite significantly by tackling problems created by game interaction overloads and social interaction overloads separately.

It was found in our study that the players need to find a safe place before talking. Thus game developers have to ensure that there are safe places with no monster on each area. Besides, providing indicators of various interactions (game or social interaction) will also help reduce this overload. For example, the player should be provided with some sort of an alert such as an audio alert when there is a new message in the chat screen as they often miss this due to being engaged in other tasks.

It might also be useful to consider making players’ avatars invincible when they engage in a trade so that they do not need to attend to social interaction (trading) and game interaction (monster killing) at the same time.

5.1.4. Handling identity construction overloads

This game has handled this problem quite appropriately by showing the avatar name on top of each character. More can be done by allowing a wider range of avatar customisation so that the player can more easily construct unique identities through visual appearances.

5.1.5. Handling user interface overloads

User interface overloads can be reduced by making important and relevant information more obvious to the player. Having the HP (health point) displayed above the avatar might be helpful as players often failed to keep track of this especially when fighting as they were concentrating on a particular area of the screen. In addition, the game might also provide some sorts of alert when the player’s HP is dangerously low.

Moreover, rather than mixing game tips with chat messages, the game tips could be provided separately in another window. Relevant information could also be emphasised through using different colours and bigger sizes.

5.2. Limitations

As explained at the beginning of this paper, our focus was to conduct a study as an exploratory investigation into cognitive load. Therefore the study is bound to a number of limitations.

5.2.1. Number of participants

Three participants were used in the data collection stage. The experiment adopted an in-depth data collection requiring each participant to play the game for about seven hours each, thus resulting in a large volume of data that we analysed. Despite this, it is believed that individual differences might influence the way people handle cognitive loads in games. For that reason we think it will be useful in future studies, if resources permit, to run the experiment with a larger number of participants (8–12).

5.2.2. Generalisation of our model

Our model was developed through the analysis of our observations of one MMORPG. For that reason, it should be pointed out that the results might not be fully applicable to single player games. For example, social interaction load might not play much (if any) role in playing single player games. In addition, there is often a difference in complexity among different MMORPGs but this was not taken into account in our study as we focused only on one MMORPG. In future projects, this needs to be investigated by running comparative studies across different genres of MMORPGs (e.g., how is cognitive load presented and handled in battle-oriented games such as World of Warcraft versus non-battle-oriented games such as the Sims Online). Finally, our study was based on PC-based games. Games on other platforms such as immersive virtual reality games, console games, handheld games etc might present additional/different forms of cognitive loads. Comparative studies across these types of games will also be of great research interest.
5.2.3. The relationship between elements

We understand that when playing games, players often have to deal with various stimuli at the same time and thus each element of cognitive load we suggest in our model is by no mean independent. During the analysis of this study, we attempted to identify each element of cognitive load that emerges from the data we collected. Most of these elements of cognitive load overlap, as shown in the data, for example, when socialising with other players, the participant is also interacting with the interface. Further research needs to be conducted to identify this relationship.

5.3. Future research

This study can be expanded in various ways. More analysis of other MMORPGs can be carried out with this model of cognitive load. It will be particularly interesting to analyse games with characteristics that are different from those of Maple Story, such as The Sims Online which is not centred on fighting and monster killing.

The model can be refined by examining specifically each type of cognitive overloads to identify more subcategories. Also, it will be very useful if we are able to identify relationships between cognitive overloads and game engagement.

Future research can be conducted to operationalise this theoretical model to practical guidelines for designing fun and challenging MMORPGs. This can be done through the use of HCI methodologies to derive useful guidelines through participation observation.

Finally, we can also examine the impact of this interface on learning from the perspective of the impact of task accomplishment on the individual players and their ability to generalise the knowledge they gain in the game to the physical world.

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