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Faculty of Cognitive Science and Human Development

# COGNITIVE STUDIES IN VIRTUAL REALITY GAMES

Azura Binti Zainal

Bachelor of Science with Honours
(Cognitive Science)
2005

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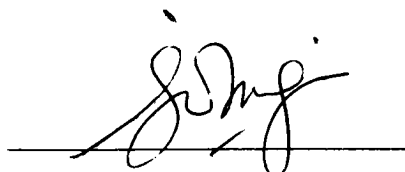5. ** sila tandakan ( √ )

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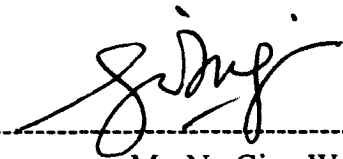
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# COGNITIVE STUDIES IN VIRTUAL REALITY GAMES

AZURA BINTI ZAINAL

This project is submitted in partial fulfillment of the requirements for Bachelor of
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# ACKNOWLEDGEMENT

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# ABSTRACT

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Generally, this research describes the experimental study that elaborates and analyses the cognitive processes in Virtual Reality (VR) games environment. The aim of this research is to create a human cognitive assessment and learning scenarios that would allow for precise control of complex stimulus representation. The interaction of cognitive processes between user and VR games analyses will then provide a useful integration between users' performance and VR environment in the future. The analysis of experiments results in a proposed of standard user's mental model to represent human cognitive processes as to facilitate VR games future designers in games application for making a meaningful interactive VR application. In addition, the findings of this study are important because it represents more than a simple linear extension of existing computer use. Through the experiments that have been conducted, it is cleared that cognitive processes does affect the player's tasks and it is concerned that they have a typical model of user when performing the task(s).

# ABSTRAK

## COGNITIVE STUDIES IN VIRTUAL REALITY GAMES

### Azura Zainal

*Secara umumnya, kajian ini menerangkan tentang hasil dapatan kajian eksperimen yang menghuraikan dan menganalisis proses-proses kognitif dalam persekitaran permainan Realiti Maya (RM). Tujuan kajian ini dijalankan adalah untuk membentuk satu senario pembelajaran dan penilaian kognitif manusia yang membenarkan satu pengawalan perwakilan stimulus yang kompleks. Analisis interaksi proses-proses kognitif yang wujud di antara pengguna dan sistem permainan RM akan menyediakan integrasi yang berkesan di antara pencapaian pengguna dengan situasi persekitaran maya pada masa hadapan. Melalui analisis eksperimen, satu model mental pemain dihasilkan sebagai perwakilan terhadap proses-proses kognitif yang berlaku yang berupaya membimbing para pereka permainan RM supaya mereka dapat melahirkan aplikasi RM dalam bidang permainan dengan lebih interaktif dan berkesan. Melalui eksperimen dan penilaian terhadap proses tersebut jelas menunjukkan bahawa proses kognitif membantu seseorang pemain itu menguasai permainan dan menyedikan suatu ruang latihan yang berkesan untuk pembelajaran. Pemain juga mempunyai satu set model mental yang khusus dan dapat menggambarkan bagaimana sesuatu proses kognitif pemain itu berlaku semasa mereka melakukan tuga-tugas tertentus.*

# CHAPTER 1

## INTRODUCTION

The technology of Virtual Reality (VR) has brought a new dimension and trends to the world of entertainment. Computer games are one of the applications that used VR as interactive tools whereby it offers 3-dimensional (3D) immersive graphics that allows for the feeling of presence and psychological immersion to the users. However, the quest for more interaction that promotes cognitive processes is also critical (Sutcliffe, 2003). The aim of this research are to describe and analyse the cognitive studies of the users that exist during the interaction with the 3D VR games. Through electronic games, children may controls levels of difficulty, game rules and tools for problem solving, allowing them to construct cognitive skills unavailable to previous generations (Baird, W.E., & Silvern, S.B., 2003). VR has simulated the action-perception relationship in physically correct manner but without involving real objects or real events.

Moreover, with the study of this research, it is hope that a standard user mental model of 3D VR games will be proposed according to the needs of cognitive processes during the experiments. The potential of this work are to improve human capability of understanding, measure and decision making in scientific study of cognitive processes from the standard mental model as well as to facilitate and guide the VR games designers in the making of meaningful interactive VR application. In addition, with the user's mental model that has been emphasized in this study, it can be provided for a new phenomenon of situated learning environment in the applications of VR. The application in this area particularly important because it represent more than a simple linear extension of existing computer technology of human use.

## 1.0    Background and Literature

In this research, there are some most important theory of cognitive processes and learning involved that used as a guideline. Cognitive flexibility theory is a relatively new cognitive theory that has significant implications for learning (Spiro & Jehng, 1990). Spiro and Jehng had proposed the Cognitive Flexibility Theory (CFT) to address issues of advanced knowledge acquisition. Knowledge are often nonlinear and complex and inappropriate for simple hierarchical organization. Their theory came out of dissatisfaction with introductory instructional approaches. Therefore instructional methodology used to present simple and well-structured information is unsuitable for more advanced

learning in ill structured domains and actually hinders the assimilation and transfer of complex knowledge.

On the other hand, *strategies* in learning are categories of cognitive task procedures each based on particular mental model and the related interpretation of information, and on set of rules. The characteristics of various *strategies* are identified to subjective performance criteria such as time needed, cognitive strain, amount of information required and quantity of failures (Pejtersen & Rasmussen, 1997). Analysis of the available effective strategies are important for the interface design because it supplies the designer with several consistent sets of mental models, data, and rules which can be used by varying expertise and capability.

## 1.1    Problem Statement

Interactive computer games have emerged as one of the popular trends of entertainment for last several decades. The technology of VR has put closer boundaries between games and VR tools. The newer generations of games are extremely varied in their content in terms of advanced graphical representation, interactive user interface design, and mutually perceivable visualization and immersion within the environment. However, multi-interaction games has not only open up new possibilities in designing more exciting and usable interfaces, but they also make the design space more complex. The potential of bad integration is increased and may lead to failure. Overload quantity of information and complicated environment in virtual games can bombard users with excessive

stimuli and burden them to assimilate complex message (Sutcliffe, 2003). Consequently, it will cause stress and vandalism, and bad VR representation can make them sick.

The system may fail to satisfy users' requirements due to the lack of interaction within cognitive processes underneath the non-dynamic stimulus environment. Nevertheless, there are needs of attention, which involves cues, prompts, sounds and colors. In this regard, a multisensory interaction should support cognitive properties of human information processing (Sutcliffe, 2003). As vision is the dominant sense modality in games playing, effective perception is the main concern to ensure that information can be seen clearly, and the environment has been perceived as naturally as possible with the appropriate range of senses (Sutcliffe, 2003). On the other hand, appropriate comprehension should be fulfill to make sure that the interactive environment and information is displayed in an appropriate to the task, so that the user can predict how to interact with the system. This also involves making sure the users take important parts of the message and follow the instruction accordingly. Moreover, effective action also takes place. Action should be intuitive and predictable. The system should provide interaction by suggesting how it should be played and tailored with users' intentions in cognitive and physical senses. This is to ensure that human capability and system are corresponding in terms of memory, problem solving and perception.

As system and user integration lead to interactive way, usability is another part that contributes to effective communication within the system. In this regard, usability is strongly tied to the extent to which a user's mental model matches and predicts the action of a system. Ideally, an interface design in virtual environment should be consistent with people's natural mental models about computers, the environment, and everyday objects. However, sometimes the technical capabilities of a system have no resemblance to objects in the world. Human Computer Interaction (HCI) practitioners have produced a large body of guidelines and heuristics used to design systems that are easier for people to understand and use (Nielsen, 1993). Through various design methods, we can build cues into a system that help users create new, accurate mental models. This is because an inaccurate mental model of what is happening in a system may leads to errors. Many systems place too many demands on the humans that use them. In this context, users are often required to adjust the way they work to accommodate with the games. Sometimes the result is a minor frustration or inconvenience, such as selection of setting has to be made before they get used with the procedures of the games.

## 1.2    Research Questions

This research intended to clarify critical issues about the significance of constructing VR games within the cognitive processes. Thus, this research would carry out an investigation of research questions as the followings:

i.  How did the VR games can improve visual perception?

ii.  In what ways the users' concentration and focus attention in VR games application can be more conducive and help boost their perceptual skills?

iii.  How did the VR games application could serve to as a powerful cognitive development and performance?

iv.  How did the VR as a situated learning environment?

## 1.4    Research Objectives

### 1.4.1   General Objectives

The main purpose of this research is to analyze the cognitive processes of user while they play with the VR 3D games. Generally, this research aim to create a human cognitive assessment and learning scenarios, which allows for precise control of complex stimulus representation.

### 1.4.2   Specific Objectives

The evolution of 3D games has led the users' perception of satisfaction in the existence of VR. The application helps adaptation process in terms of high motivation levels. Thus, the specific objectives of this study are:

i.   To analyze how the VR games being constructed within the cognitive processes.

ii.  To analyze the cognitive processes such as perception, attention, and visual perception.

iii. To come out with standards users' mental model for applying a good system design and development as well as to improve and enhance user performance and motivation in a situated learning environment.

## 1.5   Scope of the Project

In this study, the self-arranged gaming session for the experiment is intended to analyse the cognitive processes within the games as well as to come out with a new concept of mental model. In other words, the needs of users' mental model are beneficial in such a way that it will adopt a good guideline to the others 3D VR games application in the future. On the other hand, some cognitive processes that have been study in this research are believe to motivate user and improves their performance in learning scenarios.

## 1.6   Values of the Study

The vast development of 3D games has boost enormous results in VR application. Thus, the rapid changes and artistic development in the game industry in VR market is a challenge to research. The technology does not only offer

advanced visualization and interaction, but comprises a learning environment through higher order thinking which are problem solving and decision making to the users. In this context, problem solving is the action that users take when they come up against the unexpected situation during game play. This is where the games have created a learning environment to users when they are expected to think of a solution through the combination of their existing ideas in such a way to form new ideas. According to Sutcliffe (2003), in VR games, virtual objects and tools has given several cues to the user to prompt action and helps solved a problem through the cognitive affordance. The essence of cognitive affordances is that they have a physical manifestation that prompts appropriate action by concrete suggestibility (Sutcliffe, 2003). Although users use a wide variety of problem-solving strategies, the representation of necessary cues and facts in virtual environment (VE) may help them to tackle the problem space easily.

A VR games application was not interesting without interaction exist between user and the VE. Interaction is a concern when topics about games are discussed. However, interaction itself must be well understood by user in order for them to act accordingly to what they perceived. Therefore, with this study, VR games applications will provide a useful integration between users' performance and VR environment in the future. Within this context, the useful integration is referred to as information retrieval in which the users' actions are primarily directed toward navigation through the virtual space. Navigation pathways are necessary to indicate where the user might locate the information he or she needs, with hints and prompts along the way, following the concepts of information scent

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(Furnas, 1997; Pirolli & Card, 1999). Key controls such as forward, backward, stop, left and right help navigating in dynamic media, and support exploration in static media. Action execution requires controls that are easy to operate and within the human bounds of motor precision (Sutcliffe & Patel, 1996; Card, Mackinlay & Shneiderman, 1999). The environment of games should ensure that the user could perceive the feedback in an appropriate medium; for example, audio feedback cannot be heard in a noisy surrounding. The useful integration also requires the design to deliver messages appropriately so that, comprehension of scenario is efficient.

This research on cognitive processes that occurred during game sessions has numbers of advantages, not only for educational tools, but also for therapeutic purposes, particularly with regard to effects on eye-hand coordination and reaction time. According to Kinder (1991), in his book, *Playing with Power*, games have considerable educational and therapeutic value for a diverse range of groups – including athletes, cancer patients undergoing chemotherapy, young children suffering Down's syndrome and brain damage. It allows good emotions, motivation and promote mental healthy through their actions and thinking process. The visual perception and illusion that they experience in the VE, helps reduce stress and conflicts and on the other hand build up confidence through cognitive skills (Kinder, 1991). Experimental studies showed that games are used increasingly to study learning (Blumberg, 1998; Rieber, 1996), memory (Shewokis, 1997), motivation (Wong, 1996), cognitive processes (Kappas & Pecchinenda, 1999), attention and attention deficits (Pope & Bogart, 1999), and

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spatial abilities (Subrahmanyam & Greenfield, 1994; Tkacz & LaForce, 1998). Games have for years proved useful in training motor skills, such as driving and navigation (Brown, Brown, & Reid, 1992; Dorval & Pepin, 1986; Lowery & Knirk, 1983), and have been developed to promote health (Bosworth, 1994).

## 1.7 Significance of the Study

The study of cognitive processes in VR games will contributes to the current research and theory of related areas such as Cognitive Science, VR, Psychology, Multimedia Design and most importantly situated learning environment. From the results of the cognitive processes experiment, a new finding of standard users' mental model is hope to be achieved and can be applied by other games player in various types of 3D games. The model is hoped to contribute in the design of good games system as well as other VR system in the future.

As this thesis project is done with the intention and interest to explore new ideas in this area, the significance of this study is to build a strong comprehension of cognitive theories and its applications in real life through more critical higher order thinking. This will help build a very solid understanding and foundations of the complexity of cognitive processes possesses by humans, which can apply in the future system design purposes that can improve and enhance user performance and motivation in a better situated learning environment.

## 1.8 Structure of the Thesis

The thesis has been structured into different chapters that discuss on related issues and methods used to conduct the study. Chapters have been divided accordingly as the followings.

### Chapter 1: Introduction

This chapter introduced briefly about the overall thesis comprising the aims and objectives of study, values, scope, significance and delimitations and limitations of research.

### Chapter 2: Theoretical Background

In this chapter, some most important cognitive theories with related works and concept from previous research done by worldwide well-known cognitive scientist, psychologist and academicians, have been discussed and referred.

### Chapter 3: Methodology

The methodology that had been used in this thesis project is mentioned in this chapter. The selected methods are used based on their suitability to this study content.

Chapter 4: Philosophical Framework

This chapter criticized on the methodology and arguments of Chapter 2 regarding the previous research that the concepts and theories been done which were proven necessarily. It stated the "why" and "how" it is considerable in this study.

Chapter 5: Evaluation and Results

This chapter discussed the evaluation done for cognitive processes during gaming session. Results from experiments were analyzes, criticized, and discussed.

Chapter 6: Conclusion and Discussion

The overall study is concluded in this chapter and further discussion and recommendations are proposed for future works.

1.9 Delimitations and Limitations of the Study

In this study, the importance of applied knowledge and conceptual theories within this area is an advantage. The arguments concerning past theories and methods are slightly critical and contradiction. This is the major challenges to be faced and the solution to a new user's mental model is the main preference.

However, there are several limitations in this research. It includes the selection of typical games and its application limits the results in terms of systems weaknesses and design interfaces. Although the games provide for multiple

players and can be included in this study, it is not considered as part of research because of time constraint.

## 1.10 Conclusion

As a conclusion, this chapter has deeply introduced the overall content of the study and the potential of the findings that will contribute to the field of related area. It also has put closer boundaries between VR applications and Cognitive Studies in terms of meaningful learning environment that prepares for precise control of complex stimulus representation through VR platform.