INSTRUCTIONAL DESIGN AND DEVELOPMENT PROCESS OF A VIRTUAL REALITY (VR) – BASED SYSTEM FOR LEARNING BASIC PHOTOCOPYING PROCEDURES

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The work described in this Final Year Project, entitled
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17459

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ABSTRACT

INSTRUCTIONAL DESIGN AND DEVELOPMENT PROCESS
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Ting Lee Yi

This project focuses on the instructional design and development process of a desktop virtual reality (VR)–based learning system. This learning system is meant to facilitate novice photocopier users in learning its basic procedures via the use of a virtual three-dimensional (3D) photocopier. This project elaborates on how the learning system was designed and developed based on an instructional design theoretical framework and an instructional development model. It also described the design and development process of the various components of the learning system such as its surface design, interface design, scenario, instructional strategies and language. These components evolved from the single path prototype to alpha version and finally, beta version which was packaged. The design and development process involved experts and learners who provided feedback to improve the learning system. Three principles, (i) recursion or non-linearity principle; (ii) reflection principle; and (iii) participatory design were used to guide the design and development process. This project also suggested some recommendations and future works to improve the learning system.

ABSTRAK

PROSES REKA BENTUK DAN PEMBANGUNAN BAGI SISTEM BERDASARKAN REALITI MAYA UNTUK MEMPELAJARI PROSEDUR ASAS FOTOKOPI

Ting Lee Yi

Projek ini menumpukan perhatian kepada proses reka bentuk dan pembangunan sistem pembelajaran berdasarkan realiti maya. Sistem pembelajaran ini bertujuan untuk membolehkan pengguna yang tidak berpengalaman dalam menggunakan mesin fotokopi mempelajari prosedur asas fotokopi melalui mesin fotokopi maya yang berbentuk tiga demensi. Projek ini menjelaskan bagaimana sistem pembelajaran direkabentuk dan dibangunkan berdasarkan satu kerangka teori reka bentuk pengajaran dan satu model proses pembangunan. Projek ini juga menghuraikan pelbagai komponen dalam proses reka bentuk dan pembangunan seperti reka bentuk permukaan, reka bentuk antara muka, senario, strategi panduan, dan bahasa. Komponen-komponen ini dibangunkan dari versi awal kepada versi alfa dan akhirnya kepada versi beta yang dipakejkan. Proses reka bentuk dan pembangunan melibatkan pakar-pakar dan pengguna-pengguna yang akan memberi komen untuk memperbaiki sistem pembelajaran ini. Tiga prinsip telah digunakan untuk membantu proses reka bentuk dan pembangunan, iaitu (i) prinsip 'recursion or non-linearity', (ii) prinsip refleksi dan (iii) prinsip 'participatory design'. Projek ini juga memberi cadangan pembangunan masa depan untuk memperbaiki sistem pembelajaran ini.

CHAPTER 1
INTRODUCTION

1.0 Overview

This chapter discusses the background of the study, motivation, objectives, significance and scope of the study.

1.1 Background of Study

According to Trumble *et al.* (2005), Virtual Reality (VR) is the computer-generated simulation of a three-dimensional (3D) image or environment that users can interact with and navigate through in real time. VR systems have been applied in various important fields, such as in the training of surgeons, aircraft pilots, astronauts, and military personnel and were also used in interactive learning programs, video games and so on. (Allen, 1994). This system, which uses synthetic and interactive 3D virtual environment is known as an influential human-computer interaction interface for decades (Burdea & Coiffet, 2003; as cited in Wang & Li, 2004).

There are three types of VR; desktop VR, semi-immersive VR and immersive VR (Cronin, 1997; as cited in Fällman, Backman & Holmlund, 1999). Desktop VR is the most common and least expensive where it usually consists of a standard desktop computer. Users will consequently experience lack of any feeling of immersion when using this type of VR. Conversely, a semi-immersive VR system tries to give users the feeling of at least being a little immersed in a virtual environment which is frequently achieved by different type of systems, such as workbenches and reach-in displays. For the immersive VR system, it is usually referred to as being fully immersed. It typically consists of head mounted visual display units that can lead to user being fully isolated from the physical world. Fully immersive VR is able to almost completely filter out the interference with the outside world and enable one to immerse in the virtual environment. However, the equipment for this type of VR is expensive and application development in this area is commonly more difficult and time-consuming (Fällman, Backman & Holmlund, 1999).

The high cost of hardware as well as software for immersive VR system has limited the applications and their popularity (Wang & Li, 2004). The ergonomics of most VR equipments is still a major problem to make VR popular and widely acceptable tools in engineering verifications (Gomes de Sa & Zachmann, 1999; as cited in Wang & Li, 2004). Moreover, users are limited to laboratories and are required to wear devices which do not allow collective visualization and observation (Wang & Li, 2004).

According to Wang and Li (2004), "the recent advances in computer graphics have spurred interest from both academics and industries in VR enabled training applications." Compared to immersive VR system, desktop VR system offers a reasonable solution that displays a virtual environment on a conventional desktop personal computer (PC) in a non-immersive way (Rooks, 1999; as cited in Wang & Li, 2004). Compared with the use of helmet and data glove, the input devices and the use of a desktop PC offers a more convenient and easy-to-follow interface for the users. Furthermore, users prefer a desktop virtual environment in many VR applications due to its affordability and portability. During the training process, the desktop VR system enables knowledge or information sharing (Wang & Li, 2004). Coupled with the related knowledge and experience display onto the interactive 3D display, desktop VR system benefits the users by providing them with a better learning experience in the desktop VR system (Sleeman & Brown, 1982; Wenger, 1987; as cited in Wang & Li, 2004).

Furthermore, VR that is applied in education can successfully be used to sustain such complex understanding by stimulating and exploring every human sense in comparison with the traditional notions of learning which tends to focus on purely intellectual skills. VR has been proposed as a technological breach that holds the power to make easy learning for educational purposes (Fällman, Backman & Holmlund, 1999). Several examples of VR learning applications are described briefly in the following.

1.1.1 Virtual Reality (VR) Applications

Vari House is a simple desktop VR technology. It assists students to develop critical thinking about archeology by reconstructing both interior and exterior of a building (Youngblut, 1998; as cited in Fällman, Backman & Holmlund, 1999).

The next example is a Collaborative Learning Environment with Virtual Reality (CLEV-R), a web-based multi-user 3D environment. It can be used for real-time teaching and as a tool for students to communicate and collaborate with each other. Evaluation tests have been conducted to test the usability by obtaining the users' feedback and to ensuring the ability of the system functionality fulfills the users' needs. Researchers were concerned with the users' sense of immersion and presence within the 3D learning environment during the evaluation. The results had shown the overall feedback to be positive. A mobile CLEV-R embedded in PDA was provided (Mohana, McArdle & Bertolotto, 2006).

Furthermore, there are novel approaches to deaf education by using both immersive and non-immersive VR. Firstly, SMILE^{TM} is an immersive Virtual Learning Environment (VLE). It is an immersive game for stationary and portable VR systems. It is a game where deaf and hearing children ages from five to ten learn science, technology, engineering and math (STEM) and American Sign Language

(ASL) through user interaction with fantasy 3D characters which are communicated in ASL and spoken English. There are three types of evaluations conducted which are expert panel-based, formative and summative. The expert panel-based and formative evaluations emphasise on the usability and fun, visual representation quality, and are reviewed in the entire process of the development of SMILE to identify recommendations for design improvement. Summative evaluation, on the other hand, assesses learning (Adamo-Villani & Wilbur, n.d.).

MATHSIGNER™ is a non-immersive game for standard computers. It is a 3D animation ASL-based interactive software package which consists of sets of activities with implementation guidelines. It is designed to teach K-6 math concepts, signs, and corresponding English terminology to deaf children, their parents, and teachers. The evaluation is carried out throughout its development by ASL signers, faculty, and students knowledgeable in sign language and deaf education (Adamo-Villani & Wilbur, n.d.).

In short, VR has been widely proposed as an important technological breakthrough that has a great potential to facilitate learning (Youngblut, 1998; as cited in Fällman, Backman & Holmlund, 1999).

1.2 Motivation of Study

Nowadays, photocopier is widely use for the purpose of documentation. Not surprisingly, photocopier, despite being high in prices, is also a machine with complicated functioning. If a user has ever wanted to learn how to use it basically for photocopying the desired number or set of papers, he or she must have some basic knowledge on how to operate it as there are different procedures or steps for accomplishing different tasks. If one is unsure of the photocopying procedures, his or her natural instinct will be to automatically find the operation manual, read it and then follow the instructions to practice. Alternatively, the users may try to find the solution themselves by simply pressing the buttons in the hope to discover the correct procedure. These may result in wastage in terms of time and papers.

The two-dimensional (2D) image cannot provide a good solution for the user to learn on how to operate the photocopier and the user may not learn effectively. A novice may ask an experienced user for help, unfortunately, lengthy explanations would be time consuming and ineffective especially for a beginner. This is because they tend to forget and thus require relatively much work in terms of efforts and time just for the training process.

Moreover, a novice may easily make mistakes when he or she is operating the photocopier. For instance, if a person has problems with an incorrect operation procedure in the beginning, he or she would consume more papers and may even damage the photocopier itself.

To overcome these problems, VR-based learning environment is needed to show the photocopier operation procedures. This VR-based learning system allows users to obtain the same experiences of basic knowledge on how to operate the photocopier through practice in a virtual photocopier environment as a real photocopier. Besides, creating a simulated 3D photocopier in VR will make the learning become more attractive. The simulated 3D photocopier is beneficial as it is cost effective, allows errors to happen in virtual environments and is much safer compared to the real photocopier.

1.3 Aims of Study

1.3.1 Purpose

The purpose of this study is to employ a suitable instructional design and development model to guide the process of designing and developing a VR-based system for learning photocopier basic operation procedures.

1.3.2 Specific Objectives

The following are the specific objectives:

- Identify an appropriate instructional design model.
- Identify an appropriate instructional development model.
- Design the learning system based on the identified instructional design model.
- Implement the design and development process as guided by the identified instructional development model.

1.4 Significance of Study

The use of the instructional design and development models can help in the production of effective VR-based learning system. For example, a research conducted by Chen, Toh and Wan (2004) had demonstrated that the instructional design and development model is a robust model to guide the design and development process of a desktop virtual reality-based learning environment for a novice driver in Malaysia. Therefore, the instructional design and development model incorporated with the technology can provide an effective learning tool.

This study can also help the learners or a novice to use the photocopier more effectively by using a 3D virtual photocopier. The development of this VR photocopier which is guided by an instructional design model aims to enhance the learners' learning. At the same time, the cognitive processes of the learners can be enhanced and positively supported (Siemon, Munoz & Berasategi, n.d.) as they are manipulating a virtual 3D photocopier that mimics the real photocopier.

1.5 Scope

This study mainly focuses on the photocopier that is commonly used in University Malaysia Sarawak (UNIMAS). The target users of this system are novice photocopier users in UNIMAS.

This study does not perform any effective evaluation. Instead, it only focuses on the cooperation of potential learners and experts in giving feedback during the design and development process.

CHAPTER 2
LITERATURE REVIEW

2.0 Overview

This chapter discusses the instructional design, its importance and the model; as well as instructional development with its importance and the model.

2.1 Instructional Design

According to Berger and Kam (1996), instructional design as a process is the systematic development of instructional specifications using learning and instructional theory to make sure the quality of instruction. It is the whole process of analysis on learning needs and goals and development of a delivery system to fit those needs. It also includes advance in instructional materials and activities; tryout and evaluation of all instruction and learner activities.

Instructional design is also the process of designing the environment, methods, and resources for effectiveness learning of specified goals and objectives (Boettcher & Conrad, 1999 as cited in Hanlis, 2004).

However, according to Chen (2007), instructional design is a regulation which is concerned with understanding, improving, and applying ways of instruction. It brings desired changes in learners' knowledge and skills. Instructional design in fact has a relationship between cognitive theory on learning and instructional practice (Gropper, 1983; as cited in Chen, 2007).

2.1.1 Instructional Design Theoretical Framework

Chen *et al.* (2004) has proposed an instructional design theoretical framework for designing a desktop VR-based learning environment. This study is particularly aimed at the novice car drivers in Malaysia. The instructional design model consists of two strategies which are macro-strategy and micro-strategy as shown in Figure 2.1. Basically, the concept of integrative goals (Gagné & Merrill, 1990; cited as Chen, 2007) and the model for designing constructivist learning environments (Jonassen, 1999; cited as Chen, 2007) serve as macro-strategy on leading to the virtual environment–based learning environment, while a number of design principles which are derived from the cognitive theory of multimedia learning (Mayer, 2002; cited as Chen *et al.*, 2004) serves as micro-strategy that concerns with the strategies for useful presentation of the learning contents.

Many findings show that constructivist learning through the use of VR is more beneficial compared to the traditional instructional learning environment. Youngblut (1998; as cited in Fällman, Backman & Holmlund, 1999) pointed out that students who are actively involved in constructing knowledge through learning-by-doing are better in mastering, retaining and generalising new knowledge. Hence, the instructional design theoretical framework proposed by Chen *et al.* (2004) is used in this project.

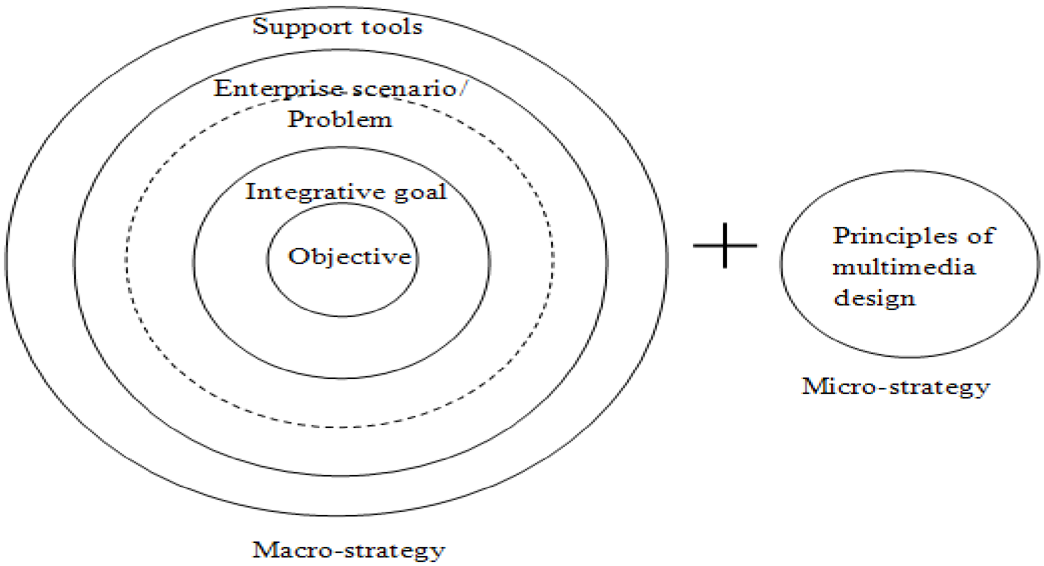

Figure 2.1 Theoretical framework for designing a desktop VR-based learning environment (Adapted from Chen *et al.*, 2004).

2.1.1.1 Instructional Design Model: Macro-Strategy

For the macro-strategy which proposed by Chen *et al.* (2004), the elements inside the ring are starting to move outward from the beginning. Hence, the objective needs to be first identified. The objective is divided into multiple objectives which are verbal information, intellectual skills, labels and cognitive strategies.

Next, these multiple objectives are gathered to make up an integrative goal. This goal would later help a learner in acquiring the interrelationships among the different instructional objectives.

Besides, this integrated goal is used to design an enterprise scenario. The term 'enterprise' refers to a purposeful activity that depends on the combination of the objectives and the term 'scenario' is used to provide a foundation for the knowledge and skills which are applied in the enterprise. During the designing of the enterprise scenario, the problems that arise need to be considered, which include problem context, problem representation and problem manipulation space.

Furthermore, there are tools needed to support the enterprise scenario. These support tools are related cases, information resources, cognitive tools, conversation and collaboration tools, and social or contextual support tools.

2.1.1.2 Instructional Design Model: Micro-Strategy

The micro-strategy which is offered by Mayer (2002) is used to assist the macro-strategy that consists of a number of multimedia design principles. These principles act as instructional messages for the learning environment and are consistent with the cognitive theory of multimedia learning. Table 2.1 shows the principles of multimedia design.

Table 2.1 *Principles of multimedia design*

Principle	Description	Theoretical Rationale
Multimedia Principle	Learners learn better in both of the words and pictures presented together than from words alone.	When both of the words and pictures are presented, learners have an opportunity to construct verbal and visual mental models and build connections between them.
Spatial Contiguity Principle	Learners learn better when corresponding words and pictures are presented near to each other rather than far from each other on the page or screen.	When corresponding words and pictures are near to each other on the screen, learners do not have to use cognitive resources to visually search the page or screen and learners are more likely to be able to hold them both in working memory at the same time.
Coherence Principle	Learners learn better when irrelevant words, pictures, and sound are excluded	Irrelevant material competed for cognitive resources in working memory and can distract attention from the