SMART EDUCATION:
Converging Technology, Pedagogy and Content

2nd International Malaysian
Educational Technology Convention
5-7 November 2008-10-26 MS Garden Hotel
Kuantan, Pahang Darul makmur, Malaysia

Chief Editor:
Rozhan M. Idrus

Editors:
Issham Ismail
Zaidatun Tasir
Fong Soon Fook
Balakrishnan Muniandy

Malaysian Educational Technology Association
2008

Published in Malaysia by:
Malaysian Educational Technology Association (META)
Educational Technology Division
Ministry of Education Malaysia
Persiaran Bukit Kiara
50604 Kuala Lumpur

The papers in this proceeding were presented at the 2nd International Malaysian Educational Technology Convention (IMETC2008) that was held at the MS Garden Hotel in Kuantan, Pahang Darul Makmur from 5-7 November 2008.

ISBN: 978-983-42733-3-0

Cover design: Fridaos Yusoff, School of Distance Education, Universiti Sains Malaysia
Printed by: Sinaran Bros. Sdn. Bhd., Penang, Malaysia

CONTENTS

Preface

The 1st International Malaysian Educational Technology Convention held in Skudai, Johor from 2-5 November 2007 was a morale booster to the endeavours of the Malaysian Educational Technology Association [META] in its effort to raise the Convention to an international status. The theme selected for this year is "Smart Education: Converging Technology, Pedagogy and Content". This theme was selected in an effort to construct learning objects, activities and engaging educational transaction that conform to the needs of the learner. In effect we are moving towards personalisation in learning. Learning experiences are not based on the needs and experiences of the learners (did we even ask them?), but are anchored on the provision text or video based learning materials developed from a teaching perspective. Quoting and adapting from Attwell's (2005) eight challenges to learning design which conform to the concept of personalisation, viz,

Challenge 1 – basing learning on learners own experiences
Challenge 2 – developing a rich and powerful learning environment
Challenge 3 – localising the programme
Challenge 4 – supporting individual learners
Challenge 5 – developing sustainable and dynamic contents
Challenge 6 – recording, validating and presenting learning
Challenge 7 – developing a community of learners
Challenge 8 – developing programmes capable of flexible modes of delivery

In a nutshell, and in AlShawi's (2008) words, personalisation, or just the right learning is about just the right CONTENT, to just the right PERSON, at just the right TIME, on just the right DEVICE, in just the right CONTEXT, and just the right WAY.

Thank you to the paper contributors. The evaluation of the abstracts submitted has been very stringent to ensure and reflect quality of the Convention. META 2008 would like to extend sincerest gratitude to all those who has put in a lot of hard work to make the Convention and the publication of the Proceedings a success.

Chief Editor

Rozhan M. Idrus (USM)

References

AlShawi, M. (2008). Creating Excellent Learning Objects. Workshop conducted at the First Forum on e-learning Excellence in the Middle East 2008, 15-18 January 2008, Dubai, UAE. Accessed at: http://elexforum.etqm.ae/archive2008/inner/summary/downloads.html

Attwell, G. (2005). The Seven Challenges of e-Learning Design (Part 2). Accessed at: http://www.knownet.com/writing/weblogs/Graham_Attwell/entries/9401428104

Unleashing the Potentials of Desktop Virtual Reality as an Educational Tool: A Look into the Design and Development Process of ViSTREET

Kee Man Chuah & Chwen Jen Chen
Faculty of Cognitive Sciences and Human Development
Universiti Malaysia Sarawak
94300 Kota Samarahan, Sarawak
chuahkeeman@gmail.com, cjchen@fcs.unimas.my

Abstract

The advancement in personal desktop computers and the advent of broadband Internet have prompted many researchers and educators to explore various learning opportunities through virtual reality particularly via desktop-based virtual environments. To fully uncover the potentials of virtual reality, one fundamental issue that needs further investigation and is addressed in this paper is to identify the appropriate instructional design models to guide its design and development. In this work, an instructional design and development framework is chosen to guide the design of an on-going project known as ViSTREET (Virtual Simulated Traffic for Road Safety Education), which aims to solve a learning problem related to children pedestrian safety skills through virtual learning environments. The paper provides an elaboration of how various components of the learning environments are designed in line with the prescribed framework. This study has managed to highlight the advantages of using the chosen framework to guide the design and development of virtual learning environments particularly its incorporation of constructivist principles and problem-based learning that can help to enhance learner's learning experience. In addition, the outcomes of this work also provide further confirmation on the vast potentials of virtual reality technology for educational purposes.

1.0 Introduction

The immense interest among the educationists to utilise information and communication technology (ICT) particularly those related to computers in the teaching and learning process has helped to revolutionise the educational system by extending the learning environments beyond the confinement of traditional classrooms. The conventional way of teaching that emphasised greatly on memorisation and factual accumulative is now obsolete. As such, various ICT tools are introduced into the classrooms, all with the ultimate goal of making learning more efficient, effective and engaging to the learners. One of the more recent technologies to be used as an educational tool is virtual reality (VR). The term virtual reality has been greatly adopted by popular culture, being used to describe anything from video games to scenes in science-fiction movies. A common image of VR often depicts a user wearing a head-mounted display (HMD) and an instrumented glove while being immersed in a virtual world (Hand, 1996). This, in turn, creates a misconception that VR is a cutting-edge technology that is infeasible to be used for educational applications. However, the advancement in desktop computer systems has eradiated such fallacy and allows the creation of VR-based learning environments without the need of expensive peripherals.

Undeniably, many researchers have elaborated on the potential of VR in learning (Hamada, 2008, Narayanan & Teh, 2000; Youngblut, 1998). Nevertheless, in order to fully benefit from the potentials of desktop-based virtual environments, as in any other technological tools, it is important to note that the utilisation of VR is more than the limited concern of hardware and software compatibility but covers a wider scope of instructional design and development principles (Jonassen, Peck, & Wilson, 1999). The effectiveness of technology depends on how well the technology is exploited in the particular instructional situation. Therefore, VR is not instructional, but simply a technology. Only when it is applied appropriately and strategically to instructional problems, does it become a powerful agent for teaching and learning. To date, despite the availability of various instructional models, there are limited models that specifically address the design and development process of VR-based learning environments. This paper, therefore, attempts to look at how to uncover the potentials of desktop virtual environments for teaching and learning by identifying a feasible framework to guide its design and development. The selected framework is described using a dekstop VR-based learning environment, which is part of an on-going project known as Virtual Simulated Traffic for Road Safety Education (ViSTREET).

2.0 Virtual Reality

Virtual reality can be defined as a user-computer interface that involves real-time simulation and interactions through multiple sensorial channels such as visual, auditory and tactile (Burdea & Coiffet, 2003). In other words, VR permits users to be immersed in a computer generated virtual world by giving techniques for user orientations in this world (Narayanan & Teh, 2000). Generally, VR can be classified in many different ways. The most common distinction is immersive and non-immersive VR (Thalmann & Thalman, 1993). Immersive VR is based on head-mounted display (HMD) that is capable of generating fully immersive computer graphics. Non-immersive or desktop VR, on the other hand, makes full use of desktop computer to present images in common monitor and allow user interaction with the computer-generated images via generic input devices like computer mouse and keyboard. Due to the advancement in computer technologies, desktop VR has become increasingly popular. The much lower cost that it incurs as compared to immersive VR has made desktop VR the preferred choice in education (Youngblut, 1998) as it does not have to depend on complex and expensive peripherals.

2.1 Educational Values of Desktop Virtual Reality

Though research on the application of VR in instruction can be traced back to as early as 1970's, it only became more ubiquitous during the 1990's. Numerous research studies (Antonietti & Cantoia, 2000; Cobb, Neale, Crosier, & Wilson, 2002; Dede, 1993; Hamada, 2008; Helsel, 1992; Roussou, 2004) on educational application of VR have highlighted how VR can offer a large number of possibilities in instruction which are otherwise unavailable in other educational technology. Hamada (2008) summarised some of these possibilities by focusing on the benefits of using VR in teaching and learning:

- VR supports experiential learning where learners use more brain sensory during the learning process.
- VR supports active learning where learners are engaged in the learning process more actively.
- VR supports collaborative learning where learners can communicate and share experience with each other in a virtual environment that simulates a classroom.
- VR allows learners to gain more control on their learning process.
- VR allows Teachers to act as facilitators not as knowledge transmitters. This means knowledge must be actively constructed by learners, not passively transmitted by teachers.

In retrospect, the aforementioned benefits of VR in education are closely related to the modern paradigm of instructional design that centers on the principles of constructivism (Chen & Teh, 2000). According to constructivism, knowledge is being actively constructed by the individual and knowing is an adaptive process, which organises the individual's experiential world (Merrill, 1991). This principle is well-served by VR due to its ability to mediate world exploration and construction, its mapping of a user to any character he or she chooses and the provision of shared virtual worlds (Burdea & Coiffet, 2003). However, the potentials of virtual environments as a tool for constructivist learning could be fully uncovered only if appropriate instructional design models are used to guide its design and development.

3.0 Instructional Design and Development Models

The field of instructional design covers the analysis of learning problems, and the design, development and evaluation of instructional processes intended to improve learning and performance particularly in educational settings. According to Reiser (2001), instructional designers often use systematic instructional design procedures and employ a variety of instructional media or technology to accomplish their goals. It is thus a process of deciding what methods of instructions are best for bringing about desired learning outcomes (Reigeluth, 1999). In most instructional design processes, an instructional designer would select a guiding framework based on the scope of the instructional materials, which are often known as instructional design models. Models serves a guidelines for us to follow and offers its user a ways of comprehending an otherwise incomprehensible problem (Wilson, 2005). Similarly, an instructional model gives structure and meaning to a certain problem concerning instructional design, enabling the designer to negotiate his or her design tasks with a resemblance of conscious understanding. Shambaugh and Magliaro (1997) define instructional model as a theoretical foundation that can be transformed into methods of instruction based on research about what works in instructional settings. The instructional model helps the designer to visualise the problem, to break it down into discrete, manageable units.

To date, various instructional design and development models have been introduced such as ADDIE, John Keller's ARCS and Gagné's nine instructional events. In the case of VR-based learning environments, however, most of the educational applications were designed based on underlying learning principles with little reference to instructional design and development models. This could be due to the fact that there are limited numbers of instructional design frameworks or models that cater specifically for the design of such learning environments. Therefore, the following section of the paper will further elaborate on the use of constructivist instructional design and development models in the design of educational virtual environments based on the present project on ViSTREET.

4.0 Virtual Simulated Traffic for Road Safety Education (Vistreet)

ViSTREET is a desktop VR-based learning environment for teaching school children pedestrian road safety skills. It aims to complement the current road safety curriculum in Malaysian schools. An in-depth analysis of fatalities due to road accidents in Malaysia showed that pedestrians are among the top three high-risk groups, after motorcyclist and motorist. Road Safety Department of Malaysia also revealed that majority of pedestrian casualties are children and young teenagers. As such, the department in collaboration with Ministry of Education has embarked a pilot road safety education programme targeting primary school students. The programme has its emphasis on teaching pedestrian safety skills to school children by using training materials like posters, video and pamphlets. Teachers are also told to use roads within the school compound to provide children necessary practical training. Practical training in pedestrian skills is known to be highly effective at improving the performance of children as young as seven years of age. The ideal context for practical training would seem to be at the roadside and there is no doubt that roadside training can be highly effective. However, when conducted at the roadside, this training can be dangerous, time-consuming, labour intensive and subject to disruption from poor weather and a lack of traffic situations of the types required. Training based on desktop or non-immersive virtual environments such as ViSTREET offers a way round these difficulties. The ability of VR to simulate real road scenarios allows the presentation of authentic problems for the learners to "interact" rather than merely following the illustrated posters or video presentations. Moreover, VR allows free exploration of the learning environments, allowing learners to be actively involved in learning various concepts and skills (i.e. traffic signs, safe crossing skills), which in turn increase their motivation (Pantelidis, 1997) as compared to other educational tools.

4.1 Instructional Design Theoretical Framework

Though there are numerous instructional design models available, the project has chosen the use of recently suggested framework by Chen, Toh and Wan (2004) as shown in Figure 1 as it serves as a feasible and useful template to guide the design of desktop VR based learning environments. This framework has been used specifically for various designs of educational virtual environments (Chen & Toh, 2005). In general, the model integrates the concept of integrative goals (Gagné & Merrill, 1990) with the model for designing constructivist learning environments by Jonassen (1999). They serve as the macro strategy, which according to Reigeluth and Merrill (1978), concerns with the selection, sequence, and organisation of the subject matter topics that are to be presented. Additionally, a number of design principles, derived from the cognitive theory of multimedia learning (Mayer, 2002) serve as the micro strategy that basically, concerns with the strategies for effective presentation of the learning contents.

In the ViSTREET project, the VR learning scenarios on road safety skills are designed and developed fulfilling all the components within the selected framework. Each specific skill (or problem) is addressed by a distinct module that consists of VR-based scenarios generated using Virtual Reality Modelling Language (VRML) version 2.0, which share the same small town setting and cast of characters. Each scenarios created in ViSTREET are problem-based, in which the learners are required to solve a given problem by utilising the problem manipulation space (exploring the virtual environments).

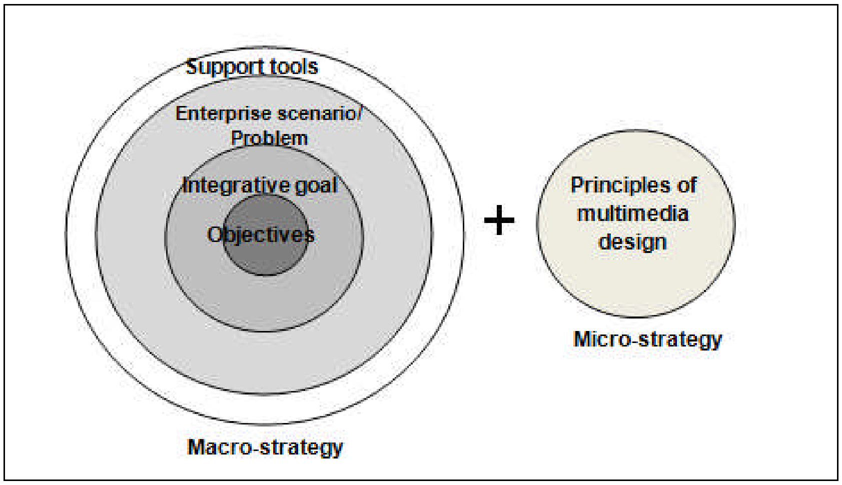

Figure 1: Instructional design theoretical framework of VR based learning environment (Adapted from Chen, Toh & Wan, 2004)

These problems require children to learn and exercise key elements of the skills being explained in order to arrive at correct solutions. The system would then provide feedback on the adequacy of the decision, for example, by permitting the child character to walk across the road and continue his or her journey or by showing what the undesirable consequences of executing the action would be. Thus, the modules permit a degree of interactions with the system and provide feedback concerning the appropriateness of the interactions. In addition, for the "support tools" component, tools such as guidance cues and help buttons on traffic safety tips are provided for the learners to facilitate them in the learning process.

4.2 The Development Methodology

Similar to the work done by Chen and Toh (2005), the constructivist instructional development model known as Recursive, Reflective Design and Development (R2D2) model was used to guide the design and development of the ViSTREET learning environment. This model is chosen because it is also derived from constructivist principles and this allowed it to complement the instructional design theoretical framework selected for this project. Furthermore, the model has been proven to be successful when designing instructions using newer technologies like VR (Chen, 2006; Willis, 1995). The R2D2 model as proposed by Willis (1995) and later revised by Willis and Wright (2000) contains three important guidelines: i) recursive, non-linear design; (ii) reflective design; (iii) participatory design. The key to this model is its non-linear approach to instructional design, in which it allows the designers to revisit any decision made at any point of the design and development cycle and make refinements if required. Apart from that, the R2D2 model also highlights three focal points: Define, Design and Development and Dissemination. Thorough details on these focal points can be obtained from Chen and Toh (2005) and Chen (2006). This paper, however, outlines the activities in the development of ViSTREET in relation to the R2D2 model.

In defining the focus of the project, a comprehensive search and review on available resources on road safety education in Malaysia as well as other countries was conducted. The materials used in Malaysia schools for road safety education were obtained through the Road Safety Department of Malaysia and Malaysian Institute of Road Safety Research (MIROS). These include posters, pamphlets and research reports. This served as a crucial step in deciding the suitable content for the learning environments. Upon deciding the relevant contents, the development environment, which consists of several flexible and powerful VRML software programmes by ParallelGraphics was set up. The programmes include VrmlPad, Internet Space Builder and Internet Space Assembler. Then, based on the instructional design theoretical framework, various components (interface design, instructional strategies and VR scene design) of the ViSTREET learning environments were designed.

A rapid prototyping of the virtual environment was subsequently produced and needed to be reviewed by the selected team of experts (content, instructional design and interface design). This was to obtain initial feedback from the working prototype as to whether any apparent flaws could be detected and modified. After the review, a complete single-path virtual environment on the first scenario of "safe crossing" was designed and developed. Again, feedback from all the experts was gathered and necessary revisions were made. This single-path prototype was then used to develop the remaining four scenarios. Upon completing the full prototype, verification from the content expert was obtained and followed by one-to-one evaluation consisting four potential learners in the pilot study. Based on the gathered feedback, necessary revisions were made to produce the final version. A sample screenshot of the VR-based learning environment in ViSTREET prototype is shown in Figure 2.

From the design and development process of ViSTREET, several advantages of the chosen instructional design theoretical framework and the R2D2 model are identified. Both the theoretical framework proposed by Chen, Toh and Wan (2004) and the R2D2 model promotes the principles of constructivism, in which every instruction needs to be designed to allow active participation of the learner in solving a problem through the exploration of the virtual world. Furthermore, unlike other linear instructional design and development models, the concept of cooperative inquiry in R2D2 model permits on-going refinement on the learning environments and hence improves its quality and effectiveness.

Figure 2: A sample screenshot of the VR-based learning environment in ViSTREET prototype

Conclusions

This paper has further highlighted the feasibility of using the constructivist theoretical framework proposed by Chen, Toh and Wan (2004) as well as the R2D2 model (Willis, 1995) in the design and development of VR-based learning environments. The current work on the ViSTREET project has shown how the models can be used to foster constructivist principles that are able to enhance learner's learning experience. Furthermore, the potentials of using VR as an education tool particularly in the case of road safety education are also presented. It is also pivotal to note from the outcome of this work that the guiding instructional design and development framework in the design of VR-based learning environments plays a major role in unleashing it vast potentials for educational purposes.

References

Burdea, G.C. & Coiffet, P. (2003). *Virtual Reality Technology (2nd Ed.).* New Jersey: Wiley & Sons.

Chen, C.J. (2006). The design, development and evaluation of a virtual reality based learning environment. *Australasian Journal of Educational Technology*, *22*(1), pp. 39–63.

Chen, C.J. & Teh, C.S. (2000). An affordable virtual reality technology for constructivist learning environments. *The 4th Global Chinese Conference on Computers in Education* Singapore, pp. 414–421.

Chen, C.J. & Toh, S.C. (2005). A feasible instructional development model for virtual reality (VR)-based learning environments: Its efficacy in the novice car driver instruction of Malaysia. *Educational Technology Research and Development*, *53*(1), pp.111–123.

Chen, C.J., Toh, S.C. & Wan, M.F. (2004). The theoretical framework for designing desktop virtual reality based learning environments. *Journal of Interactive Learning Research*, *15*(2), pp. 147–167.

Cobb, S., Neale, H., Crosier, J., Wilson, J.R. (2002). Development and evaluation of virtual environments for education. In K.M. Stanney (Ed.), *Handbook of Virtual Environments: Design, Implementation, and Applications*. New Jersey: Lawrence Erlbaum Associates Publishers, pp. 911–936.

Dede, C. (1993). Evolving from multimedia to virtual reality. In H. Maurer (Ed.). *Educational Multimedia and Hypermedia Annua*l. VA: Association for the Advancement of Computing in Education, pp. 123–130.

Gagné, R.M. & Merrill, M.D. (1990). Integrative goals for instructional design. *Educational Technology Research and Development*, *38*(1), pp. 23–30.

Hamada, M. (2008). An example of virtual environment and web-based application in learning. *International Journal of Virtual Reality*, *7*(3), pp. 1–8.

Hand, C. (1996). Other faces of virtual reality. In P. Brusilovsky, P. Kommers & N. Streitz (Eds.). *Multimedia, Hypermedia, and Vrtual Reality: Models, Systems and Applications*. Germany: Springer, pp. 107–116.

Helsel, S. (1992). Virtual Reality and education. *Educational Technology*, *32*, pp. 38–42.

Jonassen, D.H. (1999). Designing constructivist learning environments. In C.M. Reigeluth (Ed.), *Instructional-design Theories and Models: A New Paradigm of Instructional Theory*. (2nd Ed.). NJ: Lawrence Erlbaum Associates. pp. 215–239.

Mayer, R.E. (2002). *Multimedia learning*. Cambridge: Cambridge University Press.

Merrill, M.D. (1991). Constructivism and instructional design. *Educational Technology, 31*(5), pp. 45–53.

Narayanan, K. & Teh, C.S. (2000). Virtual reality in education. In H.M. Khalid (Ed.). *Virtual reality: Select issues and applications*. London: ASEAN Academic Press, pp.143–152.

Pantelidis, V. (1997). Designing virtual environments for instructions: Concept and considerations, *VR in the Schools*, *2*(4), pp 6–10.

Reigeluth, C.M. (1999). *Instructional Design Theories and Models: A New Paradigm of Instructional Theory* (Vol. II). NJ: Lawrence Erlbaum Associates.

Reigeluth, C.M. & Merrill, M.D. (1978). A knowledge base for improving our methods of instruction. *Educational Psychologist*, *13*, pp. 54–70.

Reiser, R.A. (2001). A history of instructional design and technology part II: A history of instructional design. *Educational Technology Research and Development*, *49*(2), pp. 57–67.

Roussou, M. (2004). Learning by doing and learning through play: An exploration of interactivity in virtual environments for children. *ACM Computers in Entertainment*, *2*(1), pp. 1–23.

Shambaugh, N.R. & Magliaro, S.G. (1997). *Mastering the Possibilities: A Process Approach to Instructional Design*. USA: Pearson Allyn & Bacon.

Thalmann, N.M. & Thalman, D. (1993). Virtual worlds and multimedia. USA: John Wiley & Sons.

Willis, J. (1995). Recursive, reflective instructional design model based on constructivist-interpretist theory. *Educational Technology*, *35*(6), pp. 5–23.

Willis, J. & Wright, K. (2000). A general set of procedures for constructivist instructional design: The new R2D2 model. *Educational Technology*, *40*(2), pp. 5–20.

Wilson, B.G. (2005). Broadening our foundation for instructional design: Four pillars of practice. *Educational Technology*, *45*(2), pp. 10–15.

Youngblut, C. (1998). *Educational uses of virtual reality technology*. (Tech. Rep. IDA Document D-2128). Alexandia, VA: Institute of Defense Analyses.