

SMART EDUCATION: Converging Technology, Pedagogy and Content

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CONTENTS

Contents	iii
Preface	xiii
Keynotes	
Smarter Images: Can Technology Improve Educational Graphics? <i>Richard Lowe</i>	1 - 6
Peranan ICT dalam Mewujudkan Sekolah Unggul <i>H. Isjoni</i>	7 - 17
Papers	
1. Three-Dimensional Computer Animated Graphics: An Innovative Cognitive Support for Enhancing Mental Visualisation in Orthographic Projection Learning <i>Abdul Hadi bin Mat Dawi, Toh Seong Chong & Fong Soon Fook</i>	19 - 26
2. Kesan Model Pembelajaran Berasaskan Kaedah Penyelesaian Masalah ke atas Pelajar Berbeza Gaya Kognitif dan Kemahiran Logik <i>Ahmad Rizal Madar, Nurliana Musa & Yahya Buntat</i>	27 - 35
3. The Development and Evaluation of using Video Drama in Teaching Fasting <i>Azharuddin Sahil</i>	37 - 43
4. Enhancing an Instructional Design Model for Virtual Reality (Vr)-Based Learning Environment <i>Chwen Jen Chen, D'Oria Islamiah Rosli & Chee Siong Teh</i>	45 - 48
5. Evaluating The Effectiveness of Interactive Multimedia Courseware using Problem Based Learning Approach for Mathematics Form 4 (Pbl Maths-Set) <i>Faridah Hanim Yahya & Halimah Hj. Badioze Zaman</i>	49 - 57
6. Relating Scholarship of Teaching and Learning (Sotl) to Pedagogy of Engagement Integrating Technology (Poeit) <i>Raja Maznah Raja Hussain & S.Y. Foo</i>	59 - 68
7. An Investigation of Factors Affecting E-Learning Acceptance among Student in UUM: An Empirical Analysis <i>Khairol Anuar bin Ishak</i>	69 - 80
8. Unleashing the Potentials of Desktop Virtual Reality as an Educational Tool: A Look into the Design and Development Process of ViSTREET <i>Kee Man Chuah & Chwen Jen Chen</i>	81 - 86
9. A Review of Commonly used Pedagogical Agent Technology Software in Electronic Learning Environment <i>Malliga K. Govindasamy & Balakrishnan Muniandy</i>	87 - 98
10. Students' Needs and Concerns: Experiences from a Learning Management System <i>Mas Nida Md. Khambari, Priscilla Moses, Rohoullah Khodaband, Wan Zah Wan Ali, Wong Su Luan & Ahmad Fauzi Mohd. Ayub</i>	99 - 107
11. In-Service Teachers' Attitudes Towards the use of Information and Communication Technology in Teaching Practice: The Case of Jordan <i>Naser Jamil Al-Zaidiyeen, Leong Lai Mei & Fong Soon Fook</i>	109 - 114
12. Communities of Learning within Web-Log <i>Ng Huey Zher & Raja Maznah Raja Hussain</i>	115 - 120

13. Profil Profesionalisme Pengajaran Guru-Guru Sains Matrikulasi Anjuran Kementerian Pelajaran Malaysia <i>Nooraida Yakob & Siti Hawa Abdullah, Rohaty Mohd Majzub & Norzaini Azman</i>	121 - 133
14. The Use of Shared Representation Interfaces as Collaboration Mediated Tools in a Pair Programming Environment <i>Nurzeatul Hamimah Abdul Hamid, Nur Huda Jaafar, Mazlyda Abd Rahman & Mohd Zaliman Mohd Yusoff</i>	135 - 142
15. Effects of Modality Principles among Jordanian Students <i>Osamah Mohammad Ameen Aldalalah & Fong Soon Fook</i>	143 - 152
16. The Pattern of SMS and English Language use by Secondary School Students <i>Premananthini Dhemudu & Balakrishnan Muniandy</i>	153 - 162
17. Exploring the Antecedents of Laptop use among School Teachers <i>Priscilla Moses, Mas Nida Md. Khambari, Wong Su Luan, Kamariah Abu Bakar, Rosnaini Mahmud, Ahmad Fauzi Mohd. Ayub & Hasnah Tang King Yee</i>	163 - 170
18. Metodologi Pembangunan Perisian Kursus Bacaan untuk Murid Sindrom Down (MELb-SindD) <i>Rahmah Lob Yussof & Halimah Badioze Zaman</i>	171 - 179
19. Using Video Materials in Formal Education: A Methodological Approach <i>Rossafri Mohamad, Wan Ahmad Jaafar Wan Yahaya & Balakrishnan Muniandy</i>	181 - 185
20. Prinsip Pengurusan Kepimpinan Teknologi bagi Melahirkan Kepimpinan Instruksional yang Cemerlang <i>Rossafri Mohamad, Wan Ahmad Jaafar Wan Yahaya & Balakrishnan Muniandy</i>	187 - 192
21. "As the Paper Folds, The Mind Unfolds": Instructional Design for Developing an Interactive Multimedia Application in Science Education Using the Ancient Art of Origami <i>Siew Pei Hwa</i>	193 - 200
22. Exploring the Distance Learner's Readiness on the use of Distance Technology <i>Siti Haryani Shaikh Ali, Wan Zah Wan Ali, Rusli Abdullah & Ahmad Fauzi Ayub</i>	201 - 207
23. Smiley Faces: Scales Measurement for Children Assessment <i>Wan Ahmad Jaafar Wan Yahaya & Sobihatun Nur Abdul Salam</i>	209 - 213
24. E-Learning for Arabic Language using Tutorial Approach with Modular Component <i>Suzana Ahmad, Norizan Mat Diah, Marina Ismail & Nor Shazila Binti Mansor</i>	215 - 219
25. Digital Habits of Malaysian Students and its Implications for Learning: A Preliminary Study <i>Yuen May Chan, Helena Song Sook Yee & Jong Sze Joon</i>	221 - 227
26. Penggunaan Pakej SAGE dalam Pengajaran dan Pembelajaran Matematik Kalkulus <i>Mohd Zin Mokhtar, Ahmad Fauzi Mohd Ayub & Rohani Ahmad Tarmizi</i>	229 - 236
27. Reka Bentuk Pembelajaran Koperatif Menerusi Web bagi Meningkatkan Kemahiran Komunikasi Bertulis dan Kerjasama Berkumpulan <i>Ahmad Muhaimin Mohamad, Jamalludin Hj. Harun & Baharuddin Aris</i>	237 - 243
28. Effective Instructional Courseware Design to Improve Students Cognitive Skill: A Practical Guide for Educators as Multimedia Author <i>Ahmad Zamzuri Bin Mohamad Ali</i>	245 - 252
29. Pengajaran dan Pembelajaran Membaca Berbantuan Komputer <i>Auzar</i>	253 - 258

30. Visualisasi Menerusi Sistem Berasaskan Pendekatan Pembelajaran Situasi dalam Persekitaran Autentik dalam Mempelajari Rekabentuk Infrastruktur Rangkaian Komputer bagi Program Perguruan <i>Noor Azean Atan & Zaidatun Tasir</i>	259 - 269
31. Tahap Kesiediaan Dan Keyakinan Pelajar Terhadap Penggunaan Ujian Adaptif dalam Mempelajari Konsep Pengaturcaraan Komputer <i>Norah Binti Md Noor & Noor Azean Atan</i>	271 - 278
32. A Tutorial on Creating Multimedia Content for Mobile Learning <i>Aziman Abdullah & Abdullah Mat Safri</i>	279 - 281
33. One-to-One Computing using the Class Mate Personal Computer (CMPC) <i>Chadra Shakaran, Fong Soon Fook & Rozhan M. Idrus</i>	283 - 289
34. Piawaian Kompetensi ICT untuk Pendidik – Sorotan Literatur <i>Ch'ng Pei Eng, Fong Soon Fook, Balakrishnan Muniandy & Abdul Hadi Dawi</i>	291 - 297
35. Kesan Maklum Balas Yang Berbeza Oleh Agen Pedagogi Terhadap Pencapaian Pelajar Yang Berbeza Lokus Kawalan <i>Farah Mohamad Zain, Hanafi Atan, Noorizdayantie Samar, Omar Majid & Zuraidah Abdul Rahman</i>	299 - 303
36. The Effect of Pedagogical Agents' Instructional Roles on Learners with Different Ability Levels: A Measure on Learners' Achievement and Intrinsic Motivation <i>Foo Kok Keong, Hanafi Atan, Fong Soon Fook, Omar Majid & Zuraidah Abdul Rahman</i>	305 - 311
37. Pembangunan Dan Penilaian Perisian Pengajaran Dan Pembelajaran Berbantuan Komputer (Ppbk) Multimedia Interaktif Pendidikan Jasmani Tingkatan Satu bagi Tajuk "Kecergasan Fizikal" <i>Mohd. Arif Ismail, Mohd Haizam bin Ahmad & Rosnaini Mahmud</i>	313 - 323
38. Pencarian Maklumat Menggunakan Laman Web Berasaskan Teknologi Mobil untuk Pelajar Diploma Seni Bina di Politeknik Port Dickson <i>Mohd Arif, Ismail, Isham Shah, Hassan & Rosnaini Mahmud</i>	325 - 334
39. The Effects of Video-text Display with Graphical Organizer on Critical Thinking in the Teaching of Form Four Bahasa Malaysia <i>Jalilah Shaik Abdullah, Mona Masood & Merza Abbas</i>	335 - 347
40. Kesiediaan ICT Jurulatih Pusat-Pusat Latihan Tentera Laut Diraja Malaysia: Tahap Pengetahuan ICT, Kemahiran ICT dan Sikap Terhadap ICT dan Pengaruh Faktor Demografi <i>Mohd Arif Ismail & Janudin Awang</i>	349 - 359
41. Learning Experiences with E-portfolios: A Study on Pre-Service ESL Teacher Education in Malaysia <i>Mahbub Ahsan Khan, Muhammad Kamarul Kabilan Abdullah & Puan Noorlida Ahmed</i>	361 - 371
42. Students' Acceptance of the i-Teacher e-Learning System Based on Technology Acceptance Model <i>Kathy Belaja, Foo Kok Keong, Hanafi Atan, Omar Majid & Zuraidah Abdul Rahman</i>	373 - 378
43. Kesan Sistem Pembelajaran Berasaskan Projek (Pjbl) Secara atas Talian (E-Solms) Terhadap Motivasi, Kesiediaan Pembelajaran Secara Kendiri (Sdl-Readiness) dan Lokus Kawalan Pelajar <i>Khairul Azhar Bin Mat Daud & Sharifah Norhaidah Syed Idros</i>	379 - 392
44. Kajian Tahap Kompetensi Pengetua/Guru Besar Sekolah Terhadap Pengurusan Teknologi Instruksional di Sekolah <i>Mahizer Hamzah, Yusup Hashim & Ismail Abdul Raoh</i>	393 - 401

45. An Investigation of Effects of Modern Communication Technologies (Synchronous and Asynchronous) on quality of Communication Feedback in the Online Learning Environment
Majid Reza Razavi, Rosnaini bt Mahmud, Kamariah bt Abu Bakar & Wan Zah Wan Ali 403 - 409
46. Comprehending a Story Among Deaf Children: Is it ICT or Conventional?
Marina Ismail & Sri Fatiany Abdul Kader Jailani 411 - 414
47. Keberkesanan Modul Berasaskan Project-Based Learning (Pjbl) Dalam Pembangunan Meta-Kognitif, Motivasi dan Pengurusan Kendiri Pelajar
Md. Baharuddin b. Haji Abdul Rahman & Sharifah Norhaidah Syed Idros 415 - 432
48. The Effect of Cognitive Scaffolding (CS) in Problem Based Learning (PBL) on Students' Performance in Solving Ill Structured Problems
Mohd Ali Samsudin & Fong Soon Fook 433 - 440
49. Penilaian Integrasi ICT dalam Pengajaran dan Pembelajaran Matematik di Sekolah Menengah Bestari Rintis
Nor Izzah Mohd Salleh, Norazah Mohd Nordin & Zalizan Mohd Jelas 441 - 452
50. Interactive Multimedia Application to Teach Tajweed to Children Using Scaffolding Approach
Norizan Mat Diah, Marina Ismail, Suzana Ahmad & Noor Atiqah Binti Che Juhari 453 - 457
51. PBL Sebagai Kaedah Pengajaran dan Pembelajaran Kontemporari Abad Ke-21 di Malaysia
Norliza Binti Brahim, Shaffe Bin Mohd Daud & Rosnaini Binti Mahmud 459 - 471
52. Analisa Awal Augmented Reality dalam Pembelajaran Sains bagi Pelajar Bermasalah Pendengaran
Norziha binti Megat Mohd Zainuddin & Halimah Hj Badioze Zaman 473 - 479
53. Students' Reaction towards Network Courses Learning via Network-Based Project Learning
Nur Huda Jaafar, Nurzeatul Hamimah Abd. Hamid & Mazlyda Abd. Rahman 481 - 486
54. Effectiveness of Assistive Computer Technology (ACT) for Enhancing Basic Language Skills among Students with Hearing Disabilities: A Literature Review
Nurul Hijja Mazlan & Shaffe Mohd Daud 487 - 499
55. Comparative Views of Students in Smart and Mainstream Schools on Science Learning Experience
Ong Eng Tek 501 - 509
56. Concept Learning in Virtual Environment : A Review
Rasimah Che Mohd Yusoff & Halimah Hj. Badioze Zaman 511 - 517
57. Educational Computer Games (ECG) for Malaysia Educational Settings? A Review and Prospect
Roslina Ibrahim & Nazli Yahaya 519 - 526
58. Pembangunan dan Penilaian Perisian Kursus Multimedia Interaktif "Analisis Kualitatif Garam" dalam Subjek Kimia
Rosnaini Mahmud & Norsiaty Bt Razali @ Mohd Ghazali 527 - 541
59. The Impact of Electronic Communication Technology on Written Language
Mohd. Sahandri Gani Hamzah, Mohmmad Reza Ghorbani 543 - 546
60. Pembangunan dan Penilaian Kursus NPQH secara Atas Talian Menggunakan CMS Terbuka Moodle: E-HEADSHIP Reka bentuk dan Pembangunan
Norazah Nordin, Zamri Mahamod, Mohd. Izha Mohd. Hamzah & Sham Ibrahim 547 - 556

61. Smart Use of Multimedia Technology to highlight the Plight of Orang Kanaq: Malaysia's Most Endangered Ethnic Group of Orang Asli <i>Toh Seong Chong, Zarina Samsudin, Salasiah Che Lah, Mahani Awang @ Musa, Azizi Bahauddin & Alias Abd. Ghani</i>	557 - 562
62. Effects of A Human Agent and the Application of the Modality Principle on the Learning of Chinese Idioms and the Attitudes Among Primary Three Students <i>Xuanxi Li, Fong Soo Fok & Mohd Ali Samsuddin</i>	563 - 570
63. Kolaborasi dalam Pembelajaran Berasaskan Masalah (PBM) dan Penggunaan Wiki <i>Noorizdayantie Samar, Hanafi Atan, Farah Mohamad Zain, Zuraidah Abdul Rahman & Omar Majid</i>	571 - 575
64. Fresh Graduate Teachers in Relation to Computers Use <i>Wong Kung Teck</i>	577 - 590
65. Kesan Penggunaan Perisian Multimedia Geografi kepada Pencapaian dan Kemahiran Menjawab Soalan Aras Tinggi <i>Abd. Latif Gapor & Hamdiah Jailani</i>	591 - 599
66. Kesan Agen Pedagogi Terhadap Pencapaian dan Motivasi Pelajar Dalam Pembelajaran Fizik: Dapatan Kajian Rintis <i>Nabila Akbal Noorul Kamar, Omar Majid, Zuraidah Abdul Rahman & Hanafi Atan</i>	601 - 608
67. Feasibility Study of Using Paperless System <i>Mohamad Ali Baba, Mohamad Hisyam Mohd Hashim & Masita binti Misdi</i>	609 - 614
68. Literasi Digital dan Perkongsian Maklumat: Pembangunan Pusat Sumber Digital Berasaskan Portal Web <i>Isnazhana Ismail & Ramlee Mustapha</i>	615 - 623
69. Strategi Pembelajaran Dan Sikap Pelajar Terhadap Komputer: Satu Kajian Rintis Dalam Kalangan Pelajar Tingkatan Empat <i>Norliza Ibrahim, Wong Su Luan, Ahmad Fauzi Mohd Ayub & Hasnah Tang King Yee</i>	625 - 633
70. Feedback and Reflection through the e-Learning Platform: A Window into Students' Acquisition of Soft-Skills <i>Sadih Baharom & Muhamad Ikhwan Mat Saad</i>	635 - 644
Index	645 - 646

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)

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

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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 eradicated 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 desktop 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 (Thalman & 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).

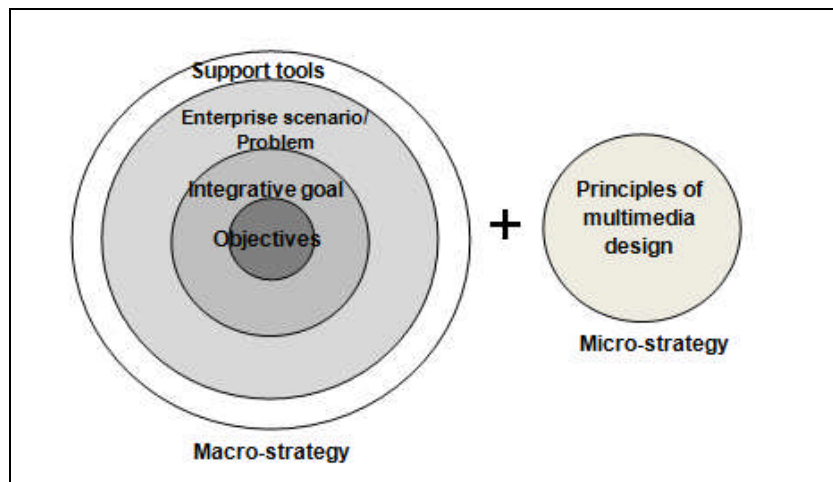


Figure 1: Instructional design theoretical framework of VR based learning environment (Adapted from Chen, Toh & Wan, 2004)

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 VrmIPad, 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 its vast potentials for educational purposes.

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