UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT AND EVALUATION OF EFFECTS OF INTERNET-BASED TUTORIAL MODULE FRAMED BY COGNITIVE APPRENTICESHIP MODEL FOR STATISTICS LEARNING AMONG MALAYSIAN POSTGRADUATE STUDENTS

FARZANEH SAADATI

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By

FARZANEH SAADATI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

July 2014

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DEDICATION

I'd dedicate each page of this dissertation to my family who have supported me throughout the process. A special feeling of gratitude to my loving parents, who gave me the courage and support to spread my wings and fly.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chairman: Associate Professor Rohani Ahmad Tarmizi, Ph.D
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This dissertation illustrates the development of an Internet-based tutorial module (***i***-TModule) framed with Cognitive Apprenticeship Model (CAM) and employing the systematic instructional design process, known as Analysis, Design, Development, Implementation, and Evaluation (ADDIE). This module has utilized a Learning Management System (LMS) to develop the tutoring environment by incorporating: a) the use of the Internet-based resources in varying formats (video, text, animation, charts, etc), b) the utilisation of engaged learning activities during "odd hours" in an effort to improve the students' mathematical achievement and problem solving skills, c) individualized the students' learning experiences by altering some subsequent instructional contents and activities based on CAM according to individual needs, and d) monitoring and assessing of individual problem-solving skills, online behaviour, and reaction during the delivery of the designed instruction.

The first phase of the study focused on conducting run-through analyses of the target group's needs, designing the learning strategies, and developing the learning assessments and activities. The major goal of this phase was to achieve a flexible and dynamic Moodle-based constructivism environment, the ***i***-TModule, based on CAM as a framework during the instructional process.

The second phase focused on evaluating the effectiveness of the designed instruction using learners' performance on statistics tests, problem-solving skills, online behaviour, online reaction, and motivation towards learning as indicators among the postgraduate students. The effects of the ***i***-TModule (facilitated using the CAM) versus the conventional Moodle-based module (not facilitated by CAM) were compared using the above-mentioned indicators. Two groups of postgraduate students

who enrolled in Educational Statistics course in one of the faculty in UPM during 2012-2013, were participant of this study. The first group received treatment by using ***i***-TModule while the following cohort group was given the conventional Moodle-based module. A pretest-posttest statistical analysis was also conducted to evaluate the effects of the ***i***-TModule on statistics performance.

The result of this study showed that the use of ***i***-TModule has a significant effect on students' statistics performance in three tests as well as their motivation toward learning. The results also clearly indicated that the developed module provided a motivating context and learning environment which could capture the interest of learners (attention), meet their personal needs (relevance), help them to believe and control success (confidence), and allow them to have good experiences (satisfaction). Furthermore, these results indicated that the delivery system based on CAM has significantly enhanced students' performance in their statistics problem-solving skills. Likewise, the study showed ***i***-TModule has influenced changes (statistically significant changes) of online behaviour and reaction among students across the 14 weeks learning sessions.

In addition, the capability of Moodle was confirmed as a teaching and learning medium in the current technological context. The results were the identification of a value added teaching and learning strategy with salient features of CAM which was able to supplement a face-to-face instruction. The developed module had incorporated into the instructional strategy and constructively supported all learning activities and assessments tasks. It also demonstrated the potential of Moodle as a web-based learning platform and confirmed the place for CAM features within the area of learning, specifically Educational Statistics among postgraduate students.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

REKA BENTUK INTERNET-BASED TUTORIAL MODULE BERASASKAN COGNITIVE APPRENTICESHIP MODEL UNTUK PENGAJARAN DAN PEMBELAJARAN STATISTIK PENDIDIKAN PEMBELAJARAN DALAM KALANGAN PELAJAR SISWAZAH UNIVERSITI DI MALAYSIA

Oleh

FARZANEH SAADATI

Julai, 2014

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Disertasi ini menghuraikan pembangunan satu modul tutorial berasaskan Internet (***i***-TModule) berdasarkan *Cognitive Apprentice Model–CAM* (Model Kognitif Perantisan) dengan mengguna reka bentuk proses pengajaran yang sistematik yang dikenali sebagai *Analysis, Design, Development, Implementation, and Evaluation-ADDIE* (Analisis, Rekabentuk, Pembangunan, Pelaksanaan, dan Penilaian). Modul ini telah melibatkan penggunaan Sistem Pengurusan Pembelajaran (LMS) untuk membangunkan persekitaran penmbelajaran dengan menggabungkan: a) penggunaan sumber berasaskan Internet dalam pelbagai format (video, teks, animasi, carta, dll.); b) penglibatan pelajar dalam aktiviti-aktiviti pembelajaran pada "waktu luar biasa" dalam usaha untuk meningkatkan pencapaian matematik pelajar dan kemahiran mereka dalam menyelesaikan masalah; c) pengalaman pembelajaran secara individu dengan membekalkan pengalaman yang istimewa melalui pelbagai isi kandungan dan aktiviti berasaskan CAM mengikut keperluan individu; dan d) memantau dan mentaksir kemahiran menyelesaikan masalah secara individu,tingkah laku atas talian, dan tindak balas pelajar semasa pengajaran yang telah dirancangkan.

Fasa pertama kajian ditumpukan kepada analisis dan mengenal pasti keperluan kumpulan sasaran semasa pengajaran dan pembelajaran statistik, mereka bentuk strategi pengajaran dan pembelajaran, dan membina instrument untuk mentaksir pembelajaran dan aktiviti-aktiviti pembelajaran. Matlamat utama bahagian ini adalah untuk membangun modul mengguna Moodle, iaitu ***i***-TModule, yang fleksibel dan dinamik berdasarkan CAM dan persekitaran pembelajaran konstruktivisme untuk menghasilkan reka bentuk proses pengajaran yang berkesan.

Fasa kedua kajian berfokus kepada keberkesanan pengajaran dan pembelajaran mengguna ***i***-TModule dan dinilai melalui prestasi pelajar dalam statistik, kemahiran menyelesaikan masalah statistik, tingkah laku pelajar semasa pembelajaran atas talian, tindak balas semasa pembelajaran atas talian, dan motivasi terhadap pembelajaran menggunakan ***i***-TModule. Keberkesanan ***i***-TModule juga dinilai dengan membandingkan kesan ***i***-TModule berasaskan CAM dengan kesan ***i***-TModule secara konvensional dengan mengguna indikator seperti dinyatakan di atas. Modul konvensional yang berasaskan Moodle telah digunakan bagi kumpulan kohort sebagai kumpulan kawalan bagi tujuan membanding kesan ***i***-TModule dan modul Moodle secara konvensional. Dua kumpulan pelajar siswazah yang mengikuti kursus Statistik Pendidikan di salah satu fakulti di UPM semasa sesi 2012-2013 telah dilibatkan. Analisis skor ujian pra dan ujian pos telah dijalankan juga untuk menilai kesan ***i***-TModule terhadap prestasi pelajar dalam statistik.

Hasil kajian ini menunjukkan penggunaan ***i***-TModule mempunyai kesan yang signifikan ke atas kedua-dua aspek iaitu prestasi pelajar dalam statistik dan motivasi terhadap pembelajaran. Keputusan juga menunjukkan dengan jelas bahawa modul yang dibina menyediakan konteks motivasi dan suasana pembelajaran yang dapat menarik minat pelajar (perhatian), memenuhi keperluan peribadi mereka (kesesuaian), membantu mereka membangunkan kepercayaan diri dan membawa kejayaan (keyakinan), dan membolehkan mereka menikmati pengalaman yang baik (kepuasan). Tambahan pula, keputusan ini menunjukkan bahawa sistem penyampaian berdasarkan CAM mempunyai kesan ke atas peningkatan kemahiran menyelesai masalah di kalangan pelajar. Begitu juga, kajian menunjukkan ***i***-TModule mempunyai kesan ke atas perubahan tingkah laku atas talian dan tindak balas dalam kalangan pelajar sepanjang 14 minggu sesi pembelajaran.

Selain itu, keupayaan Moodle sebagai medium pengajaran dan pembelajaran telah diperkukuhkan dalam konteks teknologi terkini. Hasil keputusan kajian juga telah mengenal pasti satu strategi pengajaran dan pembelajaran yang mempunyai nilai tambahan dengan menonjolkan ciri-ciri CAM yang dapat menyokong penyampaian pengajaran pengajaran dan pembelajaran bersemuka. Modul yang dibina itu sesuai diserapkan ke dalam strategi pengajaran dan ia didapati menyokong semua aktiviti pembelajaran dan penilaian tugasan. Ia juga menunjukkan potensi Moodle dan mengesahkan kepentingan ciri-ciri CAM dalam bidang pengajaran dan pembelajaran, khususnya, dalam Statistik Pendidikan bagi pelajar siswazah.

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment for the degree of Doctor of Philosophy. The members of the Supervisory committee were as follows:

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DECLARATION

Declaration by graduate student

I hereby confirm that:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.1 Background of the Study

During the past decades, attention to integrate technology in educational system, especially in mathematics teaching and learning has increased tremendously. Throughout the late 1970s and early 80s, technology training in mathematics education began with the computer science establishment (Anderson, 1996). Technology is a wide concept, which deals with the application and knowledge of tools and crafts, and it is generally defined as practical application of knowledge for enhancing performance (Spector, 2012). The National Council of Teachers of Mathematics (NCTM) has stated, "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (NCTM, 2000, p. 11).

Technology has the ability to generate potential changes and it is considered as an essential tool in teaching and learning (Niess, 2005; Webster & Hackley, 1997). Furthermore, in this technology-driven century, the major transformation in the landscape of mathematics education has been adapted with new technologies (Niess, 2005). Earlier, it was emphasized that attention to the employment of technology in teaching mathematics grew regularly over the last decades (Kutzler, 2000; Ruthven & Hennessy, 2002). This transformation could prepare a suitable circumstance for teachers and students and engage them in active mathematical experiences (Manoucherhri, 1999; White & Geer, 2013) which were inconceivable a couple of years ago. The standards and researches by the NCTM (2000) suggested new reforms pointed toward a rich mathematics curriculum in which technology is introduced as an essential component of the learning environment, not only in the curriculum but also in the instruction of the subject. In addition, efforts to improve the students' problem-solving skills and mathematical reasoning are among the underlying goals of the NCTM (2000). It is investigated that utilizing the latest technology will support learners' in depth understanding of mathematical concepts in a meaningful and accurate way which enable them to explore the mathematical facts (Chan, 2002; Roberts, Leung, & Lins, 2013) .

After the introduction of the World Wide Web in 1993, the use of the Web has immensely grown specially to deliver instruction (Smith, 2006), which is known as Web-based instruction (WBI). It may seem noticeable to most what is included in WBI defined by Khan (1997, p.6) as "a hypermedia-based instructional program which utilizes the attributes and resources of the World Wide Web to create a meaningful learning environment where learning is fostered and supported." The introduction of the Internet in educational fields could bring unprecedented opportunities to students (Chen & Fu, 2008), so the web-based instruction as a new instructional environment can be a good means to achieve increase potential in teaching and learning. For instance, the growing Internet-based resources in varying formats such as video, text, animation, apps, can support learning (Avgeriou, Papasalouros, Retalis, & Skordalakis, 2003). However, time limitation and lack of proficiency to choose and sift the relevant resources impede most of the students from using these resources effectively during instructional activities (Koneru, 2010). In line with this issue, some positive efforts to incorporate the required changes for integrating technological tools and virtual learning environment in higher education have been made (Black, Dawson, & Priem, 2008; Garrison & Vaughan, 2008; Oliver & Herrington, 2001). Following this situation, providing a web-based learning environment is endorsed as a suitable pedagogical tool in higher education by the profession (Davis, Roblyer, Charania, Ferdig, Harms, Compton, & Cho, 2007).

According to Wang (2009), web-based learning environments are certainly involved in the majority of technological elements to conduct learning activities through use of the computer as a medium in an effective learning. Since, an effective web-based learning environment is required to support learning anywhere and anytime, the criteria of easy accessibility as well as availability are introduced as the initial requirements for any learning environment (Salmon, 2004). These strong technical Internet-based platforms make the constructivist-learning environment through discussion and communication among learners more feasible and easier. Therefore, it is definitely useful to enables instructors link various learning communities together in new and different ways (Wang, 2009).

Many colleges and universities are embracing information technologies to create new learning models that enhance the effectiveness to reach the instructional requirements and programmes (Alavi & Leidner, 2001; Keengwe, Onchwari, & Agamba, 2013). The presentation model of any pedagogical tools should be designed based on an appropriate learning theory (Conole & Fill, 2005). It appears critical that the model should support the role of effective pedagogy to maximize students' learning using technological (especially electronic) environments, as well as explore the development of appropriate technology to be used.

The multitude differences and level of students' interests, abilities, and characteristics has caused some challenges in education today, and offered a high quality education (Christensen, Horn, & Johnson, 2011). Some researchers mentioned the impact of Web-Based Learning (WBL) in designing a high quality educational environment (Khan & Ealy, 2001; Kuo, Hwang, & Lee, 2011; Pawar, 2005). Through the focus on mathematics learning, Harskamp and Suhre (2006) also clarified that especially the use of interactive computer programmes can strongly improve students' mathematical problem-solving skills.

On the other hand, Cook (2007) argued that instead of asking 'if' WBL should be used, it should be clear as to 'when' and 'how' to employ this potent vigorous tool. Cook (2007) stated that 'when' relates to the selection of WBL for achieving particular learning objectives, while 'how' encompasses the determination of the technology features such as instructional methods, adaptation, and enhancements, that make it as an effective tool. Many educational researchers choose to focus on these systematic approaches named Instructional System Design (ISD) process in order to develop an enhanced learning environment (Lim & Chai, 2008; Strickland, Strickland, Wang, Zimmerly, & Moulton, 2013; Wang & Hannafin, 2005; Wang & Hsu, 2009). The following sections provide an overview of the related concepts in line with developing an Internet-based tutorial module based on cognitive apprenticeship model incorporating the analysis, design, development, implementation, and evaluation (ADDIE) process, in developing a new instructional design model for teaching and learning mathematics.

1.1.1 Teaching and Learning Mathematics

Mathematics is an underlying human activity in which one uses numbers and symbols as a procedure in making sense of the world around them (Sowder, 1992; Zhao & Okamoto, 2009). It is held as a key position in virtually all the countries and curriculum, since mathematics is the core element of the school curriculum (Jones, 2000). Even at the university level, it is an essential subject, because of its own nature, and its central connections in different fields such as the natural sciences, and the social sciences. However, some problems are stated by students while learning mathematics or statistics. Specially, the students' problems with statistics is listed in three clusters of problems, they are (a) implementation of the mathematical techniques and concepts in statistics, (b) unclear relation between the statistical models and "real life" conditions in the following, and (c) most time consuming process in understanding some concepts and new notions of statistics (Groeneboom *et al.*, 1996). Therefore, they may often postpone enrolling in educational statistics courses until the last semester of their degree programme. Jones (2000) states such an impressive position poses severe demands on teaching mathematics at universities. According to these demands, teaching of mathematics has been a considerable issue of development and change through opportunities given by new technologies (Fey, 1989).

Increasing the learners' skills of reasoning and sense making are the focused in teaching of mathematics (Henningsen & Stein, 1997; NCTM, 2008). Several researchers on students' statistical literacy also emphasised the importance of learning statistics in context (Barwell, 2013; Watson, 2001). Besides, Campos, Wodewotzki, Jabobini, and Lombardo (2010) identified the development of statistical literacy, reasoning, and thinking as three common competences in teaching and learning of statistics among researchers. Although, there is a growing emphasis on the mathematical problem-solving skills as a prominent learning objective, instructors often experience difficulties in how to approach problems, and how to make proper use of mathematical tools in order to lead students become skilled problem solvers (Harskamp & Suhre, 2006; Kuo, Hwang, & Lee, 2011; NCTM, 2008). Therefore, educators need to provide several experiences that proceed to encourage students' understanding and recognition of mathematics (Niess, 2005).

The effort to engage graduate students in a genuine-learning experience and apply statistics in original research is a suggested approach for the teaching and learning of educational statistics (Delucchi, 2006). However, supporting students, especially non-specialist students, in a course with a mathematical nature like statistics are always one of the concerns among the instructors (Yilmaz, 1996). According to Jaki and Autin (2009), the standard approach for teaching statistics is usually the teacher-centred, which requires forcing a particular learning style on students. In this method, the lecturer tries to impose his/her knowledge onto the students, and students often lose the connection when they are dealing with various statistical methods. On the other hand, in recent years, many mathematics educators and statisticians have devoted large segments of their careers in an effort to improve educational materials and pedagogical techniques in statistics (Franklin, Kader, Mewborn, Moreno, Peck, Perry, & Scheaffer, 2007). In line with emergent pedagogical insights, this approach include a number of paradigm shifts in the educational field, the shift from behaviourism to cognitivism (Papert, 1994), and from individual learning to collaborative learning (Johnson & Johnson, 1987). These shifts entail moving from 'passive' learning to 'active' learning by a learning perspective change, from teacher-centred learning to learner-centred learning (O'Neill & McMahon, 2005). Educational researchers speculate that active learning in collaborative groups of students can increase individual learning performances (Johnson, Johnson, & Stanne, 2000). As a result, collaborative learning as a method of student-centred active learning can engage graduate students in a genuine-learning experience and help them to know better application of statistics (O'Neill & McMahon, 2005).

Many instructional tools, physical as well as electronic devices, have been employed to assist teaching and learning of mathematics have been used since the early years. Sometimes, technology has functioned as a creative picture of mathematical ideas, progressing in line with the evolution of mathematics itself, while other times, technology has entered mathematics, notably from science and commerce (Roberts, Leung, & Lins, 2013). In a nutshell, according to Roberts et al. (2013) technology has opened a window in which mathematics education might enter into a new epistemological domain, where knowledge can become personal and communal, and in which connective and explorative mathematical knowledge would become more accessible.

1.1.2 Technology in Teaching and Learning Mathematics

Technology offers unprecedented opportunities for students and teachers to transform from the simple usage into the most sophisticated ways in teaching and learning process (Sulla, 1999). During the past two decades, pedagogical theories in mathematics education, such as instrumental genesis and semiotic mediation, have placed tools, artefacts, and technology at the centre stage of discussion on mathematics knowledge acquisition (Roberts *et al.*, 2013). Tools from the past are far from irrelevant to the new environment, since the Web can function as a window to access information on historical mathematical tools instantly. Roberts et al. (2013) stated that the Web could provide the potential to construct mathematical knowledge via simultaneous attention to the multifarious facets in the evolution of that knowledge, as reflected in the tools, thereby creating a virtual thematic museum of mathematical artefacts. Making technological tools somehow to attract the attention of learners, must consist of the features and aspects which can provide the perfect situation (Stohl Drier, Harper, Timmerman, Garofalo, & Shockey, 2000). Whilst technology is integrated into mathematics education in numerous ways, Niess (2005) introduced a technological tool for scaffolding learners through mathematics learning. Laborde, and Straßer (2010) in a study about the place and use of new technology in the teaching of mathematics in the past 25 years, reported three main reasons to integrate technology in teaching mathematics:

1. Technology is a medium for change in the teaching practice, or in the curriculum.
2. Technology is a tool that deeply changes mathematical activity, such as modelling or processing data, experimenting (for example by: spreadsheet, dynamic geometry), and visualizing.
3. Technology offers an intermediate level between the physical reality and the formal mathematical model to help students construct a better understanding. Furthermore, mathematics becomes more experimental with technology, which can allow learners to change the problem conditions, check strategies and receive the feedbacks.

The Internet with its excellent resources of information made available many modern technological tools which can be used in education. Web-based mathematics education offers promising ways to employ the Web in order to improve mathematics learning (Khasawneh, 2012). These applications which are known as e-learning platforms, allow teachers to assist students with different sources of material. Several researchers have highlighted the unique ability of new computer-based technologies to expand the university students' learning, and provide free and effective access to educational opportunities, and support interactivity, interaction, and collaboration (Corlett, Sharples, Bull, & Chan, 2005; Draper & Brown, 2004; Oliver, 2006).

1.1.3 Internet-Based Instruction in Teaching and Learning Process

Internet- or Web-based environments, inclusive of a hypermedia programme as well as a database information with multiple methods of navigation and features to facilitate learning, are made available on the web as a learning tool to serve a guide and to facilitate students' learning instead of face-to-face interaction with a teacher in the physical setting of a classroom. Piccoli, Ahmad, and Ives (2001) defined Virtual

Learning Environments (VLEs) as computer-based environments, which are open systems, and allowing interactions and encounters with other participants. According to Weller (2007), VLE is a specifically designed software framework for supporting teaching and learning over the Internet. The VLE is the computer software for facilitating the particular electronic education and performing education process via Computer mediate communication (CMC) or online learning. These systems also can be called Managed learning environment (MLE), Learning management system (LMS), Learning support system (LSS), Course management system (CMS), Learning platform (LP) or Learning content management system (LCMS). In the United States, CMS and LMS are the standard terms. However, LMS usually referred as common software associated with managing combined learning programmes rather than the course of instruction in the traditional education system (Steel, 2009).

These e-learning platforms as new technologies provide many attractive tools available to be used; such as videos, text documents, scanned images, linking to other useful web sites, Java Applets, and animations. These tools can improve the process of teaching and learning in order to justify many situations and concepts dynamically, which traditionally are not so easy to be understood by all learners (Martín-Blas & Serrano-Fernández, 2009).

An aggressive turn towards computer-based teaching and learning requires the new protocol for universities to adjust and adopt rigorous steps of the revolutionized technologies in teaching. Instead of using only traditional lectures, teachers are encouraged to begin active-learning and collaborative activities in which students are able to construct knowledge (O'Neill & McMahon, 2005). However, so far only a few researchers have investigated the use of the indicated learning activities for the college statistics courses (Garfield, 1993). Considering some improvements in educational styles by focusing on technology assisted teaching and learning, there has been a rising interest in constructivism (Putnam & Borko, 2000). In fact, distance learning educators should acknowledge constructivism as a new paradigm for learning (Morphew, 2000). He also stated that educators must be willing to shift the teaching practices to constructivist learning methods. However, today most of the web-based instructions are based on behaviourism, viewing the learner as an empty vessel waiting to be filled (Morphew, 2000).

Since mid 90s, the Computer-Mediated Communication (CMC) had been widely implemented for online education as the original delivery method (Harasim, 1995; Hiltz, 1994). Moreover, it is predicted that for the majority of courses offered at higher education institutions would include the online component (Lin, 2008). Some of the researches have determined that the quality of learning in these courses, by using online learning methods, have shown encouraging results in comparison with the traditional face-to-face courses (Cox & Cox, 2008; Hazari, 2004; Krentler & Willis-Flurry, 2005; Meyer, 2003; Vaughan, 2007; Wilson-Jones & Caston, 2006).

There are many attempts to adapt new methodology and method of teaching in line with the pedagogical goals. For instance, the technological features, whether mathematics specific or generic, should be introduced and illustrated in the context of meaningful content-based activities (Stohl Drier *et al.*, 2000). According to Sadeh and Zion (2009), learning will also occur when learners actively elaborate in different learning activities. The LMS has the prospect to provide special interaction among students by using online tools such as asynchronous discussion forum (Cox & Cox, 2008). For example, asynchronous discussion refers to the online communication that occurs over the period of time that participants can submit their responses from any locations at different times (Ashley, 2003).

According to De Bra, Smits, Sluijs, Cristea, Foss, Glahn, and Steiner (2013) many universities use different types of LMS (such as Blackboard, Sakai, Moodle, etc.) to support the learning process and administration. It is assumed that LMS has this potential to transform university teaching methods from the out-dated traditional teaching approaches into widely accessible student-centred approaches using interactive learning models based on the Internet (Wise & Quealy, 2006). This transformation is based around passive transfer of content to a privileged method around learning networks by the use of interactive collaborative technologies in a "community of practice" where according to Roberts et al. (2013, p. 544) "teachers and students co-construct mathematical knowledge and even formulate curriculum decisions."

1.1.4 Learning Management System in Malaysian Universities

Within the Malaysian context, as a developing country, the availability of the technological tools and their accessibility as teaching resources are considered. Malaysia has started many approaches in order to keep up with the needs of the changing the world by incorporating multimedia technology and worldwide networking, besides using Information and Communication Technology (ICT) as part of the teaching-learning environment (Chan, 2002). Along with this, in the 9th Malaysia Plan (2006 to 2010), allocations of RM40.3 billion were set aside for the spending of education and technology (Mohd Salleh, Zaini, & Mohammad, 2011). Under this plan, Malaysian has shown their support thus providing vast opportunities in the educational sectors to support the growth and the use of technology in teaching and learning in all aspects, particularly for empowering and engaging students.

Since the 1990s, ICT has rapidly advanced in Malaysia (Mokhtar, Alias, & Rahman, 2007). While, in 1997 Malaysia tried to promote the ICT application through introducing of the Malaysian Smart School Project in schools (Koo, 2008). According to Chan (2002), the Malaysian Ministry of Education has proposed three policies for ICT in education namely 1) ICT for all students, 2) the role and function of ICT in education as a teaching and learning tool, and 3) using ICT to increase the efficiency of management system. Since 1997, several ICT initiatives were introduced by government agencies (Chan, 2002). Some of the initiatives are as follow:

1. The Malaysian Smart School
2. Internet Usage, MySchoolNet
3. ICT training in schools
4. The computerisation programme in schools
5. The Electronic Book Project
6. Penang e-learning community project (SIPI)

In the year 2010, the Malaysian Ministry of Education revised its policy on the utilization of ICT in education and suggested an adoption of new teaching approachs as blended learning (Yusof, Daniel, Low, & Aziz, 2011). Blended learning is defined as a learning paradigm in which both traditional learning and distance learning advantages, potentials, and benefits are optimized while nowadays blended learning is commonly referred to as E-Learning (Saleh, El-Bakry, & Asfour, 2000).

Nowadays, most higher education universities and institutions employ some form of virtual learning environment such as Learning Management Systems (LMS) (Weller, 2007). In accordance with Malaysia's Vision 2020, a wide range of e-learning courses have been provided by local universities, and these universities use LMS adopted from other universities and companies, or some even developed their own, as a distance learning technological tool (Almarashdeh, Elias, Sahari, & Zain, 2013). Consequently, according to Almarashdeh et al. (2013), the number of users has increased, and LMSs have become the popular instructional system in Malaysian higher education organization.

The use of LMS in these universities is based on the distance learning model or a combination of face-to-face learning and e-learning, as the universities commit themselves to use e-learning and believe it can be an effective alternative to traditional approaches (Hussain, 2004). Charmonman (2005) mentioned many universities in Malaysia have been offering their degree programme via e-learning and LMS, along with Universiti Tun Abdul Razak (UNITAR) in 1998 being the first virtual or e-learning university in ASEAN. After that, most universities started to utilize e-learning systems but the usage was quite limited. For example, in 2000 Universiti Pendidikan Sultan Idris (UPSI) involved e-learning in their educational system (Karim & Hashim, 2004). They identified the three categories of e-learning usage, namely, 1) basic level included some experience using Word and simple PowerPoint presentations without any experience in e-learning and instruction, 2) intermediate level with a little experience on e-learning limited to producing and using PowerPoint presentations, and finally 3) advanced level involved some experience producing PowerPoint presentations and using them in e-learning.

According to Aziz, Yunus, Bakar, and Meseran (2006), since year 2000 Universiti Putra Malaysia has developed and implemented its own LMS or e-learning portal, which was the e-SPRINT. In March 2009, PutraLMS was launched as the latest UPM learning management system to facilitate all aspects of e-learning activities in the university (UPM official website, http://lms.upm.edu.my/i3learn/www/about.htm). The established e-learning system focuses on the development of content rather than the learning activities, and this system is being used as a tool to complement and supplement classroom-based teaching (Aziz *et al.*, 2006). To facilitate the conventional way of the learning process, embedding the pedagogical characteristics of learning in the e-learning systems is value added. Hence, these pedagogical aspects of learning activities embedded in LMS play the vital instructional role to help learners (Zin, Othman, & Yue, 2009).

1.1.5 Cognitive Apprenticeship Model (CAM) of Teaching and Learning

Considering all above-mentioned emphases on learning in higher education and its challenges for university students, the traditional teaching approach in statistics needs to undergo some alterations and reconsiderations. As a start, let's take a look at what is going on in a traditional class.

In a traditional class, the instructor of courses often presents the material in an abstract lecture format, followed by some illustrations regarding the concepts of the lectures, prototypical examples or the textbook exercises. Usually, before the class is over, the students are instructed to do some assigned problems to be completed and submit for the next session of class (Sloboda, 2005). Additionally, as another fact that Sloboda (2005) declared the standard approaches utilize the whole logical reasoning methods and mathematical skills for students of different levels of preparedness or abilities while the learning environment, materials, and supporting facilities are the same for all of them.

According to Brown, Collins, and Newman (1989), there is a gap between school learning and real-life application. Resnick (1987, p.17) suggested, "Bridging Apprenticeships" as a way to explicit the tacit knowledge. Formal learning as a learning component will take place outside of the workplace, such as university classrooms. However, Foley (2004) identified another part of learning as an informal learning in a workplace. It involves what will be learnt through experience on a job, where a practitioner's act will reflect on an action and then learning from that reflection plans a new action (Foley, 2004). Apprenticeship, as an inherently social learning approach, has a long history of helping novices to become experts in various fields like midwifery, construction, and law (Dennen, 2004). The central aim of apprenticeship is the concept in which experienced people could assist less skilled ones by providing structure and examples to support the achievement goals. This method of teaching through Modelling, Coaching, and Fading is the common form of learning for many learners (Brown *et al.*, 1989).

Cognitive apprenticeship (Brown *et al.*, 1989; Collins, Brown, & Holum, 1991) is a strategy for creating learning environments that incorporate many of the salient features of situated cognition. According to Oriol, Tumulty, and Snyder (2010), cognitive apprenticeship strategies recommend a robust and rigorous approach for teaching the complex problem-solving skills and developing vital experiences contained in a discipline. Furthermore, Brown et al. (1989) proposed the Cognitive Apprenticeship Theory based on the Vygotsky's Zone of Proximal Development (ZPD) in 1978. As mentioned before, LMS has the potential to be used like the academic learning portal, but the main challenges for instructors in LMS method are the creation of dynamic and constructive environment. Such environment can support the students on performing professional work and focus on achieving course competencies throughout the master's programme, especially for adult learners when they are struggling to equilibrate the face-to-face classrooms, personal responsibilities and their employment (Oriol *et al.*, 2010).

On the other hand, this environment lets instructors and experts acting as the facilitators (Sloboda, 2005), while the students between two face-to-face sessions are under the control of the learning process. Accordingly, this would demand active participation with stimulating activities to encourage the continued participation in the course activities (Billings, 2007; Cuellar, 2002; Koeckeritz, Malkiewicz, & Henderson, 2002). To sum up, the function of cognitive apprenticeship using online exhibition of complex concepts and applications, can enable the instructors (the experts) and students (the apprentices) to collaborate and interact in a virtual setting while they effectively take part in the learning process (Ding, 2008).

1.2 Statement of the Problem

In 1978, Wolfe emphasised the increasing importance of quantitative research in social science, hence, many students need to take statistics courses in order to strengthen their ability to interpret and predict from gathering data in their researches, which can provide higher-order thinking skill for postgraduate students in the social science. At tertiary level, statistics is universally accepted as one of the main components of almost all studies; although, graduate students often view it as the biggest hurdles (Coetzee & Merwe, 2010). In education and social science area, many higher learning institutions have made educational or social statistics courses as a general requirement for the students (Thompson, 2009). However, many researchers also showed that for many students in all faculties, the subject of statistics is one of the principal stumbling block (Groeneboom, Jong, Tischenko, & Zomeren, 1996).

According to students' problems with statistics, they may often postpone enrolling in educational statistics courses until the last semester of their degree programme (Groeneboom *et al.*, 1996). However, for social and educational science students the condition is worse and many of them usually complain about taking statistics courses (Forte, 1995; Royse & Rompf, 1992). According to Onwuegbuzie (2004), some of the reasons behind this behaviour are fears and anxieties on the subject of statistics as well as feeling indecisiveness due to lack of basic knowledge in statistics or the concern about proper use of statistical applications. A study conducted by Royse and Rompf (1992) showed in a introductory statistics course, the students taken fewer mathematics courses in high school and college reported higher levels of mathematics anxiety. As a matter of fact, this can be the demotivating reason, for both students and teachers. Subsequently, the raised concern calls for a more flexible technique and alternative approach with higher efficacy in teaching statistics.

Most of the statistical courses in the social science encountered with several problems such as low motivation, and poor statistical knowledge causing low transferability of knowledge or skills (Barab, Squire, & Dueber, 2000). One of the obvious causes behind poor mathematics' performance seems to be in the mathematical nature of statistics requiring abstract thinking and problem-solving skills of the students (Onwuegbuzie, 2004). Hence, instructors must find a way to engage students in learning statistics and acquire mathematical problem-solving skills.

Vygotsky (1978) has proposed that learning is a developmental process taking place during formal as well as social activities. To a great extent, the informal knowledge possess resembles the tacit knowledge; Foley (2004) suggests finding ways as one of the roles of adult training and education to make explicit the tacit knowledge. The cognitive apprenticeship model, as an instructional framework supported by Vygotsky's theory of learning (Alger & Kopcha, 2010) endeavours to make what is an invisible part of the expert's thinking to be visible for the novices (Collins, Brown, & Holum, 1991). Unfortunately, postgraduate students have less opportunity to interact with each other since most of these students are adult learners, mostly working fulltime or part-time, and they have little time to make connections on a college campus (Fairchild, 2003). In Malaysia after the announcement of "Vision 2020" blueprint, in which 'Human Capital' were identified as the greatest asset to elevate the K-economy, many adults, especially working adults, back to universities for continuing their postgraduate education (Muhamad & Merriam, 2001). However, as time is truly precious for this group of learners (Neeley, Niemi, & Ehrhard, 1998), and "time for adult learners is even more precious than money" (Serdyukov, 2008, p 39), they should be given the opportunity to devote part of their time for quest of knowledge and problem-solving skill acquisition. According to Fairchild (2003) they have to meet several demands of their full-time/part-time jobs and obligations towards their own family. As such, having to face and deal such challenges, changing the institutional approaches for adult learners is essential (Fairchild, 2003). Hence, the possibility of an instructional design which will support face-to-face course or lecture-delivered mode, specifically using online learning interactions as a hybrid or blended learning will be deemed necessary.

Although, the physical environment in which teaching and learning usually occurs is being replaced with an electronic classroom, the process of teaching is very much the same. However, it will begin with the use of technology in new ways (like LMSs), to advance beyond what is possible in the classroom (Downes, 2004). It is worth noting that, many university teachers have difficulty in using an LMS to create learning designs with remarkable students' engagement (Steel, 2009). Regarding this issue, a national study in Malaysia highly recommended for "setting up a special commission on e-learning at the national level to looking at the curricula, online teaching-learning methods and materials, the training of teachers on ICT skills" (Karim & Hashim, 2004, p. 58). Institutions and instructional designers should adapt these environments in order to fulfil certain needs and requirements in a field of ever-increasing demands for effective, fast and pedagogically correct education and training (Avgeriou *et al.*, 2003). However, design and implementation of LMS is not an easy task since they are complex systems that incorporate a variety of organizational, administrative, instructional and technological components (Avgeriou *et al.*, 2003; Carlson, 1998). On the other hand, the proliferation of new and emerging technologies have impacted the field of education, and have also expanded and challenged the ideas of what constitutes a learning environment (Dickey, 2005). The systematic instructional process such as ADDIE can provide an organized design approach for delivering and developing face-to-face with web-based instructional and tutorial resources (Huang, Cho, & Lin, 2005).

On the other hand, teaching statistics aimed to facilitate and support students' problem-solving skills for adapting to a future changing society through guidance course concerning information recovery and reorganization processes (Lazakidou & Retalis, 2010). Hence, these required facilitating mechanisms which may incorporate scaffolding and cognitive apprenticeship in the teaching and learning process. Finally, considering all of these issues, it seems necessary to seek possible ways to incorporate cognitive apprenticeship framework in the teaching of statistics in a web-based learning environment in order to assist postgraduate students in learning statistics.

1.3 Purpose of Study

The purposes of this study are twofold, to develop a module, and evaluate it. In this study, two specific phases were conducted. The research objectives as well as research questions for each phase are as follows.

1.3.1 Research Objectives - First Phase

The combination of the appropriate model of cognitive apprenticeship and collaborative web-based learning was developed in the first phase of study, which provided a blended instructional method via Moodle. Throughout the development of the module, formative evaluation was carried out and this essential part provided the results which were used to improve the module in order to establish more efficient and effective tutoring. Meanwhile, to ensure the effectiveness of the module, the researcher examined the strength and weaknesses of the module, and tries to resolve them through three stages of "design-evaluate-refine" cycle as formative evaluation

(Dick, Carey, & Carey, 2009). Hence, an efficient tutorial module for learning of statistics at the postgraduate level among students from the Faculty of Educational Studies was developed. Specifically, the research objectives for this phase are to:

1. Develop systematically an Internet-Based Tutorial Module (***i***-TModule) framed on CAM organized to support statistics learning among postgraduate students;
2. Investigate students' perspective on the effectiveness of the initial version of ***i***-TModule which is related to its clarity, feasibility, and impact of the module to revise it through one-to-one evaluation;
3. Evaluate the impact of revised version of ***i***-TModule on the students' statistics performance based on the results of two tests (which were carried out before and after intervention), depending on their learning pattern through small-group evaluation;
4. Investigate students' motivation by using ***i***-TModule through field-trial evaluation.

1.3.1.1 Research Questions - First Phase

With regards to the above research objectives, the research questions related to the development module and three stages of formative evaluation (one-to-one, small-group, field-trial) are attempted to answer the following research questions:

RQ1 What are the characteristics of systematic and efficient Internet-Based Tutorial Module (***i***-TModule) framed on CAM in order to support statistics learning among postgraduate students?

RQ2 What is students' perspective about the effectiveness the initial version of ***i***-TModule related to clarity, feasibility, and impact of the module in the real classroom?

RQ3 What is the impact of next version of ***i***-TModule on the students' statistics performance depending on their learning pattern?

RQ4 What are the motivational levels of the students after using the refined ***i***-TModule?

1.3.2 Research Objectives - Second Phase

In the second phase of the study, the effectiveness of the module was examined. The researcher utilized the refined ***i***-TModule and conducted summative evaluation of the module. The effectiveness of the developed module (the ***i***-TModule) was examined based on Online Reaction, Online Behaviour, Problem-Solving Skills, Statistics Performance and Motivation which were adapted from four-level model of evaluation (Reaction, Behaviour, Learning Skills, and Results) proposed by Kirkpatrick (1998). Specifically, the objectives of the second phase are to:

1. Compare the effects of the ***i***-TModule and conventional Moodle-based module on students' statistics performance;
2. Compare the effects of the ***i***-TModule and conventional Moodle-based module on the students' online behaviour during learning statistics;
3. Investigate the impact of the ***i***-TModule on the students' problem-solving skills when solving statistics problems;
4. Investigate the impact of the ***i***-TModule on the students' online reaction in learning statistics;
5. Compare the effects of the ***i***-TModule and conventional Moodle-based module on the students' motivation towards learning statistics and its subscales (ARCS).

1.3.2.1 Research Hypothesis - Second Phase

According to the above research objectives for second phase of this study, the following null hypotheses were tested:

H_0 1 There is no significant difference in the means of the students' statistics performance on Test I between the ***i*** -TModule and conventional Moodle-based groups while controlling for the scores on the test administered before the programme (PreTest).

H_0 2 There is no significant difference in the means of the students' statistics performance on Test II between the ***i*** -TModule and conventional Moodle-based groups while controlling for the scores on the test administered before the programme (PreTest).

H_0 3 There is no significant difference in the means of the students' statistics performance on Test III between the ***i***-TModule and conventional Moodle-based groups while controlling for the scores on the test administered before the programme (PreTest).

H_0 4 There is no significant difference in the means of the students' statistics performance across Test I, II, and III, between the ***i***-TModule and conventional Moodle-based groups while controlling for the scores on the test administered before the programme (PreTest).

H_0 5 There is no significant difference in students' online behaviour between the ***i***-TModule and conventional Moodle-based groups during statistics learning.

H_0 6 There are no significant changes in students' online behaviour over the twelve periods for the ***i***-TModule group during statistics learning.

H_0 7 There are no significant changes in students' problem-solving skills over the twelve periods for the ***i***-TModule group during statistics learning.

H_0 8 There are no significant changes in students' online reaction on usefulness of module over the twelve periods for the ***i***-TModule group during statistics learning.

H_0 9 There is no significant difference in students' motivation between the ***i***-TModule and conventional Moodle-based groups during statistics learning.

H_0 10 There is no significant difference in the four subscales factors of students' motivation between the ***i***-TModule and conventional Moodle-based groups during statistics learning.

1.3.2.2 Research Question - Second Phase

To support effectiveness of the ***i***-TModule and in line with the above research objectives of second phase of this study, the following research question was considered:

RQ1 What is students' perspective about the effects of ***i***-TModule (its features and CAM strategies) on their performance?

1.4 Significance of the Study

This study has provided twofold significances. First, in recent decades, the shifting paradigm has formed from behaviourism to constructivism, especially in the field of instructional design. This has possessed the researchers' attention to discuss constructivism and cognitive apprenticeship in online and virtual environment (Johnson, 2001; Dickey, 2005). On the other hand, some constructivism goals, such as reasoning, problem-solving, thinking, and reflective use of knowledge (Driscoll & Driscoll, 2005) are well-suited to the new philosophical aspect of teaching and learning mathematics. Since many instructors are going to use the constructivism teaching strategies in their classrooms (Draper, 2002; Saunders, 1992), still a few of researches have been done using the problem-solving strategies in an asynchronies constructivism environment. This study is focused on designing and developing a valuable facilitated e-learning environment as an online tutorial portal for statistics, based on the theories of constructivism and CAM. In fact, it would contribute to the knowledge of utilizing LMS for teaching and learning statistics. As usual, some students need to put in more efforts due to different learning needs, while some others are standing in a good level of understanding during learning (Christensen, Horn, & Johnson, 2011). Anyway, the design of the portal contributes towards enhancing problem-solving ability among students with a way to reduce the learning gap between them. Additionally it can help teachers do more collaborative activities by using different sources of materials, without being concerned for limitation of time.

Second, designing an educational and training programme is a challenging and exciting professional field (Knirk & Gustafson, 1986). In developing new systematic training programmes as an instructional systems design, there is a need to continue the review of best practices in developing work with the latest technology (Allen, 2006). It can enhance the effectiveness and efficiency of instruction and make learning less difficult (Morrison, Ross, Kemp, & Kalman, 2007) by understanding how university students can get the benefit of interaction with modern technology, and how instructors can take the appropriate approach to develop the advantages of integrating asynchronous activities in their guidance setting. The study offers documentation and resources regarding the use of instructional design process aligned with the development of highly required instruction model according to learners' needs (Hannafin & Hill, 2002). Since, this study is involved with the development, testing, and evaluation of an Internet-facilitated programme, it provides instructional development as the management function in systematic instructional planning (Morrison, Ross, Kemp, & Kalman, 2007).

The results of this study may help as a systematic development and implementation of alternative teaching and learning strategies, especially the extension of learning activities and communication after face-to-face sessions in a virtual environment. It gets together the advantages of online learning, while the students are meeting each other in the same place and at the same time every week. It may offer students more meaningful learning experiences in problem-solving. In addition, the product of this study can be used for future research which aims to analyze the effectiveness of e-learning in higher education by having a new perception of the Cognitive Apprenticeship Model (CAM) as a feasible constructivism framework. It is a vital investigation into this issue, because many higher learning institutions spend a large amount of money on perfecting their e-learning operations.

To sum up, since this study involved the development, formative evaluation (testing), and summative evaluation (final evaluation) of a highly systematic Internet-based instructional module, it can provide some concrete findings and conclusion about the merits of a blended instruction. Accordingly, this study is useful to educators and teachers who are seeking to better identify the impact of instructional design on students' learning achievement. This study can also be particularly valuable to university lecturers involved in more quantitative courses such as mathematics and statistics. Such educators may find some aspects of this study useful as they struggle to identify appropriate strategies for offering problem-solving tutoring in an online setting.

1.5 Limitation of Study

The following limitation of this study has been made. The scope of this study is limited to the integration of a web-assisted environment to support learning of educational statistics among postgraduate students of Faculty of Educational Studies in a public research university in Malaysia.

With regard to the limit number of participants, postgraduate students, this research cannot be counted as a true experimental design to assess the effectiveness of the *i*-TModule. The limited number of participants may pose lack of representation of the postgraduate students taking educational statistics. The group of participants may represent the actively involved group keen to interact with the activities provided on the portal, as part of their ongoing learning and training process. Participants' behaviour may also be influenced by the course instructor whom would have Internet access at home and be able to check the online activities in the portal every day.

The researcher had to develop a new LMS portal in this study. The Moodle as an LMS is chosen because it is free and open source software, with minimal payment for the cost of hosting space and buying the domain. So the purpose of study is not to evaluate the success or failure of the LMS but to provide evidence of interaction of participants in the online activity. The main aim is to assess interactions among the researcher, participants and the LMS. This study, like many other studies in human computer interactions has essential limitations and problems.

1.6 Definition of Terms

The following terms are defined for use in this study.

1.6.1 Learning Management System (LMS)

The sense of LMS is a specialized learning technological system based on the World Wide Web (www) and the Internet, which will be managed to present educational training followed by open and distance learning paradigm. In addition, it is used for reporting the training programmes, classroom, online events, e-learning, and instructional material (Wise & Quealy, 2006; Zin *et al*, 2009). These systems are complicated web-based application that nowadays, being managed in increasing numbers of different institutions and companies that desire to get involved in e-learning systems, either for providing some services to others, or for teaching and training people.

In this study, the Moodle software is used to design the learning environment as e-learning portal. This portal is supposed to support learners through discussion with other classmates as well as the facilitator. The researcher installed the 1.9.16 version of Moodle and designed the module through ADDIE process. This site used the web hosting service of Netafzar.com, and it is available via this address: www.problemsolving-Moodle.com. In this study, a Moodle-based module was designed and employed in twofold modes, as ***i***-TModule and Conventional Moodle-Based Module.

1.6.1.1 *i*-TModule

The ***i***-TModule is an Internet-based tutorial module which is framed by Cognitive Apprenticeship Model (CAM) during a systematically design process. This module is provided statistical related web contents and combination of collaborative learning activities with cognitive apprenticeship components in a Moodle website. Overall, an Internet-based tutorial module is a model of e-learning with a combination of the supporter on the Web content like learning management systems and collaborative facilities (Horton & Horton, 2003).

In this study, Moodle is designed as an Internet-based tutorial regarding to obtain the course objectives and tutor the learners through the six components of cognitive apprenticeship model. This module exploited the dimension of the virtual learning environment, which can potentially eliminate the geographical barriers while providing increased convenience, flexibility, availability of materials, and feedback over the traditional classroom.

1.6.1.2 Conventional Moodle-Based Module

Moodle-based module is an e-learning platform which is used Moodle as a learning platform. This module plays a role as a web-based mediator and environment in this blended instruction between two face-to-face classrooms.

In this study, conventional Moodle-based module is referred to the module, which includes all supportive materials, learning tools, and features similar to the ***i***-TModule. The only difference is the strategy of using the module, which is similar to using most conventional LMS. Specifically, this module is used without any emphasized activities and monitoring. In other word, this module is simply the conventional LMS portal, which usually the instructors applied in their classroom.

1.6.2 Statistics Performance

The final level of Kirkpatrick model is related to the result criteria. According to Kirkpatrick (1998), this criteria check if the effort has made any differences at the level of results that training programs pay off. Similarly, learning outcomes are proposed to provide some measure on the impact of new instruction design (Bates, 2004) and provide indicators for enhanced performance as a result of a new instructional design (Morrison, Ross, Kemp, & Kalman, 2007). In this case, statistics performance can be considered as learning outcome of a new instructional design.

In this study, statistics performance refers to the overall results which are obtained by students in three tests namely: Statistics Test I (descriptive statistics), Statistics Test II (hypothesis testing of comparison between means), and Statistics Test III (hypothesis testing of measures of association).

1.6.2.1 Statistics Performance in Test I

This test was conducted at the end of first phase of the experiment. The test covered the conceptual understanding as well as procedural knowledge related to descriptive statistics. Descriptive statistics includes (a) graphical summaries which show the spread of the data, (b) numerical summaries that measure the central tendency (a 'typical' data value) of a data set, and also (c) numerical summaries that describe the spread of the data.

The test was included two parts in which the first part consisted of some objective questions as conceptual knowledge, and the second part included the subjective questions to measure the procedural knowledge. The total score was 100 for each test which was accounted by 40 percentages of the scores in part one, and 60 percent in part two.

1.6.3 Statistics Performance in Test II

This test was conducted at the end of second phase of the experiment. The test was covered with the understanding (conceptually and procedurally) of comparing means between two groups or more. This part of statistics as comparison of means used to compare a single or multiple means with a hypothesized value, which are arising from paired data, unpaired data or different groups.

These tests were also conducted in two parts. Similar to Test I, the first part consisted of objective questions to measure conceptual knowledge, and the second part included some subjective questions to assess the procedural knowledge. The total score was 100 for each test (40 percentages of the scores in part one, plus the 60 percent of part two).

1.6.3.1 Statistics Performance in Test III

This test was conducted at the end of third or last phase of the experiment. The test was enclosed to assess students' statistics performance, as conceptual and procedural knowledge about a measure of association is a statistical quantity used to indicate the strength of the relationship between two variables. In this study, the measures of association included some related topics such as: Pearson and Spearman correlation coefficient, Chi-square Goodness of fit, Kruskal's Lambda, Cramér's V.

Again, both the objective questions and subjective questions measuring conceptual and procedural knowledge (40% + 60%) were used for this test respectively.

1.6.4 Problem-Solving Skills

According to Kirkpatrick (1998) the skills is a general criteria related to how well the participants learn the skills which the program was designed to teach, and regardless of how much they liked the program, did they actually acquire the skills the program intended to teach them. Mathematics problem-solving skills were proposed as main skills that this research attempts to assist students. The mathematics problem-solving is a process to find a solution to the problem when the procedure is not clear for problem-solvers. In this case, the problem solver needs to use some tactical skills to choose the suitable techniques as a solution. Pólya (1957) suggests the four-stage problem-solving heuristic as understanding the problem, devising a plan, carrying out, looking back.

In this study, problem-solving skills as desired learning skills were measured based on the heuristic steps of solving a problem which are grounded on Polya's four-stage problem-solving model. There were twelve weekly assessments with a worksheet designed on the four stages, which are measured with a rubric based on 0 to 8 grade.

1.6.5 Online Reaction

Kirkpatrick (1998) stated reactions as means of how well participants like a particular training programme. Reaction through an educational experience offers learners' perspectives regarding the learning experience which included quality of instruction, presentation, structural organization, teaching methods, content, and materials (Tilson *et al.*, 2011).

In this study, the online reaction referred as how well did the participants like the *i*-TModule, and found its major activities useful. It was measured based on the learners' responses to the questionnaire with 11 statements with learners' opinion about the usefulness of the developed module based on a 7-point Likert scale.

1.6.6 Online Behaviour

According to Praslova (2010), in higher education setting, behaviour refers to the evidence in which learners use the information and knowledge taken and use them in a new task. In a virtual learning environment, learners' online interaction as behaviour can be electronically captured whereas the number of hits have been used by some studies to assess the learners' behaviour (e.g. Large, Beheshti, & Rahman, 2002; Morris, Finnegan, & Wu, 2005).

In this study, the researcher accounted the learners' behaviour by the number of clicks or hits on the specific 11 activities and materials designed during the development phase. These hits consist of hits on the homepage, on the contents (lecture notes), on the tool pages (extra resources, links, videos, glossary), and on classmates' postings (on forum), the number of posts (replying posts, created posts) on the forums, and the number of the sent messages.

1.6.7 Learning Pattern

In a hypermedia environment, learning pattern was measured by identifying how often the students accessed different functions there, and how long students used the courseware (Liu & Reed, 1995; Shih, Ingebritsen, Pleasants, Flickinger, & Brown, 1998). According to Lu, Yu, and Liu (2003) the number of hits is an objective indicator for measuring learning patterns in terms of the frequency of visits in a Web-based learning environment. They also indicated that the number of hits on the course site shows the spent time in the online class.

In this study, learning pattern is the learner's track function in using the portal and recorded as learners' behaviour. The learners are divided into three percentile groups according to their behaviour: Less Frequent (LFV: first 33.33%), Partially Frequent (PFV: second 33.33%), and Most Frequent Visitors (MFV: last 33.33%).

1.6.8 Motivation

Motivation refers to a person's desire to follow a goal or perform a task (Keller, 2010). According Keller, the instructional designer is usually concerned about how to motivate learners, because a person's motivation can be influenced by external events, and Motivation can influence learning and performance. Instructors are more considered creating learning materials and environment that motivate learning. Keller's motivational model, ARCS (Attention, Relevance, Confidence, and Satisfaction) is the most appropriate instrument in the field of instructional design. He defined Attention as capturing the interest of learners and stimulating the curiosity to learn. Relevance is a factor to meet the personal needs and goals which can affect a positive learning attitude. Confidence is also defined as a measure of the amount of helping the learners to believe that they will succeed and control their success. Satisfaction is related to reinforcing accomplishment which allows students to feel good about their experiences.

In this study, increasing the students' motivation was also considered as a result of instructional design. The Keller's ARCS model was used to measure students' motivation through the Internet-based systematic instructional materials. In this case, the Keller's instrument "Instructional Material Motivation Scale (IMMS)" was adapted by the researcher to measure learners' motivation after the experiment.

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