THE DEVELOPMENT AND EFFECT OF SIMULATION-BASED E-LEARNING INTERACTIVE TRAINING ON STUDENTS' PERCEPTION AND TECHNOLOGICAL SKILLS

NORAN ADEL ABD ELRAHMAN EMARA

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by

NORAN ADEL ABD ELRAHMAN EMARA

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LIST OF ABBREVIATIONS

ADDIE	Analyze, Design, Develop, Implement and Evaluate
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
TAT	Technology Achievement Test
BB	Blackboard
CED	College of Education
CTML	Cognitive Theory of Multimedia Learning
EL	E-learning
ELT	Experimental Learning Theory
ETT	E-learning Traditional Training
iBT	Internet-based Test
IC3	Internet Core Competency Certification
ICT	Information and Communication Technology
IELTS	International English Language Testing System
LMS	Learning Management System
MSLQ	Motivated Strategies for Learning Questionnaire
QU	Qatar University
SBEIT	Simulation-based E-learning Interactive Training
SBEQ	Simulation-based E-learning Quiz
SBL	Simulation-based Learning
SBC	Senior Reform Committee
SPSS	Statistical Package for the Social Science
TAs	Teaching Assistants

TS	Technology Skills
TSQ	Technology Skills Questionnaire
VLEs	Virtual Learning Environments

PEMBANGUNAN DAN KESAN LATIHAN E-PEMBELAJARAN INTERAKTIF BERASASKAN SIMULASI TERHADAP PERSEPSI DAN KEMAHIRAN TEKNOLOGI PELAJAR

ABSTRAK

Objektif utama kajian ini adalah untuk menyelidik kesan Latihan Interaktif E-pembelajaran berasaskan Simulasi (SBEIT) terhadap persepsi dan kemahiran teknologi pelajar dalam kursus Teknologi. Penyelidik telah membangunkan dua kaedah e-pembelajaran: Latihan Tradisional E-pembelajaran (ETT) dan Latihan Interaktif E-pembelajaran (SBEIT). Penyelidik telah menggunakan beberapa program Adobe untuk mereka bentuk dan membangunkan kedua-dua kaedah ETT dan CBEIT yang disampaikan kemudiannya melalui Sistem Pengurusan Pembelajaran "Blackboard". Penyelidik dengan bantuan panel pakar telah membangunkan soalselidik kemahiran teknologi dan ujian kemahiran teknologi. Kedua-dua soalselidik dan ujian ini telah digunakan untuk menguji empat kelas yang mengikuti kursus Teknologi sebelum dan selepas intervensi. Kaedah kajian kuasi-eksperimen 2 X 2 telah digunakan untuk mengkaji kesan kaedah E-pembelajaran. Pembolehubah tak bersandar adalah kaedah E-pembelajaran yang mempunyai dua tahap: kaedah ETT dan kaedah SBEIT, pembolehubah moderator adalah jantina dan pembolehubah bersandar adalah persepsi dan kemahiran teknologi pelajar. Dalam kajian ini, seramai 180 pelajar telah dipilih secara rawak daripada berbagai pengkhususan dan terdiri daripada 90 lelaki dan 90 perempuan. Kaedah ANCOVA dua hala telah digunakan untuk menguji hipotesis yang diandaikan. Menurut hasil kajian, kaedah SBEIT memberikan kesan positif pada kedua-dua skor ujian persepsi dan kemahiran teknologi; nilai skor min dan min yang terlaras untuk pelajar-pelajar yang

menggunakan SBEIT adalah lebih tinggi secara signifikan berbanding dengan pelajar-pelajar yang menggunakan ETT. Dalam mengkaji kesan jantina ke atas keputusan kajian, dapat diperhatikan bahawa pelajar lelaki yang menggunakan kaedah SBEIT mempunyai nilai skor min dan min yang terlaras dalam ujian-pos kemahiran teknologi yang lebih tinggi berbanding dengan pelajar perempuan yang menggunakan kaedah e-pembelajaran yang sama. Walau bagaimanapun, tidak terdapat sebarang perbezaan yang signifikan bagi min dan min yang terlaras antara skor persepsi kemahiran teknologi pelajar lelaki dan perempuan. Tambahan lagi, tidak terdapat kesan interaksi yang signifikan antara kaedah-kaedah E-pembelajaran (ETT dan SBEIT) dan jantina pelajar (lelaki dan perempuan) ke atas persepsi dan kemahiran teknologi pelajar. Jelas menunjukkan berbagai ciri SBEIT yang telah digunakan seperti prinsip-prinsip multimedia (pralatihan, pengisyaratan, modaliti dan prinsip-prinsip segmentasi) dan peringkat pembelajaran pengalaman (membangunkan konsep abstrak, latihan dan mewujudkan pengalaman yang kukuh) dapat memperbaiki persepsi dan kemahiran teknologi pelajar-pelajar. Kesimpulannya, prinsip-prinsip teori multimedia dan teori pengalaman perlu dipertimbangkan dalam merekabentuk latihan interaktif e-pembelajaran berasaskan simulasi dalam rangka bagi mempromosikan kemahiran teknologi pembelajaran.

THE DEVELOPMENT AND EFFECT OF

SIMULATION-BASED E-LEARNING INTERACTIVE TRAINING ON

STUDENTS' PERCEPTION AND TECHNOLOGICAL SKILLS

ABSTRACT

The main objective of the research is to examine the effect of Simulation-based E-learning Interactive Training (SBEIT) on undergraduate students' perception and technology skills in Technology course. The researcher developed two e-learning modes: E-learning Traditional Training (ETT) and Simulation-based E-learning Interactive Training (SBEIT). The researcher used number of Adobe programs to design and develop both ETT and SBEIT modes which latter on delivered through the Blackboard (BB) Learning Management System (LMS). The researcher, with the help of panel of experts developed technology skills questionnaire and technology skills test which were used to test four classes of Technology course before and after the treatment. To investigate the effect of the E-learning modes, 2 X 2 quasi experimental design was used. The independent variable was the E-learning approach which has two levels: ETT mode and SBEIT mode, the moderator variable was the gender and the dependent variables were the student's perception and technology skills. In this research, 180 students were randomly selected from different specializations from which 90 were male and 90 were female. Two-way ANCOVA was used to test the hypotheses that were assumed. According to the results, there was positive effect for using SBEIT mode on both the scores of students' perception quesstionnaire and technology skills test as the mean and adjusted mean of scores for students used SBEIT are significantly higher than students used ETT. In examining the effects of gender on the results, it was noted that male students who are trained using SBEIT mode have

higher mean and adjusted mean scores in their technology skills post-test than the female using same e-learning mode. However, there is no significant difference for mean and adjusted mean between male and female students' perception scores of technology skills questionnaire. Moreover, there was no significant interaction effect between E-learning modes (ETT & SBEIT) and gender (Male & Female) on students' perception and technology skills. Apparently, the various features used in SBEIT mode such as multimedia principles (pre-training, signaling, modality and segmenting principles) and experiential learning stages (forming abstract concepts, training, and creating concreate experience) were able to significantly improve the students' perception and technology skills. In conclusion, the principles of multimedia theory and experiential theory need to be considered in designing e-learning simulated-based interactive training in order to promote learning technology skills.

CHAPTER 1 - INTRODUCTION

1.1 Introduction

Technology has become part of our daily life over the past three decades. Educational technology has implicitly become a vital part of educational process. Today's educators tend to think of educational technology as devices or equipment – particularly the more modern, digital devices, such as computers, cell phones and tablets. However, educational technology is not new at all, and it is by no means limited to the use of devices (Roblyer and Edwards, 2000).

Clearly, 21st century educators will have to deal with issues and situations that their predecessors could not even have imagined. New technology tools also mean new and different ways of accessing and processing information needed for teaching and learning. Both teachers and students must have the skills and knowledge that will prepare them to meet different challenges and use these powerful strategies (Roblyer and Edwards, 2000).

For students to be able to register in courses in Qatar University (QU), they have to register through an electronic system (e.g.: Banner system); to be able to communicate with the university registration department, they have to send an email through the university email system (e.g.: Outlook Mail); to be able to log in to their courses, check materials and send assignments, they have to deal with a learning management system (e.g.: Blackboard); to be able to prepare online micro-teaching presentations, they have to acquire skills in using presentation tools (e.g.: PowerPoint, Prezi, Adobe or Authorizing tool); and to be able to calculate statistical functions for

student's grades, they have to learn spreadsheet/statistical tools skills (e.g.: Excel or SPSS). Moreover, for QU students, they need to learn how to integrate technology in teaching in effective way. Therefore, knowledge of educational technology is necessary in preparing students before and during their study at the university to prepare competent students (Stasz Eide Martorell & Rand-Qatar Policy Institute 2007).

Educational technology represents the practical side of information technology; therefore, the improvement of students' information technology skills and a strongly positive attitude toward technology are required to promote competent performance in students and enhance their educational environment (Stasz Eide Martorell & Rand-Qatar Policy Institute 2007).

E-learning was developed for the innovations in information technology and can greatly decrease educational expenses. Education would be possible from every location as long as a computer with an internet access is available. This educational system can provide services to many students at once and the learning process is repeatable. This system is student- and not instructor- led and students can freely participate in the learning process and know their peers' points of view under the supervision of an instructor. The mentioned characteristics are among the most attractive properties of this learning system that have resulted in its acceptance and implementation in many accredited universities worldwide during the recent years.

However, the main challenge of e-learning researches is to provide efficient e-learning. To achieve efficiency, the e-learning systems are modeled as a directed graph

where each node represents a Learning Object (Viet and Si, 2006). Each Learning Object (LO) may contain a concept, an object, an image, or an audio session. Two events are connected if there is a dependency relation, for example, one event is a prerequisite to the other. The e-learning systems act as an adaptive system if they select the path of learning that meets the students' requirements and needs and discard those paths, which do not comply with their needs. In addition to, such an adaptive learning system must be as efficient as possible (Webster 2006).

Educational technology represents the practical side of information technology; therefore, the improvement of students' information technology skills and a strongly positive attitude toward technology are required to promote competent performance in students and enhance their educational environment (Stasz Eide Martorell & Rand-Qatar Policy Institute 2007).

E-learning traditional training (ETT) is the training conducted by presenting instructions in the form of online pdf files which are uploaded online through learning management system. ETT is the training used by the instructors in the Technology course in Qatar University-College of Education before conducting this research.

Problems with ETT: There are some problems associated with ETT from which:

- **Boring, text-heavy content:**

  One of the roadblocks in traditional E-learning training is static content with weak interactivity (Forrester, 2000). Much eLearning is where eBusiness was 5 years ago, but instead of vendors creating online catalogues, trainers are now

developing online textbooks. Much of today's eLearning implies scrolling text-heavy HTML-pages (Forrester, 2000).

- **Underuse**

  Epic Multimedia in United Kingdom has experienced the problems associated with underuse of traditional E-Learning. Underuse means that the use of traditional E-Learning systems often drops off after a "honeymoon period" immediately after launch. For vendors, continued underuse and unsuccessful initiatives could threaten the market for E-learning systems (Trondsen, 1999). This is also supported by others (Forrester, 2000), which conclude that some online courses suffer from dropout rates as high as 80%.

1.2 Background of The Study

In 1973, Qatar's first established college was College of Education. The vision of Emir of Qatar was to place education as a priority in the country's expansion. Today, Qatar University (QU) is the country's only national and major institution of higher education in Qatar. Although there are other private universities in Qatar, QU is the main target for most of the Qatari people as the medium of instruction in QU is the Arabic language not like other private universities that the medium of instruction in them is English.

In QU, the first major problem is shifting the main medium of instruction from English to Arabic in 2011-2012 in while this decision might have been the result of

pressure from the community; it was not supported by research studies (Cherif and Alkhateeb, 2015).

CED decision of shifting medium of instruction to Arabic leads to cancellation of the CED student's admission requirements of demonstrating proficiency in English -- passing Test of English as Foreign Language (Toefl iBT) with 61 points or International English Language Testing System (IELTS) with 5.5 -- as was in the previous years (Qu.edu.qa, 2015). Consequently, more Qatari -- Arabic native speakers -- students were encouraged to study in CED after 2011-2012 (Qatar University, 2014) as shown in Figure 1.2. Those Qatari students have limited English proficiency, as the main language of instruction in Qatari schools is the Arabic Languages (Rand newsroom, 2009).

Research-based studies state the importance of the foreign language as a means to access modern ideas and technological innovations. They claim that an international language, English more specifically, is a benefit to the students and that high proficiency in English is a requirement in the job market (Amin, 2009). Librarians who teach students with limited English proficiency have mentioned varies barriers limiting effective learning especially when dealing with technological innovations and accessing online scientific information (Conteh Morgan, 2002).

As a result, the first major problem facing the newly admitted students in CED is having language barriers, which limit effective learning especially that regarding using technological systems and tools which most of their interface, manuals or online tutorials are in English language.

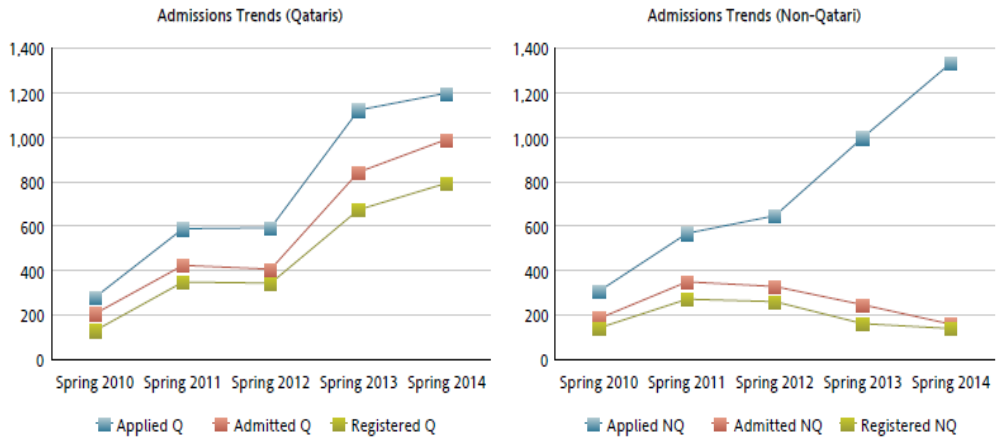

Figure 1.1 Admissions Trends: Qatari vs. Non-Qatari (Qatar University, 2014)

1.2.1 Medium of Instruction

In 2012, the Qatari Supreme Education Council decreed that Arabic would be QU official teaching language rather than teaching in English. While this decision might have been the result of pressure from the community, it was not supported by research studies (Cherif and Alkhateeb, 2015). Research-based studies on the medium of instruction in the Arab world tend to be rare; however, discussions over the issue in theoretical papers show that scholars tend to be divided in their opinions concerning the use of Arabic as the medium of instruction (Amin, 2009). Some researchers ensure the importance of the English language as a means to access modern ideas and technological innovations over the internet (Amin, 2009). That is why the first major problem faced by the students in College of Education (CED) is having Arabic as main language of instruction that act as barrier for technological innovations.

1.2.2 Computer Literacy

Moreover, QU decided to close the foundation computer department, which is the main technological bridge to study in different colleges in QU (Alarab, 2012). Foundation computer department consists of two computer courses that students must fulfill before joining QU colleges. These courses were providing students with essential computer knowledge and technological skills to help them to succeed in competitive and challenging programs in QU. These computer courses cover the basics computer concepts, train students on the use QU educational tools and systems, which enable students to enter college life more smoothly. When all new admitted students have to fulfill these courses, QU guarantee that all students who may come from different school levels have a standard awareness and skills required for using QU educational technology systems and tools. Closing the foundation computer department is considered the second major problem, which leads to students entering their colleges without any idea of how to use the QU educational technology systems and tools.

1.2.3 Students' Registration Rate

Consequently, following these policy changes, more students were encouraged to study in 2011-2012 and the trends of registered students in QU courses increased. According to the *Book of Trends* (Qatar University, 2014), students who applied for courses increased from 4,466 students in 2010-2011 to 6,213 students in 2012-2013, an increase of 39% and from 6,213 in 2011-2012 to 9,449 in 2012-2013, an increase of 52% (Table 1.2, Figure 1.1).

Table 1.1 Admissions Statistics by Gender - Academic Year (Qatar University, 2014)

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	1 Yr	5 Yrs
Applied	4,043	4,466	6,213	9,449	9,693	2.6	139.7
Male	1,411	1,537	2,279	4,427	3,999	-9.7	183.4
Female	2,632	2,929	3,934	5,022	5,694	13.4	116.3
Admitted	3,046	3,118	3,883	6,196	6,567	6.0	115.6
Male	1,025	984	1,231	2,785	2,602	-6.6	153.9
Female	2,021	2,134	2,652	3,411	3,965	16.2	96.2
% of Admitted	*75.3*	*69.8*	*62.5*	*65.6*	*67.7*		
Registered from Admitted	2,401	2,545	3,147	5,040	5,501	9.1	129.1
Male	694	685	855	2,069	1,986	-4.0	186.2
Female	1,707	1,860	2,292	2,971	3,515	18.3	105.9
% of Registered	*78.8*	*81.6*	*81.0*	*81.3*	*83.8*		

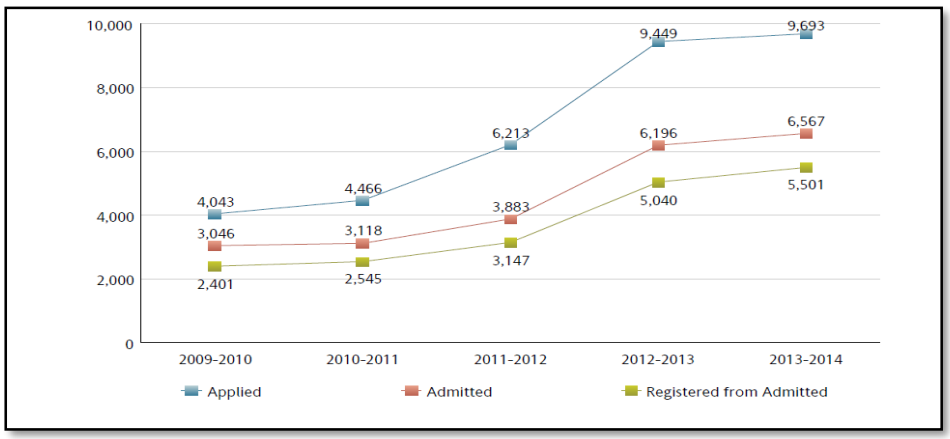

Figure 1.2 Admissions Trends (Qatar University, 2014)

This trend in the number of applying students was also seen in the registered students, with a 23% increased from 2,545 in 2010-2011 to 3,147 in 2011-2012, and a 60% increase from 3,147 in 2011-2012 to 5,040 in 2012-2013. This huge increase in registered students who have no standardized basic computer knowledge and who are studying in the Arabic language make it more problematic to deal with the English language-based QU educational technology systems and tools.

1.2.4 Simulation-based E-Learning

Simulation has been defined as a situation in which a particular set of conditions is created artificially in order to study or experience something that is possible in real life; or a generic term that refers to the artificial representation of a real world process to achieve educational goals via experimental learning (Flangan, Nestel and Joseph,2004). Simulation is a technique for practice and learning that can be applied to many different disciplines and types of trainees. It is a technique to replace and amplify real experiences with guided ones, that evoke or replicate substantial aspects of the real world in a fully interactive fashion. Simulations based E-learning allow students to learn by acting within virtual online environments, immediately applying theory to practice in realistic yet controlled settings. Simulations may easily be added as a complement to standard pedagogical practice, not as a replacement. For instance, a simulation could be the hands-on activity for a lesson in the same way a lab section may supplement a lecture.

Simulation based e-learning sessions is used by the researcher to try to overcome the previous mentioned barriers: First, it will be developed with Arabic voice explanation during the training sessions, thus the students will follow steps shown on screen and hear the Arabic translation and Arabic explanation. By this way, the designed simulation sessions could help in solving the language problem and removing the barrier of the English graphical user interface of the technology tools used.

Second, simulation-based e-learning sessions could be delivered online either through the college website or through the BB Learning management system. This online training could be conducted anytime, anywhere before starting the college courses, thus the students will be trained and ready to use QU educational technology tools and systems at the beginning of the academic year. This could solve the second problem of having the students directly admitted to their college, without having any experience of using the educational technology tools used by the college.

Third, using simulations-based e-learning sessions will help to overcome the third problem of huge number of students without enough computer labs used for their training. As the simulation-based e-learning sessions could be easily distributed online for thousands of students. Moreover, it will be one-to-one training as it is self-customizing and can be viewed on smartphones or tablets which already available with most of Qatari students. Each participant will experience a unique series of events in response to his or her own knowledge, skills, and instincts.

1.3 Statement of The Problem

E-learning systems are increasingly being integrated into universities as a new means of learning and teaching (Ishtaiwa, 2006; Ahmed, 2012). E-learning systems have many advantages to support learners using multimedia systems, but are not used effectively by faculty members in most universities (Jeong-Hoon & Kwang-Seok, 2006). According to Ahmed (2012), QU planned to increase the use of information and communication technology (ICT) in teaching and learning (QU Strategic Objectives, 2008). Accordingly, QU has adapted the Blackboard (BB) system as a

university–wide system for managing and delivering academic courses. The BB system is mainly English user interface (Blackboard Learn, 2016). However, to address the problem, various government all over the world have come up with some initiatives geared towards addressing the problem. For example, the governments have resorted to the development of virtual universities in cooperation with other countries and universities from developed countries to ensure there is enough educational resources with the right language to support the system (Mirza & Al-Abdulkareem, 2011). Examples of such universities include the Syrian Virtual University, the Hamdan bin Mohammed e-University and the Mediterranean Virtual University (MVU) among others. The main purpose of the research is to design and develop simulation-based e-learning sessions to facilitate learning technological skills. The designed and developed simulation sessions will be two modes: First mode represent the traditional E-learning training (used in the Technology course before conducting the research) where students follow steps written in online pdf files to perform specific tasks and in the second mode, they access interactive training where students will be asked to do these tasks by themselves and receive immediate feedback after learning through simulated sessions explained in Arabic language. This will be done through accessing interactive sessions in simulated environment for the programs taught. Then the researcher will investigate the effect of the designed and developed simulation-based e-learning modes on students' perception and technology skills. Moreover, the researcher will investigate differences between the effect of the two modes on male and female perception and technology skills.

1.4 Research Objectives

Objectives of the study are as following:

1. To design and develop two modes of e-learning:
    a. E-learning Traditional Training (ETT)
    b. Simulation-based E-learning Interactive Training (SBEIT)
2. To evaluate the effect of the e-learning modules (SBEIT and ETT) on Technology course students' technological skills test scores (TST) and technological skills perception (TSP).
3. To evaluate the effect of the e-learning modules (SBEIT and ETT) on male and female Technology course students' technological skills test scores (TST) and technological skills perception (TSP).
4. To identify the interaction effects between the e-learning modes and gender on students' technological skills test scores (TST) and technological skills perception (TSP).

1.5 Research Questions

The questions of the study are as following:

1- Is there effect of e-learning modules (SBEIT and ETT) on technological skills test scores (TST) regardless of gender?
2- Is there effect of gender (Male & Female) on Technology course students' technological skills test scores (TST) regardless of the e-learning mode?
3- Is there interaction effect between the e-learning modes (SBEIT & ETT) and gender (M & F) on Technology course students' technological skills test scores (TST)?

4- Is there effect of e-learning modules (SBEIT and ETT) on students' technological skills perception (TSP) regardless of gender?
5- Is there effect of gender (Male & Female) on students' technological skills perception (TSP) regardless of the e-learning mode?
6- Is there interaction effect between the e-learning modes (SBEIT and ETT) and gender (M & F) on students' technological skills perception (TSP)?

1.6 Hypotheses

Null hypotheses are used in this study; the probability level of 0.05 was used to test statistical significance:

$H_0$1: There is no significant difference between students using SBEIT and students using ETT on Technology course technological skills test scores (TST).

$H_0$2: There is no significant difference between male and female students on Technology course technological skills test scores (TST) regardless of e-learning modes.

$H_0$3: There is no significant interaction effect between the e-learning modes (SBEIT and ETT) and gender on Technology technological skills test scores (TST).

$H_0$4: There is no significant difference among students using SBEIT and students using ETT on technological skills perception (TSP).

$H_0$5: There is no significant difference between male and female students on the technological skills perception (TSP) regardless of e-learning modes.

$H_0$6: There is no significant interaction effect between the e-learning modes (SBEIT and ETT) and gender on technological skills perception (TSP).

1.7 Significance of The Study

As mentioned earlier, there was a significant increase in the students' registration in QU courses especially after closing the foundation computer department and changing the language of instruction from English into Arabic. This significant increase in newly admitted students with no background of QU educational technology systems and tools and no standardization of computer literacy. In addition, specialized students, each according to their specialization have to be trained to the use of different educational technology and web authorizing tools according to their specialization to be used in their field micro-teaching.

Using the simulation-based e-learning is useful when the cost of failure is high. Simulations are good for situations where it is important to give people practice before they face a risky or critical real-life situation such as using the banner system. The Banner system is used by the students to register for their courses online. If any mistake done during registration online, may cause that the student spends a whole semester studying wrong course. Using simulation-based e-learning training will help the faculty members to train students through educational technology tools and systems using simulated environment before dealing directly with risky systems.

Moreover, using simulation-based e-learning has advantageous when dealing with individual customized training (Bosman, 2002). Each participant experiences a unique series of events in response to his or her own knowledge, skills and instincts. That is mean that simulation-based e-learning training is dealing more with individual differences. If the student is beginner, he/she can take the whole simulation sessions

to master the training topic. But if the student has prior knowledge of this topic, he/she can customize the training by skipping the beginner part and jumping directly to the advanced part. This helps all the students' levels and at the same time save time and effort especially when many people should be trained to master complex technology topic in short time.

Using the simulation-based e-learning in the Technology course is leaning by example simulation which intervene students in incidents to determine the course of events (Kaye & Castillo, 2003). This may help the students to learn educational technology skills especially when hearing Arabic explanation to minimize the problem of having language barrier. Therefore, it may lead the students to get better scores in technology skills test. The CED may decrease their retention rate by spreading these simulation-based e-learning approaches before and during studying education courses. Faculty members can use the simulation-based e-learning approach to easily incorporate QU educational technology tools in teaching without facing difficulties with newly students and later on, the specialized students (pre-service teachers) can use the same approach with their students in schools.

This will be reflected also as a great benefit for Qatar and other countries as a large and growing body of research shows that such a high technology (high tech) workforce will create substantial economic benefits. In general, technology has been found to contribute to economic growth (Oyelaran-Oyeyinka and Lal 2005). Technology in education can reduce the costs of education per student by increasing the relative economic benefit of investment in education. By learning technological skills, students become better prepared for work that increasingly involves the use of

ICT (Kozma, 2005, p.142). In both developed and developing countries, ICTs affect employment and wages for the evolution of the composition of the labor force: the unskilled workers are the main losers in sectors where investment in technology and greater productivity are high (UNCTAD, 2007).

1.8 Theoretical Framework

The theories underlying this research are as follows:

1. Cognitive Theory of Multimedia Learning (Mayer, 2009)
2. Experiential Learning Theory (Kolb, 1984)

There is ongoing debate about whether the use of a particular technology for delivering learning solutions or the instruction design that improves learning (Clark, 2001; Kozma, 2001). The delivery medium is not the determining factor in the quality of learning; rather, the course design determines the effectiveness of the learning (Rovai, 2002). The goal of any instructional design is to promote learning. Therefore, before designing any learning material, educators must know the principles of learning and how students learn.

1.8.1 Cognitive Theory of Multimedia Learning

This study relies first on the cognitive school of learning upon which quality multimedia learning can be developed effectively. Then cognitivist strategies can be used to teach the “How” (processes & principles).

Cognitivists see learning as an internal process that involves memory, thinking, reflection, abstraction, motivation, and metacognition. Cognitivist psychology looks at learning from an information-processing perspective, where the student uses different types of memory to learn.

One of the main theories in this school is the Cognitive Theory of Multimedia Learning (CTML), which has been popularized by the work of Richard E. Mayer (2009) and others. Central to CTML is the idea that students attempt to build meaningful connections between words and pictures and that they learn more deeply than they could have with words or pictures alone (Mayer, 2009). According to CTML, one of the principal aims of multimedia instruction is to encourage the student to build a coherent mental representation from the presented material. The student's job is to make sense of the presented material as an active participant and ultimately construct new knowledge.

CTML uses a model including three memory stores: sensory, working, and long-term memories. Sweller (2005) defines sensory memory as a cognitive structure that permits us to perceive new information, working memory as a cognitive structure in which we consciously process information, and long-term memory as a cognitive structure that stores our knowledge base. We are only conscious of information in long-term memory when it has been transferred to working memory (Figure 1.5).

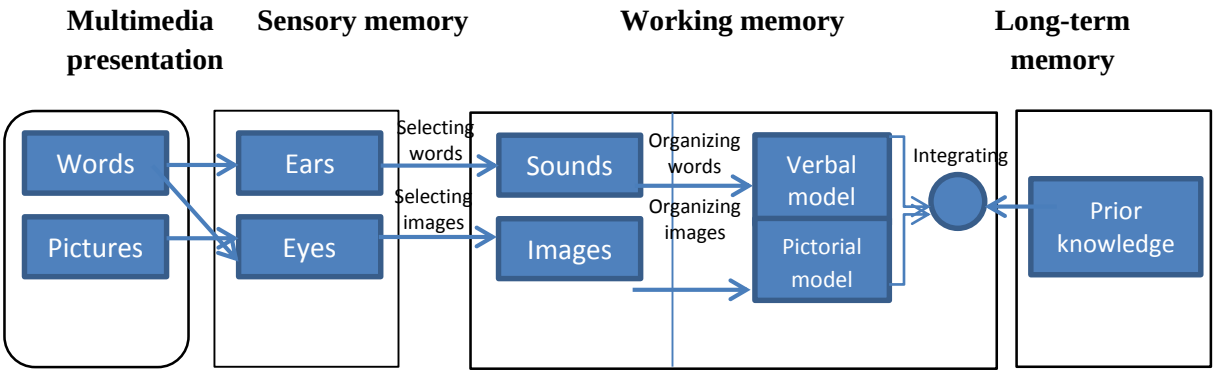

Figure 1.3 CTML Model

According to Mayer and Moreno (1998), CTML is based on three assumptions: the dual-channel, limited capacity, and active-processing assumptions. The dual-channel assumption is that working memory has auditory and visual channels based on Baddeley's (1986) theory of working memory and Paivio and colleague's (Paivio, 1986; Clark and Paivio, 1991) dual-coding theory. Mayer (2005) states that sensory memory has a visual (eye) sensory memory that briefly holds pictures and printed text as visual images; and auditory (ear) memory that briefly holds spoken words and sounds as auditory images. Working memory attends to or selects information from sensory memory for processing and integration.

The limited capacity assumption is based on cognitive load theory (Sweller, 1988, 1994) and states that each subsystem of working memory has a limited capacity. Working memory holds a processed version of what was presented for generally less than 30 seconds and can process only a few pieces of material at any one time (Mayer, 2010). Long-term memory holds the entire store of a person's knowledge for an indefinite amount of time.

The active-processing assumption suggests that people construct knowledge in meaningful ways when they pay attention to the relevant input. Mayer (2010) argues that meaningful learning from words and pictures happens when the student engages in five cognitive processes: selecting relevant words for processing in verbal working memory; selecting relevant images for processing in visual working memory; organizing selected words into a verbal model; organizing selected images into a pictorial model; and integrating the verbal and pictorial representations with each other and with prior knowledge.

A critical perspective to maintain while designing multimedia lessons based on CTML is that the multimedia instructional methods are student-centered approaches and are not technology-centered approaches (student-centered focus).

CTML can be implemented in online learning through 12 multimedia instructional principles that were identified by Mayer (2009) from those developed by nearly 100 studies over the past two decades. The 12 principles are:

1- **Coherence principle:** People learn better when extraneous material is excluded rather than included;
2- **Signaling principle:** People learn better when cues that highlight the organization of the essential material are added;
3- **Redundancy principle:** People learn better from graphics and narration than from graphics, narration and printed text (Animation and narration should be presented alone instead of presenting visual text information simultaneously to the verbal information because people cannot focus

when they hear and see the same message simultaneously during a presentation);

4- **Spatial contiguity principle:** People learn better when corresponding words and pictures are placed near each other rather than far from each other on the page or screen;

5- **Temporal contiguity principle:** People learn better when corresponding words and pictures are presented at the same time rather than in succession (aligning words to corresponding graphics);

6- **Segmenting principle:** People learn better, when a multimedia lesson is presented in user-paced segments rather than as a continuous unit (The large segments are broken down into smaller segments);

7- **Pre-training principle:** People learn more deeply from a multimedia message when they are trained in the names and characteristics of key components prior to the multimedia exercise;

8- **Modality principle:** People learn better from graphics and narration than from graphics and printed text (Present words as speech rather than as on-screen text);

9- **Multimedia principle:** People learn better from words and pictures than from words alone;

10- **Personalization principle:** People learn better from a multimedia presentation when the words are in conversational style rather than in formal style (Use conversational style rather than virtual coaches);

11- **Voice principle:** People learn better, when the words in a multimedia message are spoken by a friendly human voice rather than a machine voice;

12- **Image principal:** People do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen.

The researcher will choose only four principles, which are more related to the simulation based e-learning. First principal is Pre-training. Pre-training is chosen to ensure that the students know the names and characteristics of key concepts before the training. This is important in simulation sessions, as before starting the training, the students need to have background of the key concepts that will be used during the simulation. This will help the students to focus on these key concepts during the simulation sessions.

Second principal is Signaling. Signaling is selected to let students learn better by highlighting the essential parts in the simulated session. This principle is essential in the simulation of educational technology tools as the student need to concentrate on specific part (e.g. menu item) of the working environment where specific task need to be done. This could be achieved easily if this part is highlighted.

Third principal is Modality. Modality means people learn better from graphics and narration than from graphics and printed text (present words as speech rather than as on-screen text). This principle is chosen as it is very important during the training to explain the steps done to do specific task. According to Mayer's modality principal, this explanation is better to be provided in the form of narration than printed text.

Last principle chosen is Segmenting. Segmenting principle means people learn better, when a multimedia lesson is presented in user-paced segments rather than as a

continuous unit, (the large segments are broken down into smaller segments). According to the limited capacity assumption that states that the working memory holds a processed version of what was presented for generally less than 30 seconds and can process only a few pieces of material at any one time (Mayer, 2010). Therefore, it is important in the simulation sessions to consider the segmenting principle to present the lesson in segments of simulations rather than one long segment in order to be easier for students to grasp the segmented information more easily.

1.8.2 Experimental Learning Theory

This study relies on simulation-based learning. Simulation is grounded on action learning. Its underlying discipline is arguably the foundation of most everything we learn: experiential learning. While individuals may each perceive information through their senses, people ultimately learn by doing (Kolb, 1984).

David Kolb, learning theorist and author of *Experiential Learning Theory* (1984), describes learning as a four-step process: (1) watching, (2) thinking, (3) feeling, and (4) doing (Figure 1.7).

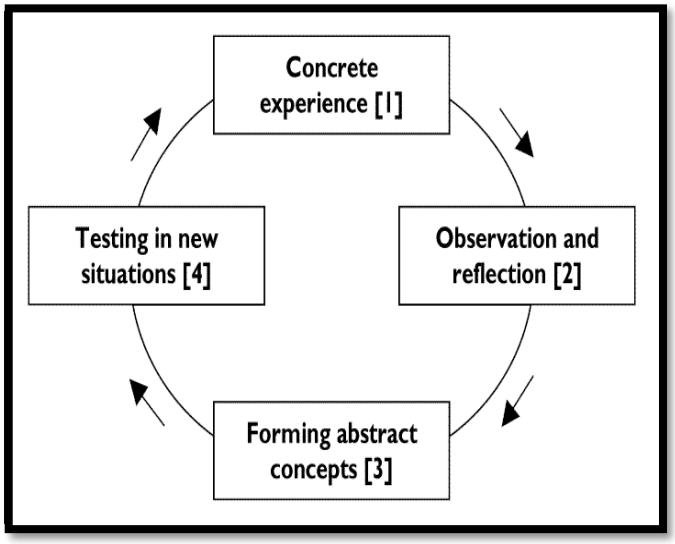

Figure 1.4 Experiential Learning Theory (Kolb, 1984)

Learners have concrete experiences that allow them to reflect on new experiences from different perspectives. From these reflective observations, learners engage in abstract conceptualization, creating generalizations or principles that integrate observations into sound theories. Finally, learners use these generalizations or theories as guides to further action. Active experimentation allows learners to test what they have learned in new, more complex situations. The result is another concrete experience, but this time at a more complex level (Bosman, 2002).

Therefore, experiential learning can be defined in terms of a learning model, which begins with the learning experience followed, by the reflection, discussion, analysis and evaluation of the experience. The assumption is that individuals seldom learn from experience unless they assess the experience, assigning their own meaning in terms of their own goals, aims, ambitions and expectations. These processes result in insights, discoveries, and understanding.

On the digital side, the computer-based simulations market emerged in the 1980's and has enabled learners to practice dangerous procedures -- such as flying an airplane or shutting down a nuclear reactor -- in a safe, computer-based environment. As technology has advanced, so too has computer-based simulations. Because of todays' faster, more efficient, less expensive computer technologies, simulations can deal with environments that are more complex. Computer-based simulations enable organizations to improve business processes; manufacturing plant, shop, hospitals and banking operations use simulations to learn where bottlenecks are located, how to decrease service and cycle times, and how to improve workflow (Horton, 2000).

1.9 Conceptual Framework

Figure 1.7 shows the relationship between the different variables under investigation.

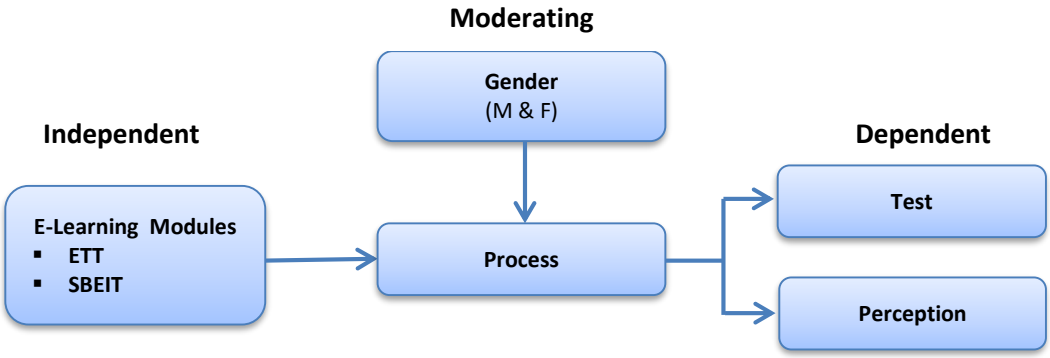

Figure 1.5 Relationship between variables

The research conceptual framework represents three main variables: Independent variable: which is e-learning modes (SBEIT and ETT); Moderating variable: which is gender (Male and Female); and Dependent Variables: which are technological skills test (TST) and technological skills perception (TSP). The effect of